LBS INSTITUTE OF TECHNOLOGY FOR WOMEN, POOJAPPURA, THIRUVANANTHAPURAM



B TECH-CURRICULUM & SYLLABUS (2019 SCHEME)
ELECTRONICS AND COMPUTER ENGINEERING

B.TECH IN ELECTRONICS AND COMPUTER ENGINEERING

Preamble: The advancement of Smart electronic devices into all areas of human life has resulted in the need for electronics engineers with the right blend of Hardware and System Software knowledge, especially embedded systems. In the current scenario ECE Graduates get a good base of Electronics Hardware system, but lack knowledge in (embedded) system software concepts as well as state of the art processor architecture. CSE Graduates gain good knowledge in software associated domains. Since all electronic products today have processors with embedded software (which include Platform management software, Communication software and embedded application software, a right combination of Electronics Engineering and Computer software Engineering is an apt blend for engineers to build a career in the electronics product industry.

Electronics and Computer engineering aims to integrate two separate engineering fields to meet the joint demands of electronics and computer industries in today's world. The job of an electronics and computer engineer is to identify and recommend system improvements to advance technical performance, conduct system evaluations and make appropriate recommendations to modify designs or repair equipment, define and execute testing and maintenance procedures for electronic software and components, design electronic software and components for commercial applications and inspect electronics to ensure compliance with all applicable regulations and safety standard.

Objectives of Electronics and Computer Engineering

The objective of the Electronics and Computer Engineering program is to create engineers capable of solving real-world problems which require computation, communication or control by utilizing the most efficient combination of hardware and software. Students will learn how to build optimal machines using knowledge gained in both computing and electronics domains.

The highlights of the program are as follows:

Intensive courses on Programming and Algorithms:

Problem Solving methods, Data Structures, OOPs, Software Application Design etc.

Fundamental courses to establish electronics fundamentals:

Electronic Circuits, Digital Electronics, Embedded Systems, Signal Processing etc.

Crossover courses covering both software and hardware aspects:

Computing Infrastructure, Programmable Devices, Computing Systems Architecture, Machine Learning, Computer and Communication Networks.

An intensive humanities track along with electives, and design thinking are also included in the curriculum.

CURRICULUM I TO VIII: B. TECH ELECTRONICS AND COMPUTER ENGINEERING

Every course of B. Tech. Programs shall be placed in one of the nine categories as listed in the table below.

Sl. No	Category	Code	Credits
1	Humanities and Social Sciences including Management courses	HMC	8
2	Basic Science courses	BSC	26
3	Engineering Science Courses	ESC	22
4	Program Core Courses	PCC	76
5	Program Elective Courses	PEC	15
6	Open Elective Courses	OEC	3
7	Project work and Seminar	PWS	10
8	Mandatory Non-credit Courses (P/F) with grade	MNC	-----
9	Mandatory Student Activities (P/F)	MSA	2
	Total Mandatory Credits	**162**	
10	Value Added Course (Optional)	VAC	20

No semester shall have more than six lecture-based courses and two laboratory and/or drawing/seminar/project courses in the curriculum. Semester-wise credit distribution shall be as below:

Sem	1	2	3	4	5	6	7	8	Total
Credits	17	21	22	22	23	23	15	17	160
Activity Points	50				50				---
Credits for Activity	2								2
G.Total									**162**

Basic Science Courses: Maths, Physics, Chemistry, Biology for Engineers, Life Science etc

Engineering science courses: Basic Electrical, Engineering Graphics, Programming, Workshop, Basic Electronics, Basic Civil, Engineering Mechanics, Mechanical Engineering, Thermodynamics, Design Engineering, Materials Engineering etc.

Humanities and Social Sciences including Management courses: English, Humanities, Professional Ethics, Management, Finance & Accounting, Life Skills, Professional Communication, Economics etc

Mandatory non-credit courses: Sustainable Engineering, Constitution of India/Essence of Indian Knowledge Tradition, Industrial Safety Engineering, disaster management etc.

Course Code and Course Number

Each course is denoted by a unique code consisting of three alphabets followed by three numerals like **E C L 2 0 1.** The first two letter code refers to the department offering the course. EC stands for course in Electronics & Communication, course code MA refers to a course in Mathematics, course code ES refers to a course in Engineering Science etc. Third letter stands for the nature of the course as indicated in Table 1.

Table 1: Code for the courses

Code	Description
T	Theory based courses (other than the lecture hours, these courses can have tutorial and practical hours, e.g., L-T-P structures 3-0-0, 3-1-2, 3-0-2 etc.)
L	Laboratory based courses (where performance is evaluated primarily on the basis of practical or laboratory work with LTP structures like 0-0-3, 1-0-3, 0-1-3 etc.)
N	Non-credit courses
D	Project based courses (Major, Mini Projects)
Q	Seminar Courses

Course Number is a three digit number and the first digit refers to the Academic year in which the course is normally offered, i.e. 1, 2, 3, or 4 for the B. Tech. Programme of four year duration. Of the other two digits, the last digit identifies whether the course is offered normally in the odd (odd number), even (even number) or in both the semesters (zero). The middle number could be any digit. ECL 201 is a laboratory course offered in EC department for third semester, MAT 101 is a course in Mathematics offered in the first semester, EET 344 is a course in Electrical Engineering offered in the sixth semester, PHT 110 is a course in Physics offered both the first and second semesters, EST 102 is a course in Basic Engineering offered by one or many departments. These course numbers are to be given in the curriculum and syllabi.

Departments

Each course is offered by a Department and their two-letter course prefix is given in Table 2.

Table 2: Departments and their codes

SL No	Department	Course Prefix	SL No	Department	Course Prefix
1	Aeronautical Engineering	AO	23	Electronics and Communication Engineering	EC
2	Agriculture Engineering	AG	24	Electronics and Computer Engineering	ER
3	Applied Electronics and Instrumentation	AE	25	Electrical and Computer Engineering	EO
4	Artificial Intelligence	AI	26	Electrical and Electronics Engineering	EE
5	Artificial Intelligence and Data Science	AD	27	Food Technology	FT
6	Artificial Engineering and Machine Learning	AM	28	Humanities	HU
7	Automobile Engineering	AU	29	Industrial Engineering	IE
8	Biomedical Engineering	BM	30	Information Technology	IT
9	Biotechnology	BT	31	Instrumentation & Control	IC
10	Chemical Engineering	CH	32	Mandatory Courses	MC
11	Chemistry	CY	33	Mathematics	MA
12	Civil Engineering	CE	34	Mechanical Engineering	ME
13	Civil and Environmental Engineering	CN	35	Mechatronics	MR
14	Computer Science and Business Systems	CB	36	Metallurgy	MT
15	Computer Science and Design	CX	37	Mechanical (Auto)	MU
16	Computer Science and Engineering	CS	38	Mechanical (Prod)	MP
17	Computer Science and Engineering (Artificial Intelligence)	CA	39	Naval & Ship Building	SB
18	Computer Science and Engineering (Artificial Intelligence and Machine Learning)	CM	40	Physics	PH
19	Computer Science and Engineering (Data Science)	CD	41	Polymer Engineering	PO
20	Computer Science and Engineering (Cyber Security)	CC	42	Production Engineering	PE
21	Cyber Physical Systems	CP	43	Robotics and Automation	RA
22	Electronics & Biomedical	EB	44	Safety & Fire Engineering	FS

SEMESTER I

SLOT	COURSE NO.	COURSES	L-T-P	HOURS	CREDIT
A	MAT 101	LINEAR ALGEBRA AND CALCULUS	3-1-0	4	4
B 1/2	PHT 100	ENGINEERING PHYSICS	3-1-0	4	4
	CYT 100	ENGINEERING CHEMISTRY	3-1-0	4	4
C 1/2	EST 100	ENGINEERING MECHANICS	2-1-0	3	3
	EST 110	ENGINEERING GRAPHICS	2-0-2	4	3
D 1/2	EST 120	BASICS OF CIVIL & MECHANICAL ENGINEERING	4-0-0	4	4
	EST 130	BASICS OF ELECTRICAL & ELECTRONICS ENGINEERING	4-0-0	4	4
E	HUN 101	LIFE SKILLS	2-0-2	4	--
S 1/2	PHL 120	ENGINEERING PHYSICS LAB	0-0-2	2	1
	CYL 120	ENGINEERING CHEMISTRY LAB	0-0-2	2	1
T 1/2	ESL 120	CIVIL & MECHANICAL WORKSHOP	0-0-2	2	1
	ESL 130	ELECTRICAL & ELECTRONICS WORKSHOP	0-0-2	2	1
TOTAL				**23/24 ***	**17**

*Minimum hours per week

NOTE: To make up for the hours lost due to the induction program, one extra hour may be allotted to each course

SEMESTER II

SLOT	COURSE NO.	COURSES	L-T-P	HOURS	CREDIT
A	MAT 102	VECTOR CALCULUS, DIFFERENTIAL EQUATIONS AND TRANSFORMS	3-1-0	4	4
B 1/2	PHT 100	ENGINEERING PHYSICS A	3-1-0	4	4
	CYT 100	ENGINEERING CHEMISTRY	3-1-0	4	4
C 1/2	EST 100	ENGINEERING MECHANICS	2-1-0	3	3
	EST 110	ENGINEERING GRAPHICS	2-0-2	4	3
D 1/2	EST 120	BASICS OF CIVIL & MECHANICAL ENGINEERING	4-0-0	4	4
	EST 130	BASICS OF ELECTRICAL & ELECTRONICS ENGINEERING	4-0-0	4	4
E	HUN 102	PROFESSIONAL COMMUNICATION	2-0-2	4	--
F	EST 102	PROGRAMMING IN C	2-1-2	5	4
S 1/2	PHL 120	ENGINEERING PHYSICS LAB	0-0-2	2	1
	CYL 120	ENGINEERING CHEMISTRY LAB	0-0-2	2	1
T 1/2	ESL 120	CIVIL & MECHANICAL WORKSHOP	0-0-2	2	1
	ESL 130	ELECTRICAL & ELECTRONICS WORKSHOP	0-0-2	2	1
TOTAL				**28/29**	**21**

NOTE:

1. Engineering Physics A and Engineering Chemistry shall be offered in both semesters. Institutions can advise students belonging to about 50% of the number of branches in the Institution to opt for Engineering Physics A in SI and Engineering Chemistry in S2 & vice versa. Students opting for Engineering Physics A in a semester should attend Physics Lab in the same semester and students opting for Engineering Chemistry in one semester should attend Engineering Chemistry Lab in the same semester.

2. Engineering Mechanics and Engineering Graphics shall be offered in both semesters. Institutions can advise students belonging to about 50% of the number of branches in the Institution to opt for Engineering Mechanics in SI and Engineering Graphics in S2 & vice versa.
3. Basics of Civil & Mechanical Engineering and Basics of Electrical & Electronics Engineering shall be offered in both semesters. Basics of Civil & Mechanical Engineering contain equal weightage for Civil Engineering and Mechanical Engineering. Slot for the course is D with CIE marks of 25 each and ESE marks of 50 each. Students belonging to branches of AEI, EI, BME, ECE, EEE, ICE, CSE, IT, RA can choose this course in S1.

   Basics of Electrical & Electronics Engineering contain equal weightage for Electrical Engineering and Electronics Engineering. Slot for the course is D with CIE marks of 25 each and ESE marks of 50 each. Students belonging to AERO, AUTO, CE, FSE, IE, ME, MECHATRONICS, PE, METALLURGY, BT, BCE, CHEM, FT, POLY can choose this course in S1. Students having Basics of Civil & Mechanical Engineering in one semester should attend Civil & Mechanical Workshop in the same semester and students having Basics of Electrical & Electronics Engineering in a semester should attend Electrical & Electronics Workshop in the same semester.

4. LIFE SKILLS

   Life skills are those competencies that provide the means for an individual to be resourceful and positive while taking on life's vicissitudes. Development of one's personality by being aware of the self, connecting with others, reflecting on the abstract and the concrete, leading and generating change, and staying rooted in time-tested values and principles is being aimed at. This course is designed to enhance the employability and maximize the potential of the students by introducing them to the principles that underlie personal and professional success, and help them acquire the skills needed to apply these principles in their lives and careers.

5. PROFESSIONAL COMMUNICATION

   Objective is to develop in the under-graduate students of engineering a level of competence in English required for independent and effective communication for their professional needs. Coverage: Listening, Barriers to listening, steps to overcome them, Purposive listening practice, Use of technology in the professional world. Speaking, Fluency & accuracy in speech, Positive thinking, improving self-expression, Tonal variations, Group discussion practice, Reading, Speed reading practice, Use of extensive readers, Analytical and critical reading practice, Writing Professional Correspondence, Formal and informal letters, Tone in formal writing, Introduction to reports. Study Skills, Use of dictionary, thesaurus etc., Importance of contents page, cover & back pages, Bibliography, Language Lab.

SEMESTER III

SLOT	COURSE NO.	COURSES	L-T-P	HOURS	CREDIT
A	MAT 203	DISCRETE MATHEMATICAL STRUCTURES	3-1-0	4	4
B	CST 201	DATA STRUCTURES	3-1-0	4	4
C	ERT 203	DIGITAL SYSTEMS AND VLSI DESIGN	3-1-0	4	4
D	ERT 205	ELECTRONIC DEVICES AND CIRCUITS	3-1-0	4	4
E 1/2	EST 200	DESIGN AND ENGINEERING	2-0-0	2	2
	HUT 200	PROFESSIONAL ETHICS	2-0-0	2	2
F	MCN 201	SUSTAINABLE ENGINEERING	2-0-0	2	--
S	CSL 201	DATA STRUCTURES LAB	0-0-3	3	2
T	ERL 201	DIGITAL SYSTEMS AND VLSI DESIGN LAB	0-0-3	3	2
R/M	VAC	REMEDIAL/MINOR COURSE	3-1-0	4**	4
TOTAL				**26/30**	**22/26**

NOTE:

1. Design & Engineering and Professional Ethics shall be offered in both S3 and S4. Institutions can advise students belonging to about 50% of the number of branches in the Institution to opt for Design & Engineering in S3 and Professional Ethics in S4 & vice versa.

2. **All Institutions shall keep 4 hours exclusively for the Remedial class/Minor course (Thursdays from 3 to 5 PM and Fridays from 2 to 4 PM). If a student does not opt for a minor programme, he/she can be given remedial classes.

SEMESTER IV

SLOT	COURSE NO.	COURSES	L-T-P	HOURS	CREDIT
A	MAT 204	PROBABILITY, RANDOM PROCESS AND NUMERICAL METHODS	3-1-0	4	4
B	CST202	COMPUTER ORGANIZATION AND ARCHITECTURE	3-1-0	4	4
C	ERT204	OBJECT ORIENTED PROGRAMMING USING JAVA	3-1-0	4	4
D	ERT206	INTEGRATED CIRCUITS	3-1-0	4	4
E 1/2	EST200	DESIGN AND ENGINEERING	2-0-0	2	2
	HUT200	PROFESSIONAL ETHICS	2-0-0	2	2
F	MCN202	CONSTITUTION OF INDIA	2-0-0	2	--
S	ERL202	INTEGRATED CIRCUITS LAB	0-0-3	3	2
T	ERL204	OBJECT ORIENTED PROGRAMMING LAB	0-0-3	3	2
R/M/H	VAC	REMEDIAL/MINOR/HONOURS COURSE	3-1-0	4**	4
TOTAL				**26/30**	**22/26**

NOTE:

1. Design & Engineering and Professional Ethics shall be offered in both S3 and S4. Institutions can advise students belonging to about 50% of the number of branches in the Institution to opt for Design & Engineering in S3 and Professional Ethics in S4 & vice versa.

2. **All Institutions should keep 4 hours exclusively for the Remedial class/Minor course (Thursdays from 3 to 5 PM and Fridays from 2 to 4 PM). If a student does not opt for minor programme, he/she can be given remedial class.

SEMESTER V

SLOT	COURSE NO.	COURSES	L-T-P	HOURS	CREDIT
A	ERT301	DIGITAL SIGNAL PROCESSING	3-1-0	4	4
B	CST303	COMPUTER NETWORKS	3-1-0	4	4
C	ERT305	DATABASE MANAGEMENT SYSTEMS	3-1-0	4	4
D	ERT307	MICROPROCESSORS AND ADVANCED MICROCONTROLLERS	3-1-0	4	4
E	CST 309	MANAGEMENT OF SOFTWARE SYSTEMS	3-0-0	3	3
F	MCN301	DISASTER MANAGEMENT	2-0-0	2	--
S	ERL331	COMPUTER NETWORKING LAB	0-0-3	3	2
T	CSL333	DATABASE MANAGEMENT SYSTEMS LAB	0-0-3	3	2
R/M/H	VAC	REMEDIAL/MINOR/HONOURS COURSE	3-1-0	4**	4
TOTAL				**27/31**	**23/27**

NOTE:

1. Industrial Economics & Foreign Trade and Management for Engineers shall be offered in both S5 and S6. Institutions can advise students belonging to about 50% of the number of branches in the Institution to opt for Industrial Economics & Foreign Trade in S5 and Management for Engineers in S6 and vice versa.

2. *All Institutions should keep 4 hours exclusively for the Remedial class/Minor/Honours course (Tuesdays from 3 to 5 PM and Wednesdays from 3 to 5 PM). If a student does not opt for a minor/honours programme, he/she can be given remedial classes.

SEMESTER VI

SLOT	COURSE NO.	COURSES	L-T-P	HOURS	CREDIT
A	ERT302	OPERATING SYSTEMS	3-1-0	4	4
B	ERT304	EMBEDDED SYSTEMS & IoT	3-1-0	4	4
C	ERT306	DATA COMMUNICATION AND NETWORKING	3-1-0	4	4
D	ERT–	PROGRAM ELECTIVE I	2-1-0	3	3
E	HUT300	INDUSTRIAL ECONOMICS AND FOREIGN TRADE	3-0-0	3	3
F	ERT308	COMPREHENSIVE COURSE WORK	1-0-0	1	1
S	ERL332	SIGNAL PROCESSING LAB	0-0-3	3	2
T	ERD334	MINI PROJECT	0-0-3	3	2
R/M/H	VAC	REMEDIAL/MINOR/HONOURS COURSE	3-1-0	4**	4
TOTAL				**25/29**	**23/27**

Different Specializations Introduced Through Various Elective Buckets

Bucket	Specialization	Semester			
		S6	S7	S8	
		PE I	PE II	PE III	PE IV
1	COMPUTER SCIENCE SPECIALIZATION	GRAPH THEORY	FORMAL LANGUAGES & AUTOMATA THEORY	COMPILER DESIGN	SYSTEM SOFTWARE
2	MACHINE LEARNING	FOUNDATIONS OF MACHINE LEARNING	MACHINE LEARNING	DEEP LEARNING	PYTHON BASICS FOR MACHINE LEARNING
3	ROBOTICS AND AUTOMATION	SENSORS AND ACTUATORS	NETWORK & LINEAR CONTROL	ROBOTICS & AUTOMATION	MICRO-ELECTRO-MECHANICAL

			SYSTEMS		SYSTEMS
4	SIGNAL PROCESSING & APPLICATIONS	BIOMEDICAL SIGNALS & TRANSDUCERS	INTRODUCTION TO BIOMEDICAL SIGNAL PROCESSING	MEDICAL IMAGE PROCESSING	SPEECH AND AUDIO PROCESSING

PROGRAM ELECTIVE I

SLOT	COURSE NO.	COURSES	L-T-P	HOURS	CREDIT
D	ERT312	SENSORS & ACTUATORS	2-1-0	3	3
	ERT 322	BIOMEDICAL SIGNAL & TRANSDUCERS	2-1-0		
	ERT332	ELECTRONIC PRODUCT DESIGN	2-1-0		
	ERT342	GRAPH THEORY	2-1-0		
	ERT352	CLOUD COMPUTING	2-1-0		
	CST312	FOUNDATIONS OF MACHINE LEARNING	2-1-0		

NOTE:

1. Industrial Economics & Foreign Trade and Management for Engineers shall be offered in both S5 and S6. Institutions can advise students belonging to about 50% of the number of branches in the Institution to opt for Industrial Economics & Foreign Trade in S5 and Management for Engineers in S6 and vice versa.
2. *All Institutions should keep 4 hours exclusively for the Remedial class/Minor/Honours course (Tuesdays from 2 to 4 PM and Wednesdays from 2 to 4 PM). If a student does not opt for a minor/honours programme, he/she can be given remedial classes.
3. Comprehensive Course Work: The comprehensive course work in the sixth semester of study shall have a written test of 50 marks. The written examination will be of objective type similar to the GATE examination and will be conducted online by the University. **Syllabus for the comprehensive examination shall be prepared by the respective BoS choosing any 5 core courses studied from semester 3 to 5**. The pass minimum for this course is 25. The course should be mapped with a faculty and classes shall be arranged for practicing questions based on the core courses listed in the curriculum.

COURSES TO BE CONSIDERED FOR COMPREHENSIVE COURSE WORK

1.DATA STRUCTURES.
2. OBJECT ORIENTED PROGRAMMING USING JAVA.
3. DATABASE MANAGEMENT SYSTEMS.
4. DIGITAL SYSTEMS AND VLSI DESIGN.
5. INTEGRATED CIRCUITS.

4. Mini project: It is introduced in sixth semester with a specific objective to strengthen the understanding of student's fundamentals through application of theoretical concepts. Mini project can help to boost their skills and widen the horizon of their thinking. The ultimate aim of an engineering student is to resolve a problem by applying theoretical knowledge. Doing more projects increases problem-solving skills. Students should identify a topic of interest in consultation with Faculty/Advisor. Review the literature and gather information pertaining to the chosen topic. State the objectives and develop a methodology to achieve the objectives. Carryout the design/fabrication or develop codes/programs to achieve the objectives. Demonstrate the novelty of the project through the results and outputs. The progress of the mini project is evaluated based on a minimum of two reviews. The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The product has to be demonstrated for its full design specifications. Innovative design concepts, reliability considerations, aesthetics/ergonomic aspects taken care of in the project shall be given due weight. The internal evaluation will be made based on the product, the report and a viva- voce examination, conducted by a 3 member committee appointed by Head of the Department comprising HoD or a senior faculty member, Academic coordinator for that program, project guide/coordinator.

Total marks: 150, CIE 75 marks and ESE 75 marks
Split up for CIE
Attendance : 10
Guide : 15
Project Report : 10

Evaluation by the Committee (will be evaluating the level of completion and demonstration of functionality/specifications, presentation, oral examination, work knowledge and involvement) : 40

SEMESTER VII

SLOT	COURSE NO.	COURSES	L-T-P	HOURS	CREDIT
A	ERT401	CMOS VLSI DESIGN	2-1-0	3	3
B	ERTXXX	PROGRAM ELECTIVE II	2-1-0	3	3
C	ERTXXX	OPEN ELECTIVE	2-1-0	3	3
D	MCN401	INDUSTRIAL SAFETY ENGINEERING	2-1-0	3	---
S	ERL411	EMBEDDED SYSTEMS AND IoT LAB	0-0-3	3	2
T	ERQ413	SEMINAR	0-0-3	3	2
U	ERD415	PROJECT PHASE I	0-0-6	6	2
R/M/H	VAC	REMEDIAL/MINOR/HONOURS COURSE	3-1-0	4*	4
TOTAL				**24/28**	**15/19**

PROGRAM ELECTIVE II

SLOT	COURSE NO.	COURSES	L-T-P	HOURS	CREDIT
B	ERT413	NETWORK AND LINEAR CONTROL SYSTEMS	2-1-0	3	3
	ERT423	INTRODUCTION TO BIOMEDICAL SIGNAL PROCESSING	2-1-0		
	ERT433	HYBRID AND ELECTRIC VEHICLES	2-1-0		
	ERT443	FORMAL LANGUAGES & AUTOMATA THEORY	2-1-0		
	CST413	MACHINE LEARNING	2-1-0		
	CST463	WEB PROGRAMMING	2-1-0		

OPEN ELECTIVE

The open elective is offered in semester 7. Each program should specify the courses (maximum 5) they would like to offer as electives for other programs. The courses listed below are offered by **the Department of ELECTRONICS & COMPUTER ENGINEERING for students of all undergraduate branches offered in the college under KTU**

SLOT	COURSE NO.	COURSES	L-T-P	HOURS	CREDIT
C	ERT435	COMPUTER HARDWARE ENGINEERING	2-1-0	3	3
	ERT425	COMPUTER BASED CONTROL SYSTEM	2-1-0		
	ERT427	ROBOTICS AND AUTOMATION	2-1-0		
	ERT445	OBJECT ORIENTED CONCEPTS	2-1-0		
	ERT455	CONCEPTS IN MACHINE LEARNING	2-1-0		
	ERT465	INTERNET OF THINGS	2-1-0		

NOTE :

1. *All Institutions should keep 4 hours exclusively for Remedial class/Minor/Honours course (Mondays from 10 to 12 and Wednesdays from 10 to 12 Noon). If a student does not opt for minor/honours programme, he/she can be given remedial class.
2. Seminar: To encourage and motivate the students to read and collect recent and reliable information from their area of interest confined to the relevant discipline from technical publications including peer reviewed journals, conference, books, project reports etc., prepare a report based on a central theme and present it before a peer audience. Each student shall present the seminar for about 20 minutes duration on the selected topic. The report and the presentation shall be evaluated by a team of faculty members comprising Academic coordinator for that program, seminar coordinator and seminar guide based on style of presentation, technical content, adequacy of references, depth of knowledge and overall quality of the report.

Total marks: 100, only CIE, minimum required to pass 50

Attendance	10
Seminar Diary	10
Guide	20
Report	20
Presentation	40

3. Project Phase I: The course 'Project Work' is mainly intended to evoke the innovation and invention skills in a student. The course will provide an opportunity to synthesize and apply the knowledge and analytical skills learned, to be developed as a prototype or simulation. The project extends to 2 semesters and will be evaluated in the 7th and 8th semester separately, based on the achieved objectives. One third of the project credits shall be completed in 7th semester and two third in 8th semester. It is recommended that the projects may be finalized in the thrust areas of the respective engineering stream or as interdisciplinary projects. Importance should be given to address societal problems and developing indigenous technologies. The assignment to normally include:
   - Literature study/survey of published literature on the assigned topic
   - Formulation of objectives
   - Formulation of hypothesis/ design/ methodology
   - Formulation of work plan and task allocation.
   - Block level design documentation
   - Seeking project funds from various agencies
   - Preliminary Analysis/Modeling/Simulation/Experiment/ Design/Feasibility study
   - Preparation of Phase 1 report

Total marks: 100, only CIE, minimum required to pass	50
Guide	30
Interim evaluation by the Evaluation committee	20
Final evaluation by the Evaluation committee	30
Phase – I Report (By Evaluation committee)	20

The evaluation committee comprises HoD or a senior faculty member, Project coordinator and project supervisor.

SEMESTER VIII

SLOT	COURSE NO.	COURSES	L-T-P	HOURS	CREDIT
A	ERT402	ALGORITHM ANALYSIS AND DESIGN	2-1-0	3	3
B	XXX	PROGRAM ELECTIVE III	2-1-0	3	3
C	XXX	PROGRAM ELECTIVE IV	2-1-0	3	3
D	XXX	PROGRAM ELECTIVE V	2-1-0	3	3
E	ERT404	COMPREHENSIVE VIVA VOCE	1-0-0	1	1
U	ERD416	PROJECT PHASE II	0-0-12	12	4
R/M/H	VAC	REMEDIAL/MINOR/HONOURS COURSE	3-1-0	4*	4
TOTAL				**25/28**	**17/21**

PROGRAM ELECTIVE III

SLOT	COURSE NO.	COURSES	L-T-P	HOURS	CREDIT
B	ERT414	ROBOTICS AND AUTOMATION	2-1-0	3	3
	ERT424	MEDICAL IMAGE PROCESSING	2-1-0		
	ERT434	HYBRID AND ELECTRIC VEHICLES	2-1-0		
	ERT444	COMPILER DESIGN	2-1-0		
	CST414	DEEP LEARNING	2-1-0		
	ERT454	CRYPTOGRAPHY AND NETWORK SECURITY	2-1-0		

PROGRAM ELECTIVE IV

SLOT	COURSE NO.	COURSES	L-T-P	HOURS	CREDIT
C	ERT416	MICRO-ELECTRO-MECHANICAL SYSTEMS	2-1-0	3	3
	ERT426	SPEECH AND AUDIO PROCESSING	2-1-0		
	ERT436	COMMUNICATION ENGINEERING	2-1-0		
	ERT446	PYTHON BASICS FOR MACHINE LEARNING	2-1-0		
	ERT456	SYSTEM SOFTWARE	2-1-0		
	CST426	CLIENT SERVER ARCHITECTURE	2-1-0		

PROGRAM ELECTIVE V

SLOT	COURSE NO.	COURSES	L-T-P	HOURS	CREDIT
D	ERT418	PLC AND DATA ACQUISITION SYSTEMS	2-1-0	3	3
	ERT428	POWER ELECTRONICS	2-1-0		
	ERT438	LOW POWER VLSI	2-1-0		
	CST428	BLOCK CHAINTECHNOLOGIES	2-1-0		
	ERT458	WIRELESS SENSOR NETWORKS	2-1-0		
	ERT468	REAL TIME OPERATING SYSTEMS	2-1-0		

NOTE

1. *All Institutions should keep 4 hours exclusively for the Remedial class/Minor/Honours course (Mondays from 10 to 12 and Wednesdays from 10 to 12). If a student does not opt for a minor/honours programme, he/she can be given remedial classes.
2. Comprehensive Course Viva: The comprehensive course viva in the eighth semester of study shall have a viva voce for 50 marks. The viva voce shall be conducted based on the syllabus mentioned for comprehensive course work in the sixth semester. The viva voce will be conducted by the same three member committee assigned for final project phase II evaluation towards the end of the semester. The pass minimum for this course is 25. The course should be mapped with a faculty and classes shall be arranged for practicing questions based on the core courses listed in the curriculum. The mark will be treated as internal and should be uploaded along with internal marks of other courses.
3. **Project Phase II:** The object of Project Work II & Dissertation is to enable the student to extend further the investigative study taken up in Project 1, either fully theoretical/practical or involving both theoretical and practical work, under the guidance of a Supervisor from the Department alone or jointly with a Supervisor drawn from R&D laboratory/Industry. This is expected to provide good training for the student(s) in R&D work and technical leadership. The assignment to normally include:
    - In depth study of the topic assigned in the light of the Report prepared under Phase I;
    - Review and finalization of the Approach to the Problem relating to the assigned topic;
    - Detailed Analysis/ Modeling/ Simulation/ Design/ Problem Solving/ Experiment as needed;
    - Final development of product/process, testing, results, conclusions and future directions;
    - Preparing a paper for Conference presentation/Publication in Journals, if possible;

- Preparing a Dissertation in the standard format for being evaluated by the Department;
- Final Presentation before a Committee

Total marks: 150, only CIE, minimum required to pass 75

Guide : 30

Interim evaluation, 2 times in the semester by a committee : 50

Quality of the report evaluated by the above committee : 30

(The evaluation committee comprises HoD or a senior faculty member, Project coordinator and project supervisor).

Final evaluation by the final evaluation committee : 40

(The final evaluation committee comprises Project coordinator, expert from Industry/research Institute and a senior faculty from a sister department. The same committee will conduct Comprehensive for 50 marks).

MINOR

Minor is an additional credential a student may earn if s/he does 20 credits worth of additional learning in a discipline other than her/his major discipline of B.Tech. degree. The objective is to permit a student to customize their Engineering degree to suit their specific interests. Upon completion of an Engineering Minor, a student will be better equipped to perform interdisciplinary research and will be better employable. Engineering Minors allow a student to gain interdisciplinary experience and exposure to concepts and perspectives that may not be a part of their major degree programs.

The academic units offering minors in their discipline will prescribe the set of courses and/or other activities like projects necessary for earning a minor in that discipline. A specialist basket of 3-6 courses is identified for each Minor. Each basket may rest on one or more foundation courses. A basket may have sequences within it, i.e., advanced courses may rest on basic courses in the basket. S/he accumulates credits by registering for the required courses, and if the requirements for a particular minor are met within the time limit for the course, the minor will be awarded. This will be mentioned in the Degree Certificate as “Bachelor of Technology in xxx with Minor in yyy”. The fact will also be reflected in the consolidated grade card, along with the list of courses taken. If one specified course cannot be earned during the course of the programme, that minor will not be awarded. The individual course credits earned, however, will be reflected in the consolidated grade card.
(i) The curriculum/syllabus committee/BoS shall prepare syllabus for courses to be included in the curriculum from third to eight semesters for all branches. The minor courses shall be identified by **M-slot courses.**

(ii) Registration is permitted for minors at the beginning of third semester. Total credits required is 182 (162 + 20 credits from value added courses)

(iii) Out of the 20 Credits, 12 credits shall be earned by undergoing a minimum of three courses listed in the curriculum for minor, of which one course shall be a mini project based on the chosen area. They can do mini projects either in S7 or in S8. The remaining 8 credits could be acquired by undergoing 2 MOOCs recommended by the Board of studies and approved by the Academic Council or through courses listed in the curriculum. The classes for Minor shall be conducted along with regular classes and no extra time shall be required for conducting the courses.

(iv) There won't be any supplementary examination for the courses chosen for Minor.

(v) On completion of the program, "Bachelor of Technology in xxx with Minor in yyy" will be awarded.

(vi) The registration for the minor program will commence from semester 3 and all academic units offering minors in their discipline should prescribe a set of such courses. The courses shall be grouped into a maximum of 3 baskets. The basket of courses may have sequences within it, i.e., advanced courses may rest on basic courses in the basket. Reshuffling of courses between various baskets will not be allowed. There is an option to skip any two courses listed here and to opt for equivalent MOOC courses approved by the Academic Council. In any case, they should carry out a mini project based on the chosen area in S7 or S8. Students who have registered **for B.Tech Minor in the ELECTRONICS & COMPUTER ENGINEERING Branch** can opt to study the courses listed below.

SEMESTER	GROUP I				GROUP II				GROUP III			
	Course No.	Course Name	HOURS	CREDIT	Course No.	Course Name	HOURS	CREDIT	Course No.	Course Name	Hours	Credit
S3	ERT281	LOGIC CIRCUIT DESIGN	4	4	CST285	DATA COMMUNICATION	4	4	CST283	PYTHON FOR MACHINE LEARNING	4	4
S4	ERT282	MICROPROCESSORS AND MICROCONTROLLERS	4	4	CST286	INTRODUCTION TO COMPUTER NETWORKS	4	4	CST284	MATHEMATICS FOR MACHINE LEARNING	4	4
S5	ERT381	EMBEDDED SYSTEMS	4	4	CST385	CLIENT SERVER SYSTEMS	4	4	CST383	CONCEPTS IN MACHINE LEARNING	4	4
S6	ERT382	INTERNET OF THINGS	4	4	CST386	WIRELESS NETWORKS AND IOT APPLICATIONS	4	4	CST384	CONCEPTS IN DEEP LEARNING	4	4
S7	ERD481	MINIPROJECT	4	4	ERD481	MINIPROJECT	4	4	ERD481	MINIPROJECT	4	4
S8	ERD482	MINIPROJECT	4	4	ERD482	MINIPROJECT	4	4	ERD482	MINIPROJECT	4	4

HONOURS

Honours is an additional credential a student may earn if s/he opts for the extra 20 credits needed for this in her/his own discipline. Honours is not indicative of class. KTU is providing this option for academically extra brilliant students to acquire Honours. Honours is intended for a student to gain expertise/specialize in an area inside his/her major B.Tech discipline and to enrich knowledge in emerging/advanced areas in the branch of engineering concerned. It is particularly suited for students aiming to pursue higher studies. Upon completion of Honours, a student will be better equipped to perform research in her/his branch of engineering. On successful accumulation of credits at the end of the programme, this will be mentioned in the Degree Certificate as "Bachelor of Technology in xxx, with Honours." The fact will also be reflected in the consolidated grade card, along with the list of courses taken. If one specified course cannot be earned during the course of the programme, Honours will not be awarded. The individual course credits earned, however, will be reflected in the consolidated grade card.

The courses shall be grouped into a maximum of 3 groups, each group representing a particular specialization in the branch. The students shall select only the courses from the same group in all semesters. It means that the specialization is to be fixed by the student and cannot be changed subsequently. The internal evaluation, examination and grading shall be exactly as for other mandatory courses. The Honours courses shall be identified by H slot courses.

(i) The curriculum/syllabus committee/BoS shall prepare syllabus for courses to be included in the curriculum from fourth to eight semesters for all branches. The honours courses shall be identified by H slot courses.

(ii) Registration is permitted for Honours at the beginning of fourth semester. Total credits required is 182 (162 + 20 credits from value added courses).

(iii) Out of the 20 Credits, 12 credits shall be earned by undergoing a minimum of three courses listed in the curriculum for honours, of which one course shall be a mini project based on the chosen area. The remaining 8 credits could be acquired by undergoing 2 MOOCs recommended by the Board of Studies and approved by the Academic Council or through courses listed in the curriculum. The classes for Honours shall be conducted along with regular classes and no extra time shall be required for conducting the courses. The students should earn a grade of 'C' or better for all courses under honours.

(iv) There won't be any supplementary examination for the courses chosen for honours.

(v) On successful accumulation of credits at the end of the programme, "Bachelor of Technology in xxx, with Honours" will be awarded if overall CGPA is greater than

or equal to 8.5, earned a grade of 'C' or better for all courses chosen for honours and without any history of 'F' Grade.

(vi) The registration for honours program will commence from semester 4 and all academic units offering honours in their discipline should prescribe a set of such courses. The courses shall be grouped into a maximum of 3 groups, each group representing a particular specialization in the branch. The students shall select only the courses from the same group in all semesters. It means that the specialization is to be fixed by the student and cannot be changed subsequently. There is an option to skip any two courses listed here and to opt for equivalent MOOC courses approved by the Academic Council. In any case, they should carry out a mini project based on the chosen area in S8. Students who have registered for **B.Tech HONOURS in ELECTRONICS & COMPUTER ENGINEERING** can opt to study the courses listed below.

SEMESTER	GROUP I				GROUP II				GROUP III			
	Course No.	Course Name	HOURS	CREDIT	Course No.	Course Name	HOURS	CREDIT	Course No.	Course Name	HOURS	CREDIT
S4	ERT292	DIGITAL SYSTEM DESIGN	4	4	CST 294	COMPUTATIONAL FUNDAMENTALS FOR MACHINE LEARNING	4	4	CST292	NUMBER THEORY	4	4
S5	ERT393	FPGA BASED SYSTEM DESIGN	4	4	CST 395	NEURAL NETWORKS AND DEEP LEARNING	4	4	CST393	CRYPTOGRAPHIC ALGORITHMS	4	4
S6	ERT394	ELECTRONIC DESIGN AND AUTOMATION TOOLS	4	4	CST 396	ADVANCED TOPICS IN MACHINE LEARNING	4	4	CST394	NETWORK SECURITY	4	4
S7	ERT495	MEMS DESIGN	4	4	CST 497	ADVANCED TOPICS IN ARTIFICIAL INTELLIGENCE	4	4	CST495	CYBER FORENSICS	4	4
S8	ERD496	MINIPROJECT	4	4	ERD 496	MINIPROJECT	4	4	ERD 496	MINIPROJECT	4	4

INDUCTION PROGRAM

There will be a three weeks induction program for first semester students. It is a unique three-week immersion Foundation Programme designed especially for the fresher's which includes a wide range of activities right from workshops, lectures and seminars to sports tournaments, social work and much more. The programme is designed to mold students into well-rounded individuals, aware and sensitized to local and global conditions and foster their creativity, inculcate values and ethics, and help students to discover their passion. Foundation Programme also serves as a platform for the fresher's to interact with their batch mates and seniors and start working as a team with them. The program is structured around the following five themes:

The programme is designed keeping in mind the following objectives:

- **Values and Ethics**: Focus on fostering a strong sense of ethical judgment and moral fortitude.
- **Creativity**: Provide channels to exhibit and develop individual creativity by expressing themselves through art, craft, music, singing, media, dramatics, and other creative activities.
- **Leadership, Communication and Teamwork**: Develop a culture of teamwork and group communication.
- **Social Awareness**: Nurture a deeper understanding of the local and global world and our place as concerned citizens of the world.
- **Physical Activities & Sports**: Engage students in sports and physical activity to ensure healthy physical and mental growth.

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEMESTER I

KTU
Estd.
2014

MAT 101	LINEAR ALGEBRA AND CALCULUS	CATEGORY	L	T	P	CREDIT	Year of Introduction
		BSC	3	1	0	4	2019

Preamble: This course introduces students to some basic mathematical ideas and tools which are at the core of any engineering course. A brief course in Linear Algebra familiarises students with some basic techniques in matrix theory which are essential for analysing linear systems. The calculus of functions of one or more variables taught in this course are useful in modelling and analysing physical phenomena involving continuous change of variables or parameters and have applications across all branches of engineering.

Prerequisite: A basic course in one-variable calculus and matrix theory**.**

Course Outcomes: After the completion of the course the student will be able to

CO 1	solve systems of linear equations, diagonalize matrices and characterise quadratic forms
CO 2	compute the partial and total derivatives and maxima and minima of multivariable functions
CO 3	compute multiple integrals and apply them to find areas and volumes of geometrical shapes, mass and centre of gravity of plane laminas
CO 4	perform various tests to determine whether a given series is convergent, absolutely convergent or conditionally convergent
CO 5	determine the Taylor and Fourier series expansion of functions and learn their applications.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	3	3	2	1			1	2		2
CO 2	3	3	3	3	2	1			1	2		2
CO 3	3	3	3	3	2	1			1	2		2
CO 4	3	2	3	2	1	1			1	2		2
CO 5	3	3	3	3	2	1			1	2		2

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination (Marks)
	Test 1 (Marks)	Test 2 (Marks)	
Remember	10	10	20
Understand	20	20	40
Apply	20	20	40
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE marks	ESE marks	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

Assignments: Assignment should include specific problems highlighting the applications of the methods introduced in this course in science and engineering.

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): Solve systems of linear equations, diagonalize matrices and characterise quadratic forms

1. A is a real matrix of order $3 \times 3$and $X = \begin{bmatrix} x \\ y \\ z \end{bmatrix}$. What can you say about the solution of $AX = 0$if rank of A is 1? 2 ?3?
2. Given$A = \begin{bmatrix} 3 & 0 & 2 \\ 0 & 2 & 0 \\ -2 & 0 & 0 \end{bmatrix}$, find an orthogonal matrix Pthat diagonalizes A.
3. Find out what type of conic section the following quadratic form represents

$$17x^2 - 30x_1x_2 + 17x_2^2 = 128$$

4. The matrix $A = \begin{bmatrix} -2 & 2 & -3 \\ 2 & 1 & -6 \\ -1 & -2 & 0 \end{bmatrix}$has an eigen value5 with corresponding Eigen vector$X = \begin{bmatrix} 1 \\ 2 \\ -1 \end{bmatrix}$. Find A^5X

Course Outcome 2 (CO2): compute the partial and total derivatives and maxima and minima of multivariable functions

1. Find the slope of the surface $z = x^2y + 5y^3$in the x-direction at the point (1,-2)

2. Given the function $w = xy + z$, use chain rule to find the instantaneous rate of change of $w$at each point along the curve $x = cost, y = sint, z = t$

3. Determine the dimension of rectangular box open at the top , having a volume 32 cubic ft and requiring the least amount of material for it's construction.

Course Outcome 3(CO3): compute multiple integrals and apply them to find areas and volumes of geometrical shapes, mass and centre of gravity of plane laminas.

1. Evaluate $\iint_D (x + 2y)\, DA$where D is the region bounded by the parabolas $y = 2x^2$and $y = 1 + x^2$

2. Explain how you would find the volume under the surface $z = f(x, y)$and over a specific region Din the xyplane using (i) double integral (ii) triple integral?

3. Find the mass and centre of gravity of a triangular lamina with vertices (0,0), (2,1), (0,3) if the density function is $f(x, y) = x + y$

4. Use spherical coordinates to evaluate $\iiint_B (x^2 + y^2 + z^2)^3\, dV$where B is the unit ball defined by $B = \{(x, y, z): x^2 + y^2 + z^2 \leq 1\}$

Course Outcome 4 (CO4): perform various tests to determine whether a given series is convergent, absolutely convergent or conditionally convergent.

1. What is the difference between a sequence and a series and when do you say that they are convergent? Divergent?

2. Determine whether the series $\sum_{n=1}^{n=\infty} \frac{5}{2n^2+4n+3}$converges or diverges.

3. Is the series $\sum_{n=1}^{n=\infty} \frac{(-1)^{n-1}}{n}$convergent? Absolutely convergent? Conditionally convergent?

Course Outcome 5 (CO5): determine the Taylor and Fourier series expansion of functions and learn their applications.

1. Assuming the possibility of expansion find the Maclaurin series expansion of

   $f(x) = (1 + x)^k$for$|x| < 1$where $k$is any real number. What happens if $k$is a positive integer?

2. Use Maclaurin series of $ln(1 + x), -1 < x \leq 1$to find an approximate value of$ln2$.

3. Find the Fourier series of the function$f(x) = x^2, -2 \leq x < 2, f(x + 4) = f(x)$. Hence using Parseval's identity prove that $1 + \frac{1}{2^4} + \frac{1}{3^4} + \ \ldots \ = \frac{\pi^4}{90}$

4. Expand the function $f(x) = x\ (0 < x < 1/2)$ into a (i) Fourier sine series (ii) Fourier cosine series.

Model Question paper

QP CODE: PAGES:3

Reg No:_____

Name :_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY FIRST SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: **MAT 101**

Max. Marks: 100 **Duration: 3 Hours**

LINEAR ALGEBRA AND CALCULUs

(2019-Scheme)

(Common to all branches)

PART A

(Answer **all** questions, **each** question carries 3 marks)

1. Determine the rank of the matrix $A = \begin{bmatrix} 1 & 2 & -1 \\ -2 & -4 & 2 \\ 3 & 6 & -3 \end{bmatrix}$.
2. Write down the eigen values of $= \begin{bmatrix} 2 & 0 \\ 0 & -1 \end{bmatrix}$. What are the eigen values of $P^{-1}AP$ where $P = \begin{bmatrix} -4 & 2 \\ 3 & -1 \end{bmatrix}$?
3. Find $f_x(1,3)$ and $f_y(1,3)$ for the function $f(x,y) = 2x^3y^2 + 2y + 4x$.
4. Show that the function $u(x,t) = \sin(x - ct)$ is a solution of the equation $\frac{\partial^2 u}{\partial t^2} = c^2 \frac{\partial^2 u}{\partial x^2}$.
5. Use double integral to find the area of the region enclosed between the parabolas $y = \frac{1}{2}x^2$ and the line $y = 2x$.
6. Use polar coordinates to evaluate the area of the region bounded by $x^2 + y^2 = 4$, the line $y = x$ and the y axis in the first quadrant
7. Test the convergence of the series $\sum_{k=1}^{\infty} \frac{k}{k+1}$.
8. Test the convergence of the alternating series $\sum_{k=1}^{\infty} (-1)^{k+1} \frac{1}{k}$ using Leibnitz test.
9. Find the Taylor series expansion of $sin\pi x$ about $x = \frac{1}{2}$.
10. Find the values to which the Fourier series of

$f(x) = x$ for $-\pi < x < \pi$, with $f(x + 2\pi) = f(x)$ converges (10x3=30)

PART B

(Answer **one full** question from each module, each question carries **14** marks)

Module -I

11. (a) Solve the following system of equations

$$y + z - 2w = 0$$
$$2x - 3y - 3z + 6w = 2$$
$$4x + y + z - 2w = 4$$

(b) Find the eigen values and eigen vectors of the matrix $\begin{bmatrix} -2 & 2 & -3 \\ 2 & 1 & -6 \\ -1 & -2 & 0 \end{bmatrix}$

12. (a) Diagonalize the matrix $\begin{bmatrix} -1 & 2 & -2 \\ 2 & 4 & 1 \\ 2 & 1 & 4 \end{bmatrix}$

(b) What kind of conic section the quadratic form $3x_1^2 + 22x_1x_2 + 3x_2^2 = 0$ represents? Transform it to principal axes.

Module - II

13. (a) Find the local linear approximation to $f(x, y) = \sqrt{x^2 + y^2}$ at the point $(3, 4)$.Use it to approximate $f(3.04,3.98)$

(b) Let $w = \sqrt{x^2 + y^2 + z^2}$, $x = cos\theta, y = sin\theta, z = tan\theta$. Use chain rule to find $\frac{dw}{d\theta}$when $\theta = \frac{\pi}{4}$.

14. (a) Let $z = f(x, y)$ where $x = rcos\theta, y = rsin\theta,$ prove that $\left(\frac{\partial z}{\partial x}\right)^2 + \left(\frac{\partial z}{\partial y}\right)^2 = \left(\frac{\partial z}{\partial r}\right)^2 + \frac{1}{r^2}\left(\frac{\partial z}{\partial \theta}\right)^2$.

(b) Locate all relative maxima, relative minima and saddle points $f(x, y) = xy + \frac{a^3}{x} + \frac{b^3}{y}(a \neq 0, b \neq 0)$.

Module - III

15. (a) Evaluate $\iint_D (2x^2y + 9y^3)\, dxdy$ where D is the region bounded by $y = \frac{2}{3}x$ and $y = 2\sqrt{x}$

(b) Evaluate $\int_0^4 \int_{\sqrt{y}}^2 e^{x^3}\, dxdy$ changing the order of integration.

16. (a) Find the volume of the solid bounded by the cylinder $x^2 + y^2 = 4$ and the planes $y + z = 4$ and $z = 0$..

(b) Evaluate $\iiint \sqrt{1 - x^2 - y^2 - z^2}\, dxdydz$, taken throughout the volume of the sphere $x^2 + y^2 + z^2 = 1$, by transforming to spherical polar coordinates

Module - IV

17. (a) Test the convergence of the series

(i) $\sum_{k=1}^{\infty} \frac{k^k}{k!}$ (ii) $\sum_{k=2}^{\infty} \left(\frac{4k-5}{2k+1}\right)^k$

(b) Determine the convergence or divergence of the series $\sum_{k=1}^{\infty} (-1)^k \frac{(2k-1)!}{3^k}$

18. (a) Check whether the series $\sum_{k=1}^{\infty} (-1)^{k+1} \frac{(2k)!}{(3k-2)!}$is absolutely convergent, conditionally convergent or divergent.

(b) Test the convergence of the series $1+\frac{1.2}{1.3}+\frac{1.2.3}{1.3.5}+\frac{1.2.3.4}{1.3.5.7}+\cdots$

Module - V

19. (a) Obtain the Fourier series of for $f(x)=e^{-x}$, in the interval $0<x<2\pi$.with $f(x+2\pi)=f(x)$. Hence deduce the value of $\sum_{n=2}^{\infty}\frac{(-1)^n}{1+n^2}$.

    (b) Find the half range sine series of $f(x)=\begin{cases}\frac{2kL}{x} & if\ 0<x<\frac{L}{2}\\ \frac{2k(L-x)}{L} & if\ \frac{L}{2}<x<L\end{cases}$

20. (a)Expand $(1+x)^{-2}$.as a Taylor series about $x=0$and state the region of convergence of the series.

(b) Find the Fourier series for $f(x)=x^2$ in the interval $-\pi<x<\pi$

with $f(x+2\pi)=f(x)$.Hence show that $\frac{1}{1^4}+\frac{1}{2^4}+\frac{1}{3^4}+\cdots=\frac{\pi^4}{90}$. (14X5=70)

Syllabus

Module 1 (Linear algebra)

(Text 2: Relevant topics from sections 7.3, 7.4, 7.5, 8.1,8.3,8.4)

Systems of linear equations, Solution by Gauss elimination, row echelon form and rank of a matrix, fundamental theorem for linear systems (homogeneous and non-homogeneous, without proof), Eigen values and eigen vectors. Diagonaliztion of matrices, orthogonal transformation, quadratic forms and their canonical forms.

Module 2 (multivariable calculus-Differentiation)

(Text 1: Relevant topics from sections 13.3, 13.4, 13.5, 13.8)

Concept of limit and continuity of functions of two variables, partial derivatives, Differentials, Local Linear approximations, chain rule, total derivative, Relative maxima and minima, Absolute maxima and minima on closed and bounded set.

Module 3(multivariable calculus-Integration)

(Text 1: Relevant topics from sections 14.1, 14.2, 14.3, 14.5, 14.6, 14.8)

Double integrals (Cartesian), reversing the order of integration, Change of coordinates (Cartesian to polar), finding areas and volume using double integrals, mass and centre of gravity of inhomogeneous laminas using double integral. Triple integrals, volume calculated as triple integral, triple integral in cylindrical and spherical coordinates (computations involving spheres, cylinders).

Module 4 (sequences and series)

(Text 1: Relevant topics from sections 9.1, 9.3, 9.4, 9.5, 9.6)

Convergence of sequences and series, convergence of geometric series and p-series(without proof), test of convergence (comparison, ratio and root tests without proof); Alternating series and Leibnitz test, absolute and conditional convergence.

Module 5 (Series representation of functions)

(Text 1: Relevant topics from sections 9.8, 9.9. Text 2: Relevant topics from sections 11.1, 11.2, 11.6)

Taylor series (without proof, assuming the possibility of power series expansion in appropriate domains), Binomial series and series representation of exponential, trigonometric, logarithmic functions (without proofs of convergence); Fourier series, Euler formulas, Convergence of Fourier series (without proof), half range sine and cosine series, Parseval's theorem (without proof).

Text Books

1. H. Anton, I. Biven,S.Davis, "Calculus", Wiley, 10th edition, 2015.
2. Erwin Kreyszig, Advanced Engineering Mathematics, 10thEdition, John Wiley & Sons, 2016.

Reference Books

1. J. Stewart, Essential Calculus, Cengage, 2nd edition, 2017
2. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9 th Edition, Pearson, Reprint, 2002.
3. Peter V. O'Neil, Advanced Engineering Mathematics , Cengage, 7th Edition, 2012
4. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.
5. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36 Edition, 2010.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Linear Algebra (10 hours)**	
1.1	Systems of linear equations, Solution by Gauss elimination	1
1.2	Row echelon form, finding rank from row echelon form, fundamental theorem for linear systems	3
1.3	Eigen values and eigen vectors	2
1.4	Diagonaliztion of matrices, orthogonal transformation, quadratic forms	4

	and their canonical forms.	
2	**Multivariable calculus-Differentiation (8 hours)**	
2.1	Concept of limit and continuity of functions of two variables, partial derivatives	2
2.2	Differentials, Local Linear approximations	2
2.3	Chain rule, total derivative	2
2.4	Maxima and minima	2
3	**Multivariable calculus-Integration (10 hours)**	
3.1	Double integrals (Cartesian)-evaluation	2
3.2	Change of order of integration in double integrals, change of coordinates (Cartesian to polar),	2
3.3	Finding areas and volumes, mass and centre of gravity of plane laminas	3
3.4	Triple integrals	3
4	**Sequences and series (8 hours)**	
4.1	Convergence of sequences and series, geometric and p-series	2
4.2	Test of convergence(comparison, ratio and root)	4
4.3	Alternating series and Leibnitz test, absolute and conditional convergence	2
5	**Series representation of functions (9 hours)**	
5.1	Taylor series, Binomial series and series representation of exponential, trigonometric, logarithmic functions;	3
5.2	Fourier series, Euler formulas, Convergence of Fourier series(Dirichlet's conditions)	3
5.3	Half range sine and cosine series, Parseval's theorem.	3

PHT 110	ENGINEERING PHYSICS B (FOR NON-CIRCUIT BRANCHES)	Category	L	T	P	CREDIT	Year of Introduction
		BSC	3	1	0	4	2019

Preamble: The aim of the Engineering Physics program is to offer students a solid background in the fundamentals of Physics and to impart that knowledge in engineering disciplines. The program is designed to develop scientific attitudes and enable the students to correlate the concepts of Physics with the core programmes

Prerequisite: Higher secondary level Physics, Mathematical course on vector calculus, differential equations and linear algebra

Course Outcomes: After the completion of the course the student will be able to

CO 1	Compute the quantitative aspects of waves and oscillations in engineering systems.
CO 2	Apply the interaction of light with matter through interference, diffraction and identify these phenomena in different natural optical processes and optical instruments.
CO 3	Analyze the behaviour of matter in the atomic and subatomic level through the principles of quantum mechanics to perceive the microscopic processes in electronic devices.
CO 4	Apply the knowledge of ultrasonics in non-destructive testing and use the principles of acoustics to explain the nature and characterization of acoustic design and to provide a safe and healthy environment
CO 5	Apply the comprehended knowledge about laser and fibre optic communication systems in various engineering applications

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	2						1	2			1
CO 2	3	2						1	2			1
CO 3	3	2						1	2			1
CO 4	3							1	2			1
CO 5	3	2						1	2			1

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination (Marks)
	Test 1 (Marks)	Test 2 (Marks)	
Remember	15	15	30
Understand	25	25	50

Apply	10	10	20
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE MARKS	ESE MARKS	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Explain the effect of damping force on oscillators.
2. Distinguish between transverse and longitudinal waves.
3. (a) Derive an expression for the fundamental frequency of transverse vibration in a stretched string.
   (b) Calculate the fundamental frequency of a string of length 2 m weighing 6 g kept stretched by a load of 600 kg.

Course Outcome 2 (CO2):

1. Explain colours in thin films.
2. Distinguish between Fresnel and Fraunhofer diffraction.
3. (a) Explain the formation of Newton's rings and obtain the expression for radii of bright and dark rings in reflected system. Also explain how it is used to determine the wavelength of a monochromatic source of light.
   (b) A liquid of refractive index μ is introduced between the lens and glass plate. What happens to the fringe system? Justify your answer.

Course Outcome 3 (CO3):

1. Give the physical significance of wave function?

2. What are excitons ?

3. (a) Solve Schrodinger equation for a particle in a one dimensional box and obtain its energy eigen values and normalised wave functions.

(b) Calculate the first three energy values of an electron in a one dimensional box of width 1 A^0 in electron volt.

Course Outcome 4 (CO4):

1. Explain reverberation and reverberation time.
2. How ultrasonic waves are used in non-destructive testing.
3. (a) With a neat diagram explain how ultrasonic waves are produced by a piezoelectric oscillator.

(b) Calculate frequency of ultrasonic waves that can be produced by a nickel rod of length 4 cm. (Young's Modulus = 207 G Pa, Density = 8900 Kg /m^3)

Course Outcome 5 (CO 5):

1. Distinguish between spontaneous emission and stimulated emission.
2. Explain optical resonators.
3. (a) Explain the construction and working of Ruby Laser.

(b) Calculate the numerical aperture and acceptance angle of a fibre with a core refractive index of 1.54 and a cladding refractive index of 1.50 when the fibre is inside water of refractive index 1.33.

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Model Question paper

QP CODE: PAGES:3

Reg No:_____

Name :_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY FIRST SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: PHT 110

Course Name: Engineering Physics B

Max.Marks: 100 **Duration: 3 Hours**

PART A

Answer all Questions. Each question carries 3 Marks

1. Compare electrical and mechanical oscillators.

2. Distinguish between longitudinal and transverse waves.

3. Write a short note on antireflection coating.

4. Diffraction of light is not as evident in daily experience as that of sound waves. Give reason.

5. State and explain Heisenberg's Uncertainty principle. With the help of it explain natural line broadening.

6. Explain surface to volume ratio of nanomaterials.

7. Define sound intensity level. Give the values of threshold of hearing and threshold of pain.

8. Describe the method of non-destructive testing using ultra sonic waves

9. Explain the condition of population inversion

10. Distinguish between step index and graded index fibre. (10x3=30)

PART B

Answer any one full question from each module. Each question carries 14 Marks

Module 1

11. (a) Derive the differential equation of damped harmonic oscillator and deduce its solution. Discuss the cases of over damped, critically damped and under damped cases. (10)

(b) The frequency of a tuning fork is 500 Hz and its Q factor is $7\times10^{4.}$ Find the relaxation time. Also calculate the time after which its energy becomes 1/10 of its initial undamped value. (4)

12. (a) Derive an expression for the velocity of propagation of a transverse wave in a stretched string. Deduce laws of transverse vibrations. (10)

(b) The equation of transverse vibration of a stretched string is given by y =0.00327 sin (72.1x-2.72t) m, in which the numerical constants are in S.I units. Evaluate (i) Amplitude (ii) Wavelength (iii) Frequency and (iv) Velocity of the wave. (4)

Module 2

13. (a) Explain the formation of Newton's rings and show that the radius of dark ring is proportional to the square root of natural numbers. How can we use Newton's rings experiment to determine the refractive index of a liquid? (10)

(b) Two pieces of plane glass are placed together with a piece of paper between two at one end. Find the angle of the wedge in seconds if the film is viewed with a monochromatic light of wavelength 4800Å. Given $\beta = 0.0555$ cm. (4)

14. (a) Explain the diffraction due to a plane transmission grating. Obtain the grating equation. (10)

(b) A grating has 6000 lines per cm. Find the angular separation of the two yellow lines of mercury of wavelengths 577 nm and 579 nm in the second order. (4)

Module 3

15. (a) Derive time dependent and independent Schrodinger equations. (10)

(b) An electron is confined to one dimensional potential box of length 2Å. Calculate the energies corresponding to the first and second quantum states in eV. (4)

16. (a) Classify nanomaterials based on dimensionality of quantum confinement and explain the following nanostructures. (i) nano sheets (ii) nano wires (iii) quantum dots. (10)

(b) Find the de Broglie wavelength of electron whose kinetic energy is 15 eV. (4)

Module 4

17. (a) Explain reverberation and reverberation time? What is the significance of Reverberation time. Explain the factors affecting the acoustics of a building and their corrective measures? (10)

(b) The volume of a hall is 3000 m^3. It has a total absorption of 100m^2 sabine. If the hall is filled with audience who add another 80 m^2sabine, then find the difference in reverberation time. (4)

18. (a) With a neat diagram explain how ultrasonic waves are produced by piezoelectric oscillator. Also discuss the piezoelectric method of detection of ultrasonic waves. (10)

(b) An ultrasonic source of 0.09 MHz sends down a pulse towards the sea bed which returns after 0.55 sec. The velocity of sound in sea water is 1800 m/s. Calculate the depth of the sea and the wavelength of the pulse. (4)

Module 5

19. (a) Outline the construction and working of Ruby laser. (8)

(b) What is the principle of holography? How is a hologram recorded? (6)

20. (a) Define numerical aperture of an optic fibre and derive an expression for the NA of a step index fibre with a neat diagram. (10)

(b) An optical fibre made with core of refractive index 1.5 and cladding with a fractional index difference of 0.0006. Find refractive index of cladding and numerical aperture. (4)

(14x5=70)

SYLLABUS

ENGINEERING PHYSICS B (FOR NON-CIRCUIT BRANCHES)

Module 1

Oscillations and Waves

Harmonic oscillations, Damped harmonic motion-Derivation of differential equation and its solution, Over damped, Critically damped and Under damped Cases, Quality factor-Expression, Forced oscillations-Differential Equation-Derivation of expressions for amplitude and phase of forced oscillations, Amplitude Resonance-Expression for Resonant frequency, Quality factor and Sharpness of Resonance, Electrical analogy of mechanical oscillators

Wave motion- Derivation of one dimensional wave equation and its solution, Three dimensional wave equation and its solution (no derivation), Distinction between transverse and longitudinal waves, Transverse vibration in a stretched string, Statement of laws of vibration

Module 2

Wave Optics

Interference of light-Principle of superposition of waves, Theory of thin films - Cosine law (Reflected system), Derivation of the conditions of constructive and destructive Interference, Interference due to wedge shaped films -Determination of thickness and test for optical planeness, Newton's rings - Measurement of wavelength and refractive index, Antireflection coatings

Diffraction of light, Fresnel and Fraunhofer classes of diffraction, Diffraction grating-Grating equation, Rayleigh criterion for limit of resolution, Resolving and Dispersive power of a grating with expression (no derivation)

Module 3

Quantum Mechanics & Nanotechnology

Introduction for the need of Quantum mechanics, Wave nature of Particles, Uncertainty principle, Applications-Absence of electrons inside a nucleus and Natural line broadening Mechanism, Formulation of time dependent and independent Schrodinger wave equations-Physical Meaning of wave function, Particle in a one dimensional box- Derivation for normalised wave function and energy eigen values, Quantum Mechanical Tunnelling (Qualitative)

Introduction to nanoscience and technology, Increase in surface to volume ratio for nanomaterials, Quantum confinement in one dimension, two dimension and three dimension-Nano sheets, Nano wires and Quantum dots, Properties of nanomaterials-mechanical, electrical and optical, Applications of nanotechnology (qualitative ideas)

Module 4

Acoustics & Ultrasonics

Acoustics, Classification of sound-Musical sound-Noise, Characteristics of Musical Sounds-Pitch or frequency-Loudness or Intensity-Measurement of Intensity level-Decibel-Quality or timbre, Absorption coefficient, Reverberation-Reverberation time-Significance- Sabine's formula (no derivation), Factors affecting architectural acoustics and their remedies

Ultrasonics-Production- Magnetostriction effect and Piezoelectric effect, Magnetostriction oscillator and Piezoelectric oscillator –Working, Detection of ultrasonic waves - Thermal and Piezoelectric

methods, Ultrasonic diffractometer- Expression for the velocity of ultrasonic waves in a liquid , Applications of ultrasonic waves -SONAR,NDT and Medical

Module 5

Laser and Fibre optics

Properties of laser, Absorption and emission of radiation, Spontaneous and stimulated emission, Einstein's coefficients (no derivation), Population inversion, Metastable states, basic components of laser, Active medium, Pumping mechanism, Optical resonant cavity, working principle, Construction and working of Ruby laser and Helium neon laser ,Construction and working of semiconductor laser(Qualitative) ,Applications of laser, Holography, Difference between hologram and photograph, Recording of hologram and reconstruction of image, Applications

Optic fibre-Principle of propagation of light, Types of fibres-Step index and Graded index fibres, Numerical aperture –Derivation, Fibre optic communication system (block diagram), Industrial, Medical and Technological applications, Fibre optic sensors-Intensity Modulated and Phase modulated sensors

Text Books

1. M.N.Avadhanulu, P.G.Kshirsagar,TVS Arun Murthy "A Text book of Engineering Physics", S.Chand &Co., Revised Edition, 2019.

2. H.K.Malik , A.K. Singh, "Engineering Physics" McGraw Hill Education, Second Edition, 2017.

Reference Books

1. Arthur Beiser, "Concepts of Modern Physics ", Tata McGraw Hill Publications, 6th Edition 2003
2. D.K. Bhattacharya, Poonam Tandon, "Engineering Physics", Oxford University Press, 2015
3. Md.N.Khan & S.Panigrahi "Principles of Engineering Physics 1&2", Cambridge University Press, 2016
4. Aruldhas G., "Engineering Physics", PHI Pvt. Ltd., 2015
5. Ajoy Ghatak, "Optics", Mc Graw Hill Education, Sixth Edition, 2017
6. T. Pradeep, "Nano:The Essentials'', McGraw Hill India Ltd, 2007
7. B. B. Laud, "Lasers and Non linear optics", New age International Publishers, 2nd Edition ,2005
8. Premlet B., "Advanced Engineering Physics", Phasor Books,10th edition ,2017
9. I. Dominic and. A. Nahari, "A Text Book of Engineering physics", Owl Books Publishers, Revised edition, 2016

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Oscillations and Waves (9 hours)**	
1.1	Harmonic oscillations, Damped harmonic motion-Derivation of differential equation and its solution, Over damped, Critically damped and Under damped Cases, Quality factor-Expression	2 hrs
1.2	Forced oscillations-Differential Equation-Derivation of expressions for amplitude and phase of forced oscillations, Amplitude Resonance-Expression for Resonant frequency, Quality factor and Sharpness of Resonance, Electrical analogy of mechanical oscillators	3hrs
1.3	Wave motion- Derivation of one dimensional wave equation and its solution, Three dimensional wave equation and its solution (no derivation)	2 hrs
1.4	Distinction between transverse and longitudinal waves, Transverse vibration in a stretched string, Statement of laws of vibration	2 hrs
2	**Wave Optics (9 hours)**	
2.1	Interference of light-Principle of superposition of waves, Theory of thin films - Cosine law (Reflected system), Derivation of the conditions of constructive and destructive Interference	2 hrs
2.2	Interference due to wedge shaped films -Determination of thickness and test for optical planeness, Newton's rings - Measurement of wavelength and refractive index, Antireflection coatings	4 hrs
2.3	Diffraction of light, Fresnel and Fraunhofer classes of diffraction, Diffraction grating-Grating equation	2 hrs
2.4	Rayleigh criterion for limit of resolution, Resolving and Dispersive power of a grating with expression (no derivation)	1 hr
3	**Quantum Mechanics &Nanotechnology (9hours)**	
3.1	Introduction for the need of Quantum mechanics, Wave nature of Particles, Uncertainty principle, Applications-Absence of electrons inside a nucleus and Natural line broadening mechanism	2 hrs
3.2	Formulation of time dependent and independent Schrodinger wave equations-Physical Meaning of wave function, Particle in a one dimensional box- Derivation for normalised wave function and energy eigen values, Quantum Mechanical Tunnelling (Qualitative)	4 hrs
3.3	Introduction to nanoscience and technology, Increase in surface to volume ratio for nanomaterials, Quantum confinement in one dimension, two dimension and three dimension-Nano sheets, Nano wires and Quantum dots	2 hrs
3.4	Properties of nanomaterials-mechanical, electrical and optical Applications of nanotechnology (qualitative ideas)	1 hr
4	**Acoustics & Ultrasonics (9hrs)**	
4.1	Acoustics, Classification of sound-Musical sound-Noise, Characteristics	3 hrs

	of Musical Sounds-Pitch or frequency-Loudness or Intensity-Measurement of Intensity level-Decibel-Quality or timbre, Absorption coefficient, Reverberation-Reverberation time-Significance- Sabine's formula (no derivation)	
4.2	Factors affecting architectural acoustics and their remedies	1 hr
4.3	Ultrasonics-Production- Magnetostriction effect and Piezoelectric effect, Magnetostriction oscillator and Piezoelectric oscillator – Working, Detection of ultrasonic waves - Thermal and Piezoelectric methods	3hrs
4.4	Ultrasonic diffractometer- Expression for the velocity of ultrasonic waves in a liquid ,Applications of ultrasonic waves -SONAR,NDT and Medical.	2 hr
5	**Laser and Fibre optics (9hours)**	
5.1	Properties of laser, Absorption and emission of radiation, Spontaneous and stimulated emission, Einstein's coefficients (no derivation), Population inversion, Metastable states, basic components of laser, Active medium, Pumping mechanism, Optical resonant cavity, working principle	2 hrs
5.2	Construction and working of Ruby laser and Helium neon laser ,Construction and working of semiconductor laser(Qualitative) Applications of laser	3 hrs
5.3	Holography, Difference between hologram and photograph, Recording of hologram and reconstruction of image, Applications	1 hr
5.4	Optic fibre-Principle of propagation of light, Types of fibres-Step index and Graded index fibres, Numerical aperture –Derivation, Fibre optic communication system (block diagram), Industrial, Medical and Technological applications, Fibre optic sensors-Intensity Modulated and Phase modulated sensors	3 hrs

PHT 100	ENGINEERING PHYSICS A (FOR CIRCUIT BRANCHES)	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		BSC	3	1	0	4	2019

Preamble: The aim of the Engineering Physics Program is to offer students a solid background in the fundamentals of Physics and to impart that knowledge in engineering disciplines. The program is designed to develop scientific attitudes and enable the students to correlate the concepts of Physics with the core programmes

Prerequisite: Higher secondary level Physics, Mathematical course on vector calculus, differential equations and linear algebra

Course Outcomes: After the completion of the course the student will be able to

CO 1	Compute the quantitative aspects of waves and oscillations in engineering systems.
CO 2	Apply the interaction of light with matter through interference, diffraction and identify these phenomena in different natural optical processes and optical instruments.
CO 3	Analyze the behaviour of matter in the atomic and subatomic level through the principles of quantum mechanics to perceive the microscopic processes in electronic devices.
CO 4	Classify the properties of magnetic materials and apply vector calculus to static magnetic fields and use Maxwell's equations to diverse engineering problems
CO 5	Analyze the principles behind various superconducting applications, explain the working of solid state lighting devices and fibre optic communication system

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	2						1	2			1
CO 2	3	2						1	2			1
CO 3	3	2						1	2			1
CO 4	3	1						1	2			1
CO 5	3	1						1	2			1

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination (Marks)
	Test 1 (Marks)	Test 2 (Marks)	
Remember	15	15	30
Understand	25	25	50
Apply	10	10	20

Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE marks	ESE marks	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Explain the effect of damping force on oscillators.
2. Distinguish between transverse and longitudinal waves.
3. (a) Derive an expression for the fundamental frequency of transverse vibration in a stretched string.

   (b) Calculate the fundamental frequency of a string of length 2 m weighing 6 g kept stretched by a load of 600 kg.

Course Outcome 2 (CO2):

1. Explain colours in thin films.
2. Distinguish between Fresnel and Fraunhofer diffraction.
3. (a) Explain the formation of Newton's rings and obtain the expression for radii of bright and dark rings in reflected system. Also explain how it is used to determine the wavelength of a monochromatic source of light.

   (b) A liquid of refractive index μ is introduced between the lens and glass plate.

What happens to the fringe system? Justify your answer.

Course Outcome 3 (CO3):

1. Give the physical significance of wave function ?

2. What are excitons ?

3. (a) Solve Schrodinger equation for a particle in a one dimensional box and obtain its energy eigen values and normalised wave functions.

(b) Calculate the first three energy values of an electron in a one dimensional box of width 1 A^0 in electron volt.

Course Outcome 4 (CO4):

1. Compare displacement current and conduction current.

2. Mention any four properties of ferro magnetic materials.

3. (a) Starting from Maxwell's equations, derive the free space electromagnetic wave equation and show that velocity of electromagnetic wave is $1/ (\mu_o \varepsilon_o)^{½}$

(b) An electromagnetic wave is described by $E = 100 \exp 8\pi i [10^{14} t – (10^6 z / 3)]$ V/m. Find the direction of propagation of the wave,speed of the wave and magnetic flux density in the wave.

Course Outcome 5 (CO5):

1. Explain the working of a solar cell.

2. Distinguish between Type I and Type II super conductors.

3. (a) Define numerical aperture and derive an expression for it.

(b) Explain the working of intensity modulated fibre optic sensor.

Model Question paper

QP CODE: PAGES:3

Reg No:_____

Name :_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY FIRST SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: PHT 100

Course Name: Engineering Physics A

Max. Marks: 100 **Duration: 3 Hours**

PART A

Answer all Questions. Each question carries 3 Marks

1. Compare electrical and mechanical oscillators
2. Distinguish between longitudinal and transverse waves
3. Write a short note on antireflection coating.
4. Diffraction of light is not as evident in daily experience as that of sound waves. Give reason.
5. State and explain Heisenberg's Uncertainty principle. With the help of it explain natural line broadening.
6. Explain surface to volume ratio of nanomaterials.
7. State Faraday's laws of electromagnetic induction.
8. Compare displacement current and conduction current
9. List four important applications of superconductors.
10. Give the working principle of LED. (10x3=30)

PART B

Answer any one full question from each module. Each question carries 14 Marks

Module 1

11. (a) Derive the differential equation of damped harmonic oscillator and deduce its solution.Discuss the cases of over damped, critically damped and under damped cases. (10)

(b) The frequency of a tuning fork is 500 Hz and its Q factor is $7\times10^{4.}$ Find the relaxation time. Also calculate the time after which its energy becomes 1/10 of its initial undamped value.(4)

12. (a) Derive an expression for the velocity of propagation of a transverse wave in a stretched string. Deduce laws of transverse vibrations. (10)

(b) The equation of transverse vibration of a stretched string is given by y =0.00327 sin (72.1x-2.72t)m, in which the numerical constants are in S.I units. Evaluate (i) Amplitude (ii) Wavelength (iii) Frequency and (iv)Velocity of the wave. (4)

Module 2

13.(a)Explain the formation of Newton's rings and show that the radius of dark ring is proportional to the square root of natural numbers. How can we use Newton's rings experiment to determine the refractive index of a liquid. (10)

(b) Two pieces of plane glass are placed together with a piece of paper between two at one end. Find the angle of the wedge in seconds if the film is viewed with a monochromatic light of wavelength 4800Å. Given β = 0.0555 cm. (4)

14. (a) Explain the diffraction due to a plane transmission grating. Obtain the grating equation. (10)

(b) A grating has 6000 lines per cm. Find the angular separation of the two yellow lines of mercury of wavelengths 577 nm and 579 nm in the second order. (4)

Module 3

15.(a) Derive time dependent and independent Schrodinger equations. (10)

(b) An electron is confined to one dimensional potential box of length 2Å. Calculate the energies corresponding to the first and second quantum states in eV. (4)

16.(a) Classify nanomaterials based on dimensionality of quantum confinement and explain the following nanostructures. (i) nano sheets (ii) nano wires (iii) quantum dots. (10)

(b) Find the de Broglie wavelength of electron whose kinetic energy is 15 eV. (4)

Module 4

17.(a) State Poynting's Theorem. Calculate the value of Poynting vector at the surface of the sun if the power radiated by the sun is 3.8×10^{26} W and its radius is 7×10^{8} m. (5)

(b) Distinguish between paramagnetic, diamagnetic and ferromagnetic materials. (9)

18.(a) Starting from Maxwell's Equations, derive electromagnetic wave equations in free space. (10)

(b) If the magnitude of **H** in a plane wave is 1 A/m, find the magnitude of **E** in free space. (4)

Module 5

19.(a) Show that superconductors are perfect diamagnets. Distinguish between Type I and Type II superconductors with suitable examples. (10)

(b) Write a short note on high temperature superconductors. (4)

20.(a) Define numerical aperture of an optic fibre and derive an expression for the NA of a step index fibre with a neat diagram. (10)

(b) Calculate the numerical aperture and acceptance angle of a fibre with a core refractive index of 1.54 and a cladding refractive index of 1.50 when the fibre is inside water of refractive index 1.33. (4) (14x5=70)

Syllabus

ENGINEERING PHYSICS A
(FOR CIRCUIT BRANCHES)

Module 1

Oscillations and Waves

Harmonic oscillations, Damped harmonic motion-Derivation of differential equation and its solution, Over damped, Critically damped and Under damped Cases, Quality factor-Expression, Forced oscillations-Differential Equation-Derivation of expressions for amplitude and phase of forced oscillations, Amplitude Resonance-Expression for Resonant frequency, Quality factor and Sharpness of Resonance, Electrical analogy of mechanical oscillators

Wave motion- Derivation of one dimensional wave equation and its solution, Three dimensional wave equation and its solution (no derivation), Distinction between transverse and longitudinal waves, Transverse vibration in a stretched string, Statement of laws of vibration

Module 2

Wave Optics

Interference of light-Principle of superposition of waves, Theory of thin films - Cosine law (Reflected system), Derivation of the conditions of constructive and destructive Interference, Interference due to wedge shaped films -Determination of thickness and test for optical planeness, Newton's rings - Measurement of wavelength and refractive index, Antireflection coatings

Diffraction of light, Fresnel and Fraunhofer classes of diffraction, Diffraction grating-Grating equation, Rayleigh criterion for limit of resolution, Resolving and Dispersive power of a grating with expression (no derivation)

Module 3

Quantum Mechanics & Nanotechnology

Introduction for the need of Quantum mechanics, Wave nature of Particles, Uncertainty principle, Applications-Absence of electrons inside a nucleus and Natural line broadening mechanism, Formulation of time dependent and independent Schrodinger wave equations-Physical meaning of wave function, Particle in a one dimensional box- Derivation for normalised wave function and energy eigen values, Quantum Mechanical Tunnelling (Qualitative)

Introduction to nanoscience and technology, Increase in surface to volume ratio for nanomaterials, Quantum confinement in one dimension, two dimension and three dimension-Nano sheets, Nano wires and Quantum dots, Properties of nanomaterials-mechanical, electrical and optical, Applications of nanotechnology (qualitative ideas)

Module 4

Magnetism & Electro Magnetic Theory

Magnetic field and Magnetic flux density, Gauss's law for Magnetic flux density, Ampere's Circuital law, Faraday's law in terms of EMF produced by changing magnetic flux, Magnetic permeability and susceptibility, Classification of magnetic materials-para, dia and ferromagnetic materials

Fundamentals of vector calculus, concept of divergence, gradient and curl along with physical significance, Line, Surface and Volume integrals, Gauss divergence theorem & Stokes' theorem, Equation of continuity, Derivation of Maxwell's equations in vacuum, Comparison of displacement current with conduction current. Electromagnetic waves, Velocity of Electromagnetic waves in free space, Flow of energy and Poynting's vector (no derivation)

Module 5

Superconductivity & Photonics

Superconducting phenomena, Meissner effect and perfect diamagnetism, Types of superconductors-Type I and Type II, BCS Theory (Qualitative), High temperature superconductors-Applications of super conductivity

Introduction to photonics-Photonic devices-Light Emitting Diode, Photo detectors -Junction and PIN photodiodes, Solar cells-I-V Characteristics, Optic fibre-Principle of propagation of light, Types of fibres-Step index and Graded index fibres, Numerical aperture –Derivation, Fibre optic communication system (block diagram), Industrial, Medical and Technological applications of optical fibre, Fibre optic sensors-Intensity Modulated and Phase modulated sensors.

Text Books

1. M.N.Avadhanulu, P.G.Kshirsagar,TVS Arun Murthy "A Text book of Engineering Physics", S.Chand &Co., Revised Edition 2019

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2. D.K. Bhattacharya, Poonam Tandon, "Engineering Physics", Oxford University Press, 2015
3. Md.N.Khan & S.Panigrahi "Principles of Engineering Physics 1&2", Cambridge University Press, 2016
4. Aruldhas G., "Engineering Physics", PHI Pvt. Ltd., 2015
5. Ajoy Ghatak, "Optics", Mc Graw Hill Education, Sixth Edition, 2017
6. T. Pradeep, "Nano:The Essentials'', McGraw Hill India Ltd, 2007
7. Halliday, Resnick, Walker, "Fundamentals of Physics'', John Wiley & Sons.Inc, 2001
8. David J Griffiths, "Introduction to Electrodynamics'', Addison-Wesley publishing, 3rd Edition, 1999
9. Premlet B., "Advanced Engineering Physics", Phasor Books,10th edition,2017
10. I. Dominic and. A. Nahari, "A Text Book of Engineering physics", Owl Books Publishers, Revised edition, 2016

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Oscillations and Waves (9 hours)**	
1.1	Harmonic oscillations, Damped harmonic motion-Derivation of differential equation and its solution, Over damped, Critically damped and Under damped Cases, Quality factor-Expression	2 hrs
1.2	Forced oscillations-Differential Equation-Derivation of expressions for amplitude and phase of forced oscillations, Amplitude Resonance-Expression for Resonant frequency, Quality factor and Sharpness of Resonance, Electrical analogy of mechanical oscillators	3hrs
1.3	Wave motion- Derivation of one dimensional wave equation and its solution, Three dimensional wave equation and its solution (no derivation)	2 hrs
1.4	Distinction between transverse and longitudinal waves. Transverse vibration in a stretched string, Statement of laws of vibration	2 hrs
2	**Wave Optics (9 hours)**	
2.1	Interference of light-Principle of superposition of waves, Theory of thin films - Cosine law (Reflected system), Derivation of the conditions of constructive and destructive Interference	2 hrs
2.2	Interference due to wedge shaped films -Determination of thickness and test for optical planeness, Newton's rings - Measurement of wavelength and refractive index, Antireflection coatings	4 hr
2.3	Diffraction of light, Fresnel and Fraunhofer classes of diffraction, Diffraction grating-Grating equation	2 hrs
2.4	Rayleigh criterion for limit of resolution, Resolving and Dispersive power of a grating with expression (no derivation)	1 hr
3	**Quantum Mechanics &Nanotechnology (9hours)**	
3.1	Introduction for the need of Quantum mechanics, Wave nature of Particles, Uncertainty principle, Applications-Absence of electrons inside a nucleus and Natural line broadening mechanism	2 hrs
3.2	Formulation of time dependent and independent Schrodinger wave equations-Physical Meaning of wave function, Particle in a one dimensional box- Derivation for normalised wave function and energy eigen values, Quantum Mechanical Tunnelling (Qualitative)	4 hrs
3.3	Introduction to nanoscience and technology, Increase in surface to volume ratio for nanomaterials, Quantum confinement in one dimension, two dimension and three dimension-Nano sheets, Nano wires and Quantum dots	2 hrs
3.4	Properties of nanomaterials-mechanical, electrical and optical Applications of nanotechnology (qualitative ideas)	1 hr
4	**Magnetism & Electro Magnetic Theory (9 hours)**	
4.1	Magnetic field and Magnetic flux density, Gauss's law for Magnetic flux	2 hrs

	density, Ampere's Circuital law, Faraday's law in terms of EMF produced by changing magnetic flux	
4.2	Explanation for Magnetic permeability and susceptibility Classification of magnetic materials- para, dia and ferromagnetic materials	1 hr
4.3	Fundamentals of vector calculus, concept of divergence, gradient and curl along with physical significance, Line, Surface and Volume integrals, Gauss divergence theorem & Stokes' theorem	2 hrs
4.4	Equation of continuity, Derivation of Maxwell's equations in vacuum, Comparison of displacement current with conduction current. Electromagnetic waves, Velocity of Electromagnetic waves in free space, Flow of energy and Poynting's vector (no derivation)	4 hrs
5	**Superconductivity &Photonics (9hours)**	
5.1	Super conducting Phenomena, Meissner effect and perfect diamagnetism, Types of superconductors-Type I and Type II	2 hrs
5.2	BCS Theory (Qualitative), High temperature superconductors, Applications of super conductivity	2 hrs
5.3	Introduction to photonics-Photonic devices-Light Emitting Diode, Photo detectors -Junction and PIN photodiodes, Solar cells-I-V Characteristics	2 hrs
5.4	Optic fibre-Principle of propagation of light, Types of fibres-Step index and Graded index fibres, Numerical aperture –Derivation, Fibre optic communication system (block diagram), Industrial, Medical and Technological applications of optical fibre, Fibre optic sensors-Intensity Modulated and Phase modulated sensors	3 hrs

CYT 100	ENGINEERING CHEMISTRY	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		BSC	3	1	0	4	2019

Preamble: To enable the students to acquire knowledge in the concepts of chemistry for engineering applications and to familiarize the students with different application oriented topics like spectroscopy, electrochemistry, instrumental methods etc. Also familiarize the students with topics like mechanism of corrosion, corrosion prevention methods, SEM, stereochemistry, polymers, desalination etc., which enable them to develop abilities and skills that are relevant to the study and practice of chemistry.

Prerequisite: Concepts of chemistry introduced at the plus two levels in schools

Course outcomes: After the completion of the course the students will be able to

CO 1	Apply the basic concepts of electrochemistry and corrosion to explore its possible applications in various engineering fields.
CO 2	Understand various spectroscopic techniques like UV-Visible, IR, NMR and its applications.
CO 3	Apply the knowledge of analytical method for characterizing a chemical mixture or a compound. Understand the basic concept of SEM for surface characterisation of nanomaterials.
CO 4	Learn about the basics of stereochemistry and its application. Apply the knowledge of conducting polymers and advanced polymers in engineering.
CO 5	Study various types of water treatment methods to develop skills for treating wastewater.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	1	2	1									
CO 2	1	1		1	2							
CO 3	1	1		1	2							
CO 4	2	1										
CO 5	1			1			3					

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	15	15	30
Understand	25	25	50
Apply	10	10	20
Analyse			
Evaluate			
Create			

End Semester Examination Pattern: There will be two parts- **Part A** and **Part B. Part A** contains **10** questions (**2** questions from each module), having **3** marks for each question. Students should answer **all** questions. **Part B** contains **2** questions from each module, of which student should answer any one. Each question can have maximum **2** subdivisions and carries **14** marks.

Course Level Assessment Questions

Course Outcome 1 (CO 1):

1. What is calomel electrode? Give the reduction reaction (3 Marks)

2. List three important advantages of potentiometric titration (3 Marks)

3. (a) Explain how electroless plating copper and nickel are carried out (10 Marks)

(b) Calculate the emf of the following cell at 30°C, Z n / Zn^{2+} (0.1M) // Ag^{+} (0.01M) // Ag.

Given E^0 Zn^{2+}/Zn = -0.76 V, E^0 Ag^{+}/Ag = 0.8 V. (4 Marks)

Course Outcome 2 (CO 2)

1. State Beer Lambert's law (3 Marks)

2. List the important applications of IR spectroscopy (3 Marks)

3. (a) What is Chemical shift? What are factors affecting Chemical shift? How ^1H NMR spectrum of CH_3COCH_2Cl interpreted using the concept of chemical shift. (10 Marks)

(b) Calculate the force constant of HF molecule, if it shows IR absorption at 4138 cm^{-1}. Given that atomic masses of hydrogen and fluorine are 1u and 19u respectively. (4 Marks)

Course Outcome 3 (CO 3):

1. Distinguish between TGA and DTA (3 Marks)

2. Give two differences between GSC and GLC (3 Marks)

3. (a) Explain the principle, instrumentation and procedure of HPLC (10 Marks)

(b) Interpret TGA of $CaC_2O_4 . H_2O$ (4 Marks)

Course Outcome 4 (CO 4):

1. Explain the geometrical isomerism in double bonds (3 Marks)

2. What are the rules of assigning R-S notation? (3 Marks)

3. (a) What are conducting polymers? How it is classified? Give the preparation of polyaniline (10 Marks)

(b) Draw the stereoisomers possible for CH_3-$(CHOH)_2$-COOH (4 Marks)

Course Outcome 5 (CO 5):

1. What is degree of hardness? (3 Marks)

2. Define BOD and COD (3 Marks)

3. (a) Explain the EDTA estimation of hardness (10 Marks)

(b) Standard hard water contains 20 g of CaCO3 per liter,50 mL of this required 30mL of EDTA solution, 50mL of sample water required 20mL of EDTA solution. 50mL sample water after boiling required 14 mL EDTA solution. Calculate the temporary hardness of the given sample of water, in terms of ppm. (4 Marks)

MODEL QUESTION PAPER

Total Pages:

Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIRST SEMESTER B.TECH DEGREE EXAMINATION

Course Code: CYT100,

Course Name: ENGINEERING CHEMISTRY

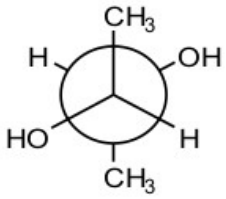
Max. Marks: 100 Duration: 3 Hours

PART A

Answer all questions, each carries 3 marks Marks

1	What is potentiometric titration? How the end point is determined graphically?	(3)
2	What is Galvanic series? How is it different from electrochemical series?	(3)
3	Which of the following molecules can give IR absorption? Give reason? (a) O_2 (b) H_2O (c) N_2 (d) HCl	(3)
4	Which of the following molecules show UV-Visible absorption? Give reason. (a) Ethane (b) Butadiene (c) Benzene	(3)

5		What are the visualization techniques used in TLC?	(3)
6		Write the three important applications of nanomaterials.	(3)
7		Draw the Fischer projection formula and find R-S notation of	(3)



8		Write the structure of a) Polypyrroleb) Kevlar.	(3
9		What is break point chlorination?	(3)
10		What is reverse osmosis?	(3)

PART B

Answer any one full question from each module, each question carries 14 marks

Module 1

11	a)	Give the construction of Li-ion cell. Give the reactions that take place at the electrodes during charging and discharging. What happens to anodic material when the cell is 100% charged.	(10)
	b)	Calculate the standard electrode potential of Cu, if its electrode potential at 25 °C is 0.296 V and the concentration of Cu^{2+} is 0.015 M.	(4)

OR

12	a)	Explain the mechanism of electrochemical corrosion of iron in oxygen rich and oxygen deficient acidic and basic environments.	(10)
	b)	Given below are reduction potentials of some species	(4)

$MnO_4^- + 8H^+ + 5e \rightarrow Mn^{2+} + 4H_2O$; $E^0 = +1.51$ V

$Cl_2 + 2e \rightarrow 2Cl^-$; $E^0 = +1.36$ V

$S_2O_8^{2-} + 2e \rightarrow 2SO_4^{2-}$; $E^0 = +1.98$ V

Use the above data to examine whether the acids, dil. HCl and dil. H_2SO_4 , can be used to provide acid medium in redox titrations involving $KMnO_4$.

Module 2

13	a)	What is spin-spin splitting? Draw the NMR spectrum of (i) CH_3 CH_2CH_2 Br (ii) $CH_3CH(Br)CH_3$ Explain how NMR spectrum can be used to identify the two isomers.	(10)
	b)	A dye solution of concentration 0.08M shows absorbance of 0.012 at 600 nm; while a test solution of same dye shows absorbance of 0.084 under same conditions. Find the concentration of the test solution.	(4)

OR

14	a)	Explain the basic principle of UV-Visible spectroscopy. What are the possible electronic transitions? Explain with examples.	(10)
	b)	Sketch the vibrational modes of CO_2 and H_2O. Which of them are IR active?	(4)

Module 3

15 a) Explain the principle, instrumentation and procedure involved in gas chromatography. (10)

b) Explain the DTA of $CaC_2O_4.H_2O$ with a neat sketch. (4)

OR

16 a) Explain the various chemical methods used for the synthesis of nanomaterial (10)

b) How TGA is used to analyse the thermal stability of polymers? (4)

Module 4

17 a) What are conformers? Draw the*cis* and *trans*isomers of 1, 3-dimethylcylohexane. Which conformer (chair form) is more stable in each case? (10)

b) What is ABS? Give properties and applications. (4)

OR

18 a) Explain the various structural isomers with suitable example. (10)

b) What is OLED? Draw a labelled diagram. (4)

Module 5

19 a) What are ion exchange resins? Explain ion exchange process for removal of hardness of water? How exhausted resins are regenerated? (10)

b) 50 mL sewage water is diluted to 2000 mL with dilution water; the initial dissolved oxygen was 7.7 ppm. The dissolved oxygen level after 5 days of incubation was 2.4 ppm. Find the BOD of the sewage. (4)

OR

20 a) What are the different steps in sewage treatment? Give the flow diagram. Explain the working of trickling filter. (10)

b) Calculate the temporary and permanent hardness of a water sample which contains $[Ca^{2+}]$ = 160 mg/L, $[Mg^{2+}]$ = 192 mg/L and $[HCO_3^-]$ = 122 mg/L. (4)

Syllabus

Module 1

Electrochemistry and Corrosion

Introduction - Differences between electrolytic and electrochemical cells - Daniel cell - redox reactions - cell representation. Different types of electrodes (brief) - Reference electrodes - SHE - Calomel electrode - Glass Electrode - Construction and Working. Single electrode potential - definition - Helmholtz electrical double layer -Determination of E^0 using calomel electrode.Determination of pH using glass electrode.Electrochemical series and its applications. Free energy and EMF - Nernst Equation - Derivation - single electrode and cell (Numericals) -Application - Variation of emf with temperature. Potentiometric titration - Introduction -Redox titration only.Lithiumion cell - construction and working.Conductivity- Measurement of conductivity of a solution (Numericals).

Corrosion-Electrochemicalcorrosion – mechanism. Galvanic series- cathodic protection - electroless plating –Copper and Nickel plating.

Module 2

Spectroscopic Techniques and Applications

Introduction- Types of spectrum - electromagnetic spectrum - molecular energy levels - Beer Lambert's law (Numericals). UV-Visible Spectroscopy – Principle - Types of electronic transitions - Energy level diagram of ethane, butadiene, benzene and hexatriene. Instrumentation of UV-Visible spectrometer and applications.IR-Spectroscopy – Principle - Number of vibrational modes - Vibrational energy states of a diatomic molecule and -Determination of force constant of diatomic molecule (Numericals) –Applications. ^{1}H NMR spectroscopy – Principle - Relation between field strength and frequency - chemical shift - spin-spin splitting (spectral problems) - coupling constant (definition) - applications of NMR- including MRI (brief).

Module 3

Instrumental Methods and Nanomaterials

Thermal analysis –TGA- Principle, instrumentation (block diagram) and applications – TGA of $CaC_2O_4.H_2O$ and polymers. DTA-Principle, instrumentation (block diagram) and applications - DTA of $CaC_2O_4.H_2O$. Chromatographic methods - Basic principles and applications of column and TLC-Retention factor. GC and HPLC-Principle, instrumentation (block diagram) - retention time and applications.

Nanomaterials - Definition - Classification - Chemical methods of preparation - Hydrolysis and Reduction - Applications of nanomaterials - Surface characterisation -SEM – Principle and instrumentation (block diagram).

Module 4

Stereochemistry and Polymer Chemistry

Isomerism-Structural, chain, position, functional, tautomerism and matamerism - Definition with examples - Representation of 3D structures-Newman, Sawhorse, Wedge and Fischer projection of substituted methane and ethane. Stereoisomerism - Geometrical isomerism in double bonds and cycloalkanes (cis-trans and E-Z notations). R-S Notation – Rules and examples - Optical isomerism, Chirality, Enantiomers and Diastereoisomers-Definition with examples.Conformational analysis of ethane, butane, cyclohexane, mono and di methyl substituted cyclohexane.

Copolymers - Definition - Types - Random, Alternating, Block and Graft copolymers - ABS - preparation, properties and applications.Kevlar-preparation, properties and applications.Conducting polymers - Doping -Polyaniline and Polypyrrole - preparation properties and applications. OLED - Principle, construction and advantages.

Module 5

Water Chemistry and Sewage Water Treatment

Water characteristics - Hardness - Types of hardness- Temporary and Permanent - Disadvantages of hard water -Units of hardness- ppm and mg/L -Degree of hardness (Numericals) - Estimation of

hardness-EDTA method (Numericals). Water softening methods-Ion exchange process-Principle, procedure and advantages. Reverse osmosis – principle, process and advantages. Municipal water treatment (brief) - Disinfection methods - chlorination, ozone andUV irradiation.

Dissolved oxygen (DO) -Estimation (only brief procedure-Winkler's method), BOD and COD-definition, estimation (only brief procedure) and significance (Numericals). Sewage water treatment - Primary, Secondary and Tertiary - Flow diagram -Trickling filter and UASB process.

Text Books

1. B. L. Tembe, Kamaluddin, M. S. Krishnan, "Engineering Chemistry (NPTEL Web-book)", 2018.

2. P. W. Atkins, "Physical Chemistry", Oxford University Press, 10th edn., 2014.

Reference Books

1. C. N. Banwell, "Fundamentals of Molecular Spectroscopy", McGraw-Hill, 4thedn., 1995.
2. Donald L. Pavia, "Introduction to Spectroscopy", Cengage Learning India Pvt. Ltd., 2015.
3. B. R. Puri, L. R. Sharma, M. S. Pathania, "Principles of Physical Chemistry", Vishal Publishing Co., 47th Edition, 2017.
4. H. H. Willard, L. L. Merritt, "Instrumental Methods of Analysis", CBS Publishers, 7th Edition, 2005.
5. Ernest L. Eliel, Samuel H. Wilen, "Stereo-chemistry of Organic Compounds", WILEY, 2008.
6. Raymond B. Seymour, Charles E. Carraher, "Polymer Chemistry: An Introduction", Marcel Dekker Inc; 4th Revised Edition, 1996.
7. MuhammedArif, Annette Fernandez, Kavitha P. Nair "Engineering Chemistry", Owl Books, 2019.
8. Ahad J., "Engineering Chemistry", Jai Publication, 2019.
9. Roy K. Varghese, "Engineering Chemistry", Crownplus Publishers, 2019.
10. Soney C. George,RinoLaly Jose, "Text Book of Engineering Chemistry", S. Chand & Company Pvt Ltd, 2019.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures (hrs)
1	**Electrochemistry and Corrosion**	**9**
1.1	Introduction - Differences between electrolytic and electrochemical cells- Daniel cell - redox reactions - cell representation. Different types of electrodes (brief) - Reference electrodes- SHE - Calomel electrode - Glass Electrode - Construction and Working.	**2**
1.2	Single electrode potential – definition - Helmholtz electrical double layer - Determination of E^0 using calomel electrode. Determination of pH using glass electrode. Electrochemical series and its applications. Free energy and EMF - Nernst Equation – Derivation - single electrode and cell (Numericals) -Application -Variation of emf with temperature.	**3**
1.3	Potentiometric titration - Introduction -Redox titration only. Lithiumion cell - construction and working. Conductivity- Measurement of conductivity of a solution (Numericals).	**2**
1.4	Corrosion-Electrochemicalcorrosion – mechanism. Galvanic series- cathodic protection - electroless plating –Copper and Nickel plating.	**2**
2	**Spectroscopic Techniques and Applications**	**9**
2.1	Introduction- Types of spectrum - electromagnetic spectrum - molecular energy levels - Beer Lambert's law (Numericals).	**2**
2.2	UV-Visible Spectroscopy – Principle - Types of electronic transitions - Energy level diagram of ethane, butadiene, benzene and hexatriene. Instrumentation of UV-Visible spectrometer and applications.	**2**
2.3	IR-Spectroscopy – Principle - Number of vibrational modes -Vibrational energy states of a diatomic molecule and -Determination of force constant of diatomic molecule (Numericals) –Applications.	**2**
2.4	^{1}H NMR spectroscopy – Principle - Relation between field strength and frequency - chemical shift - spin-spin splitting (spectral problems) - coupling constant (definition) - applications of NMR- including MRI (brief).	**3**
3	**Instrumental Methods and Nanomaterials**	**9**
3.1	Thermal analysis –TGA- Principle, instrumentation (block diagram) and applications – TGA of $CaC_2O_4.H_2O$ and polymers. DTA-Principle, instrumentation (block diagram) and applications - DTA of $CaC_2O_4.H_2O$.	**2**

3.2	Chromatographic methods - Basic principles and applications of column and TLC-Retention factor.	**2**
3.3	GC and HPLC-Principle, instrumentation (block diagram) - retention time and applications.	**2**
3.4	Nanomaterials - Definition - Classification - Chemical methods of preparation - Hydrolysis and Reduction - Applications of nanomaterials - Surface characterisation -SEM – Principle and instrumentation (block diagram).	**3**
4	**Stereochemistry and Polymer Chemistry**	**9**
4.1	Isomerism-Structural, chain, position, functional, tautomerism and matamerism - Definition with examples - Representation of 3D structures-Newman, Sawhorse, Wedge and Fischer projection of substituted methane and ethane. Stereoisomerism - Geometrical isomerism in double bonds and cycloalkanes (cis-trans and E-Z notations).	**2**
4.2	R-S Notation – Rules and examples - Optical isomerism, Chirality, Enantiomers and Diastereoisomers-Definition with examples.	**1**
4.3	Conformational analysis of ethane, butane, cyclohexane, mono and di methyl substituted cyclohexane.	**2**
4.4	Copolymers - Definition - Types - Random, Alternating, Block and Graft copolymers - ABS - preparation, properties and applications. Kevlar-preparation, properties and applications. Conducting polymers - Doping -Polyaniline and Polypyrrole - preparation properties and applications. OLED - Principle, construction and advantages.	**4**
5	**Water Chemistry and Sewage Water Treatment**	**9**
5.1	Water characteristics - Hardness - Types of hardness- Temporary and Permanent - Disadvantages of hard water -Units of hardness- ppm and mg/L -Degree of hardness (Numericals) - Estimation of hardness-EDTA method (Numericals). Water softening methods-Ion exchange process-Principle, procedure and advantages. Reverse osmosis – principle, process and advantages.	**3**
5.2	Municipal water treatment (brief) - Disinfection methods - chlorination, ozone andUV irradiation.	**2**
5.3	Dissolved oxygen (DO) -Estimation (only brief procedure-Winkler's method), BOD and COD-definition, estimation (only brief procedure) and significance (Numericals).	**2**
5.4	Sewage water treatment - Primary, Secondary and Tertiary - Flow diagram - Trickling filter and UASB process.	**2**

EST 100	ENGINEERING MECHANICS	CATEGORY	L	T	P	CREDIT	Year of Introduction
		ESC	2	1	0	3	2019

Preamble: Goal of this course is to expose the students to the fundamental concepts of mechanics and enhance their problem-solving skills. It introduces students to the influence of applied force system and the geometrical properties of the rigid bodies while stationary or in motion. After this course students will be able to recognize similar problems in real-world situations and respond accordingly.

Prerequisite: Nil

Course Outcomes: After completion of the course the student will be able to:

CO 1	Recall principles and theorems related to rigid body mechanics
CO 2	Identify and describe the components of system of forces acting on the rigid body
CO 3	Apply the conditions of equilibrium to various practical problems involving different force system.
CO 4	Choose appropriate theorems, principles or formulae to solve problems of mechanics.
CO 5	Solve problems involving rigid bodies, applying the properties of distributed areas and masses

Mapping of course outcomes with program outcomes (Minimum requirement)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2	2	-	-	-	-	-	-	-	-	-	-
CO 2	3	3	-	-	-	-	-	-	-	-	-	-
CO 3	3	3	-	-	-	-	-	-	-	-	-	-
CO 4	3	3	-	-	-	-	-	-	-	-	-	-
CO 5	3	3	-	-	-	-	-	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination (Marks)
	Test 1 (Marks)	Test 2 (Marks)	
Remember	10	10	15
Understand	10	10	15
Apply	30	30	70
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE marks	ESE marks	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions:

Part A

Course Outcome 1 (CO1): (One question from each module to meet the course objective 1: *To recall principles and theorems related to rigid body mechanics***)**

1. Explain D'Alembert's principle

2. Distinguish static and dynamic friction

3. State and explain perpendicular axis theorem

Course Outcome 2 (CO2) (One question from each module to meet the course objective 2: *To identify and describe the components of system of forces acting on the rigid body***)**

1. A simply supported beam AB of span 5 m is carrying point loads 5 kN, 3 kN and 2 kN at 1m, 3m and 4m respectively from support A. Calculate the support reaction at B.

2. A gymnast holding onto a bar, is suspended motionless in mid-air. The bar is supported by two ropes that attach to the ceiling. Diagram the forces acting on the combination of gymnast and bar

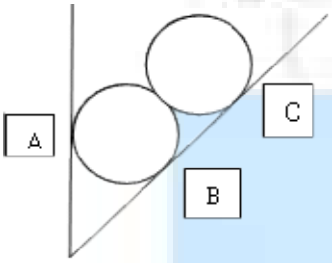
3. While you are riding your bike, you turn a corner following a circular arc. Illustrate the forces that act on your bike to keep you along the circular path ?

Part B

All the questions under this section shall assess the learning levels corresponding to the course outcomes listed below.

CO 3	To apply the conditions of equilibrium to various practical problems involving different force system.
CO 4	To choose appropriate theorems, principles or formulae to solve problems of mechanics.
CO 5	To solve problems involving rigid bodies, applying the properties of distributed areas and masses

1. Two rollers each of weight 100 N are supported by an inclined plane and a vertical wall. Find the reaction at the points of contact A, B, C. Assume all the surfaces to be smooth.

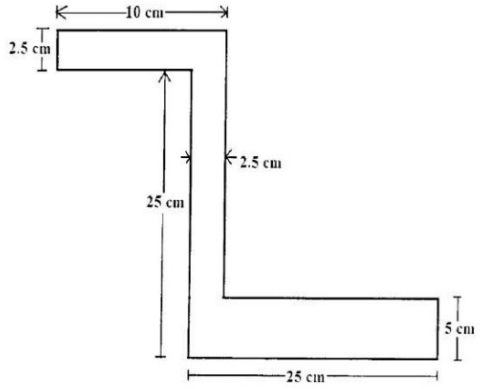


Course outcome identifier	Description of course outcome	Learning level assessed	Marks allocated
CO 3	To apply the conditions of equilibrium to various practical problems involving different force system.	Applying – (Sketch the free body diagram that represent equilibrium state of the body)	4
CO 4	To choose appropriate theorems, principles or formulae to solve problems of mechanics.	Applying (Choose the equations and formulae required for calculation)	4
CO 5	To solve problems involving rigid bodies, applying the properties of distributed areas and masses	Applying (Solve the problem based on the descriptions given in CO3 and CO4)	6
Total			14

2. A cylindrical disc, 50 cm diameter and cm thickness, is in contact with a horizontal conveyor belts running at uniform speeds of 5 m/s. Assuming there is no slip at points of contact determine (i) angular velocity of disc (ii) Angular acceleration of disc if velocity of conveyor changes to 8 m/s. Also compute the moment acting about the axis of the disc in both cases.

Course outcome identifier	Description of course outcome	Learning level assessed	Marks allocated
CO 3	To apply the conditions of equilibrium to various practical problems involving different force system.	Applying – (Sketch the free body diagram that represent state of the body)	4
CO 4	To choose appropriate theorems, principles or formulae to solve problems of mechanics.	Applying (Choose the equations and formulae required for calculation)	4
CO 5	To solve problems involving rigid bodies, applying the properties of distributed areas and masses	Applying (Solve the problem based on the descriptions given in CO3 and CO4)	6
Total			14

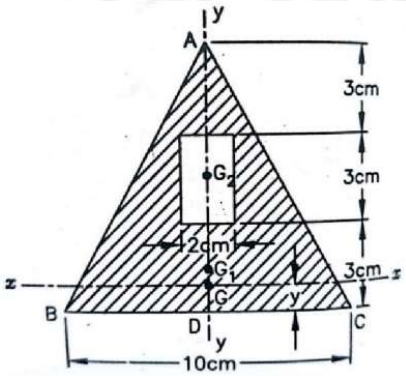
3. Determine the centroid of the given section



Course outcome identifier	Description of course outcome	Learning level assessed	Marks allocated
CO 3	To apply the conditions of equilibrium to various practical problems involving different force system.	Applying – (Illustrate the computation of centroid for the given geometrical shape)	4
CO 4	To choose appropriate theorems, principles or formulae to solve problems of mechanics.	Applying (Choose the equations and formulae required for calculation)	4
CO 5	To solve problems involving rigid bodies, applying the properties of distributed	Applying (Solve the problem based on the descriptions	6

	areas and masses	given in CO3 and CO4)	
Total			14

4. A rectangular hole is made in a triangular section as shown. Find moment of inertia about the section x-x passing through the CG of the section and parallel to BC.



Course outcome identifier	Description of course outcome	Learning level assessed	Marks allocated
CO 3	To apply the conditions of equilibrium to various practical problems involving different force system.	Applying – (Illustrate the computation of moment of inertia for the given geometrical shape)	4
CO 4	To choose appropriate theorems, principles or formulae to solve problems of mechanics.	Applying (Choose the equations and formulae required for calculation)	4
CO 5	To solve problems involving rigid bodies, applying the properties of distributed areas and masses	Applying (Solve the problem based on the descriptions given in CO3 and CO4)	6
Total			14

Model Question Paper

QP CODE:

Reg No.:_____

Name:_____ ___

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY FIRST SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: EST 100

ENGINEERING MECHANICS

Max. Marks: 100 Duration: 3 hours

Part A

(Answer all questions; each question carries 3 marks)

1. Explain D'Alembert's principle

2. Distinguish static and dynamic frictioni.

3. State and explain perpendicular axis theorem.

4. A simply supported beam AB of span 5 m is carrying point loads 5 kN, 3 kN and 2 kN at 1m, 3m and 4m respectively from support A. Calculate the support reaction at B.

5. A gymnast holding onto a bar, is suspended motionless in mid-air. The bar is supported by two ropes that attach to the ceiling. Diagram the forces acting on the combination of gymnast and bar

6. While you are riding your bike, you turn a corner following a circular arc. Illustrate the forces that act on your bike to keep you along the circular path ?

7. Compare damped and undamped free vibrations.

8. State the equation of motion of a rotating rigid body, rotating about its fixed axis.

9. Illustrate the significance of instantaneous centre in the analysis of rigid body undergoing rotational motion.

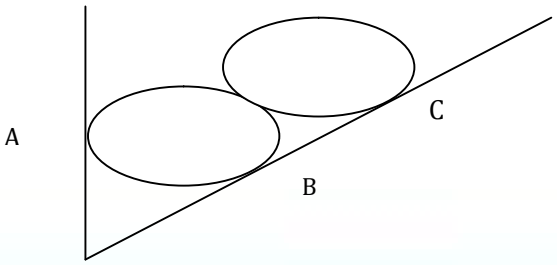
10. Highlight the principles of mechanics applied in the evaluation of elastic collusion of rigid bodies.

PART B

(Answer **one full** question from each module, each question carries **14** marks)

Module -I

11. Two identical rollers each of weight 100 N are supported by an inclined plane, making an angle of 30° with the vertical, and a vertical wall. Find the reaction at the points of contact A, B, C. Assume all the surfaces to be smooth. (14 marks)

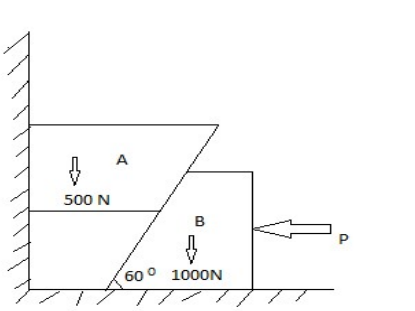


12. A string tied to a wall is made to pass over a pulley placed 2m away from it. A weight P is attached to the string such that the string stretches by 2m from the support on the wall to the location of attachment of weight. Determine the force P required to maintain 200 kg body in position for $\theta = 30^{o}$, The diameter of pulley B is negligible. (14 marks)

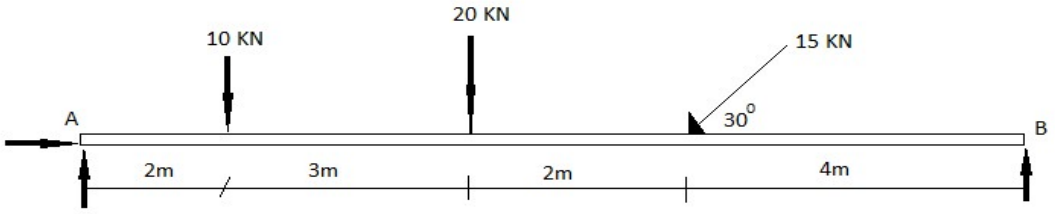
Module – 2

13. Two blocks A & B are resting against a wall and the floor as shown in figure below. Find the value of horizontal force P applied to the lower block that will hold the system in equilibrium. Coefficient of friction are : 0.25 at the floor, 0.3 at the wall and 0.2 between the blocks.

(14 marks)

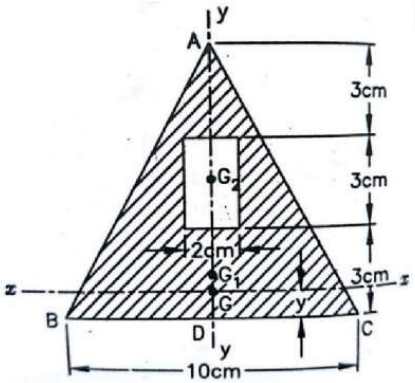


14. A beam is hinged at A and roller supported at B. It is acted upon by loads as shown below. Find the reactions at A & B. (14 marks)

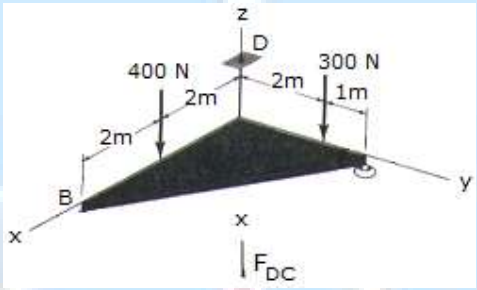


Module – 3

15. A rectangular hole is made in a triangular section as shown. Find moment of inertia about the section x-x passing through the CG of the section and parallel to BC. (14 marks)



16. Support A has ball and socket connection. Roller support at B prevents motion in the —z direction. Corner *C* is tied to *D* by a rope. The triangle is weightless. Determine the unknown force components acting at *A*, *B*, and *C*. (14 marks)



Module - 4

17. A cricket ball is thrown by a fielder from a height of 2m at an angle of 30^0 to the horizontal with an initial velocity of 20 m/s , hits the wickets at a height of 0.5 m from the ground. How far was the fielder from the wicket? (14 marks)

18. An engine of weight 500 kN pull a train weighing 1500 kN up an incline of 1 in 100. The train starts from rest and moves with constant acceleration against a resistance of 5 N/kN. It attains a maximum speed of 36 kmph in 1 km distance. Determine the tension in the coupling between train and engine and the traction force developed by the engine. (14marks)

Module – 5

19. A cylindrical disc, 50 cm diameter and 10 cm thickness having mass of 10 kg, is in contact with a horizontal conveyor belt running at uniform speeds of 5 m/s. Assuming there is no slip at points of contact determine (i) angular velocity of disc (ii) Angular acceleration of disc if velocity of conveyor changes to 8 m/s in 10 seconds. Also compute the moment acting about the axis of the disc in both cases. (14 marks)

20. A wheel rotating about fixed axis at 20 rpm is uniformly accelerated for 70 seconds during which time it makes 50 revolutions. Find the (i) angular velocity at the end of this interval and (ii) time required for the velocity to reach 100 revolutions per minute. (14 marks)

SYLLABUS

Module 1

Introduction to Engineering Mechanics-statics-basic principles of statics-Parallelogram law, equilibrium law, principles of superposition and transmissibility, law of action and reaction(review) free body diagrams.

Concurrent coplanar forces-composition and resolution of forces-resultant and equilibrium equations – methods of projections – methods of moments – Varignon's Theorem of moments.

Module 2

Friction – sliding friction - Coulomb's laws of friction – analysis of single bodies –wedges, ladder-analysis of connected bodies .

Parallel coplanar forces – couple - resultant of parallel forces – centre of parallel forces – equilibrium of parallel forces – Simple beam subject to concentrated vertical loads. General coplanar force system - resultant and equilibrium equations.

Module 3

Centroid of composite areas- – moment of inertia-parallel axis and perpendicular axis theorems. Polar moment of inertia,radius of gyration,mass moment of inertia-ring,cylinder and disc.

Theorem of Pappus Guldinus(demonstration only)

Forces in space - vectorial representation of forces, moments and couples –resultant and equilibrium equations – concurrent forces in space (simple problems only)

Module 4

Dynamics – rectilinear translation - equations of kinematics(review)

kinetics – equation of motion – D'Alembert's principle. – motion on horizontal and inclined surfaces, motion of connected bodies. Impulse momentum equation and work energy equation (concepts only).

Curvilinear translation - equations of kinematics –projectile motion(review), kinetics – equation of motion. Moment of momentum and work energy equation (concepts only).

Module 5

Rotation – kinematics of rotation- equation of motion for a rigid body rotating about a fixed axis – rotation under a constant moment.

Plane motion of rigid body – instantaneous centre of rotation (concept only).

Simple harmonic motion – free vibration –degree of freedom- undamped free vibration of spring mass system-effect of damping(concept only)

Text Books

1. Timoshenko and Young, Engineering Mechanics, McGraw Hill Publishers
2. Shames, I. H., Engineering Mechanics - Statics and Dynamics, Prentice Hall of India.
3. R. C. Hibbeler and Ashok Gupta, Engineering Mechanics, Vol. I statics, Vol II Dynamics, Pearson Education.

References

1. Merriam J. L and Kraige L. G., Engineering Mechanics - Vols. 1 and 2, John Wiley.

2. Tayal A K, Engineering Mechanics – Statics and Dynamics, Umesh Publications

3. Bhavikkatti, S.S., Engineering Mechanics, New Age International Publishers

4. F.P.Beer abd E.R.Johnston (2011), Vector Mechanics for Engineers, Vol.I-Statics, Vol.II-Dynamics, 9th Ed, Tata McGraw Hill

5. Rajasekaran S and Sankarasubramanian G, Engineering Mechanics - Statics and Dynamics, Vikas Publishing House Pvt Ltd.

Course Contents and Lecture Schedule:

Module	Topic	Course outcomes addressed	No. of Hours
1	**Module 1**		**Total: 7**
1.1	Introduction to engineering mechanics – introduction on statics and dynamics - Basic principles of statics – Parellogram law, equilibrium law – Superposition and transmissibility, law of action and reaction (review the topics)	CO1 and CO2	1
1.2	Free body diagrams. Degree of freedom-types of supports and nature of reactions - exercises for free body diagram preparation – composition and resolution of forces, resultant and equilibrium equations (review the topics) - numerical exercises for illustration.	CO1 and CO2	1
1.3	Concurrent coplanar forces - analysis of concurrent forces -methods of projections – illustrative numerical exercise – teacher assisted problem solving.	CO1 and CO2	1
1.4	Analysis of concurrent forces -methods of moment-Varignon's Theorem of Moments - illustrative numerical exercise– teacher assisted problem solving.	CO1 and CO2	1
1.5	Analysis of concurrent force systems – extended problem solving - Session I.	CO3,CO4 and CO5	1
1.6	Analysis of concurrent force systems – extended problem solving - Session II – learning review quiz.	CO3,CO4 and CO5	1
1.7	Analysis of concurrent force systems – extended problem solving - Session III.	CO3,CO4 and CO5	1
2	**Module 2**		**Total: 7**
2.1	Friction – sliding friction - Coulomb's laws of friction – analysis of single bodies –illustrative examples on wedges and ladder-teacher	CO1 and CO2	1

	assisted problem solving tutorials using problems from wedges and ladder.		
2.2	Problems on friction - analysis of connected bodies. illustrative numerical exercise– teacher assisted problem solving.	CO3, CO4 and CO5	1
2.3	Problems on friction-extended problem solving	CO3,C04 and CO5	1
2.4	Parallel coplanar forces – couple - resultant of parallel forces – centre of parallel forces – equilibrium of parallel forces – Simple beam subject to concentrated vertical loads.	CO1 and CO2	1
2.5	General coplanar force system - resultant and equilibrium equations - illustrative examples- teacher assisted problem solving.	CO1 and CO2	1
2.6	General coplanar force system-resultant and equilibrium equations - illustrative examples	CO3, CO4 and CO5	1
2.7	General coplanar force system - Extended problem solving - Quiz to evaluate learning level.	CO3, CO4 and CO5	1
3	**Module 3**		**Total: 7**
3.1	Centroid of simple and regular geometrical shapes – centroid of figures in combination - composite areas- examples for illustration – problems for practice to be done by self.	CO1 and CO2	1
3.2	Moment of inertia- parallel axis theorem –examples for illustration - problems for practice to be done by self.	CO1 and CO2	1
3.3	Moment of inertia - perpendicular axis theorem - example for illustration to be given as hand out and discussion on the solved example.	CO1 and CO2	1
3.4	Solutions to practice problems – problems related to centroid and moment of inertia - problems for practice to be done by self.	CO3, CO4 and CO5	1
3.5	Polar moment of inertia, Radius of gyration. Mass moment of inertia of ring, cylinder and uniform disc. Theorem of Pappus Guldinus - Demonstration	CO1 and CO2	1
3.6	Introduction to forces in space – vectorial representation of forces, moments and couples – simple problems to illustrate vector representations of forces, moments and couples to be done in class.	CO1,and CO2	1
3.7	Solution to practice problems - resultant and equilibrium equations for concurrent forces in space – concurrent forces in space - 2 simple problems to illustrate the application of resultant and equilibrium equations for concurrent forces in space.	CO3,CO4 and CO5	1
4	**Module 4**		**Total: 7**

4.1	Introduction to dynamics – review of rectilinear translation - equations of kinematics – problems to review the concepts – additional problems involving extended application as exercises .	CO1 and CO2	1
4.2	Solutions to exercises with necessary explanation given as hand out – introduction to kinetics – equation of motion – D'Alembert's principle – illustration of the concepts using one numerical exercise from motion on horizontal and inclined surfaces.	CO1 and CO2	1
4.3	Motion of connected bodies - example for illustration to be given as hand out and discussion on the solved example – problems for practice to be done by self.	CO3, CO4 and CO5	1
4.4	Motion of connected bodies-extended problem solving.	CO3, CO4 & CO5	1
4.5	Curvilinear translation - Review of kinematics –projectile motion – simple problems to review the concepts – introduction to kinetics – equation of motion – illustration of the concepts using numerical exercises.	CO3, CO4 & CO5	1
4.6	Extended problem solving – rectilinear and curvilinear translation.	CO3, CO4 & CO5	1
4.7	Concepts on Impulse momentum equation and work energy equation (rectilinear translation – discussions to bring out difference between elastic and inelastic collusions). Concepts on Moment of momentum and work energy equation (curvilinear translation).	CO1 and CO2	1
5	**Module 5**		**Total: 7**
5.1	Rotation – kinematics of rotation- equation of motion for a rigid body rotating about a fixed axis – simple problems for illustration.	CO1 and CO2	1
5.2	Rotation under a constant moment – teacher assisted problem solving.	CO3,CO4 and CO5	1
5.3	Rotation under a constant moment - extended problem solving.	CO3, CO4 and CO5	1
5.4	Plane motion of rigid body- instantaneous centre of rotation (concept only).	CO1 and CO2	1
5.5	Introduction to harmonic oscillation –free vibrations - simple harmonic motion – differential equation and solution. Degree of freedom – examples of single degree of freedom (SDOF) systems – Idealisation of mechanical systems as spring-mass systems (concept only).	CO1 and CO2	1

5.6	SDOF spring mass system –equation of motion – undamped free vibration response - concept of natural frequency. Free vibration response due to initial conditions. Simple problems on determination of natural frequency and free vibration response to test the understanding level.	CO1 and CO2	1
5.7	Free vibration analysis of SDOF spring-mass systems – Problem solving Effect of damping on free vibration response (concept only).	CO1and CO2	1

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY KTU

EST 110	ENGINEERING GRAPHICS	CATEGORY	L	T	P	CREDIT	Year of Introduction
		ESC	2	0	2	3	2019

Preamble: To enable the student to effectively perform technical communication through graphical representation as per global standards.

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO 1	Draw the projection of points and lines located in different quadrants
CO 2	Prepare multiview orthographic projections of objects by visualizing them in different positions
CO 3	Draw sectional views and develop surfaces of a given object
CO 4	Prepare pictorial drawings using the principles of isometric and perspective projections to visualize objects in three dimensions.
CO 5	Convert 3D views to orthographic views
CO 6	Obtain multiview projections and solid models of objects using CAD tools

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3											
CO 2	3											
CO 3	3	1										
CO 4	3									1		
CO 5	3									2		
CO 6	3				3					3		

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination (100 Marks)
	Test 1 (15 Marks)	Test 2 (15 Marks)	
Remember			
Understand	5		20
Apply	10	10	80
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE (Marks)	ESE (Marks)	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

CIA for section A carries 25 marks (15 marks for 1 test and Class work 10 marks)

CIA for section B carries 15 marks (10 marks for 1 test and Class work 5 marks)

End Semester Examination Pattern:

ESE will be of 3 hour duration on A4 size answer booklet and will be for 100 marks. The question paper shall contain two questions from each module of Section A only. Student has to answer any one question from each module. Each question carries 20 marks.

Course Level Assessment Questions

(Questions may be framed based on the outline given under each course outcome)

Course Outcome 1 (CO1):

1. Locate points in different quadrants as per given conditions.
2. Problems on lines inclined to both planes .
3. Find True length, Inclinations and Traces of lines.

Course Outcome 2 (CO2)

1. Draw orthographic views of solids and combination solids
2. Draw views of solids inclined to any one reference plane.
3. Draw views of solids inclined to both reference planes.

Course Outcome 3 (CO3):

1. Draw views of solids sectioned by a cutting plane
2. Find location and inclination of cutting plane given true shape of the section
3. Draw development of lateral surface of solids and also its sectioned views

Course Outcome 4 (CO4):

1. Draw Isometric views/projections of soilds
2. Draw Isometric views/projections of combination of soilds
3. Draw Perspective views of Soilds

Course Outcome 5 (CO5):

1. Draw Orthographic views of solids from given three dimensional view

Course Outcome 6 (CO6):

1. Draw the given figure including dimensions using 2D software
2. Create 3D model using modelling software from the given orthographic views or 3D figure or from real 3D objects

Model Question paper

QP CODE: PAGES:3

Reg No:_____

Name :_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY FIRST SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: EST 110

ENGINEERING GRAPHICS

Max.Marks:100 **Duration: 3 Hours**

PART A

Answer all Questions. Each question carries 3 Marks

Instructions: Retain necessary Construction lines
Show necessary dimensions
Answer any ONE question from each module
Each question carries 20 marks

MODULE I

1. The end point A of a line is 20mm above HP and 10mm in front of VP. The other end of the line is 50mm above HP and 15mm behind VP. The distance between the end projectors is 70mm. Draw the projections of the line. Find the true length and true inclinations of the line with the principal planes. Also locate the traces of the line.
2. One end of a line is 20mm from both the principal planes of projection. The other end of the line is 50mm above HP and 40mm in front of VP. The true length of the line is 70mm. Draw the projections of the line. Find its apparent inclinations, elevation length and plan length. Also locate its traces.

MODULE II

3. A pentagonal pyramid of base side 25mm and height 40mm, is resting on the ground on one of its triangular faces. The base edge of that face is inclined 30° to VP. Draw the projections of the solid.

4. A hexagonal prism has side 25mm and height 50mm has a corner of its base on the ground and the long edge containing that corner inclined at 30° to HP and 45° to VP. Draw the projections of the solid.

MODULE III

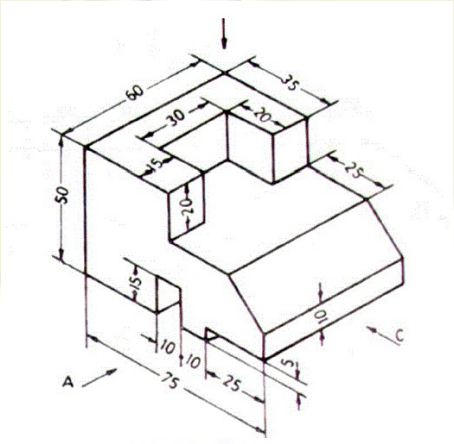
5. A triangular prism of base side 40mm and height 70mm is resting with its base on the ground and having an edge of the base perpendicular to VP. Section the solid such that the true shape of the section is a trapezium of parallel sides 30mm and 10mm. Draw the projections showing the true shape. Find the inclination of the cutting plane with the ground plane.
6. Draw the development of a pentagonal pyramid of base side 30mm and height 50mm. A string is wound from a corner of the base round the pyramid and back to the same point through the shortest distance. Show the position of the string in the elevation and plan.

MODULE IV

7. The frustum of a cone has base diameter 50mm and top diameter 40mm has a height of 60mm. It is paced centrally on top of a rectangular slab of size 80x60mm and of thickness 20mm. Draw the isometric view of the combination.
8. A hexagonal prism has base side 35mm and height 60mm. A sphere of diameter 40mm is placed centrally on top of it. Draw the isometric projection of the combination.

MODULE V

9. Draw the perspective view of a pentagonal prism, 20mm side and 45mm long lying on one of its rectangular faces on the ground and having its axis perpendicular to picture plane. One of its pentagonal faces touches the picture plane and the station point is 50mm in front of PP, 25mm above the ground plane and lies in a central plane, which is 70mm to the left of the center of the prism.
10. Draw three orthographic views with dimensions of the object shown in figure below.



(20X5=100)

Time : 3 hours **EST110 ENGINEERING GRAPHICS** **Max. Marks: 100**

SCHEME OF VALUATION

1. Locating the points and drawing the projections of the line – 4 marks
   Finding true length by any one method – 6 marks
   Finding true inclination with VP – 2 marks
   Finding true inclination with HP – 2 marks
   Locating horizontal trace – 2 marks
   Locating vertical trace – 2 marks
   Dimensioning and neatness – 2 marks

   Total = 20 marks

2. Locating the points and drawing true length of the line – 4 marks
   Finding projections by any method – 6 marks
   Finding length of elevation and plan – 2 marks
   Finding apparent inclinations – 2 marks
   Locating horizontal trace – 2 marks
   Locating vertical trace – 2 marks
   Dimensioning and neatness – 2 marks

   Total = 20 marks

3. Drawing initial position plan and elevation – 4 marks
   First inclination views – 4 marks
   Second inclination views -8 marks
   Marking invisible edges – 2 marks
   Dimensioning and neatness – 2 marks

   Total = 20 marks

   (Any one method or combination of methods for solving can be used.
   If initial position is wrong then maximum 50% marks may be allotted for the answer)

4. Drawing initial position plan and elevation – 4 marks
   First inclination views – 4 marks
   Second inclination views -8 marks
   Marking invisible edges – 2 marks
   Dimensioning and neatness – 2 marks

   Total = 20 marks

   (Any one method or combination of methods for solving can be used
   If initial position is wrong then maximum 50% marks may be allotted for the answer)

5. Drawing initial position plan and elevation – 4 marks
   Locating section plane as per given condition – 5 marks
   Drawing true shape -5 marks
   Finding inclination of cutting plane – 2 marks
   Dimensioning and neatness – 2 marks

   Total = 20 marks

6. Drawing initial position plan and elevation – 4 marks
   Development of the pyramid – 6 marks

Locating string in development -2 marks
Locating string in elevation – 3 marks
Locating string in plan – 3 marks
Dimensioning and neatness – 2 marks

Total = 20 marks

7. Drawing initial positions – 4 marks
   Isometric View of Slab -6 marks
   Isometric View of Frustum – 10 marks
   Dimensioning and neatness – 2 marks

   Total = 20 marks

   (Initial position is optional, hence redistribute if needed.
   Reduce 4 marks if Isometric scale is taken)

8. Drawing initial positions – 4 marks
   Isometric scale – 4 marks
   Isometric projection of prism -5 marks
   Isometric projection of sphere – 5 marks
   Dimensioning and neatness – 2 marks

   Total = 20 marks

   (Initial position is optional, hence redistribute if needed.

9. Drawing the planes and locating the station point – 4 marks
   Locating elevation points – 2 marks
   Locating plan points – 2 marks
   Drawing the perspective view – 10 marks
   Dimensioning and neatness – 2 marks

   Total = 20 marks

10. Drawing the elevation – 8marks
    Drawing the plan – 4 marks
    Drawing the side view – 4 marks
    Marking invisible edges – 2 marks
    Dimensioning and neatness – 2 marks

    Total = 20 marks

SYLLABUS

General Instructions:

- First angle projection to be followed
- Section A practice problems to be performed on A4 size sheets
- Section B classes to be conducted on CAD lab

SECTION A

Module 1

Introduction : Relevance of technical drawing in engineering field. Types of lines, Dimensioning, BIS code of practice for technical drawing.

Orthographic projection of Points and Lines: Projection of points in different quadrants, Projection of straight lines inclined to one plane and inclined to both planes. Trace of line. Inclination of lines with reference planes True length of line inclined to both the reference planes.

Module 2

Orthographic projection of Solids: Projection of Simple solids such as Triangular, Rectangle, Square, Pentagonal and Hexagonal Prisms, Pyramids, Cone and Cylinder. Projection of solids in simple position including profile view. Projection of solids with axis inclined to one of the reference planes and with axis inclined to both reference planes.

Module 3

Sections of Solids: Sections of Prisms, Pyramids, Cone, Cylinder with axis in vertical position and cut by different section planes. True shape of the sections. Also locating the section plane when the true shape of the section is given.

Development of Surfaces: Development of surfaces of the above solids and solids cut by different section planes. Also finding the shortest distance between two points on the surface.

Module 4

Isometric Projection: Isometric View and Projections of Prisms, Pyramids, Cone , Cylinder, Frustum of Pyramid, Frustum of Cone, Sphere, Hemisphere and their combinations.

Module 5

Perspective Projection: Perspective projection of Prisms and Pyramids with axis perpendicular to the ground plane, axis perpendicular to picture plane.

Conversion of Pictorial Views: Conversion of pictorial views into orthographic views.

SECTION B

(To be conducted in CAD Lab)

Introduction to Computer Aided Drawing: Role of CAD in design and development of new products, Advantages of CAD. Creating two dimensional drawing with dimensions using suitable software. (Minimum 2 exercises mandatory)

Introduction to Solid Modelling: Creating 3D models of various components using suitable modelling software. (Minimum 2 exercises mandatory)

Text Books

1. Bhatt, N.D., Engineering Drawing, Charotar Publishing House Pvt. Ltd.
2. John, K.C. Engineering Graphics, Prentice Hall India Publishers.

Reference Books

1. Anilkumar, K.N., Engineering Graphics, Adhyuth narayan Publishers
2. Agrawal, B. And Agrawal, C.M., Engineering Darwing, Tata McGraw Hill Publishers.
3. Benjamin, J., Engineering Graphics, Pentex Publishers- 3rd Edition, 2017
4. Duff, J.M. and Ross, W.A., Engineering Design and Visualisation, Cengage Learning.
5. Kulkarni, D.M., Rastogi, A.P. and Sarkar, A.K., Engineering Graphics with AutoCAD, PHI.
6. Luzaddff, W.J. and Duff, J.M., Fundamentals of Engineering Drawing, PHI.
7. Varghese, P.I., Engineering Graphics, V I P Publishers
8. Venugopal, K., Engineering Drawing and Graphics, New Age International Publishers.

Course Contents and Lecture Schedule

No	**SECTION A**	No. of Hours
1	**MODULE I**	
1.1	Introduction to graphics, types of lines, Dimensioning	1
1.2	Concept of principle planes of projection, different quadrants, locating points on different quadrants	2
1.3	Projection of lines, inclined to one plane. Lines inclined to both planes, trapezoid method of solving problems on lines.	2
1.4	Problems on lines using trapezoid method	2
1.5	Line rotation method of solving, problems on line rotation method	2
2	**MODULE II**	
2.1	Introduction of different solids, Simple position plan and elevation of solids	2
2.2	Problems on views of solids inclined to one plane	2
2.3	Problems on views of solids inclined to both planes	2
2.4	Practice problems on solids inclined to both planes	2

3	**MODULE III**	
3.1	Introduction to section planes. AIP and AVP. Principle of locating cutting points and finding true shape	2
3.2	Problems on sections of different solids	2
3.3	Problems when the true shape is given	2
3.4	Principle of development of solids, sectioned solids	2
4	**MODULE IV**	
4.1	Principle of Isometric View and Projection, Isometric Scale. Problems on simple solids	2
4.2	Isometric problems on Frustum of solids, Sphere and Hemisphere	2
4.3	Problems on combination of different solids	2
5	**MODULE V**	
5.1	Introduction to perspective projection, different planes, station point etc. Perspective problems on pyramids	2
5.2	Perspective problems on prisms	2
5.3	Practice on conversion of pictorial views into orthographic views	2
	SECTION B *(To be conducted in CAD lab)*	
1	Introduction to CAD and software. Familiarising features of 2D software. Practice on making 2D drawings	2
2	Practice session on 2D drafting	2
3	Introduction to solid modelling and software	2
4	Practice session on 3D modelling	2

EST 120	BASICS OF CIVIL & MECHANICAL ENGINEERING	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		ESC	4	0	0	4	2019

Preamble:

Objective of this course is to provide an insight and inculcate the essentials of Civil Engineering discipline to the students of all branches of Engineering and to provide the students an illustration of the significance of the Civil Engineering Profession in satisfying the societal needs.

To introduce the students to the basic principles of mechanical engineering

Prerequisite: NIL

Course Outcomes: After completion of the course, the student will be able to

CO 1	Recall the role of civil engineer in society and to relate the various disciplines of Civil Engineering.
CO 2	Explain different types of buildings, building components, building materials and building construction
CO 3	Describe the importance, objectives and principles of surveying.
CO 4	Summarise the basic infrastructure services MEP, HVAC, elevators, escalators and ramps
CO 5	Discuss the Materials, energy systems, water management and environment for green buildings.
CO 6	Analyse thermodynamic cycles and calculate its efficiency
CO 7	Illustrate the working and features of IC Engines
CO 8	Explain the basic principles of Refrigeration and Air Conditioning
CO 9	Describe the working of hydraulic machines
CO 10	Explain the working of power transmission elements
CO 11	Describe the basic manufacturing, metal joining and machining processes

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	-	-	-	-	3	2	2	-	-	-	-
CO2	3	2	-	1	3	-	-	3	-	-	-	-
CO3	3	2	-	-	3	-	-	-	2	-	-	-

CO4	3	2	-	-	3	-	-	-	2	-	-	-
CO5	3	2	-	-	3	2	3	-	2	-	-	-
CO6	3	2										
CO7	3	1										
CO8	3	1										
CO9	3	2										
CO10	3	1										
CO11	3											

Assessment Pattern

Bloom's Category	**Basic Civil Engineering**			**Basic Mechanical Engineering**		
	Continuous Assessment		**End Semester Examination (marks)**	**Continuous Assessment**		**End Semester Examination (marks)**
	Test 1 marks	**Test 2 marks**		**Test 1 marks**	**Test 2 marks**	
Remember	5	5	10	7.5	7.5	15
Understand	20	20	40	12.5	12.5	25
Apply				5	5	10
Analyse						
Evaluate						
Create						

Mark distribution

Total Marks	**CIE (Marks)**	**ESE (Marks)**	**ESE Duration**
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern:

There will be two parts; Part I – Basic Civil Engineering and Part II – Basic Mechanical Engineering. Part I and PART II carries 50 marks each. For the end semester examination, part I contain 2 parts -

Part A and Part B. Part A contain 5 questions carrying 4 marks each (not exceeding 2 questions from each module). Part B contains 2 questions from each module out of which one to be answered. Each question carries 10 mark and can have maximum 2 sub-divisions. The pattern for end semester examination for part II is same as that of part I. **However, student should answer both part I and part 2 in separate answer booklets.**

Course Level Assessment Questions:

Course Outcome CO1: *To recall the role of civil engineer in society and to relate the various disciplines of Civil Engineering.*

1.Explain relevance of Civil engineering in the overall infrastructural development of the country.
Course outcome 2 (CO2) (One question from each module and not more than two)

Explain different types of buildings, building components, building materials and building construction

1. Discuss the difference between plinth area and carpet area.

Course outcome 3 (CO3) (One question from each module and not more than two)

Describe the importance, objectives and principles of surveying.

1. Explain the importance of surveying in Civil Engineering

Course outcome 4 (CO4) (One question from each module and not more than two)

Summarise the basic infrastructure services MEP, HVAC, elevators, escalators and ramps

1. Explain the civil engineering aspects of elevators, escalators and ramps in buildings

Course outcome 5 (CO5) (One question from each module and not more than two)

Discuss the Materials, energy systems, water management and environment for green buildings.

1. Discuss the relevance of Green building in society

Section II *Answer any 1 full question from each module. Each full question carries 10 marks*

Course Outcome 1 (CO1) (Two full question from each module and each question can have maximum 2 sub-divisions)

To recall the role of civil engineer in society and to relate the various disciplines of Civil Engineering
CO Questions

1. a List out the types of building as per occupancy. Explain any two, each in about five sentences.
b. Discuss the components of a building with a neat figure.
2. a. What are the major disciplines of civil engineering and explain their role in the infrastructural framework.

b. Explain the role of NBC, KBR & CRZ norms in building rules and regulations prevailing in our country.

Course Outcome 2 (CO2) & Course Outcome 3 (CO3) (Two full question from each module and each question can have maximum 2 sub-divisions)

Explain different types of buildings, building components, building materials and building construction & Describe the importance, objectives and principles of surveying.

CO Questions

1. **a.** What are the different kinds of cement available and what is their use.
   b. List the properties of good building bricks. Explain any five.
2. a. List and explain any five modern construction materials used for construction.
   b. Explain the objectives and principles of surveying

Course outcome 4 (CO4) & Course outcome 5 (CO5) (Two full question from each module and each question can have maximum 2 sub-divisions)

Summarise the basic infrastructure services MEP, HVAC, elevators, escalators and ramps & Discuss the Materials, energy systems, water management and environment for green buildings.

CO Questions

1. **a**. Draw the elevation and plan of one brick thick wall with English bond
   b. Explain the energy systems and water management in Green buildings

2. **a.** Draw neat sketch of the following foundations: (i) Isolated stepped footing; (ii) Cantilever footing; and (iii) Continuous footing.

   b. Discuss the civil engineering aspect of MEP and HVAC in a commercial building

Course Outcome 6 (CO6):

1. In an air standard Otto cycle the compression ratio is 7 and compression begins at 35°C, 0.1 MPa. The maximum temperature of the cycle is 1100°C. Find
   i) Heat supplied per kg of air,
   ii) Work done per kg of air,
   iii) Cycle efficiency
   Take Cp = 1.005 kJ/kgK and Cv=0.718 kJ/kgK
2. A Carnot cycle works with adiabatic compression ratio of 5 and isothermal expansion ratio of 2. The volume of air at the beginning of isothermal expansion is 0.3 m^{3}. If the maximum temperature and pressure is limited to 550K and 21 bar, determine the minimum temperature in the cycle and efficiency of the cycle.
3. In an ideal diesel cycle, the temperature at the beginning and end of compression is 65°C and 620°C respectively. The temperature at the beginning and end of the expansion is 1850°C and 850 ^{o}C. Determine the ideal efficiency of the cycle.

4. Explain the concepts of CRDI and MPFI in IC Engines.

Course Outcome 7 (CO7)

1. With the help of a neat sketch explain the working of a 4 stroke SI engine
2. Compare the working of 2 stroke and 4 stroke IC engines
3. Explain the classification of IC Engines.

Course Outcome 8(CO8):

1. Explain the working of vapour compression refrigeration system.
2. With the help of suitable sketch explain the working of a split air conditioner.
3. Define: COP, specific humidity, relative humidity and dew point temperature.

Course Outcome 9 (CO9):

1. Explain the working of a single stage centrifugal pump with sketches.
2. With the help of a neat sketch, explain the working of a reciprocating pump.
3. A turbine is to operate under a head of 25 m at 200 rpm. The discharge is 9 m^3/s. If the overall efficiency of the turbine is 90%. Determine the power developed by the turbine.

Course Outcome 10 (CO10):

1. Explain the working of belt drive and gear drive with the help of neat sketches
2. Explain a single plate clutch.
3. Sketch different types of gear trains and explain.

Course Outcome 11 (CO11):

1. Describe the operations which can be performed using drilling machine.
2. Explain the functions of runners and risers used in casting.
3. With a neat sketch, explain the working and parts of a lathe.

Model Question Paper

QP CODE: **EST120** page:3

Reg No:_____

Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY FIRST SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: EST 120

Course Name: BASICS OF CIVIL AND MECHANICAL ENGINEERING

Max. Marks: 100 Duration: 3 hours

Answer both part I and part 2 in separate answer booklets

PART I: BASIC CIVIL ENGINEERING

PART A

(Answer all questions. Each question carries 4 marks)

1. Explain relevance of Civil engineering in the overall infrastructural development of the country.
2. Discuss the difference between plinth area and carpet area.
3. Explain different types of steel with their properties.
4. What are the different kinds of cement available and what is their use?
5. Define bearing capacity of soil.

(5 x 4 = 20)

Part B

Answer one full question from each module.

MODULE I

6a. List out the types of building as per occupancy. Explain any two, each in about five sentences. (5)

b. Discuss the components of a building with a neat figure. (5)

OR

7a. What are the major disciplines of civil engineering and explain their role in the infrastructural framework. (5)

b. Explain the role of NBC, KBR & CRZ norms in building rules and regulations prevailing in our country. (5)

MODULE II

8a. What are the different kinds of cement available and what is their use. (5)

b. List the properties of good building bricks. Explain any five. (5)

OR

9a. List and explain any five modern construction materials used for construction. (5)

b. Explain the objectives and principles of surveying (5)

MODULE III

10a. Draw the elevation and plan of one brick thick wall with English bond (5)

b. Explain the energy systems and water management in Green buildings (5)

OR

11a. Draw neat sketch of the following foundations: (i) Isolated stepped footing; (ii) Cantilever footing; and (iii) Continuous footing. (5)

b. Discuss the civil engineering aspect of MEP and HVAC in a commercial building (5)

[10 x 3 = 30]

PART II: BASIC MECHANICAL ENGINEERING

PART A

Answer all questions. Each question carries 4 marks

1. Sketch the P-v and T-s diagram of a Carnot cycle and List the processes.
2. Illustrate the working of an epicyclic gear train.
3. Explain cooling and dehumidification processes.
4. Differentiate between soldering and brazing.
5. Explain the principle of Additive manufacturing.

4 x 5 = 20 marks

Part B

Answer one full question from each module.

MODULE I

6. In an air standard Otto cycle the compression ratio is 7 and compression begins at 35°C, 0.1MPa. The maximum temperature of the cycle is 1100°C. Find
   i) Heat supplied per kg of air,
   ii) Work done per kg of air,
   iii)Cycle efficiency

   Take C_p = 1.005 kJ/kgK and C_v=0.718 kJ/kgK — 10 marks

OR

7. a) Explain the working of a 4 stroke SI engine with neat sketches. — 7 marks
   b) Explain the fuel system of a petrol engine. — 3 marks

MODULE II

8. a) Explain the working of a vapour compression system with help of a block diagram. — 7 marks
   b) Define: Specific humidity, relative humidity and dew point temperature. — 3 marks

OR

9. With the help of a neat sketch, explain the working of a centrifugal pump. — 10 marks

MODULE III

10. Explain the two high, three high, four high and cluster rolling mills with neat sketches. — 10 marks

OR

11. a) Describe the arc welding process with a neat sketch. — 6 marks
    b) Differentiate between up-milling and down-milling operations. — 4 marks

SYLLABUS

Module 1

General Introduction to Civil Engineering: Relevance of Civil Engineering in the overall infrastructural development of the country. Responsibility of an engineer in ensuring the safety of built environment. Brief introduction to major disciplines of Civil Engineering like Transportation Engineering, Structural Engineering, Geo-technical Engineering, Water Resources Engineering and Environmental Engineering.

Introduction to buildings: Types of buildings, selection of site for buildings, components of a residential building and their functions.

Building rules and regulations: Relevance of NBC, KBR & CRZ norms (brief discussion only).

Building area: Plinth area, built up area, floor area, carpet area and floor area ratio for a building as per KBR.

Module 2

Surveying: Importance, objectives and principles.

Construction materials, Conventional construction materials**:** types, properties and uses of building materials: bricks, stones, cement, sand and timber

Cement concrete: Constituent materials, properties and types.

Steel: Steel sections and steel reinforcements, types and uses.

Modern construction materials:- Architectural glass, ceramics, Plastics, composite materials, thermal and acoustic insulating materials, decorative panels, waterproofing materials. Modern uses of gypsum, pre-fabricated building components (brief discussion only).

Module 3

Building Construction: Foundations: Bearing capacity of soil (definition only), functions of foundations, types – shallow and deep (brief discussion only). Load bearing and framed structures (concept only).

Brick masonry: - Header and stretcher bond, English bond & Flemish bond random rubble masonry.

Roofs and floors: - Functions, types; flooring materials (brief discussion only).

Basic infrastructure services: MEP, HVAC, elevators, escalators and ramps (Civil Engineering aspects only), fire safety for buildings.

Green buildings:- Materials, energy systems, water management and environment for green buildings. (brief discussion only).

Module 4

Analysis of thermodynamic cycles: Carnot, Otto, Diesel cycles, Derivation of efficiency of these cycles, Problems to calculate heat added, heat rejected, net work and efficiency. IC Engines: CI, SI, 2-Stroke, 4-Stroke engines. Listing the parts of different types of IC Engines. Efficiencies of IC Engines(Definitions only), Air, Fuel, cooling and lubricating systems in SI and CI Engines, CRDI, MPFI. Concept of hybrid engines.

Module 5

Refrigeration: Unit of refrigeration, reversed Carnot cycle,COP, vapour compression cycle (only description and no problems); Definitions of dry, wet & dew point temperatures, specific humidity and relative humidity, Cooling and dehumidification, Layout of unit and central air conditioners.

Description about working with sketches of: Reciprocating pump, Centrifugal pump, Pelton turbine, Francis turbine and Kaplan turbine. Overall efficiency, Problems on calculation of input and output power of pumps and turbines (No velocity triangles)

Description about working with sketches of: Belt and Chain drives, Gear and Gear trains, Single plate clutches.

Module 6

Manufacturing Process: Basic description of the manufacturing processes – Sand Casting, Forging, Rolling, Extrusion and their applications.

Metal Joining Processes: List types of welding, Description with sketches of Arc Welding, Soldering and Brazing and their applications

Basic Machining operations: Turning, Drilling, Milling and Grinding.

Description about working with block diagram of: Lathe, Drilling machine, Milling machine, CNC Machine. Principle of CAD/CAM, Rapid and Additive manufacturing.

Text Books:

1. Rangwala, S. C., Essentials of Civil Engineering, Charotar Publishing House
2. Mckay, W.B. and Mckay, J. K., Building Construction, Volumes 1 to 4, Pearson India Education Services

References Books:

1. Chen W.F and Liew J Y R (Eds), The Civil Engineering Handbook. II Edition CRC Press (Taylor and Francis)
2. Chudley, R and Greeno R, Building construction handbook, Addison Wesley, Longman group, England
3. Chudley, R, Construction Technology, Vol. I to IV, Longman group, England Course Plan
4. Kandya A A, Elements of Civil Engineering, Charotar Publishing house
5. Mamlouk, M. S., and Zaniewski, J. P., Materials for Civil and Construction Engineering, Pearson Publishers
6. Rangwala S.C and Dalal K B Building Construction Charotar Publishing house
7. Clifford, M., Simmons, K. and Shipway, P., An Introduction to Mechanical Engineering Part I - CRC Press
8. Roy and Choudhary, Elements of Mechanical Engineering, Media Promoters &Publishers Pvt. Ltd., Mumbai.
9. Sawhney, G. S., Fundamentals of Mechanical Engineering, PHI
10. G Shanmugam, M S Palanichamy, Basic Civil and Mechanical Engineering, McGraw Hill Education; First edition, 2018
11. Benjamin,J.,Basic Mechanical Engineering,Pentex Books,9th Edition,2018
12. Balachandran, P.Basic Mechanical Engineering,Owl Books

Course Contents and Lecture Schedule:

No	Topic	Course outcomes addressed	No. of Lectures
1	**Module I**		**Total: 7**
1.1	*General Introduction to Civil Engineering*: Relevance of Civil Engineering in the overall infrastructural development of the country. Responsibility of an engineer in ensuring the safety of built environment.	CO1	1
1.2	Brief introduction to major disciplines of Civil Engineering like Transportation Engineering, Structural Engineering, Geo-technical Engineering, Water Resources Engineering and Environmental Engineering.	CO1	2
1.3	*Introduction to buildings:* Types of buildings, selection of site for buildings, components of a residential building and their functions.	CO2	2
1.4	*Building rules and regulations:* Relevance of NBC, KBR & CRZ norms (brief discussion only)	CO2	1
1.5	*Building area:* Plinth area, built up area, floor area, carpet area and floor area ratio for a building as per KBR.	CO2	1
2	**Module 2**		**Total: 7**
2.1	*Surveying:* Importance, objectives and principles.	CO3	1
2.2	Bricks: - Classification, properties of good bricks, and tests on bricks	CO2	1
2.3	Stones: - *Qualities* of good stones, types of stones and their uses. Cement: - Good qualities of cement, types of cement and their uses.	CO2	1
2.4	Sand: - Classification, qualities of good sand and sieve analysis (basics only). Timber: - Characteristics, properties and uses.	CO2	1
2.5	Cement concrete: - Constituent materials, properties and types, Steel: - Steel sections and steel reinforcements, types and uses.	CO2	1

2.6	Modern construction materials: - Architectural glass, ceramics, plastics, composite materials, thermal and acoustic insulating materials, decorative panels, waterproofing materials, modern uses of gypsum, pre-fabricated building components (brief discussion only)	CO2	2
3	**Module 3**		**Total: 7**
3.1	Foundations: - Bearing capacity of soil (definition only), functions of foundations, types – shallow and deep (brief discussion only). Brick masonry: - Header and stretcher bond, English bond & Flemish bond– elevation and plan (one & one and a half brick wall only). Random rubble masonry.	CO2	2
3.2	Roofs: Functions, types; roofing materials (brief discussion only) Floors: Functions, types; flooring materials (brief discussion only)	CO2	2
3.3	*Basic infrastructure services:* MEP, HVAC, Elevators, escalators and ramps (Civil Engineering aspects only) fire safety for buildings	CO4	2
3.4	*Green buildings:*- Materials, energy systems, water management and environment for green buildings. (brief discussion only)	CO5	1
4	**MODULE 4**		
4.1	Analysis of thermodynamic cycles: Carnot, Otto, and Diesel cycle- Derivation of efficiency of these cycles, Problems to calculate heat added, heat rejected, net work and efficiency		4
4.2	IC Engines: CI, SI, 2-Stroke, 4-Stroke engines. Listing the parts of different types of IC Engines, efficiencies of IC Engines(Description only)		2
4.3	Air, Fuel, cooling and lubricating systems in SI and CI Engines, CRDI, MPFI. Concept of hybrid engines		2
5	**MODULE 5**		
5.1	Refrigeration: Unit of refrigeration, reversed Carnot cycle, COP, vapour compression cycle (only description and no problems)		1
5.2	Definitions of dry, wet & dew point temperatures, specific humidity and relative humidity, Cooling and dehumidification, Layout of unit and central air conditioners.		1

5.3	Description about working with sketches : Reciprocating pump, Centrifugal pump, Pelton turbine, Francis turbine and Kaplan turbine. Overall efficiency, Problems on calculation of input and output power of pumps and turbines (No velocity triangles)	4
5.4	Description about working with sketches of: Belt and Chain drives, Gear and Gear trains, Single plate clutches	3
6	**MODULE 6**	
6.1	Manufacturing Process: Basic description of the manufacturing processes – Sand Casting, Forging, Rolling, Extrusion and their applications.	2
6.2	Metal Joining Processes :List types of welding, Description with sketches of Arc Welding, Soldering and Brazing, and their applications	1
6.3	Basic Machining operations: Turning, Drilling, Milling and Grinding Description about working with block diagrams of: Lathe, Drilling machine, Milling machine, CNC Machine	3
6.4	Principle of CAD/CAM, Rapid and Additive manufacturing	1

EST 130	BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		ESC	4	0	0	4	2019

Preamble:

This course aims to (1) equip the students with an understanding of the fundamental principles of electrical engineering(2) provide an overview of evolution of electronics, and introduce the working principle and examples of fundamental electronic devices and circuits (3) provide an overview of evolution of communication systems, and introduce the basic concepts in radio communication.

Prerequisite: Physics and Mathematics (Pre-university level)

Course Outcomes: After the completion of the course the student will be able to

CO 1	Apply fundamental concepts and circuit laws to solve simple DC electric circuits
CO 2	Develop and solve models of magnetic circuits
CO 3	Apply the fundamental laws of electrical engineering to solve simple ac circuits in steady state
CO 4	Describe working of a voltage amplifier
CO 5	Outline the principle of an electronic instrumentation system
CO 6	Explain the principle of radio and cellular communication

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	1	-	-	-	-	-	-	-	-	-	2
CO 2	3	1	-	-	-	-	-	-	-	-	-	2
CO 3	3	1	-	-	-	-	-	-	-	-	-	2
CO 4	2	-	-	-	-	-	-	-	-	-	-	-
CO 5	2	-	-	-	-	-	-	-	-	-	-	2
CO 6	2	-	-	-	-	-	-	-	-	-	-	2

Assessment Pattern

Bloom's Category	Basic Electrical Engineering			Basic Electronics Engineering		
	Continuous Assessment Tests		End Semester Examination (Marks)	Continuous Assessment Tests		End Semester Examination (Marks)
	Test 1 (Marks)	Test 2 (Marks)		Test 1 (Marks)	Test 2 (Marks)	
Remember	0	0	10	10	10	20
Understand	12.5	12.5	20	15	15	30
Apply	12.5	12.5	20			
Analyse						
Evaluate						
Create						

Mark distribution

Total Marks	CIE marks	ESE marks	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part I – Basic Electrical Engineering and Part II – Basic Electronics Engineering. Part I and PART II carries 50 marks each. For the end semester examination, part I contain 2 parts - Part A and Part B. Part A contain 5 questions carrying 4 marks each (not exceeding 2 questions from each module). Part B contains 2 questions from each module out of which one to be answered. Each question carries 10 mark and can have maximum 2 sub-divisions. The pattern for end semester examination for part II is same as that of part I. **However, student should answer both part I and part 2 in separate answer booklets.**

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Solve problems based on current division rule.

2. Solve problems with Mesh/node analysis.

3. Solve problems on Wye-Delta Transformation.

Course Outcome 2 (CO2):

1. Problems on series magnetic circuits

2. Problems on parallel magnetic circuits

3. Problems on composite magnetic ciruits

4. **Course Outcome 3 (CO3):**

1. problems on self inductance, mutual inductance and coefficient of coupling

2. problems on rms and average values of periodic waveforms

3. problems on series ac circuits

4. Compare star and Delta connected 3 phase AC systems.

Course Outcome 4 (CO4): Describe working of a voltage amplifier

1.What is the need of voltage divider biasing in an RC coupled amplifier?

2. Define operating point in the context of a BJT amplifier.

3. Why is it required to have a voltage amplifier in a public address system?

Course Outcome 5 (CO5): Outline the principle of an electronic instrumentation system

1. Draw the block diagram of an electronic instrumentation system.

2. What is a transducer?

3. Explain the working principle of operation of digital multimeter.

Course Outcome 6 (CO6): Explain the principle of radio and cellular communication

1. What is the working principle of an antenna when used in a radio transmitter?

2. What is the need of two separate sections RF section and IF section in a super heterodyne receiver?

3. What is meant by a cell in a cellular communication?

Model Question Paper

QP CODE: Pages: 3

Reg No.:_____

Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY FIRST SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: EST 130

Course Name: BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING

Max. Marks: 100 Duration: 3 hours

Answer both part I and part 2 in separate answer booklets

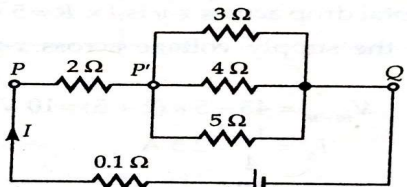
PART I

BASIC ELECTRICAL ENGINEERING

PART A

Answer all questions; each question carries 4 marks.

1. Calculate the current through the 4Ω resistor in the circuit shown, applying current division rule:



2. Calculate the RMS and average values of a purely sinusoidal current having peak value 15A.

3. An alternating voltage of (80+j60)V is applied to an RX circuit and the current flowing through the circuit is (-4+j10)A. Calculate the impedance of the circuit in rectangular and polar forms. Also determine if X is inductive or capacitive.

4. Derive the relation between line and phase values of voltage in a three phase star connected system.

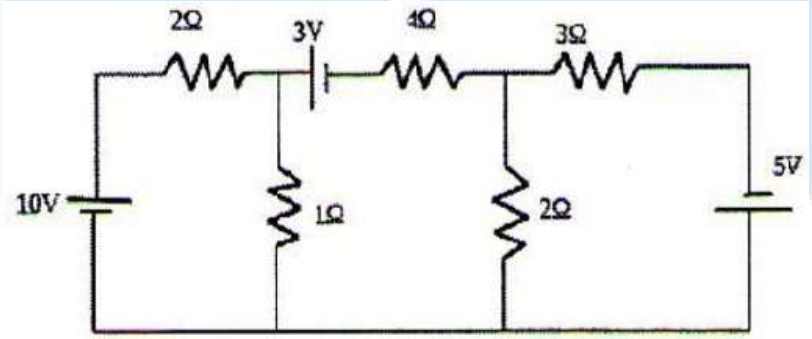
5. Compare electric and magnetic circuits. *(5x4=20)*

PART B

Answer one question from each module; each question carries 10 marks.

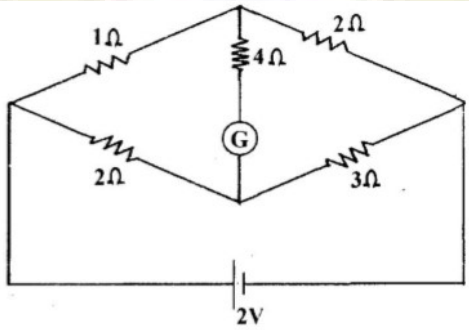
Module 1

6. . Calculate the node voltages in the circuit shown, applying node analysis:



7. (a) State and explain Kirchhoff's laws. (4 marks)

(b) Calculate the current through the galvanometer (G) in the circuit shown:



(6 marks)

Module 2

8. (a) State and explain Faraday's laws of electromagnetic induction with examples. (4 marks)

(b) Differentiate between statically and dynamically induced emf. A conductor of length 0.5m moves in a uniform magnetic field of flux density 1.1T at a velocity of 30m/s. Calculate the emf induced in the conductor if the direction of motion of the conductor is inclined at 60^0 to the direction of field. (6 marks)

9. (a) Derive the amplitude factor and form factor of a purely sinusoidal waveform. (5 marks)

(b) A current wave is made up of two components-a 5A dc component and a 50Hz ac component, which is a sinusoidal wave with a peak value of 5A. Sketch the resultant waveform and determine its RMS and average values. (5 marks)

Module 3

10. Draw the power triangle and define active, reactive and apparent powers in ac circuits. Two coils A and B are connected in series across a 240V, 50Hz supply. The resistance of A is 5Ω and the inductance of B is 0.015H. If the input from the supply is 3kW and 2kVAR, find the inductance of A and the resistance of B. Also calculate the voltage across each coil.

11. A balanced three phase load consists of three coils each having resistance of 4Ω and inductance 0.02H. It is connected to a 415V, 50Hz, 3-phase ac supply. Determine the phase voltage, phase current, power factor and active power when the loads are connected in (i) star (ii) delta.

(3x10=30)

PART II

BASIC ELECTRONICS ENGINEERING

PART A

Answer all questions; each question carries 4 marks.

1. Give the specifications of a resistor. The colour bands marked on a resistor are Blue, Grey, Yellow and Gold. What are the minimum and maximum resistance values expected from that resistance?
2. What is meant by avalanche breakdown?
3. Explain the working of a full-wave bridge rectifier.
4. Discuss the role of coupling and bypass capacitors in a single stage RC coupled amplifier.
5. Differentiate AM and FM communication systems.

(5x4=20)

PART B

Answer one question from each module; each question carries 10 marks.

Module 4

6. a) Explain with diagram the principle of operation of an NPN transistor. (5)
   b) Sketch and explain the typical input-output characteristics of a BJT when connected in common emitter configuration. (5)

OR

7. a) Explain the formation of a potential barrier in a P-N junction diode. (5)
   b) What do you understand by Avalanche breakdown? Draw and explain the V-I characteristics of a P-N junction and Zener diode. (5)

Module 5

8. a) With a neat circuit diagram, explain the working of an RC coupled amplifier. (6)
   b) Draw the frequency response characteristics of an RC coupled amplifier and state the reasons for the reduction of gain at lower and higher frequencies. (4)

OR

9. a) With the help of block diagram, explain how an electronic instrumentation system. (6)
   b) Explain the principle of an antenna. (4)

Module 6

10. a) With the help of a block diagram, explain the working of Super hetrodyne receiver. (6)
    b) Explain the importance of antenna in a communication system. (4)

OR

11. a) With neat sketches explain a cellular communication system. (5)
    b) Explain GSM communication with the help of a block diagram. (5)

(3x10=30)

SYLLABUS

MODULE 1: Elementary Concepts of Electric Circuits

Elementary concepts of DC electric circuits: Basic Terminology including voltage, current, power, resistance, emf; Resistances in series and parallel; Current and Voltage Division Rules; Capacitors & Inductors: V-I relations and energy stored. Ohms Law and Kirchhoff's laws-Problems; Star-delta conversion (resistive networks only-derivation not required)-problems.

Analysis of DC electric circuits: Mesh current method - Matrix representation - Solution of network equations. Node voltage methods-matrix representation-solution of network equations by matrix methods. Numerical problems.

MODULE 2: Elementary Concepts of Magnetic circuits, Electromagnetic Induction and AC fundamentals

Magnetic Circuits: Basic Terminology: MMF, field strength, flux density, reluctance - comparison between electric and magnetic circuits- Series and parallel magnetic circuits with composite materials, numerical problems.

Electromagnetic Induction: Faraday's laws, problems, Lenz's law- statically induced and dynamically induced emfs - Self-inductance and mutual inductance, coefficient of coupling

Alternating Current fundamentals: Generation of alternating voltages-Representation of sinusoidal waveforms: frequency, period, Average, RMS values and form factor of waveforms-Numerical Problems.

MODULE 3: AC Circuits

AC Circuits: Phasor representation of sinusoidal quantities. Trignometric, Rectangular, Polar and complex forms. Analysis of simple AC circuits: Purely resistive, inductive & capacitive circuits; Inductive and capacitive reactance, concept of impedance. Average Power Power factor. Analysis of RL, RC and RLC series circuits-active, reactive and apparent power. Simple numerical problems.

Three phase AC systems: Generation of three phase voltages; advantages of three phase systems, star and delta connections (balanced only), relation between line and phase voltages, line and phase currents- Numerical problems

MODULE 4

Introduction to Semiconductor devices: Evolution of electronics – Vacuum tubes to nano electronics. Resistors, Capacitors and Inductors (constructional features not required): types, specifications. Standard values, color coding. PN Junction diode: Principle of operation, V-I characteristics, principle of avalanche breakdown. Bipolar Junction Transistors: PNP and NPN structures, Principle of operation, relation between current gains in CE, CB and CC, input and output characteristics of common emitter configuration.

MODULE 5

Basic electronic circuits and instrumentation: Rectifiers and power supplies: Block diagram description of a dc power supply, Working of a full wave bridge rectifier, capacitor filter (no analysis), working of simple zener voltage regulator. Amplifiers: Block diagram of Public Address system, Circuit diagram and working of common emitter (RC coupled) amplifier with its frequency response, Concept of voltage divider biasing. Electronic Instrumentation: Block diagram of an electronic instrumentation system.

MODULE 6

Introduction to Communication Systems: Evolution of communication systems – Telegraphy to 5G. Radio communication: principle of AM & FM, frequency bands used for various communication systems, block diagram of super heterodyne receiver, Principle of antenna – radiation from accelerated charge. Mobile communication: basic principles of cellular communications, principle and block diagram of GSM.

Text Books

1. D P Kothari and I J Nagrath, "Basic Electrical Engineering", Tata McGraw Hill, 2010.
2. D C Kulshreshtha, "Basic Electrical Engineering", Tata McGraw Hill, 2010.
3. ChinmoySaha, Arindham Halder and Debarati Ganguly, Basic Electronics - Principles and Applications, Cambridge University Press, 2018.
4. M.S.Sukhija and T.K.Nagsarkar, Basic Electrical and Electronics Engineering, Oxford University Press, 2012.
5. Wayne Tomasi and Neil Storey, A Textbook On Basic Communication and Information Engineering, Pearson, 2010.

Reference Books

1. Del Toro V, "Electrical Engineering Fundamentals", Pearson Education.
2. T. K. Nagsarkar, M. S. Sukhija, "Basic Electrical Engineering", Oxford Higher Education.
3. Hayt W H, Kemmerly J E, and Durbin S M, "Engineering Circuit Analysis", Tata McGraw-Hill
4. Hughes, "Electrical and Electronic Technology", Pearson Education.
5. V. N. Mittle and Arvind Mittal, "Basic Electrical Engineering," Second Edition, McGraw Hill.
6. Parker and Smith, "Problems in Electrical Engineering", CBS Publishers and Distributors.
7. S. B. Lal Seksena and Kaustuv Dasgupta, "Fundamentals of Electrical Engineering", Cambridge University Press.
8. Anant Agarwal, Jeffrey Lang, Foundations of Analog and Digital Electronic Circuits, Morgan Kaufmann Publishers, 2005.
9. Bernard Grob, Ba sic Electronics, McGraw Hill.
10. A. Bruce Carlson, Paul B. Crilly, Communication Systems: An Introduction to Signals and Noise in Electrical Communication, Tata McGraw Hill, 5th Edition.

COURSE CONTENTS AND LECTURE SCHEDULE

No	Topic	No. of Lectures
1	***Elementary Concepts of Electric Circuits***	
1.1	**Elementary concepts of DC electric circuits:** Basic Terminology including voltage, current, power, resistance, emf; Resistances in series and parallel; Current and Voltage Division Rules; Capacitors & Inductors: V-I relations and energy stored. Ohms Law and Kirchhoff's laws-Problems; Star-delta conversion (resistive networks only-derivation not required)-problems.	1 2 1
1.2	**Analysis of DC electric circuits:** Mesh current method - Matrix representation - Solution of network equations. Node voltage methods-matrix representation-solution of network equations by matrix methods. Numerical problems.	1 1 2
2	**Elementary Concepts of Magnetic circuits, Electromagnetic Induction and AC fundamentals**	
2.1	**Magnetic Circuits:** Basic Terminology: MMF, field strength, flux density, reluctance - comparison between electric and magnetic circuits- Series and parallel magnetic circuits with composite materials, numerical problems.	1 2
2.2	**Electromagnetic Induction:** Faraday's laws, problems, Lenz's law-statically induced and dynamically induced emfs - Self-inductance and mutual inductance, coefficient of coupling	1 2
2.3	**Alternating Current fundamentals:** Generation of alternating voltages-Representation of sinusoidal waveforms: frequency, period, Average, RMS values and form factor of waveforms-Numerical Problems.	2
3	**AC Circuits**	

3.1	**AC Circuits:** Phasor representation of sinusoidal quantities. Trigonometric, Rectangular, Polar and complex forms. Analysis of simple AC circuits: Purely resistive, inductive & capacitive circuits; Inductive and capacitive reactance, concept of impedance. Average Power, Power factor. Analysis of RL, RC and RLC series circuits-active, reactive and apparent power. Simple numerical problems.	1 2 1 2
3.2	**Three phase AC systems:** Generation of three phase voltages; advantages of three phase systems, star and delta connections (balanced only), relation between line and phase voltages, line and phase currents- Numerical problems.	2
4	**Introduction to Semiconductor devices**	
4.1	Evolution of electronics – Vacuum tubes to nano electronics (In evolutional perspective only)	1
4.2	Resistors, Capacitors and Inductors: types, specifications. Standard values, color coding (No constructional features)	2
4.3	**PN Junction diode**: Principle of operation, V-I characteristics, principle of avalanche breakdown	2
4.4	**Bipolar Junction Transistors:** PNP and NPN structures, Principle of operation, relation between current gains in CE, CB and CC, input and output characteristics of common emitter configuration	3
5	**Basic electronic circuits and instrumentation**	
5.1	**Rectifiers and power supplies:** Block diagram description of a dc power supply, Working of a full wave bridge rectifier, capacitor filter (no analysis), working of simple zener voltage regulator	3
5.2	**Amplifiers:** Block diagram of Public Address system, Circuit diagram and working of common emitter (RC coupled) amplifier with its frequency response, Concept of voltage divider biasing	4
5.3	**Electronic Instrumentation:** Block diagram of an electronic instrumentation system	2
6	**Introduction to Communication Systems**	
6.1	Evolution of communication systems – Telegraphy to 5G	1

6.2	**Radio communication:** principle of AM & FM, frequency bands used for various communication systems, block diagram of super heterodyne receiver, Principle of antenna – radiation from accelerated charge	4
6.3	**Mobile communication:** basic principles of cellular communications, principle and block diagram of GSM.	2

Suggested Simulation Assignments for Basic Electronics Engineering

1. Plot V-I characteristics of Si and Ge diodes on a simulator
2. Plot Input and Output characteristics of BJT on a simulator
3. Implementation of half wave and full wave rectifiers
4. Simulation of RC coupled amplifier with the design supplied
5. Generation of AM signal

Note: The simulations can be done on open tools such as QUCS, KiCad, GNURadio or similar software to augment the understanding.

HUN 101	LIFE SKILLS	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		MNC	2	0	2	---	2019

Preamble: Life skills are those competencies that provide the means for an individual to be resourceful and positive while taking on life's vicissitudes. Development of one's personality by being aware of the self, connecting with others, reflecting on the abstract and the concrete, leading and generating change, and staying rooted in time-tested values and principles is being aimed at. This course is designed to enhance the employability and maximize the potential of the students by introducing them to the principles that underly personal and professional success, and help them acquire the skills needed to apply these principles in their lives and careers.

Prerequisite: None

Course Outcomes: After the completion of the course the student will be able to

CO 1	Define and Identify different life skills required in personal and professional life
CO 2	Develop an awareness of the self and apply well-defined techniques to cope with emotions and stress.
CO 3	Explain the basic mechanics of effective communication and demonstrate these through presentations.
CO 4	Take part in group discussions
CO 5	Use appropriate thinking and problem solving techniques to solve new problems
CO 6	Understand the basics of teamwork and leadership

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1						2		1	2	2	1	3
CO 2									3			2
CO 3						1			1	3		
CO 4										3		1
CO 5		3	2	1								
CO 6						1			3			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	50	50	2 hours

Continuous Internal Evaluation
Total Marks: 50

Attendance	: 10 marks
Regular assessment	: 15 marks
Series test (one test only, should include first three modules)	: 25 marks

Regular assessment

- Group Discussion (Marks: 9)

  Create groups of about 6 students each and engage them on a GD on a suitable topic for about 20 minutes. Parameters to be used for evaluation are as follows:

  - Communication Skills : 3 marks
  - Subject Clarity : 2 marks
  - Group Dynamics : 2 marks
  - Behaviours & Mannerisms : 2 marks

- Presentation Skills (Marks: 6)

  Identify a suitable topic and ask the students to prepare a presentation (preferably a power point presentation) for about 10 minutes. Parameters to be used for evaluation are as follows:

  - Communication Skills : 2 marks
  - Platform Skills : 2 marks
  - Subject Clarity/Knowledge : 2 marks

End Semester Examination
Total Marks: 50 **Time: 2 hrs.**

Part A: Short answer question (25 marks)
There will be one question from each MODULE (five questions in total, five marks each). Each question should be written in about maximum of 400 words. Parameters to be used for evaluation are as follows:
(i) Content Clarity/Subject Knowledge
(ii) Presentation style
(iii) Organization of content

Part B: Case Study (25 marks)
The students will be given a case study with questions at the end. The students have to analyze the case and answer the question at the end. Parameters to be used for evaluation are as follows:
(i) Analyze the case situation
(ii) Key players/characters of the case
(iii) Identification of the problem (both major & minor if exists)
(iv) Bring out alternatives
(v) Analyze each alternative against the problem
(vi) Choose the best alternative
(vii) Implement as solution
(viii) Conclusion

(ix) Answer the question at the end of the case

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. List 'life skills' as identified by WHO
2. What do you mean by effective communication?
3. What are the essential life skills required by a professional?

Course Outcome 2 (CO2)

1. Identify an effective means to deal with workplace stress.
2. How can a student apply journaling to stress management?
3. What is the PATH method? Describe a situation where this method can be used effectively.

Course Outcome 3(CO3):

1. Identify the communication network structure that can be observed in the given situations. Describe them.

   (a) A group discussion on development.

   (b) An address from the Principal regarding punctuality.

   (c) A reporter interviewing a movie star.

   (d) Discussing the answers of a test with a group of friends.

2. Elucidate the importance of non-verbal communication in making a presentation
3. Differentiate between kinesics, proxemics, and chronemics with examples.

Course Outcome 4 (CO4):

1. How can a participant conclude a group discussion effectively?
2. 'Listening skills are essential for effectively participating in a group discussion.' Do you agree? Substantiate your answer.

Course Outcome 5 (CO5):

1. Illustrate the creative thinking process with the help of a suitable example
2. Translate the following problem from verbal to graphic form and find the solution : *In a quiz, Ananth has 50 points more than Bimal, Chinmay has 60 points less than Ananth, and Dharini is 20 points ahead of Chinmay. What is the difference in points between Bimal and Dharini?*

3. List at least five ways in which the problem "How to increase profit?" can be redefined

Course Outcome 6 (CO6):

1. A group of engineers decided to brainstorm a design issue on a new product. Since no one wanted to disagree with the senior members, new ideas were not flowing freely. What group dynamics technique would you suggest to avoid this 'groupthink'? Explain the procedure.
2. "A group focuses on individual contribution, while a team must focus on synergy." Explain.
3. Identify the type of group formed / constituted in each of the given situations

    a) A Police Inspector with subordinates reporting to him

    b) An enquiry committee constituted to investigate a specific incident

    c) The Accounts Department of a company

    d) A group of book lovers who meet to talk about reading

Syllabus

Module 1

Overview of Life Skills: Meaning and significance of life skills, Life skills identified by WHO: Self-awareness, Empathy, Critical thinking, Creative thinking, Decision making, problem solving, Effective communication, interpersonal relationship, coping with stress, coping with emotion.

Life skills for professionals: positive thinking, right attitude, attention to detail, having the big picture, learning skills, research skills, perseverance, setting goals and achieving them, helping others, leadership, motivation, self-motivation, and motivating others, personality development, IQ, EQ, and SQ

Module 2

Self-awareness: definition, need for self-awareness; Coping With Stress and Emotions, Human Values, tools and techniques of SA: questionnaires, journaling, reflective questions, meditation, mindfulness, psychometric tests, feedback.

Stress Management: Stress, reasons and effects, identifying stress, stress diaries, the four A's of stress management, techniques, Approaches: action-oriented, emotion-oriented, acceptance-oriented, resilience, Gratitude Training,

Coping with emotions: Identifying and managing emotions, harmful ways of dealing with emotions, PATH method and relaxation techniques.

Morals, Values and Ethics: Integrity, Civic Virtue, Respect for Others, Living Peacefully. Caring, Sharing, Honesty, Courage, Valuing Time, Time management, Co operation, Commitment, Empathy, Self-Confidence, Character, Spirituality, Avoiding Procrastination, Sense of Engineering Ethics.

Module 3

21st century skills: Creativity, Critical Thinking, Collaboration, Problem Solving, Decision Making, Need for Creativity in the 21st century, Imagination, Intuition, Experience, Sources of Creativity, Lateral Thinking, Myths of creativity, Critical thinking Vs Creative thinking, Functions of Left Brain & Right brain, Convergent & Divergent Thinking, Critical reading & Multiple Intelligence.

Steps in problem solving: Problem Solving Techniques, Six Thinking Hats, Mind Mapping, Forced Connections. Analytical Thinking, Numeric, symbolic, and graphic reasoning. Scientific temperament and Logical thinking.

Module 4

Group and Team Dynamics: Introduction to Groups: Composition, formation, Cycle, thinking, Clarifying expectations, Problem Solving, Consensus, Dynamics techniques, Group vs Team, Team Dynamics, Virtual Teams. Managing team performance and managing conflicts, Intrapreneurship.

Module 5

Leadership: Leadership framework, entrepreneurial and moral leadership, vision, cultural dimensions. Growing as a leader, turnaround leadership, managing diverse stakeholders, crisis management. Types of Leadership, Traits, Styles, VUCA Leadership, Levels of Leadership, Transactional vs Transformational Leaders, Leadership Grid, Effective Leaders.

Lab Activities

Verbal

Effective communication and Presentation skills.
Different kinds of communication; Flow of communication; Communication networks, Types of barriers; Miscommunication
Introduction to presentations and group discussions.
Learning styles: visual, aural, verbal, kinaesthetic, logical, social, solitary; Previewing, KWL table, active listening, REAP method
Note-taking skills: outlining, non-linear note-taking methods, Cornell notes, three column note taking.
Memory techniques: mnemonics, association, flashcards, keywords, outlines, spider diagrams and mind maps, spaced repetition.
Time management: auditing, identifying time wasters, managing distractions, calendars and checklists; Prioritizing - Goal setting, SMART goals; Productivity tools and apps, Pomodoro technique.

Non Verbal:
Non-verbal Communication and Body Language: Forms of non-verbal communication; Interpreting body-language cues; Kinesics; Proxemics; Chronemics; Effective use of body language, Communication in a multi cultural environment.

Reference Books

1. Shiv Khera, You Can Win, Macmillan Books, New York, 2003.
2. Barun K. Mitra, “Personality Development & Soft Skills”, Oxford Publishers, Third impression, 2017.
3. ICT Academy of Kerala, "Life Skills for Engineers", McGraw Hill Education (India) Private Ltd., 2016.
4. Caruso, D. R. and Salovey P, “The Emotionally Intelligent Manager: How to Develop and Use the Four Key Emotional Skills of Leadership”, John Wiley & Sons, 2004.
5. Kalyana, “Soft Skill for Managers”; First Edition; Wiley Publishing Ltd, 2015.
6. Larry James, “The First Book of Life Skills”; First Edition, Embassy Books, 2016.
7. Shalini Verma, “Development of Life Skills and Professional Practice”; First Edition; Sultan Chand (G/L) & Company, 2014.
8. Daniel Goleman, "Emotional Intelligence"; Bantam, 2006.
9. Remesh S., Vishnu R.G., "Life Skills for Engineers", Ridhima Publications, First Edition, 2016.
10. Butterfield Jeff, “Soft Skills for Everyone”, Cengage Learning India Pvt Ltd; 1 edition, 2011.
11. Training in Interpersonal Skills: Tips for Managing People at Work, Pearson Education, India; 6 edition, 2015.
12. The Ace of Soft Skills: Attitude, Communication and Etiquette for Success, Pearson Education; 1 edition, 2013.

PHL 120	ENGINEERING PHYSICS LAB	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		BSC	0	0	2	1	2019

Preamble: The aim of this course is to make the students gain practical knowledge to co-relate with the theoretical studies and to develop practical applications of engineering materials and use the principle in the right way to implement the modern technology.

Prerequisite: Higher secondary level Physics

Course Outcomes: After the completion of the course the student will be able to

CO 1	Develop analytical/experimental skills and impart prerequisite hands on experience for engineering laboratories
CO 2	Understand the need for precise measurement practices for data recording
CO 3	Understand the principle, concept, working and applications of relevant technologies and comparison of results with theoretical calculations
CO 4	Analyze the techniques and skills associated with modern scientific tools such as lasers and fiber optics
CO 5	Develop basic communication skills through working in groups in performing the laboratory experiments and by interpreting the results

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3				3			1	2			1
CO 2	3				3			1	2			1
CO 3	3				3			1	2			1
CO 4	3				3			1	2			1
CO 5	3				3			1	2			1

Mark distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration(Internal)
100	100	-	1 hour

Continuous Internal Evaluation Pattern:

Attendance	: 20 marks
Class work/ Assessment /Viva-voce	: 50 marks
End semester examination (Internally by college)	: 30 marks

End Semester Examination Pattern: Written Objective Examination of one hour

SYLLABUS

LIST OF EXPERIMENTS

(Minimum 8 experiments should be completed)

1. CRO-Measurement of frequency and amplitude of wave forms
2. Measurement of strain using strain gauge and wheatstone bridge
3. LCR Circuit – Forced and damped harmonic oscillations
4. Melde's string apparatus- Measurement of frequency in the transverse and longitudinal mode
5. Wave length measurement of a monochromatic source of light using Newton's Rings method.
6. Determination of diameter of a thin wire or thickness of a thin strip of paper using air wedge method.
7. To measure the wavelength using a millimeter scale as a grating.
8. Measurement of wavelength of a source of light using grating.
9. Determination of dispersive power and resolving power of a plane transmission grating
10. Determination of the particle size of lycopodium powder
11. Determination of the wavelength of He-Ne laser or any standard laser using diffraction grating
12. Calculate the numerical aperture and study the losses that occur in optical fiber cable.
13. I-V characteristics of solar cell.
14. LED Characteristics.
15. Ultrasonic Diffractometer- Wavelength and velocity measurement of ultrasonic waves in a liquid
16. Deflection magnetometer-Moment of a magnet- Tan A position.

Reference books

1. S.L.Gupta and Dr.V.Kumar, "Practical physics with viva voice", Pragati PrakashanPublishers, Revised Edition, 2009

2. M.N.Avadhanulu, A.A.Dani and Pokely P.M, "Experiments in Engineering Physics", S.Chand&Co,2008

3. S. K. Gupta, "Engineering physics practicals", Krishna Prakashan Pvt. Ltd., 2014

4. P. R. Sasikumar "Practical Physics", PHI Ltd., 2011.

CYL 120	ENGINEERING CHEMISTRY LAB	CATEGORY	L	T	P	CREDIT
		BSC	0	0	2	1

Preamble: To impart scientific approach and to familiarize with the experiments in chemistry relevant for research projects in higher semesters

Prerequisite: Experiments in chemistry introduced at the plus two levels in schools

Course outcomes: After the completion of the course the students will be able to

CO 1	Understand and practice different techniques of quantitative chemical analysis to generate experimental skills and apply these skills to various analyses
CO 2	Develop skills relevant to synthesize organic polymers and acquire the practical skill to use TLC for the identification of drugs
CO 3	Develop the ability to understand and explain the use of modern spectroscopic techniques for analysing and interpreting the IR spectra and NMR spectra of some organic compounds
CO 4	Acquire the ability to understand, explain and use instrumental techniques for chemical analysis
CO 5	Learn to design and carry out scientific experiments as well as accurately record and analyze the results of such experiments
CO 6	Function as a member of a team, communicate effectively and engage in further learning. Also understand how chemistry addresses social, economical and environmental problems and why it is an integral part of curriculum

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3				2							3
CO 2	3				3							3
CO 3	3				3							3
CO 4	3				3							3
CO 5	3				1							3
CO 6	3				1							3

Mark distribution

Total Marks	CIE marks	ESE marks	ESE Duration(Internal)
100	100	-	1 hour

Continuous Internal Evaluation Pattern:

Attendance	: 20 marks
Class work/ Assessment /Viva-voce	: 50 marks
End semester examination (Internally by college)	: 30 marks

End Semester Examination Pattern: Written Objective Examination of one hour

SYLLABUS

LIST OF EXPERIMENTS (MINIMUM 8 MANDATORY)

1. Estimation of total hardness of water-EDTA method
2. Potentiometric titration
3. Determination of cell constant and conductance of solutions.
4. Calibration of pH meter and determination of pH of a solution
5. Estimation of chloride in water
6. Identification of drugs using TLC
7. Determination of wavelength of absorption maximum and colorimetric estimation of Fe^{3+} in solution
8. Determination of molar absorptivity of a compound ($KMnO_4$ or any water soluble food colorant)
9. Synthesis of polymers (a) Urea-formaldehyde resin (b) Phenol-formaldehyde resin
10. Estimation of iron in iron ore
11. Estimation of copper in brass
12. Estimation of dissolved oxygen by Winkler's method
13. (a) Analysis of IR spectra (minimum 3 spectra) (b) Analysis of ^1H NMR spectra (minimum 3 spectra)
14. Flame photometric estimation of Na^+ to find out the salinity in sand
15. Determination of acid value of a vegetable oil
16. Determination of saponification of a vegetable oil

Reference Books

1. G. Svehla, B. Sivasankar, "Vogel's Qualitative Inorganic Analysis", Pearson, 2012.
2. R. K. Mohapatra, "Engineering Chemistry with Laboratory Experiments", PHI Learning, 2017.
3. Muhammed Arif, "Engineering Chemistry Lab Manual", Owl publishers, 2019.
4. Ahad J., "Engineering Chemistry Lab manual", Jai Publications, 2019.
5. Roy K Varghese, "Engineering Chemistry Laboratory Manual", Crownplus Publishers, 2019.
6. Soney C George, Rino Laly Jose, "Lab Manual of Engineering Chemistry", S. Chand & Company Pvt Ltd, New Delhi, 2019.

ESL 120	CIVIL & MECHANICAL WORKSHOP	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
			0	0	2	1	2019

Preamble: The course is designed to train the students to identify and manage the tools, materials and methods required to execute an engineering project. Students will be introduced to a team working environment where they develop the necessary skills for planning, preparing and executing an engineering project.

To enable the student to familiarize various tools, measuring devices, practices and different methods of manufacturing processes employed in industry for fabricating components.

Prerequisite: None

Course Outcomes: After the completion of the course the student will be able to:

Course Outcome	Course Outcome Description
CO 1	Name different devices and tools used for civil engineering measurements
CO 2	Explain the use of various tools and devices for various field measurements
CO 3	Demonstrate the steps involved in basic civil engineering activities like plot measurement, setting out operation, evaluating the natural profile of land, plumbing and undertaking simple construction work.
CO 4	Choose materials and methods required for basic civil engineering activities like field measurements, masonry work and plumbing.
CO 5	Compare different techniques and devices used in civil engineering measurements
CO 6	Identify Basic Mechanical workshop operations in accordance with the material and objects
CO 7	Apply appropriate Tools and Instruments with respect to the mechanical workshop trades
CO 8	Apply appropriate safety measures with respect to the mechanical workshop trades

Mapping of course outcomes with program outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	1	-	-	-	1	1	-	-	2	2	-	-
CO 2	1	-	-	-	1	1	-	-	2	2	-	-
CO 3	1	-	-	-	1	1	-	2	2	2	1	-
CO 4	1	-	-	-	1	1	-	2	2	2	1	1
CO 5	1	-	-	-	1	1	-	-	2	2		1
CO 6	2											

CO 7	2											
CO 8	2											

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	70	30	1 hour

Assessment Procedure: Total marks allotted for the course is 100 marks. CIE shall be conducted for 70 marks and ESE for 30 marks. CIE should be done for the work done by the student and also viva voce based on the work done on each practical session. ESE shall be evaluated by written examination of one hour duration conducted internally by the institute.

Continuous Internal Evaluation Pattern:

Attendance : 20 marks
Class work/ Assessment /Viva-voce : 50 marks
End semester examination (Internally by college) : 30 marks

End Semester Examination Pattern: Written Objective Examination of one hour

SYLLABUS

PART 1

CIVIL WORKSHOP

Exercise 1. Calculate the area of a built-up space and a small parcel of land- Use standard measuring tape and digital distance measuring devices

Exercise 2. (a) Use screw gauge and vernier calliper to measure the diameter of a steel rod and thickness of a flat bar

(b) Transfer the level from one point to another using a water level

(c) Set out a one room building with a given plan and measuring tape

Exercise 3. Find the level difference between any two points using dumpy level

Exercise 4. (a) Construct a $1\frac{1}{2}$ thick brick wall of 50 cm height and 60 cm length using English bond. Use spirit level to assess the tilt of walls.

(b) Estimate the number of different types of building blocks to construct this wall.

Exercise 5. (a) Introduce the students to plumbing tools, different types of pipes, type of connections, traps, valves ,fixtures and sanitary fittings.

(b) Install a small rainwater harvesting installation in the campus

Reference Books:

1. Khanna P.N, "Indian Practical Civil Engineering Handbook", Engineers Publishers.
2. Bhavikatti. S, "Surveying and Levelling (Volume 1)", I.K. International Publishing House
3. Arora S.P and Bindra S.P, " Building Construction", Dhanpat Rai Publications
4. S. C. Rangwala, "Engineering Materials," Charotar Publishing House.

PART II

MECHANICAL WORKSHOP

LIST OF EXERCISES

(Minimum EIGHT units mandatory and FIVE models from Units 2 to 8 mandatory)

UNIT 1:- General : Introduction to workshop practice, Safety precautions, Shop floor ethics, Basic First Aid knowledge.

Study of mechanical tools, components and their applications: (a) Tools: screw drivers, spanners, Allen keys, cutting pliers etc and accessories (b) bearings, seals, O-rings, circlips, keys etc.

UNIT 2:- Carpentry : Understanding of carpentry tools

Minimum any one model

1. T –Lap joint 2. Cross lap joint 3. Dovetail joint 4. Mortise joints

UNIT 3:- Foundry : Understanding of foundry tools

Minimum any one model

1.Bench Molding 2. Floor Molding 3. Core making 4. Pattern making

UNIT 4: - Sheet Metal : Understanding of sheet metal working tools

Minimum any one model

1. Cylindrical shape
2. Conical shape
3. Prismatic shaped job from sheet metal

UNIT 5: - Fitting : Understanding of tools used for fitting

Minimum any one model

1. Square Joint
2. V- Joint
3. Male and female fitting

UNIT 6: - Plumbing : Understanding of plumbing tools, pipe joints

Any one exercise on joining of pipes making use of minimum three types of pipe joints

UNIT 7: - Smithy: Understanding of tools used for smithy.

Demonstrating the forge-ability of different materials (MS, Al, alloy steel and cast steels) in cold and hot states.

Observing the qualitative difference in the hardness of these materials

Minimum any one exercise on smithy

1. Square prism
2. Hexagonal headed bolt
3. Hexagonal prism
4. Octagonal prism

UNIT 8: -Welding: Understanding of welding equipments

Minimum any one welding practice

Making Joints using electric arc welding. bead formation in horizontal, vertical and over head positions

UNIT 9: - Assembly: Demonstration only

Dissembling and assembling of

1. Cylinder and piston assembly
2. Tail stock assembly
3. Bicycle
4. Pump or any other machine

UNIT 10: - Machines: Demonstration and applications of the following machines

Shaping and slotting machine; Milling machine; Grinding Machine; Lathe; Drilling Machine.

UNIT 11: - Modern manufacturing methods: Power tools, CNC machine tools, 3D printing, Glass cutting.

Course Contents and Lecture Schedule:

No	Topic	No of Sessions
1	**INTRODUCTION**	
1.1	Workshop practice, shop floor precautions, ethics and First Aid knowledge. Studies of mechanical tools, components and their applications: (a) Tools: screw drivers, spanners, Allen keys, cutting pliers etc and accessories (b) bearings, seals, O-rings, circlips, keys etc	1
2	**CARPENTRY**	
2.1	Understanding of carpentry tools and making minimum one model	2

3	**FOUNDRY**	
3.1	Understanding of foundry tools and making minimum one model	2
4	**SHEET METAL**	
4.1	Understanding of sheet metal working tools and making minimum one model	2
5	**FITTING**	
5.1	Understanding of fitting tools and making minimum one model	2
6	**PLUMBING**	
6.1	Understanding of pipe joints and plumbing tools and making minimum one model	2
7	**SMITHY**	
7.1	Understanding of smithy tools and making minimum one model	2
8	**WELDING**	
8.1	Understanding of welding equipments and making minimum one model	2
9	**ASSEMBLY**	
9.1	Demonstration of assembly and dissembling of multiple parts components	1
10	**MACHINES**	
10.1	Demonstration of various machines	1
11	**MODERN MANUFACTURING METHODS**	
11.1	Demonstrations of: power tools, CNC Machine tools, 3D printing, Glass cutting	1

ESL 130	ELECTRICAL & ELECTRONICS WORKSHOP	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		ESC	0	0	2	1	2019

Preamble: Electrical Workshop is intended to impart skills to plan and carry out simple electrical wiring. It is essential for the practicing engineers to identify the basic practices and safety measures in electrical wiring.

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO 1	Demonstrate safety measures against electric shocks.
CO 2	Identify the tools used for electrical wiring, electrical accessories, wires, cables, batteries and standard symbols
CO 3	Develop the connection diagram, identify the suitable accessories and materials necessary for wiring simple lighting circuits for domestic buildings
CO 4	Identify and test various electronic components
CO 5	Draw circuit schematics with EDA tools
CO 6	Assemble and test electronic circuits on boards
CO 7	Work in a team with good interpersonal skills

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	-	-	-	-	-	3	-	-	-	-	-	1
CO 2	2	-	-	-	-	-	-	-	-	1	-	-
CO 3	2	-	-	1	-	1	-	1	2	2	-	2
CO 4	3	-	-	-	-	-	-	-	-	-	-	2
CO 5	3	-	-	-	2	-	-	-	-	-	-	2
CO 6	3	-	-	-	2	-	-	-	-	-	-	1
CO 7	-	-	-	-	-	-	-	-	3	2	-	2

Mark distribution

Total Marks	CIE	ESE	ESE Duration(Internal)
100	100	-	1 hour

Continuous Internal Evaluation Pattern:

Attendance	: 20 marks
Class work/ Assessment /Viva-voce	: 50 marks
End semester examination (Internally by college)	: 30 marks

End Semester Examination Pattern: Written Objective Examination of one hour

Syllabus

PART 1

ELECTRICAL

List of Exercises / Experiments

1. a) Demonstrate the precautionary steps adopted in case of Electrical shocks.
   b)Identify different types of cables, wires, switches, fuses, fuse carriers, MCB, ELCB and MCCB with ratings.
2. Wiring of simple light circuit for controlling light/ fan point (PVC conduit wiring)
3. Wiring of light/fan circuit using Two way switches . (Staircase wiring)
4. Wiring of Fluorescent lamps and light sockets (6A) with a power circuit for controlling power device. (16A socket)
5. Wiring of power distribution arrangement using single phase MCB distribution board with ELCB, main switch and Energy meter.
6. a)Identify different types of batteries with their specifications.
   b)Demonstrate the Pipe and Plate Earthing Schemes using Charts/Site Visit.

PART II

ELECTRONICS

List of Exercises / Experiments (Minimum of 7 mandatory)

1. Familiarization/Identification of electronic components with specification (Functionality, type, size, colour coding, package, symbol, cost etc. [Active, Passive, Electrical, Electronic, Electro-mechanical, Wires, Cables, Connectors, Fuses, Switches, Relays, Crystals, Displays, Fasteners, Heat sink etc.)

2. Drawing of electronic circuit diagrams using BIS/IEEE symbols and introduction to EDA tools (such as Dia or XCircuit), Interpret data sheets of discrete components and IC's, Estimation and costing.

3. Familiarization/Application of testing instruments and commonly used tools. [Multimeter, Function generator, Power supply, DSO etc.] [Soldering iron, De-soldering pump, Pliers, Cutters, Wire strippers, Screw drivers, Tweezers, Crimping tool, Hot air soldering and de- soldering station etc.]

4. Testing of electronic components [Resistor, Capacitor, Diode, Transistor and JFET using multimeter.]

5. Inter-connection methods and soldering practice. [Bread board, Wrapping, Crimping, Soldering - types - selection of materials and safety precautions, soldering practice in connectors and general purpose PCB, Crimping.]

6. Printed circuit boards (PCB) [Types, Single sided, Double sided, PTH, Processing methods, Design and fabrication of a single sided PCB for a simple circuit with manual etching (Ferric chloride) and drilling.]
7. Assembling of electronic circuits using SMT (Surface Mount Technology) stations.
8. Assembling of electronic circuit/system on general purpose PCB, test and show the functioning (**Any Two circuits).**

    1. Fixed voltage power supply with transformer, rectifier diode, capacitor filter, zener/IC regulator.
    2. Square wave generation using IC 555 timer in IC base.
    3. Sine wave generation using IC 741 OP-AMP in IC base.
    4. RC coupled amplifier with transistor BC107.

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEMESTER III

KTU
Estd.
2014

MAT 203	DISCRETE MATHEMATICAL STRUCTURES	CATEGORY	L	T	P	CREDITS
		BSC	3	1	0	4

Preamble: The purpose of this course is to create awareness in students about the basic terminologies used in advanced courses in Computer Science and develop rigorous logical thinking for solving different kinds of problems in Computer Science. This course helps the learner to apply the theory and applications of elementary Counting Principles, Propositional Logic, Predicate Logic, Lattices, Generating Functions, Recurrence Relations and Algebraic Structures eventually in practical applications.

Prerequisite: A sound background in higher secondary school Mathematics

Course Outcomes: After the completion of the course the student will be able to

CO#	CO
CO1	Check the validity of predicates in Propositional and Quantified Propositional Logic using truth tables, deductive reasoning and inference theory on Propositional Logic **(Cognitive Knowledge Level: Apply)**
CO2	Solve counting problems by applying the elementary counting techniques - Rule of Sum, Rule of Product, Permutation, Combination, Binomial Theorem, Pigeonhole Principle and Principle of Inclusion and Exclusion **(Cognitive Knowledge Level: Apply)**
CO3	Classify binary relations into various types and illustrate an application for each type of binary relation, in Computer Science (**Cognitive Knowledge Level: Understand)**
CO4	Illustrate an application for Partially Ordered Sets and Complete Lattices, in Computer Science **(Cognitive Knowledge Level: Apply)**
CO5	Explain Generating Functions and solve First Order and Second Order Linear Recurrence Relations with Constant Coefficients **(Cognitive Knowledge Level: Apply)**
CO6	Illustrate the abstract algebraic systems - Semigroups, Monoids, Groups, Homomorphism and Isomorphism of Monoids and Groups **(Cognitive Knowledge Level: Understand)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓								✓
CO2	✓	✓	✓	✓								✓
CO3	✓	✓	✓	✓		✓						✓
CO4	✓	✓	✓	✓		✓						✓
CO5	✓	✓	✓	✓								✓
CO6	✓	✓	✓	✓								✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks (%)
	Test 1 (%)	Test 2 (%)	
Remember	30	30	30
Understand	30	30	30
Apply	40	40	40
Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3

Continuous Internal Evaluation Pattern:

Attendance **10 marks**

Continuous Assessment Tests (Average of Series Tests 1 & 2) **25 marks**

Continuous Assessment Assignment **15 marks**

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 full questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

Syllabus

Module – 1 (Fundamentals of Logic)

Mathematical logic - Basic connectives and truth table, Statements, Logical Connectives, Tautology, Contradiction. Logical Equivalence - The Laws of Logic, The Principle of duality, Substitution Rules . The implication - The Contrapositive, The Converse,The Inverse.

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Logical Implication - Rules of Inference. The use of Quantifiers - Open Statement, Quantifier. Logically Equivalent – Contrapositive, Converse , Inverse , Logical equivalences and implications for quantified statement, Implications , Negation .

Module - 2 (Fundamentals of Counting Theory)

The Rule of Sum – Extension of Sum Rule . The Rule of Product - Extension of Product Rule . Permutations. Combinations. The Binomial Theorem (without proof). Combination with Repetition. The Pigeon hole Principle. The Principle of Inclusion and Exclusion Theorem (Without Proof) - Generalization of the Principle. Derangements.

Module - 3 (Relations and Functions)

Cartesian Product - Binary Relation. Function – domain , range-one to one function, Image-restriction. Properties of Relations- Reachability Relations, Reflexive Relations, Symmetric Relations, Transitive relations, Anti-symmetric Relations, Partial Order relations, Equivalence Relations, Irreflexive relations.

Partially ordered Set – Hasse Diagram, Maximal-Minimal Element, Least upper bound (lub), Greatest Lower bound(glb) (Topological sorting Algorithm- excluded). Equivalence Relations and Partitions - Equivalence Class.

Lattice - Dual Lattice , Sub lattice , Properties of glb and lub , Properties of Lattice , Special Lattice , Complete Lattice, Bounded Lattice, Completed Lattice , Distributive Lattice.

Module - 4 (Generating Functions and Recurrence Relations)

Generating Function - Definition and Examples , Calculation techniques, Exponential generating function. First order linear recurrence relations with constant coefficients – homogeneous, non-homogeneous Solution. Second order linear recurrence relations with constant coefficients, homogeneous, non-homogeneous Solution.

Module - 5 (Algebraic Structures)

Algebraic system-properties- Homomorphism and Isomorphism. Semi group and monoid – cyclic monoid , sub semi group and sub monoid, Homomorphism and Isomorphism of Semi group and monoids. Group- Elementary properties, subgroup, symmetric group on three symbols ,The direct product of two groups, Group Homomorphism, Isomorphism of groups, Cyclicgroup. Rightcosets - Leftcosets. Lagrange's Theorem

Text Book

1. Discrete and Combinatorial Mathematics (An Applied Introduction), Ralph P Grimaldi, B V Ramana , 5th Edition, Pearson

Reference Books

1) Kenneth H. Rosen, Discrete Mathematics and Its Applications with Combinatorics and Graph Theory, Seventh Edition, MGH, 2011
2) Trembly J.P and Manohar R, "Discrete Mathematical Structures with Applications to Computer Science", Tata Mc Graw Hill Pub. Co. Ltd., New Delhi, 2003.
3) Bernard Kolman, Robert C. Busby, Sharan Cutler Ross, "Discrete Mathematical Structures", Pearson Education Pvt Ltd., New Delhi, 2003
4) Kenneth H .Rosen, "Discrete Mathematics and its Applications", 5/e, Tata Mc Graw Hill Pub. Co. Ltd, New Delhi 2003
5) Richard Johnsonbaugh, "Discrete Mathematics", 5/e, Pearson Education Asia, NewDelhi, 2002.
6) Joe L Mott, Abraham Kandel, Theodore P Baker,"Discrete Mathematics for Computer Scientists and Mathematicians", 2/e, Prentice-Hall India, 2009.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Show that R∨M , ⌉ R∨S , ⌉ M , ⌉ S cannot exist simultaneously (without using truth table)
2. Represent the following statement in symbolic form "Not every city in Canada is clean".

Course Outcome 2 (CO2):

1. How many possible arrangements are there for the letters in MASSASAUGA in which 4 A' s are together?
2. Find the number of integers between 1 and 1000 inclusive, which are not divisible by 5, 6 or 8

Course Outcome 3 (CO3):

1. If A = {1, 2, 3, 4}, give an example of a relation R that is reflexive and symmetric but not transitive.
2. Let Z be the set of integers. R is a relation called "Congruence Modulo 3 " defined by R = { (x,y) /x ε Z,y ε Z, x - y is divisible by 3 } . Show that R is an equivalence relation.

Course Outcome 4 (CO4):

1. Assume A ={ a, b, c}. Let P(A) be its power set and '≤ ' be the subset relation on the power set. Draw the Hasse diagram of (P(A), ≤).
2. What is meant by Bounded Lattice ? Give an example.

Course Outcome 5 (CO5):

1. Solve $a_r - 3a_{r-1} - 4a_{r-2} = 3^r$ using Generating function method; Given $a_0 = 1$, $a_1 = 2$.
2. Find the generating function for the sequence 1, 3, 3^2, 3^3 …….

Course Outcome 6 (CO6):

1. Prove that the group { 1,-1, i, -i } is cyclic with generators i and –i.
2. State and prove Lagrange's Theorem.

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Model Question Paper

QP CODE:

Reg No:_____

Name :_____ **PAGES : 3**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

THIRD SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: MAT 203

Course Name: Discrete Mathematical Structures

Max.Marks :100 **Duration: 3 Hrs**

PART A

Answer all Questions. Each question carries 3 Marks

1. Show the following implication without constructing the truth table: (P ^ Q) => P→Q
2. Write the negation of the following statement. " If I drive, then I will not walk"
3. What is pigeon hole principle? Explain. If you select any five numbers from 1 to 8 then prove that at least two of them will add up to 9 .
4. In how many ways can the letters of the word ALLAHABAD be arranged ?
5. Show that the divisibility relation ' / ' is a partial ordering on the set Z^+.
6. Consider the functions given by f(x) = 2x+3 and g(x) = x^2. Find (g o f) and (f o g).
7. What is meant by exponential generating function? Explain.
8. Provide one example of linear homogeneous recurrence relation. Mention the degree also.
9. What is a monoid ? Explain.
10. Let (A, .) be a group. Show that $(ab)^{-1} = b^{-1}a^{-1}$

(10 x 3 = 30 Marks)

PART B

(Answer any one Question from each Module. Each question carries 14 Marks)

11.

(a) Show that S ∨ R is tautologically implied by (PVQ) ∧ (P→R) ∧ (Q→S)

(6 marks)

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(b) Show that from

(ii) $(\exists x)(F(x) \wedge S(x)) \rightarrow (y)(M(y) \rightarrow W(y))$.

(iii) $(\exists y)(M(y) \wedge \neg W(y))$ the conclusion $(x)(F(x) \rightarrow \neg S(x))$ follows.

(8 marks)

OR

12.

(a) Show that $(x)(P(x) \vee Q(x)) \Rightarrow ((x)P(x) \vee (\exists x)Q(x))$ using indirect method of proof .

(6 marks)

(b) Discuss indirect method of proof . Show that the following premises are inconsistent

(i) If Jack misses many classes through illness, then he fails high school.

(ii) If Jack fails high school, then he is uneducated.

(iii) If Jack reads a lot of books, then he is not uneducated.

(iv) Jack misses many classes through illness and reads a lot of books.

(8 marks)

13.

(a) Explain binomial theorem. Determine the coefficient of x^9y^3 in the expansion of $(x+y)^{12}$, $(x+2y)^{12}$ and $(2x-3y)^{12}$ using binomial theorem.

(6 marks)

(b) How many 5 digit numbers can be formed from the digits 1,2,3,4,5 using the digits without repetition ?

(i) How many of them are even?

(ii) How many are even and greater than 30,000?

(8 marks)

OR

14.

(a) There are 8 guests in a party. Each guest brings a gift and receives another gift in return. No one is allowed to receive the gift they bought. How many ways are there to distribute the gifts?

(6 marks)

(b) Six papers are set in an examination of which two are mathematical. Only one examination will be conducted in a day. In how many different orders ,can the papers be arranged so that

(i) Two mathematical papers are consecutive?

(ii) Two mathematical papers are not consecutive?

(8 marks)

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15.

(a) Let A = { 1,2,3,4,...11,12} and let R be the equivalence relation on A x A defined by (a,b) R (c,d) iff a+d = b+c. Prove that R is an equivalence relation and find the equivalence class of (2 ,5)

(8 marks)

(b) What is a chain lattice ? Explain. Also show that every chain is a distributive lattice.

(6 marks)

OR

16.

(a) Suppose f(x) = x+2 , g(x) = x-2, and h(x) = 3x for x ε R , where R is the set of real numbers. Find (g o f) , (f o g) , (f o f) and (g o g)

(8 marks)

(b) Let R and S be two relations on a set A . If R and S are symmetric, Prove that (R∩S) is also symmetric.

(6 marks)

17.

(a) Solve the recurrence relation $a_r - 7a_{r-1} + 10a_{r-2} = 0$ for $r \geq 2$; Given $a_0 = 0$; $a_1 = 41$ using generating functions

(8 marks)

(b) Solve the recurrence relation $a_r - 4a_{r-1} + 4a_{r-2} = (r+1)^2$ using generating function.

(6 marks)

OR

18.

(a) Solve $a_n - 3a_{n-1} + 2$; $a_0 = 1$ $n \geq 1$, using generating functions.

(8 marks)

(b) Use generating function to solve the following recurrence relation $a_n = 2a_{n-1} + 2^n$; with $a_0 = 2$.

(6 marks)

19.

(a) Prove that the set 'Q' of rational numbers other than 1 forms an abelian group with respect to the operation ' * ' defined by a * b = a+b -ab.

(8 Marks)

(b) Show that the direct product of two group is a group.

(6 Marks)

OR

20.

(a) Show that the subgroup of a cyclic group is cyclic.

(8 Marks)

(b) Let (A,*) be a group. Show that (A,*) is an abelian group if and only if $a^2 * b^2 = (a*b)^2$ for all 'a' and 'b' in A

(6 Marks)

TEACHING PLAN

No	Contents	No of Lecture Hrs
Module – 1 (Fundamentals of Logic) (9 hrs)		
1.1	Mathematical logic, Basic Connectives and Truth Table	1
1.2	Statements, Logical Connectives, Tautology, Contradiction	1
1.3	Logical Equivalence, The Laws of Logic	1
1.4	The Principle of duality, Substitution Rules	1
1.5	The implication, The Contrapositive, the Converse , the Inverse	1
1.6	Logical Implication,Rules of Inference, Logical Implication	1
1.7	The use of Quantifiers, Open Statement, Quantifier, Negation	1
1.8	Logically Equivalent, Contrapositive, The Converse, The Inverse	1
1.9	Logical Implications	1
Module - 2 (Fundamentals of Counting Theory) (9 hrs)		
2.1	The Pigeon-hole Principle	1
2.2	The Rule of Sum	1
2.3	Extension of Sum Rule	1
2.4	The Rule of Product	1
2.5	Extension of Product Rule , Permutations	1
2.6	Combinations, Combination with repetition	1
2.7	The Binomial Theorem	1
2.8	The Principle of Inclusion and Exclusion Theorem (Without Proof) Generalization of the Principle	1
2.9	Derangements	1
Module - 3 (Relations and Functions) (9 hrs)		
3.1	Cartesian Product, Binary Relation, Function, Domain, Range , One to One Function Image - Restriction	1
3.2	Properties, Reachability Relations, Reflexive Relations,Symmetric Relations,Transitive relations, Antisymmetric Relations.	1

ELECTRONICS AND COMPUTER ENGINEERING

3.3	Partial Order relations	1
3.4	Equivalence Relation, Irreflexive Relations.	1
3.5	Partially ordered Set, Hasse Diagram.	1
3.6	Maximal-Minimal Element, Least Upper bound, Greatest Lower Bound	1
3.7	Equivalence Relations and Partitions ,Equivalence Class	1
3.8	Lattice- Dual Lattice,sub lattice , Properties of glb and lub	1
3.9	Properties of Lattice , Special Lattice , Complete Lattice, Bounded Lattice, Completed Lattice, Distributive Lattice	1
Module - 4 (Generating Functions and Recurrence Relations) (9 hrs)		
4.1	Generating Function , Definition and Examples	1
4.2	Exponential Generating Function.	1
4.3	First Order Linear Recurrence Relations with Constant Coefficients (Lecture I)	1
4.4	First Order Linear Recurrence Relations with Constant Coefficients (Lecture II)	1
4.5	Homogeneous Solution	1
4.6	Non homogeneous Solution	1
4.7	Second order linear recurrence relations with constant coefficients	1
4.8	Homogeneous Solution	1
4.9	Non homogeneous Solution	1
Module - 5 (Algebraic Structures)(9 hrs)		
5.1	Algebraic System-Properties, Homomorphism and Isomorphism	1
5.2	Semi group , Monoid, Cyclic monoid	1

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5.3	Sub semigroup and sub monoid	1
5.4	Homomorphism and Isomorphism of Semigroup, Monoids and Groups	1
5.5	Elementary Properties, Subgroup, Symmetric group on three symbols	1
5.6	The direct Product of two Groups	1
5.7	Group Homomorphism, Isomorphism, Cyclic group	1
5.8	Right coset, Left coset	1
5.9	Lagrange's Theorem	1

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
KTU
Estd.
2014

CST201	DATA STRUCTURES	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		PCC	3	1	0	4	2019

Preamble: This course aims at moulding the learner to understand the various data structures, their organization and operations. The course helps the learners to assess the applicability of different data structures and associated algorithms for solving real world problem which requires to compare and select appropriate data structures to solve the problem efficiently. This course introduces abstract concepts for data organization and manipulation using data structures such as stacks, queues, linked lists, binary trees, heaps and graphs for designing their own data structures to solve practical application problems in various fields of Computer Science.

Prerequisite: Topics covered under the course Programming in C (EST 102)

CO1	Design an algorithm for a computational task and calculate the time/space complexities of that algorithm **(Cognitive Knowledge Level: Apply)**
CO2	Identify the suitable data structure (array or linked list) to represent a data item required to be processed to solve a given computational problem and write an algorithm to find the solution of the computational problem **(Cognitive Knowledge Level: Apply)**
CO3	Write an algorithm to find the solution of a computational problem by selecting an appropriate data structure (binary tree/graph) to represent a data item to be processed **(Cognitive Knowledge Level: Apply)**
CO4	Store a given dataset using an appropriate Hash Function to enable efficient access of data in the given set **(Cognitive Knowledge Level: Apply)**
CO5	Select appropriate sorting algorithms to be used in specific circumstances (Cognitive Knowledge Level: **Analyze**)
CO6	Design and implement Data Structures for solving real world problems efficiently **(Cognitive Knowledge Level: Apply)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓		✓						✓
CO2	✓	✓	✓	✓		✓						✓
CO3	✓	✓	✓	✓		✓						✓
CO4	✓	✓	✓	✓		✓						✓
CO5	✓	✓	✓	✓		✓						✓
CO6	✓	✓	✓	✓		✓						✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks
	Test1 (Percentage)	Test2 (Percentage)	
Remember	30	30	30
Understand	30	30	30
Apply	40	40	40

Analyse			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	**50**	**100**	**3 hours**

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Tests : 25 marks

Continuous Assessment Assignment : 15 marks

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks

First Internal Examination shall be preferably conducted after completing the first half of the syllabus and the Second Internal Examination shall be preferably conducted after completing remaining part of the syllabus.

There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly covered module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly covered module), each with 7 marks. Out of the 7 questions in Part B, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

SYLLABUS

Module 1

Basic Concepts of Data Structures

System Life Cycle, Algorithms, Performance Analysis, Space Complexity, Time Complexity, Asymptotic Notation, Complexity Calculation of Simple Algorithms

Module 2

Arrays and Searching

Polynomial representation using Arrays, Sparse matrix, Stacks, Queues-Circular Queues, Priority Queues, Double Ended Queues, Evaluation of Expressions

Linear Search and Binary Search

Module 3

Linked List and Memory Management

Self Referential Structures, Dynamic Memory Allocation, Singly Linked List-Operations on Linked List. Doubly Linked List, Circular Linked List, Stacks and Queues using Linked List, Polynomial representation using Linked List

Memory allocation and de-allocation-First-fit, Best-fit and Worst-fit allocation schemes

Module 4

Trees and Graphs

Trees, Binary Trees-Tree Operations, Binary Tree Representation, Tree Traversals, Binary Search Trees- Binary Search Tree Operations

Graphs, Representation of Graphs, Depth First Search and Breadth First Search on Graphs, Applications of Graphs

Module 5

Sorting and Hashing

Sorting Techniques – Selection Sort, Insertion Sort, Quick Sort, Merge Sort and Heap Sort

Hashing- Hashing Techniques, Collision Resolution, Overflow handling, Hashing functions – Mid square, Division, Folding, Digit Analysis

Text Book

1. Ellis Horowitz, Sartaj Sahni and Susan Anderson-Freed, Universities Press, Fundamentals of Data Structures in C

Reference Books

1. Samanta D., Classic Data Structures, Prentice Hall India.
2. Richard F. Gilberg, Behrouz A. Forouzan, Data Structures: A Pseudocode Approach with C, 2/e, Cengage Learning.
3. Aho A. V., J. E. Hopcroft and J. D. Ullman, Data Structures and Algorithms, Pearson Publication.
4. Tremblay J. P. and P. G. Sorenson, Introduction to Data Structures with Applications, Tata McGraw Hill.
5. Peter Brass, Advanced Data Structures, Cambridge University Press.
6. Lipschuts S., Theory and Problems of Data Structures, Schaum's Series.
7. Wirth N., Algorithms + Data Structures = Programs, Prentice Hall.
8. Hugges J. K. and J. I. Michtm, A Structured Approach to Programming, PHI.
9. Martin Barrett, Clifford Wagner, C And Unix: Tools For Software Design, John Wiley.

Sample Course Level Assessment Questions

Course Outcome1(CO1): Write an algorithm for matrix multiplication and calculate its time complexity.

Course Outcome 2(CO2): How a linked list can be used to represent the polynomial $5x^4y^6+24x^3y^4-17x^2y^3+15xy^2+45$.Write an algorithm to add two Bivariate polynomials represented using linked list.

Course Outcome 3(CO3): Create a Binary search Tree with node representing the following sequence 14, 15, 4, 18, 9, 16, 20, 17, 3, 7, 5, 2 and perform inorder, preorder and postorder traversals on the above tree and print the output.

Course Outcome 4(CO4): The size of a hash table is 7. The index of the hash table varies from 0 to 6. Consider the keys 89, 18, 49, 58, 25 in the order. Show how the keys are stored in the hash table using Linear probing.

Course Outcome 5(CO5): In what circumstances does Quick Sort perform over Merge sort.

Course Outcome 6(CO6): Design a reservation system for railways that include waiting list. If the reservation is full "Display reservation full" and put the passenger in in waiting list and give a waiting list number. If a passenger cancels the ticket, then the seat should be automatically allocated to the first passenger in the waiting list.

Model Question Paper

QP CODE: PAGES:3

Reg No:_____

Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY THIRD SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: CST 201

Course Name: DATA STRUCTURES

Max.Marks:100 **Duration: 3 Hours**

PART A

Answer all Questions. Each question carries 3 Marks

1. Calculate the frequency count of the statement x = x+1; in the following code segment

   for (i = 0; i< n; i++)

   for (j = 0; j< n; j*=2)

   x = x + 1;

2. What is the relevance of verification in System Life Cycle?

3. Write an algorithm to insert a new element in a particular position of an array.

4. Convert the expression ((A/(B-D+E))*(F-G)*H) to postfix form. Show each step in the conversion including the stack contents

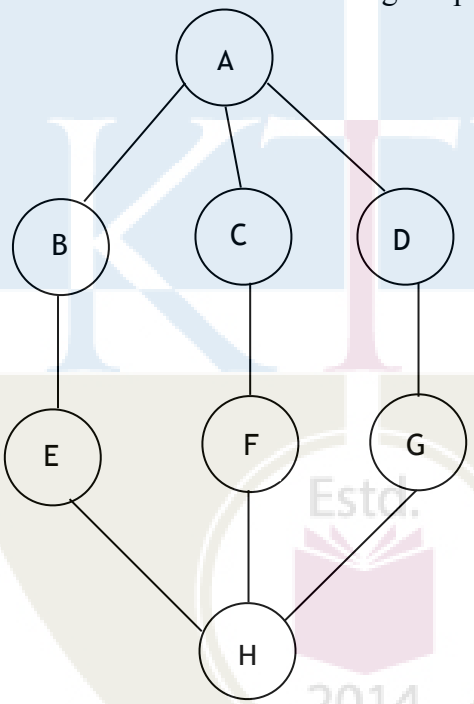
5. Write an algorithm to count the number of occurrences of a character in a linked list (each node contains only one character)

6. Write an algorithm for best-fit method of memory allocation

7. Draw the binary tree whose sequential representation is given below

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A	B	C	-	D	E	-	-	-	-	F	G	-	-	-

8. Find the Depth First Search of the following Graph



9. Write an algorithm to arrange n numbers in nonincreasing order.

10. Let the size of a hash table is 10. The index of the hash table varies from 0 to 9. Assume the keys 73, 54, 15, 48, 89, 66, 37, 18, 41, 22, 62 are mapped using modulo operator. Show how the keys are distributed using chaining method.

Part B

Answer any one Question from each module. Each question carries 14 Marks

11. a) Explain the System Life Cycle in detail (10)

    b) How the performance of an algorithm is evaluated? (4)

OR

12. a) Write algorithms for Linear Search and Binary Search and Compare their time complexities (10)

    b) Between O(nlogn) and O(logn) which one is better and why? (4)

13. a) Write algorithms to insert and delete elements from a double ended queue. Demonstrate with examples (10)

    b) Compare and contrast Circular Queue with a Normal Queue (4)

OR

14. a) Write an algorithm to insert and delete elements from a Priority Queue (8)

    b) Discuss an algorithm to convert an infix expression to a prefix expression (6)

15. a) Write an algorithm to multiply two polynomials represented using linked list (10)

    b) How doubly linked list can be used to find palindromes ? (4)

OR

16. a) How is memory compaction (de-allocation) done in memory management ? (8)

    b) Discuss the advantages and disadvantages of First-fit, Best-fit and Worst-fit allocation schemes (6)

17. a) List the properties of Binary Search Tree. Write an algorithm to search an element from a Binary Search Tree (10)

b) Write an iterative algorithm for in-order traversal of a Binary Tree (4)

OR

18. a) Give algorithms for DFS and BFS of a graph and explain with examples (8)

b) How graphs can be represented in a Computer? (6)

19. a) Write algorithms for Merge sort and Quick Sort. (10)

b) Illustrate the working of Quick sort on the following input 38, 8, 0, 28, 45, -12, 89, 66, 42 (4)

OR

20. a) With examples discuss the different hash functions used for hashing (10)

b) Apply the hash function h(x) = x mod 7 for linear probing on the data 2341, 4234, 2839, 430, 22, 397, 3920 and show the resulting hash table (4)

Teaching Plan		
Module 1 :Basic Concepts of Data Structures		(5 hours)
1.1	System Life Cycle,	1 hour
1.2	Algorithms , Performance Analysis	1 hour
1.3	Space Complexity, Time Complexity	1 hour
1.4	Asymptotic Notation (Big O Notation)	1 hour
1.5	Complexity Calculation of Simple Algorithms	1hour
Module 2 :**Arrays and Searching**		(10 hours)
2.1	Polynomial representation using Arrays	1 hour
2.2	Sparse matrix (Lecture 1)	1 hour
2.3	Sparse matrix (Lecture 2)	1 hour

2.4	Stacks	1 hour
2.5	Queues, Circular Queues	1 hour
2.6	Priority Queues,	1 hour
2.7	Double Ended Queues,	1 hour
2.8	Conversion and Evaluation of Expressions (Lecture 1)	1 hour
2.9	Conversion and Evaluation of Expressions (Lecture 2)	1 hour
2.10	Linear Search and Binary Search	1 hour
Module 3 : **Linked List and Memory Management**		(12 hours)
3.1	Self Referential Structures	1 hour
3.2	Dynamic Memory Allocation	1 hour
3.3	Singly Linked List-Operations on Linked List,	1 hour
3.4	Doubly Linked List	1 hour
3.5	Circular Linked List	1 hour
3.6	Stacks using Linked List	1 hour
3.7	Queues using Linked List	1 hour
3.8	Polynomial representation using Linked List (Lecture 1)	1 hour
3.9	Polynomial representation using Linked List (Lecture2)	1 hour
3.10	Memory de-allocation	1 hour
3.11	Memory allocation-First-fit	1 hour
3.12	Best-fit and Worst-fit allocation schemes	1hour
Module 4 :**Trees and Graphs**		(8 hours)
4.1	Trees, Binary Trees	1hour
4.2	Tree Operations, Binary Tree Representation,	1hour
4.3	Tree Traversals	1hour
4.4	Binary Search Trees	1hour
4.5	Binary Search Tree Operations	1hour
4.6	Graphs, Representation of Graphs	1hour

4.7	Depth First Search and Breadth First Search on Graphs	1hour
4.8	Applications of Graphs	1hour
Module 5 : **Sorting and Hashing**		(10 hours)
5.1	Sorting Techniques – Selection Sort	1hour
5.2	Insertion Sort	1hour
5.3	Quick Sort	1hour
5.4	Merge Sort	1hour
5.5	Heap Sort	1hour
5.6	Hashing- Hashing Techniques	1hour
5.7	Collision Resolution	1hour
5.8	Overflow handling	1hour
5.9	Hashing functions – Mid square and Division methods	1hour
5.10	Folding and Digit Analysis methods	1hour

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
KTU
Estd.
2014

ERT203	DIGITAL SYSTEMS AND VLSI DESIGN	Category	L	T	P	Credit	Year of Introduction
		PCC	3	1	0	4	2021

Preamble: The objective of the course is to familiarize learners with the basics of Boolean algebra, digital systems, and VLSI design. This course covers the basic concepts of the number system and its conversions, the design of simple combinational and sequential logic circuits with hardware description language implementation, with a brief understanding of VLSI design concepts. These help to understand the basic digital system design concepts and working principles of computer systems with knowledge of peripheral design.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

COURSE OUTCOMES	
CO1	Understand the basic concepts of number systems and its conversions (**Cognitive Knowledge level: Understand**)
CO2	Apply the Boolean Functions to design, simplify and realize digital circuits with Logic Gates and Hardware Description Language (HDL) (**Cognitive Knowledge level: Apply**)
CO3	Apply the design procedures of combinational circuits and implement them with Logic Gates and HDL **(Cognitive Knowledge level: Apply)**
CO4	Apply the design procedures of sequential circuits and implement them with Logic Gates and HDL **(Cognitive Knowledge level: Apply)**
CO5	Understand the basic concepts of MOS devices (**Cognitive Knowledge level: Understand**)

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓										
CO2	✓	✓	✓		✓							
CO3	✓	✓	✓		✓							
CO4	✓	✓	✓		✓							
CO5	✓	✓	✓									

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern:

Bloom's Category	Test 1 (%)	Test 2 (%)	End Semester Examination Marks (%)
Remember	20	20	20
Understand	35	35	35
Apply	45	45	45
Analyze			
Evaluate			
Create			

Mark Distribution:

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test : 25 marks
Continuous Assessment Assignment : 15 marks

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

SYLLABUS

Module 1: Number systems, Operations & Codes

Decimal, Binary, Octal and Hexadecimal Number Systems- Number Base Conversions. Addition, Subtraction, Multiplication and Division of binary numbers. Representation of negative numbers- Complements, Subtraction with complements. Addition and subtraction of BCD, Octal and Hexadecimal numbers.

Module 2: Boolean Algebra

Postulates of Boolean Algebra. Basic theorems and Properties of Boolean Algebra. Boolean Functions - Canonical and Standard forms. Simplification of Boolean Functions- Using Karnaugh- Map Method (upto four variables), Don't care conditions, Product of sums

simplification. Digital Logic Gates- Implementation of Boolean functions using basic and universal gates. Introduction to Hardware Description Language (Verilog) – Implementation of basic gates using HDL.

Module 3: Combinational Logic Circuits

Design Procedure & Implementation of combinational logic circuits- Half adder, Full adder, Half subractor, full subtractor, Binary Parallel adder, BCD adder, Code converter, Magnitude comparator, Encoder, Decoder, Multiplexer, Demultiplexer. Implementation of combinational circuits using HDL.

Module 4: Sequential logic circuits

Flip-flops- SR, JK, T and D. Triggering of flip-flops- Master slave flip- flops, Edge- triggered flip-flops. Excitation table and characteristic equation. Counter design: Asynchronous counters- Binary and BCD counters, timing sequences and state diagrams. Synchronous counters- Binary Up- down counter, BCD counter. Implementation of flip-flops & Counters using HDL.

Module 5: Shift registers & Introduction to MOS and related VLSI technology

Shift registers -Serial in Serial Out, Serial In Parallel Out, Bidirectional Shift Register with Parallel load. Ring counter. Johnson counter- timing sequences and state diagrams.

Introduction to MOS and related VLSI technology – The Metal Oxide Semiconductor (MOS) - N Channel Metal Oxide Semiconductors (NMOS)-P Channel Metal Oxide Semiconductors (PMOS)- Complementary Metal Oxide Semiconductors (CMOS)- Inverter – NAND- NOR

Text Books:

1. M. Morris Mano, Digital Logic & Computer Design, 4/e, Pearson Education, 2013
2. Thomas L Floyd, Digital Fundamentals, 10/e, Pearson Education, 2009.
3. M. Morris Mano, Computer System Architecture, 3/e, Pearson Education, 2007.

Reference Books:

1. M. Morris Mano, Michael D Ciletti , Digital Design With An Introduction to the Verilog HDL, 5/e, Pearson Education, 2013.
2. Donald D Givone, Digital Principles and Design, Tata McGraw Hill, 2003

Sample Course Level Assessment Questions

Course Outcome1(CO1): Perform the following number base conversions:

a) $(250.55)_{10}$ to Hexadecimal b) $(357)_8$ to Decimal

Course Outcome 2(CO2): Given a Boolean function F and don't care conditions D, using Karnaugh map obtain the simplified expression in (i) SOP and (ii) POS:

$$F(A, B, C, D) = A'B'D' + A'CD + A'BC$$
$$D(A, B, C, D) = A'BC'D + ACD + AB'D$$

Course Outcome 3(CO3): Design a BCD to Excess-3 Code Convertor.

Course Outcome 4(CO4): Design a 4- bit binary ripple counter.

Course Outcome 5(CO5): Explain briefly about accumulation, depletion and inversion in MOSFETs

ELECTRONICS AND COMPUTER ENGINEERING

Model Question Paper

QP CODE: PAGES: 2

Reg No:_____

Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY THIRD SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: ERT203

Course name : DIGITAL SYSTEMS AND VLSI DESIGN

Max Marks: 100 **Duration: 3 Hours**

PART-A

(Answer All Questions. Each question carries 3 marks)

1. Do the following base conversions

   a) $(73AE)_{16}$ to Decimal

   b) $(1111011100)_2$ to octal.

2. Subtract $(0101)_2$ from $(11110)_2$ using: i) complement and ii) complement arithmetic.
3. State and prove extended De Morgan's theorem
4. Simplify the Boolean function F= XY′+XY+YZ. Draw the circuit using basic gates. How many logic gates do you save by simplification?
5. Design a half subtractor with NAND gates only.
6. Differentiate between ripple counter and synchronous counter.
7. Construct D flip- flop using NAND gates. Also give its truth table.
8. Explain how a shift register is used for serial data transfer?
9. Draw & explain the structure of Metal Oxide Semiconductor
10. Illustrate the circuit of a CMOS inverter.

PART-B

(Answer any one full question from each module) **(14x5=70)**

11. a) Convert i) (687)10 to binary, octal, BCD and hexadecimal (4x1 Marks)

    ii) (354) to binary, octal, BCD and hexadecimal (4x1 Marks)

    b) Represent -246 and -517 in

    i) sign magnitude form (2x1 Marks)

    ii) 1's complement form (2x1 Marks)

    iii) 2's complement form (2x1 Marks)

OR

12. (a) Add the following numbers without converting them to decimal. (3x2 Marks)

(i) Binary numbers 1010111 and 101010.

(ii) Octal numbers 3674 and 7526

(iii) Hexadecimal numbers 364E and 7ADE

(b) (b) Represent the unsigned decimal numbers 78942 and 64521 in BCD, and then show the steps necessary to form their sum. (8)

13. (a) Prove that (i) $AB + A(B + C) + B(B + C) = B + AC$

(ii) $AB + A(B + C) + B(B + D) = A$

(b) Using K-map, simplify the Boolean function F in sum of products form, using the don't care conditions d: (4)

$$F(w, x, y, z) = w'(x'y + x'y' + xyz) + x'z'(y + w)$$
$$d(w, x, y, z) = w'x(y'z + yz') + wyz$$

OR

14. (a) Simplify the following expressions using Karnaugh- map method. (8)

(i) $F = \Sigma(0,2,4,6,9,11,13,15,17,21,25,27,29,31)$

(ii) $F = \Pi(0,2,5,7)$

(b) Convert the following to the other canonical form: (6)

(i) $F(x, y, z, a) = \sum (1,3,7)$

(ii) $F(x, y, z) = \Pi(0,3,6,7)$

(iii) $F(A, B, C, D) = \Pi(0,1,2,3,4,6,12)$

15. (a) Implement Full adder circuit using NAND gate only. (4)

(b) Design a code converter for converting BCD to Excess 3 code (10)

OR

16. (a) Write the HDL for a half adder using any 2 different styles of modelling (6)

(b) Design a Gray to binary code converter using a 4x1 MUX. Draw the circuit diagram and explain. (8)

17. (a) Design a counter that count the states 0,3,5,6,0… using T flip- flops. (10)

(b) Write the characteristics equation, excitation table of JK, T and D flipflop. (4)

OR

18. (a) Explain Johnson Counter with timing diagram (6)

(b) Design a synchronous Binary Up-Down Counter. (8)

19. (a) Explain the working of a CMOS inverter with neat diagram. (9)

(b) Write the differences between NMOS & PMOS (5)

OR

20. (a) Illustrate the 3 modes of operation in a MOSFET (8)

(b) Explain the working of NMOS & PMOS (6)

Teaching Plan

Module 1: Number systems, Operations & Codes (No algorithms)		**(7 hours)**
1.1	**Number Systems**: Decimal, Binary, Octal and Hexadecimal number systems, Number Base Conversions. (Lecture-1)	**1 hour**
1.2	**Number Systems**: Decimal, Binary, Octal and Hexadecimal number systems, Number Base Conversions. (Lecture-2)	**1 hour**
1.3	**Binary Arithmetic:** Addition, Subtraction, Multiplication & Division of Binary Numbers. (Lecture-1)	**1 hour**
1.4	**Binary Arithmetic:** Addition, Subtraction, Multiplication & Division of Binary Numbers. (Lecture-2)	**1 hour**
1.5	Representation of Negative Numbers- Complements, subtraction with complements.	**1 hour**
1.6	**BCD Arithmetic:** Addition and Subtraction of BCD Numbers	**1 hour**
1.7	**Octal and Hexadecimal Arithmetic**: Addition & Subtraction of Octal and Hexadecimal Numbers.	**1 hour**

ELECTRONICS AND COMPUTER ENGINEERING

Module 2: Boolean Algebra		**(10 hours)**
2.1	**Introduction to Boolean Algebra:** Postulates of Boolean Algebra , Basic theorems and Properties of Boolean Algebra	**1 hour**
2.2	**Boolean Functions:** Canonical and Standard Forms	**1 hour**
2.3	**Simplification of Boolean Functions**: Karnaugh -Map Method (upto four variables), Don't care conditions (Lecture-1)	**1 hour**
2.4	**Simplification of Boolean Functions**: Karnaugh -Map Method (upto four variables), Don't care conditions (Lecture-2)	**1 hour**
2.5	**Product of sums simplification**	**1 hour**
2.6	**Digital Logic Gates:** AND, OR, NOT, NAND, NOR, XOR, XNOR, Implementation of Boolean functions using basic and universal gates. (Lecture-1)	**1 hour**
2.7	**Digital Logic Gates:** AND, OR, NOT, NAND, NOR, XOR, XNOR, Implementation of Boolean functions using basic and universal gates. (Lecture-2)	**1 hour**
2.8	Introduction to Hardware Description Language (Verilog) – Implementation of basic gates using HDL. (Lecture-1)	**1 hour**
2.9	Introduction to Hardware Description Language (Verilog) – Implementation of basic gates using HDL. (Lecture-2)	**1 hour**
2.10	Introduction to Hardware Description Language (Verilog) – Implementation of basic gates using HDL. (Lecture-3)	**1 hour**
Module 3: Combinational Logic Circuits		**(10 hours)**
3.1	Design Procedure & Implementation of Combinational Circuits	**1 hour**
3.2	**Binary Adders:** Implementation of Half Adder, Full Adder (lecture-1)	**1 hour**
3.3	**Binary Adders:** Implementation of Half Adder, Full Adder (lecture-2)	**1 hour**
3.4	**Binary Subtractors:** Implementation of Half Subtractor, Full Subtractor	**1 hour**
3.5	Implementation of Binary Parallel Adder , BCD Adder	**1 hour**

3.6	**Implementation of Various Combinational Circuits:** Code Converters, Magnitude Comparator	**1 hour**
3.7	Implementation of Encoder , Decoder	**1 hour**
3.8	Implementation of, Multiplexer Demultiplexer	**1 hour**
3.9	Implementation of combinational circuits using HDL (lecture-1)	**1 hour**
3.10	Implementation of combinational circuits using HDL (lecture-2)	**1 hour**
Module 4: Sequential logic circuits		**(11 hours)**
4.1	**Flip flops:** SR, JK, T and D flip- flops (lecture-1)	**1 hour**
4.2	**Flip flops:** SR, JK, T and D flip- flops (lecture-2)	**1 hour**
4.3	Triggering of flip-flops- Master slave flip- flop, Edge- triggered flip-flops	**1 hour**
4.4	Excitation table and characteristic equations of flip- flops (Lecture-1)	**1 hour**
4.5	Excitation table and characteristic equations of flip- flops (Lecture-2)	**1 hour**
4.6	**Counter Design:** Asynchronous counters- Binary and BCD counters- timing sequences and state diagrams. (lecture-1)	**1 hour**
4.7	**Counter Design:** Asynchronous counters- Binary and BCD counters- timing sequences and state diagrams. (lecture-2)	**1 hour**
4.8	Synchronous counters- Binary Up- down counter, BCD counter (lecture-1)	**1 hour**
4.9	Synchronous counters- Binary Up- down counter, BCD counter (lecture-2)	**1 hour**
4.10	Implementation of flip-flops & Counters using HDL (lecture-1)	**1 hour**
4.11	Implementation of flip-flops & Counters using HDL (lecture-2)	**1 hour**
Module 5: Shift registers & Introduction to MOS and related VLSI technology		**(7 hours)**
5.1	**Shift Registers** - Serial In Serial Out, Serial In Parallel Out. Bidirectional Shift Register with Parallel load (lecture-1)	**1 hour**
5.2	**Shift Registers** - Serial In Serial Out, Serial In Parallel Out. Bidirectional Shift Register with Parallel load (lecture-2)	**1 hour**
5.3	**Shift register counters** - Ring Counter, Johnson Counter- timing sequences and state diagrams	**1 hour**
5.4	**Introduction to MOS and related VLSI technology** – The Metal Oxide Semiconductor (MOS)	**1 hour**
5.5	N Channel Metal Oxide Semiconductors (NMOS)-P Channel Metal Oxide Semiconductors (PMOS)-	**1 hour**
5.6	Complementary Metal Oxide Semiconductors (CMOS)- - Inverter – NAND- NOR (lecture-1)	**1 hour**
5.7	Complementary Metal Oxide Semiconductors (CMOS)- - Inverter – NAND- NOR (lecture-2)	**1 hour**

ELECTRONICS AND COMPUTER ENGINEERING

ERT205	ELECTRONIC DEVICES AND CIRCUITS	CATEGORY	L	T	P	CREDITS
		PCC	3	1	0	4

Preamble : This course aims to develop the skill of the design of various analog circuits. in practical applications

Prerequisite: Fundamentals of Electronics and semiconductor devices

Course Outcomes: After the completion of the course the student will be able to

CO#	COURSE OUTCOMES
CO1	Design analog signal processing circuits using diodes and first order RC circuits. **(Cognitive Knowledge Level:Apply)**
CO2	Analyse various transistor biasing circuits and BJT amplifier circuits. **(Cognitive Knowledge Level:Apply)**
CO3	Identify a power amplifier with appropriate specifications for electronic circuit applications. **(Cognitive Knowledge Level:Apply)**
CO4	Design and analyse the wave- shaping multivibrator and oscillator circuits using BJT. **(Cognitive Knowledge Level:Apply)**
CO5	Design and develop feedback amplifiers and regulated power supply**(Cognitive Knowledge Level:Apply)**

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	✔				✔							✔
CO 2	✔	✔			✔							✔
CO 3	✔	✔			✔							✔
CO 4	✔	✔			✔							✔
CO 5	✔	✔			✔							✔

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks (%)
	Test 1 (%)	Test 2 (%)	
Remember	10	10	20
Understand	20	20	40
Apply	20	20	40
Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3

Continuous Internal Evaluation Pattern:

Attendance **10 marks**

Continuous Assessment Tests(Average of SeriesTests1&2 **25 marks**

Continuous Assessment Assignment **15 marks**

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 full questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

Module 1 Wave shaping circuits: First order RC differentiating and integrating circuits, First order RC low pass and high pass filters. Diode Clipping circuits - Positive, negative and biased clipper. Diode Clamping circuits - Positive, negative and biased clamper.

Bipolar Junction Transistors: Review of BJT characteristics- Operating point of BJT – Factors affecting stability of Q point. DC Biasing–Biasing circuits: fixed bias, collector to base bias, voltage divider bias, role of emitter resistance in bias stabilisation. Stability factor (Derivation of stability factors for Voltage Divider Biasing only).

Module 2: BJT Amplifiers: RC coupled amplifier (CE configuration) – need of various components and design, Concept of AC load lines, voltage gain and frequency response. Small signal analysis of CE configuration using small signal hybrid-pi model for mid frequency and low frequency. (gain, input and output impedance). High frequency equivalent circuits of BJT, Miller effect, Analysis of high frequency response of CE amplifier.

Module 3 : Multistage and Power Amplifiers

Multistage amplifiers: Direct, RC, transformer coupled Amplifiers, Applications. Power amplifiers using BJT: Class A, Class B, Class AB, Class C and Class D. Conversion efficiency – derivation (Class A and Class B). Distortion in power amplifiers.

Module 4 Wave Generating circuits: Multivibrator and Oscillator Circuits

Multivibrators - Types of multivibrators - Feedback concepts, Barkhausen's criterion for oscillation - Types of oscillators – RC phase shift, Wien bridge, Hartley, Colpitt's and crystal oscillators.(Analysis of RC phase shift and Wein bridge oscillator required)

Module 5 Feedback amplifiers: Effect of positive and negative feedback on gain, frequency response and distortion. The four basic feedback topologies, Analysis of discrete BJT circuits in voltage- series and voltage-shunt feedback topologies - voltage gain, input and output impedance

Regulated power supply: Shunt voltage regulator, series voltage regulator, Short circuit protection and fold back protection, Output current boosting, SMPS.

Text Book

1. Robert Boylestad and L Nashelsky, "Electronic Devices and Circuit Theory", 11/e Pearson, 2015.
2. Sedra A. S. and K. C. Smith, "Microelectronic Circuits", 6/e, Oxford University Press, 2013.

References

1. Razavi B., “Fundamentals of Microelectronics”, Wiley, 2015
2. Neamen D., “Electronic Circuits, Analysis and Design”, 3/e, TMH, 2007.
3. David A Bell, “Electronic Devices and Circuits”, Oxford University Press, 2008.
4. Rashid M. H., “Microelectronic Circuits - Analysis and Design”, Cengage Learning, 2/e,2011
5. Millman J. and C. Halkias, “Integrated Electronics”, 2/e, McGraw-Hill, 2010.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. For the given specification design a differentiator / integrator circuit.
2. For the given transfer characteristics design clipping / clamping circuit.
3. Design first order RC low-pass / high-pass circuit for the given specification.
4. Compare the performance of voltage divider biasing and fixed biasing.
5. Draw the load line for voltage divider biasing and fix a suitable operating point to avoid signal distortion.

Course Outcome 2 (CO2):

1. For the given transistor biasing circuit, determine the resistor values, biasing currents and voltages.
2. Design a RC coupled amplifier for a given gain.
3. Analyse the frequency response of BJT RC coupled amplifier using hybrid π model.

Course Outcome 3 (CO3):

1. Compare the efficiency of class A, class B and class C power amplifiers.
2. Define cross over distortion. How it can be avoided in class AB amplifier.
3. Derive the expression for maximum efficiency of class B power amplifiers.

Course Outcome 4 (CO4):

1. Design an a stable multi-vibrator for generating a 1kHz square waveform.
2. State the Barkhausen criteria for a sine wave oscillator, and explain why they must be fulfilled to sustain oscillations.
3. Draw the circuit diagram of a RC Phase shift, Wein bridge, Hartley and Colpitts oscillator.

Course Outcome 5 (CO5):

ELECTRONICS AND COMPUTER ENGINEERING

1. Discuss the different feedback topologies in amplifiers
2. Deduce the expression for voltage gain, input impedance and output impedance of the four feedback amplifier topologies.
3. Design voltage regulator for the given specifications.

Model Question Paper

Reg No: Name :

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY THIRD SEMESTER

B. TECH DEGREE EXAMINATION, Duration: 3 Hours

MONTH AND YEAR ***Course Code: EST205*** Max. Marks: 100

Course Name: ELECTRONIC DEVICES & CIRCUITS

PART A

Answer all questions, each carries 3 marks

1. Design the first order RC high pass filter with cut off frequency 2KHz.
2. With neat diagrams explain DC load lines in transistor. What is the significance of Q point?
3. Draw and explain the h parameter small signal low frequency model for BJT.
4. What is the significance of Miller effect on high frequency amplifiers?
5. Derive the maximum efficiency of the complementary-symmetry class B power amplifiers
6. Explain how cross over distortion is avoided in class AB amplifier
7. Design a Wein bridge oscillator to generate a sinusoidal waveform of 2 kHz
8. State and explain Barkhausen's criterion of oscillation.
9. Discuss the advantages of negative feedback amplifier.
10. What is line regulation and load regulation in the context of a voltage regulator?

PART B

Answer any one full question from each module. Each question carries 14 Marks

Module 1

11. Design a voltage divider bias circuit to operate from a 18V supply in which bias conditions are to be $V_{CE}=V_E=6V$ and $I_C=1.5mA$. $\beta=90$. Also calculate the stability factor S? (14 Marks)

12. A) Design a differentiator circuit for a square wave signal with Vpp=10 and frequency 10KHz. (7 marks)

B) Define operating point and explain the factors affecting the operating point stability. (7 Marks)

Module 2

13. A) Sketch the frequency response curve of RC coupled amplifier and discuss methods to improve gain bandwidth product? (7 marks)
B) Which are the internal capacitances of a BJT? How these are incorporated in the high frequency hybid pi model of BJT? (7 Marks)

14. A CE amplifier has the h-parameters given by hie= 1000Ω, hre = $2*10^{-4}$, hfe=50, hoe= 25μΩ. If both the load and source resistances are 1kΩ, determine the a) current gain and b) voltage gain (14 Marks)

Module 3

15. Define conversion efficiency of power amplifier. Prove that the maximum conversion efficiency of a series fed class A amplifier is 25%.
(14 Marks)

16. With neat circuit diagrams, explain the working of a two-stage RC coupled amplifier and derive the output relation of each stage.
(14 Marks)

Module 4

17. Design the RC elements of RC phase shift oscillator for the operation at f=3KHz and draw the oscillator circuit diagram.(14 Marks)

18. a) Draw the circuit of Hartley oscillator and derive the frequency of oscillation (8marks)

    b) Outline the advantages of crystal oscillator. (6marks)

Module 5

19. Give the block schematic of current-series feedback amplifier configuration and deduce the expression for gain, input impedance and output impedance with feedback. Design a practical circuit for this current-series feedback amplifier. (14 marks)

20. Design a discrete series voltage regulator with short circuit protection for regulated output voltage 10V and maximum current 100mA (14 marks)

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Wave Shaping Circuits**	**10**
1.1	First order RC differentiating and integrating circuits	1
1.2	First order RC low pass and high pass filters	1
1.3	Diode Clipping circuits - Positive, negative and biased clipper	1
1.4	Diode Clamping circuits - Positive, negative and biased clamper.	1
1.5	Diode Clamping circuits - Positive, negative and biased clamper	1

1.6	Bipolar Junction Transistors: Review of BJT characteristics- Operating point of BJT	1
1.7	Operating point of BJT,DC load line	1
1.8	Factors affecting stability of Q point.	1
1.9	DC Biasing–Biasing circuits: fixed bias, collector to base bias, voltage divider bias, role of emitter resistance in bias stabilization	1
1.10	Stability factor (Derivation of stability factors for Voltage Divider Biasing only).	1
2	**BJT Amplifiers**	**9**
2.1	RC coupled amplifier (CE configuration) –Introduction	1
2.2	Need of various components and design	1
2.3	Concept of AC load lines, voltage gain and frequency response	1
2.4	Small signal hybrid- pi model of BJT	1
2.5	Small signal analysis of CE configuration using small signal hybrid-pi model for mid frequency and low frequency. (gain, input and output impedance).	1
2.6	High frequency hybrid- pi model of BJT	1
2.7	High frequency equivalent circuits of BJT, Miller effect	1
2.8	Analysis of high frequency response of CE amplifier.	1
2.9	Short circuit current gain and 3-db frequency	1
3	**Multistage amplifiers**	**8**
3.1	Direct & RC coupling	1
3.2	Transformer coupled Amplifiers, Applications	1
3.3	Power amplifiers using BJT:	1

ELECTRONICS AND COMPUTER ENGINEERING

3.4	Power amplifiers : introduction and characteristics	1
3.5	Class A, Class B Class AB, Class C and Class D	1
3.6	Conversion efficiency – derivation (Class A-Transformer coupled)	1
3.7	Conversion efficiency – derivation (Class B-push pull)	1
3.8	Distortion in power amplifiers.	1
4	**Wave Shaping Multivibrator and Oscillator Circuits**	**8**
4.1	Feedback concepts, feedback connection types	1
4.2	feedback connection types	1
4.3	Multivibrators - Types of multivibrators	1
4.4	Astable and monostable multivibrators	1
4.5	Barkhausen's criterion for oscillation	1
4.6	Types of oscillators – RC phase shift(Analysis of frequency of oscillation)	1
4.7	Wien bridge (Analysis of frequency of oscillation)	1
4.8	Hartley, Colpitt's and crystal oscillators.(No analysis required)	1
5	**Feedback amplifiers**	**10**
5.1	Effect of positive and negative feedback on gain	1
5.2	frequency response and distortion	1
5.3	The four basic feedback topologies	**1**
5.4	Block diagram schematic of four feedback topologies	1
5.5	Analysis of discrete BJT circuits in voltage-series feedback topologies - voltage gain, input and output impedance	1
5.6	Analysis of discrete BJT circuits in voltage- shunt feedback topologies - voltage gain, input and output impedance	1
5.7	Regulated power supply: Shunt voltage regulator	1
5.8	Series voltage regulator	1
5.9	Short circuit protection and fold back protection, Output current boosting	1
5.10	SMPS	1

CSL201	DATA STRUCTURES LAB	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		PCC	0	0	3	2	2019

Preamble: The aim of the Course is to give hands-on experience for Learners on creating and using different Data Structures. Data Structures are used to process data and arrange data in different formats for many applications. The most commonly performed operations on data structures are traversing, searching, inserting, deleting and few special operations like merging and sorting.

Prerequisite: Topics covered under the course Programming in C (EST 102)

CO1	Write a time/space efficient program using arrays/linked lists/trees/graphs to provide necessary functionalities meeting a given set of user requirements **(Cognitive Knowledge Level: Analyse)**
CO2	Write a time/space efficient program to sort a list of records based on a given key in the record **(Cognitive Knowledge Level: Apply)**
CO3	Examine a given Data Structure to determine its space complexity and time complexities of operations on it **(Cognitive Knowledge Level: Apply)**
CO4	Design and implement an efficient data structure to represent given data **(Cognitive Knowledge Level: Apply)**
CO5	Write a time/space efficient program to convert an arithmetic expression from one notation to another **(Cognitive Knowledge Level: Apply)**
CO6	Write a program using linked lists to simulate Memory Allocation and Garbage Collection **(Cognitive Knowledge Level: Apply)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓		✓		✓		✓		✓
CO2	✓	✓	✓	✓				✓		✓		✓
CO3	✓	✓	✓	✓				✓		✓		✓
CO4	✓	✓	✓	✓				✓		✓		✓
CO5	✓	✓	✓					✓		✓		✓
CO6	✓	✓	✓					✓		✓		✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	Continuous Assessment Test (Internal Exam)*Percentage*	End Semester Examination *Percentage*
Remember	20	20
Understand	20	20
Apply	60	60
Analyse		
Evaluate		
Create		

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	**75**	**75**	**3 hours**

Continuous Internal Evaluation Pattern:

Attendance : 15 marks

Continuous Evaluation in Lab : 30 marks

Continuous Assessment Test : 15 marks

Viva-voce : 15 marks

Internal Examination Pattern: The marks will be distributed as Algorithm 30 marks, Program 20 marks, Output 20 marks and Viva 30 marks. Total 100 marks which will be converted out of 15 while calculating Internal Evaluation marks.

End Semester Examination Pattern: The marks will be distributed as Algorithm 30 marks, Program 20 marks, Output 20 marks and Viva 30 marks. Total 100 marks will be converted out of 75 for End Semester Examination.

Operating System to Use in Lab **:** Linux

Compiler/Software to Use in Lab **:** gcc

Programming Language to Use in Lab **:** Ansi C

Fair Lab Record:

All Students attending the Data Structures Lab should have a Fair Record. The fair record should be produced in the University Lab Examination. Every experiment conducted in the lab should be noted in the fair record. For every experiment in the fair record the right hand page should contain Experiment Heading, Experiment Number, Date of Experiment, Aim of Experiment, Data Structure used and the operations performed on them, Details of Experiment including algorithm and Result of Experiment. The left hand page should contain a print out of the code used for the experiment and sample output obtained for a set of input.

SYLLABUS

1. Implementation of Polynomials and Sparse matrices using arrays**
2. Implementation of Stack , Queues, Priority Queues, DEQUEUE and Circular Queues using arrays**
3. Application problems using stacks: Conversion of expression from one notation to another notation . **
4. Implementation of various linked list operations. **
5. Implementation of stack, queue and their applications using linked list.pression
6. Implementation of trees using linked list
7. Representation of polynomials using linked list, addition and multiplication of polynomials. **
8. Implementation of binary trees using linked lists and arrays- creations, insertion, deletion and traversal. **
9. Implementation of binary search trees – creation, insertion, deletion, search
10. Any application programs using trees
11. Implementation of sorting algorithms – bubble, insertion, selection, quick, merge sort

and heap sort.**

12. Implementation of searching algorithms – linear search, binary search.**

13. Representation of graphs and computing various parameters (in degree, out degree etc.) - adjacency list, adjacency matrix.

14. Implementation of BFS and DFS for each graph representations.**

15. Implementation of hash table using your own mapping functions and observe collisions and overflow resolving schemes.**

16. Simulation of first-fit, best-fit and worst-fit allocations.

17. Simulation of a basic memory allocator and garbage collector using doubly linked list.

** mandatory.

DATA STRUCTURES LAB - PRACTICE QUESTIONS

1. Write a program to read two polynomials and store them in an array. Calculate the sum of the two polynomials and display the first polynomial, second polynomial and the resultant polynomial.

2. C Write a program to enter two matrices in normal form . Write a function to convert two matrices to tuple form and display it. Also find the transpose of the two matrices represented in tuple form and display it. Find the sum of the two matrices in tuple form and display the sum in tuple form.

3. Write a program to enter two matrices in normal form . Write a function to convert two matrices to tuple form and display it. Also find the transpose of the two matrices represented in tuple form and display it. Find the sum of the two matrices in tuple form and display the sum in tuple form.

4. Implement a circular queue using arrays with the operations:
   4.1. Insert an element to the queue.
   4.2. Delete an elements from the queue.
   4.3. Display the contents of the queue after each operation.

5. Implement a Queue using arrays with the operations:

5.1. Insert elements to the Queue.
5.2. Delete elements from the Queue.
5.3. Display the contents of the Queue after each operation.

6. Implement a Stack using arrays with the operations:
   6.1. Pushing elements to the Stack.
   6.2. Popping elements from the Stack
   6.3. Display the contents of the Stack after each operation.

7. Implement a Priority Queue using arrays with the operations:
   7.1. Insert elements to the Priority Queue.
   7.2. Delete elements from the Priority Queue.
   7.3. Display the contents of the Priority Queue after each operation.

8. Implement a Double-Ended Queue (DEQUEUE) with the operations:
   8.1. Insert elements to the Front of the queue.
   8.2. Insert elements to the Rear of the queue
   8.3. Delete elements from the Front of the queue.
   8.4. Delete elements from the Rear of the queue.
   8.5. Display the queue after each operation.

9. Using stack convert an infix expression to a postfix expression and evaluate the postfix expression.

10. Write a program to convert an infix expression to a prefix expression using stacks.

11. Convert an infix expression to a postfix expression without using a stack

12. Write a menu driven program for performing the following operations on a Linked List:
   12.1. Display
   12.2. Insert at Beginning
   12.3. Insert at End
   12.4. Insert at a specified Position
   12.5. Delete from Beginning
   12.6. Delete from End
   12.7. Delete from a specified Position

13. Implement a stack using linked list with the operations:
   13.1. Push elements to the queue.
   13.2. Pop elements from the queue.
   13.3. Display the queue after each operation.

14. Implement a Queue using linked list with the operations:

14.1. Insert an elements to the queue.
14.2. Delete an elements from the queue.
14.3. Display the queue after each operation.

15. Write a program to reverse the content of queue using stack

16. Write a program to read two polynomials and store them using linked list. Calculate the sum of the two polynomials and display the first polynomial, second polynomial and the resultant polynomial.

17. Write a program to read two polynomials and store them using linked list. Find the product of two polynomials and store the result using linked list. Display the resultant polynomial.

18. Write a program for addition of polynomials containing two variables using linked list.

19. The details of students(number, name, total-mark) are to be stored in a linked list. Write functions for the following operations:
    19.1. Insert
    19.2. Delete
    19.3. Search
    19.4. Sort on the basis of number
    19.5. Display the resultant list after every operation

20. Create a Doubly Linked List from a string taking each character from the string. Check if the given string is palindrome in an efficient method.

21. Create a binary tree with the following operations
    21.1. Insert a new node
    21.2. Inorder traversal.
    21.3. Preorder traversal.
    21.4. Postorder traversal.
    21.5. Delete a node.

22. Write a program to create a binary search tree and find the number of leaf nodes

23. Create a binary search tree with the following operations:
    23.1. Insert a new node .
    23.2. Inorder traversal.
    23.3. Preorder traversal.
    23.4. Postorder traversal.
    23.5. Delete a node.

24. Write a program to sort a set of numbers using a binary tree.

25. Represent any given graph and
    25.1. Perform a depth first search .
    25.2. Perform a breadth first search

26. Create a text file containing the name, height, weight of the students in a class. Perform Quick sort and Merge sort on this data and store the resultant data in two separate files. Also write the time taken by the two sorting methods into the respective files.

Eg.	Sony Mathew	5.5	60
	Arun Sajeev	5.7	58
	Rajesh Kumar	6.1	70

27. Write a program to sort a set of numbers using Heap sort and find a particular number from the sorted set using Binary Search.

28. Implement a Hash table using Chaining method. Let the size of hash table be 10 so that the index varies from 0 to 9.

29. Implement a Hash table that uses Linear Probing for collision resolution

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
KTU
Estd.
2014

ERL201	DIGITAL SYSTEMS AND VLSI DESIGN LAB	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		PCC	0	0	3	2	2021

Preamble: This course aims to (i) familiarize students with the Digital Logic Design through the implementation of Logic Circuits using ICs of basic logic gates (ii) familiarize students with the HDL based Digital Design Flow

Course Outcomes : After the completion of the course the student will be able to:

CO 1	Realize digital circuits with Logic Gates and Hardware Description Language (**Cognitive Knowledge level: Apply**)
CO 2	Design and implement combinational logic circuits. (**Cognitive Knowledge level: Apply**)
CO 3	Design and implement sequential logic circuits. (**Cognitive Knowledge level: Apply**)

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	✓	✓	✓	✓	✓			✓	✓			
CO 2	✓	✓	✓	✓	✓			✓	✓			
CO 3	✓	✓	✓	✓	✓			✓	✓			

LIST OF EXPERIMENTS

** Mandatory experiments

PART-A [Any six experiments]

1. Familiarization of logic gates**
2. Half adder and full adder using NAND**
3. Realization of 8:1 MUX and 1:8 DEMUX**
4. Realization of 8:3 encoder and 3:8 decoder**
5. Flip-flop circuits (SR, JK,T,D &Master slave)
6. Asynchronous up/down counter
7. Johnson and ring counters

PART-B [Any four experiments]

1. Familiarization of FPGA devices**
2. Implementation of basic gates using Verilog & simulate the result using test bench**
3. Implementation of half adder & full adder using Verilog & simulate the result using test bench**
4. Implementation of MUX & DEMUX using Verilog & simulate the result using test bench
5. Implementation of encoder & decoder using Verilog & simulate the result using test bench
6. Implementation of flipflops using Verilog & simulate the result using test bench

Reference Books:

1. Samir Palnikar"Verilog HDL: A Guide to Digital Design and Syntheis", Sunsoft Press
2. Bhasker J "A Verilog Hdl Primer" Bs Publications/bsp Books
3. R.P. Jain, "Modern digital Electronics", Tata McGraw Hill, 4th edition, 2009
4. A. Ananthakumar," Fundamentals of Digital Circuits", Prentice Hall, 2nd edition, 2016

Assessment Pattern

Mark distribution :

Total Marks	CIE	ESE	ESE Duration
150	75	75	2.5 hours

Continuous Internal Evaluation (CIE) Pattern:

Attendance	Continuous Evaluation including Viva	Internal Test	Total
15	30	30	75

End Semester Examination Pattern:

The following guidelines should be followed regarding award of marks:

(a) Preliminary work: 15 Marks
(b) Implementing the work/Conducting the experiment: 10 Marks
(c) Performance, result and inference (usage of equipment and troubleshooting): 25 Marks
(d) Viva voce: 20 marks
(e) Record: 5 Marks

General instructions: Practical examination to be conducted immediately after the second series test covering entire syllabus given below. Evaluation is a serious process that is to be conducted under the equal responsibility of both the internal and external examiners. The number of candidates evaluated per day should not exceed 20. Students shall be allowed for the University examination only on submitting the duly certified record. The external examiner shall endorse the record

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEMESTER III

MINOR

KTU
Estd.
2014

ERT 281	LOGIC CIRCUIT DESIGN	CATEGORY	L	T	P	CREDITS
		VAC	3	1	0	4

Preamble: The objective of the course is to familiarize learners with the basic concepts of Boolean algebra and digital systems. This course covers the design of simple combinational and sequential logic circuits, representation and arithmetic algorithms for Binary, BCD (Binary Coded Decimal) and Floating point numbers which in turn are helpful in understanding organization & design of a computer system and understanding how patterns of ones and zeros can be used to store information on computers, including multimedia data.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO#	CO
CO1	Illustrate decimal, binary, octal, hexadecimal and BCD number systems, perform conversions among them and do the operations - complementation, addition, subtraction, multiplication and division on binary numbers (**Cognitive Knowledge level: Understand**)
CO2	Simplify a given Boolean Function and design a combinational circuit to implement the simplified function using Digital Logic Gates (**Cognitive Knowledge level: Apply**)
CO3	Design combinational circuits - Adders, Code Convertors, Decoders, Magnitude Comparators, Parity Generator/Checker and design the Programmable Logic Devices - ROM and PLA. **(Cognitive Knowledge level: Apply)**
CO4	Design sequential circuits - Registers, Counters and Shift Registers. **(Cognitive Knowledge level: Apply)**
CO5	Use algorithms to perform addition and subtraction on binary, BCD and floating point numbers **(Cognitive Knowledge level: Understand)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓										✓
CO2	✓	✓	✓	✓		✓						✓
CO3	✓	✓	✓	✓		✓						✓
CO4	✓	✓	✓	✓		✓						✓
CO5	✓	✓	✓									✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Lifelong learning

Assessment Pattern:

Bloom's Category	Test 1 (%)	Test 2 (%)	End Semester Examination Marks (%)
Remember	20	20	20
Understand	35	35	35
Apply	45	45	45
Analyse			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3

Continuous Internal Evaluation Pattern:

Attendance	**10 marks**
Continuous Assessment Tests (Average of SeriesTests1&2)	**25 marks**
Continuous Assessment Assignment	**15 marks**

Internal Examination Pattern : Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any5.

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 full questions

from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

Syllabus

Module- 1 (Number systems, Operations & Codes)

Decimal, Binary, Octal and Hexadecimal Number Systems- Number Base Conversions. Addition, Subtraction, Multiplication and Division of binary numbers. Representation of negative numbers- Complements, Subtraction with complements. Addition and subtraction of BCD, Octal and Hexadecimal numbers. Binary codes- Decimal codes, Error detection codes, Reflected code, Character coding schemes – ASCII, EBCDIC. Logic Gates – NOT, AND, OR, NAND, NOR, XOR, XNOR

Module- 2 (Boolean Algebra)

Postulates of Boolean Algebra. Basic theorems and Properties of Boolean Algebra. Boolean Functions - Canonical and Standard forms. Simplification of Boolean Functions- Using Karnaugh-Map Method (up to four variables), Don't care conditions, Product of sums simplification, Tabulation Method. Digital Logic Gates- Implementation of Boolean functions using basic and universal gates.

Module- 3 (Combinational Logic Circuits)

Design Procedure & Implementation of combinational logic circuits- Binary adders and subtractors, Binary Parallel adder, Carry look ahead adder, BCD adder, Code converter, Magnitude comparator, Decoder, Demultiplexer, Encoder, Multiplexer, Parity generator/ Checker.

Module- 4 (Sequential logic circuits)

Flip-flops- SR, JK, T and D. Triggering of flip-flops- Master slave flip- flops, Edge- triggered flip-flops. Excitation table and characteristic equation. Registers- register with parallel load. Counter design: Asynchronous counters- Binary and BCD counters, timing sequences and state diagrams. Synchronous counters- Binary Up- down counter, BCD counter.

Module- 5 (Shift registers)

Shift registers – Serial In Serial Out, Serial In Parallel Out, Bidirectional Shift Register with Parallel load. Ring counter. Johnson counter- timing sequences and state diagrams. Memory - ROM -PROM – EPROM – RAM- Solid state drives Sequential Programmable Logic Devices - PAL, PLA, FPGA. Introduction to Verilog, Design using Verilog basic gates, arithmetic circuits, basic- combinational and sequential logic circuits

Text Book

1. M. Morris Mano, Digital Logic & Computer Design, 4/e, Pearson Education, 2013
2. Thomas L Floyd, Digital Fundamentals, 10/e, Pearson Education, 2009.
3. M. Morris Mano, Computer System Architecture, 3/e, Pearson Education, 2007.

References

1. M. Morris Mano, Michael D Ciletti , Digital Design With An Introduction to the Verilog HDL, 5/e, Pearson Education, 2013.
2. Donald D Givone, Digital Principles and Design, Tata McGraw Hill, 2003

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Perform the following operations (i)$D9CE_{16}$-$CFDA_{16}$ (ii) 6575_8-5732_8
2. Convert decimal 6,514 to both BCD and ASCII codes. For ASCII, an even parity bit is to be appended at the left.

Course Outcome 2 (CO2):

1. Simplify using K-map $F(a,b,c,d) = \Sigma\, m\,(4,5,7,8,9,11,12,13,15)$
2. Explain the operation of a 8x1 multiplexer and implement the following using an 8x1 multiplexer $F(A, B, C, D) = \Sigma\, m\,(0, 1, 3, 5, 6, 7, 8, 9, 11, 13, 14)$

Course Outcome 3 (CO3):

1. Draw the circuit and explain the operation of a TTL NAND gate
2. Compare TTL, CMOS logic families in terms of fan-in, fan-out and supply voltage

Course Outcome 4 (CO4):

1. Explain a MOD 6 asynchronous counter using JK Flip Flop
2. Realize a T flip-flop using NAND gates and explain the operation with truth table, excitation table and characteristic equation

Course Outcome 5 (CO5):

1. Draw the logic diagram of 3 bit PIPO shift register with LOAD/SHIFT control and explain its working
2. Draw the logic diagram of 3 bit SIPO shift register with LOAD/SHIFT with proper diagram

Model Question Paper

QP CODE:
Reg No:_____
Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

THIRD SEMESTER B. TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: ERT281

Course name: LOGIC CIRCUIT DESIGN

Max Marks: 100 **Duration: 3 Hours**

PART-A

Answer All Questions. Each question carries 3 marks

1. Represent the decimal numbers (459)10 and (859)10 in hexadecimal and perform addition of these hexadecimal numbers.
2. Subtract (1101)2 from (11010)2 using: i) complement and ii) complement arithmetic.
3. Find the dual and complement of the boolean function F = AB′ + B(A + B′).
4. Using K-map, reduce the expression: AB+ABC+ABC+BC.
5. Design a half subtractor with NAND gates only.
6. Design a combinational circuit that multiplies an input decimal digit by 5 represented in BCD. The output is also in BCD. Show that the outputs can be obtained from the input lines without using any logic gates.
7. Differentiate between ripple counter and synchronous counter.
8. Construct D flip- flop using NAND gates. Also give its truth table.
9. Explain how a shift register is used for serial data transfer?
10. Write a Verilog code for D Flipflop.

(10 x 3 = 30 Marks)

PART-B

(Answer any one full question from each module. Each question carries 14 Marks)

11. (a) Perform the following operations using 2's complement arithmetic: **(8 marks)**

(i) $88_{10} + (-37)_{10}$ (ii) $(-20)_{10} + (-12)_{10}$

(b) Perform the following base conversions: (i) $(101011.11)_2$ to octal **(6 marks)**

(i) $(3F\ 9B)_{16}$ to binary (iii) $(121)_{10}$ to binary (iv) $(3077)_8$ to binary

OR

12. (a) Find the 12 bit complement representation of the following decimal numbers. **(6 marks)**

(i) – 97 (ii) – 224 (iii) - 197.5

(b) Perform the following operations **(8 marks)**

(i) $(520)_8 + (488)_8$ (ii) $(520)_{16} - (488)_{16}$

13. (a) Prove that (i) $AB + A(B + C) + B(B + C) = B + AC$ **(4 marks)**

(ii) $AB + A(B + C) + B(B + D) = A$

(b) Using K-map, simplify the Boolean function F in sum of products form, using the don't care conditions d: **(10 marks)**

$F(w, x, y, z) = w'(x'y + x'y' + x\,yz) + x'z'(y + w)$

$d(w, x, y, z) = w'x\,(y'z + yz') + wyz$

OR

14. (a) Simplify the following expressions using Karnaugh- map method. **(8 marks)**

(i) $F = \Sigma(0,2,4,6,9,11,13,15,17,21,25,27,29,31)$

(ii) $F = \Pi(0,2,5,7)$

(b) Convert the following to the other canonical form: **(6 marks)**

(i) $F(x, y, z, a) = \sum (1,3,7)$

(ii) $F(x, y, z) = \Pi(0,3,6,7)$

(iii) $F(A, B, C, D) = \Pi(0,1,2,3,4,6,12)$

15. (a) Implement Full adder circuit using NAND gate only. **(4 marks)**

(b) Design a code converter for converting BCD to Excess 3 code **(6 marks)**

OR

16. (a) With a neat diagram explain 4-bit carry look-ahead adder **(6 marks)**

(b) Design a Gray to binary code converter using a 4x1 MUX. Draw the circuit diagram and explain. **(8 marks)**

17. (a) Design a counter that count the states 0,3,5,6,0… using T flip- flops. **(10 marks)**

(b) Write the characteristics equation, excitation table of JK, T and D flip-flop. **(4 marks)**

OR

18. (a) Explain race around condition and how it can be avoided. **(6 marks)**

(b) Design a synchronous Binary Up-Down Counter. **(8 marks)**

19. (a) With a neat diagram explain universal shift register. **(8 marks)**

(b) Explain Johnson Counter with timing diagram. **(6 marks)**

OR

20. (a) Differentiate between PROM, PLA and PAL. **(7 marks)**

(b) Write Verilog Code for a full adder circuit. **(7 marks)**

TEACHING PLAN

No	Contents	No of Lecture Hrs
Module- 1 (Number systems, Operations & Codes) (No algorithms) (7 hrs)		
1.1	Number Systems: Decimal, Binary, Octal and Hexadecimal number systems, Number Base Conversions.	1
1.2	Binary Arithmetic: Addition, Subtraction, Multiplication & Division of Binary Numbers. (Lecture 1)	1
1.3	Addition, Subtraction, Multiplication & Division of Binary Numbers. (Lecture 2)	1
1.4	Representation of Negative Numbers- Complements, subtraction with complements.	1
1.5	BCD Arithmetic: Addition and Subtraction of BCD Numbers	1
1.6	Octal and Hexadecimal Arithmetic: Addition & Subtraction of Octal and Hexadecimal Numbers.	1

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1.7	Binary Codes: Decimal Codes, Error detection codes, Reflected code, Character Coding Schemes-ASCII, EBCDIC, Logic Gates – NOT, AND, OR, NAND, NOR, XOR, XNOR	1
Module - 2 (Boolean Algebra) (9 hrs)		
2.1	Introduction to Boolean Algebra: Postulates of Boolean Algebra	1
2.2	Basic theorems and Properties of Boolean Algebra	1
2.3	Boolean Functions: Canonical and Standard Forms	1
2.4	Simplification of Boolean Functions: Karnaugh -Map Method (up to four variables), Don't care conditions (Lecture 1)	1
2.5	Simplification of Boolean Functions: Karnaugh -Map Method (up to four variables), Don't care conditions (Lecture 2)	1
2.6	Product of sums simplification	1
2.7	Tabulation method	1
2.8	Digital Logic Gates: AND, OR, NOT, NAND, NOR, XOR, XNOR, Implementation of Boolean functions using basic and universal gates. (Lecture 1)	1
2.9	Digital Logic Gates: AND, OR, NOT, NAND, NOR, XOR, XNOR, Implementation of Boolean functions using basic and universal gates. (Lecture 2)	1
Module – 3 (Combinational Logic Circuits) (9 hrs)		
3.1	Design Procedure & Implementation of Combinational Circuits	1
3.2	Binary Adders: Implementation of Half Adder, Full Adder	1
3.3	Binary Subtractors: Implementation of Half Subtractor, Full Subtractor	1
3.4	Implementation of Binary Parallel Adder ,Carry look ahead Adder, BCD Adder (Lecture 1)	1
3.5	Implementation of Binary Parallel Adder ,Carry look ahead Adder, BCD Adder (Lecture 2)	1

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3.6	Implementation of Various Combinational Circuits: Code Converters, Magnitude Comparator	1
3.7	Implementation of Decoder, Demultiplexer	1
3.8	Implementation of Encoder, Multiplexer	1
3.9	Implementation of Parity Generator/Checker	1
Module - 4 (Sequential logic circuits) (9 hrs)		
4.1	Flip flops: SR, JK, T and D flip- flops (Lecture 1)	1
4.2	SR, JK, T and D flip- flops (Lecture 2)	1
4.3	Triggering of flip-flops- Master slave flip- flop, Edge- triggered flip-flops (Lecture 1)	1
4.4	Triggering of flip-flops- Master slave flip- flop, Edge- triggered flip-flops (Lecture 2)	1
4.5	Excitation table and characteristic equations of flip- flops	1
4.6	Registers- Register with parallel load	1
4.7	Counter Design: Asynchronous counters- Binary and BCD counters- timing sequences and state diagrams. (Lecture 1)	1
4.8	Asynchronous counters- Binary and BCD counters- timing sequences and state diagrams. (Lecture 2)	1
4.9	Synchronous counters- Binary Up- down counter, BCD counter	1
Module- 5 (Shift registers, Arithmetic algorithms & PLD's) (11 hrs)		
5.1	Shift Registers - Serial In Serial Out, Serial In Parallel Out.	1
5.2	Bidirectional Shift Register with Parallel load	1

5.3	Shift register counters - Ring Counter, Johnson Counter- timing sequences and state diagrams	1
5.4	Memory - ROM -PROM – EPROM – RAM- Solid state drives	1
5.5	Sequential Programmable Logic Devices - PAL, PLA	1
5.6	FPGA	1
5.7	Introduction to Verilog	1
5.8	Design using Verilog basic gates	1
5.9	arithmetic circuits	1
5.10	basic- combinational logic circuits	1
5.11	basic- sequential logic circuits	1

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CST 283	PYTHON FOR MACHINE LEARNING	Category	L	T	P	Credit	Year of Introduction
		VAC	3	1	0	4	2019

Preamble: This is a programming course for awarding B. Tech. Minor in Computer Science and Engineering with specialization in ***Machine Learning***. The objective of the course is to provide learners an insight into Python programming, and develop programming skills to manage the development of software systems. It covers programming environment, important instructions, data representations, intermediate level features, Object Oriented Programming and file data processing of Python. This course lays the foundation to develop web applications, Machine Learning, and Artificial Intelligence-based applications and tools, Data Science and Data Visualization applications.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO1	Write, test and debug Python programs **(Cognitive Knowledge level: Apply)**
CO2	Illustrate uses of conditional (if, if-else, if-elif-else and switch-case) and iterative (while and for) statements in Python programs **(Cognitive Knowledge level: Apply)**
CO3	Develop programs by utilizing the modules Lists, Tuples, Sets and Dictionaries in Python **(Cognitive Knowledge level: Apply)**
CO4	Implement Object Oriented programs with exception handling **(Cognitive Knowledge level: Apply)**
CO5	Write programs in Python to process data stored in files by utilizing the modules Numpy, Matplotlib, and Pandas **(Cognitive Knowledge level: Apply)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✔	✔	✔		✔						✔	✔
CO2	✔	✔	✔		✔					✔		✔
CO3	✔	✔	✔		✔	✔	✔					✔
CO4	✔	✔	✔		✔		✔					✔
CO5	✔	✔	✔	✔	✔	✔						✔

Abstract POs defined by National Board of Accreditation

#PO	Broad PO	#PO	Broad PO
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	Test 1 (*Marks in percentage*)	Test 2 (*Marks in percentage*)	End Semester Examination (*Marks in percentage*)
Remember	20	20	20
Understand	35	35	35
Apply	45	45	45
Analyse			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	**50**	**100**	**3**

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test : 25 marks
Continuous Assessment Assignment : 15 marks

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. The first series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing the remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have a maximum of 2 sub-divisions and carries 14 marks.

SYLLABUS

Module I

Programming Environment and Python Basics:

Getting Started with Python Programming - Running code in the interactive shell, Editing, Saving, and Running a script. Using editors - IDLE, Jupyter. The software development process - Case Study.

Basic coding skills - Working with data types, Numeric data types and Character sets, Keywords, Variables and Assignment statement, Operators, Expressions, Working with numeric data, Type conversions, Comments in the program. Input, Processing, and Output. Formatting output. How Python works. Detecting and correcting syntax errors. Using built in functions and modules in math module.

Module II

Building Python Programs:

Control statements - Selection structure (if-else, switch-case), Iteration structure(for, while), Testing the control statements, Lazy evaluation. Functions - Hiding redundancy and complexity, Arguments and return values, Variable scopes and parameter passing, Named arguments, Main function, Working with recursion, Lambda functions. Strings and number systems - String function, Handling numbers in various formats.

Module III

Data Representation:

Lists - Basic list Operations and functions, List of lists, Slicing, Searching and sorting list, List comprehension. Work with tuples. Sets. Work with dates and times. Dictionaries - Dictionary

functions, dictionary literals, adding and removing keys, accessing and replacing values, traversing dictionaries, reverse lookup. Case Study - Data Structure Selection.

Module IV

Object Oriented Programming:

Design with classes - Objects and Classes, Methods, Instance Variables, Constructor, Accessors and Mutators. Structuring classes with Inheritance and Polymorphism. Abstract Classes. Exceptions - Handle a single exception, handle multiple exceptions.

Module V

Data Processing:

The *os* and *sys* modules. Introduction to file I/O - Reading and writing text files, Manipulating binary files. NumPy - Basics, Creating arrays, Arithmetic, Slicing, Matrix Operations, Random numbers. Plotting and visualization. Matplotlib - Basic plot, Ticks, Labels, and Legends. Working with CSV files. – Pandas - Reading, Manipulating, and Processing Data.

Text Books:

1. Kenneth A Lambert., Fundamentals of Python : First Programs, 2/e, Cengage Publishing, 2016
2. Wes McKinney, Python for Data Analysis, 2/e, Shroff / O'Reilly Publishers, 2017

Reference Books:

1. Allen B. Downey, Think Python: How to Think Like a Computer Scientist, 2/e, Schroff, 2016
2. Michael Urban and Joel Murach, Python Programming, Shroff/Murach, 2016
3. David M.Baezly, Python Essential Reference. Addison-Wesley Professional; 4/e, 2009.
4. Charles Severance. Python for Informatics: Exploring Information,
5. http://swcarpentry.github.io/python-novice-gapminder/

Sample Course Level Assessment Questions

Course Outcome1(CO1): What is type conversion? How is it done in Python?

Course Outcome 2(CO2): Write a Python program which takes a positive integer **n** as input and finds the sum of cubes all positive even numbers less than or equal to the number.

Course Outcome 3(CO3): Given is a list of of words, *wordlist*, and a string, *name.* Write a Python function which takes *wordlist* and *name* as input and returns a tuple. The first element of

the output tuple is the number of words in the *wordlist* which have *name* as a substring in it. The second element of the tuple is a list showing the index at which the *name* occurs in each of the words of the *wordlist* and a 0 if it doesn't occur.

Course Outcome 4(CO4): Write a Python program to implement the addition, subtraction, and multiplication of complex numbers using classes. Use constructors to create objects. The input to the program consist of real and imaginary parts of the complex numbers.

Course Outcome 5(CO5): Given a file "auto.csv" of automobile data with the fields *index, company, body-style, wheel-base, length, engine-type, num-of-cylinders, horsepower, average-mileage,* and *price***,** write python code to

1) Clean and Update the CSV file
2) Print total cars of all companies
3) Find the average mileage of all companies
4) Find the highest priced car of all companies.

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Model Question Paper

QP CODE: PAGES:

Reg No:_____
Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
THIRD SEMESTER B.TECH (MINOR) DEGREE EXAMINATION, MONTH & YEAR

Course Code: CST 283

Course name : PYTHON FOR MACHINE LEARNING

Max Marks: 100 **Duration: 3 Hours**

PART-A

(Answer All Questions. Each question carries 3 marks)

1. Explain the basic data types available in Python, with examples.
2. Write a Python program to reverse a number and also find the sum of digits of the number. Prompt the user for input.
3. Explain the concept of scope and lifetime of variables in Python programming language, with a suitable example.
4. Discuss format specifiers and escape sequences with examples.
5. Discuss the relation between tuples, lists, and dictionaries in detail.
6. Discuss the following dictionary methods with an example.
   i. *get( )* ii. *Keys( )* iii. *pop( )* iv. *update( )* v. *values( )* vi. *items( )*
7. What is polymorphism? Give an example in the context of OOP in Python.
8. How is exception handling accomplished in Python programs?
9. Write a note on the **os** and **os.path** modules in Python. Also, discuss the *walk( )* and *getcwd( )* methods of the **os** module.
10. Describe the characteristics of the CSV format.

PART-B

(Answer any one full question from each module)

11. (a) Compare and contrast interpreted languages and compiled languages. How does it affect the quality of program development and execution of the program? (6)

(b) What are the possible errors in a Python program. Write a Python program to print the value of $2^{2n}+n+5$ for n provided by the user. (8)

OR

12. (a) Describe Arithmetic operators, Assignment operators, Comparison operators, Logical operators, and Bitwise operators in detail with examples. (6)

(b) Explain the software development process in detail. (8)

13. (a) Write a Python code to check whether a given year is a leap year or not [An year is a leap year if it's divisible by 4 but not divisible by 100 except for those divisible by 400]**.** (5)

(b) Input 4 integers (+ve and −ve). Write a Python code to find the sum of negative numbers, positive numbers, and print them. Also, find the averages of these two groups of numbers and print. (9)

OR

14. (a) Write a Python program to find the value for *sin(x)* up to *n* terms using the series (8)

$$\sin(x) - \frac{x}{1!} - \frac{x^3}{3!} + \frac{x^5}{5!} - \frac{x^7}{7!} + \cdots$$ where x is in degrees

(b) Write a Python code to determine whether the given string is a Palindrome or not using slicing. Do not use any string function. (6)

15. (a) Write a Python code to create a function called *list_of_frequency* that takes a string and prints the letters in non-increasing order of the frequency of their occurrences. Use dictionaries. (5)

(b) Write a Python program to read a list of numbers and sort the list in a non-decreasing order without using any built in functions. Separate function should be written to sort the list wherein the name of the list is passed as the parameter. (9)

OR

16. (a) Illustrate the following Set methods with an example. (6)
i. *intersection( )* ii. *Union( )* iii. *Issubset( )* iv. *Difference( )* v. *update( )* vi. *discard( )*

(b) Write a Python program to check the validity of a password given by the user. (8)
The Password should satisfy the following criteria:
1. Contains at least one letter between **a** and **z**
2. Contains at least one number between **0** and **9**
3. Contains at least one letter between **A** and **Z**
4. Contains at least one special character from **$, #, @**
5. Minimum length of password: **6**

17. (a) How can a class be instantiated in Python? Write a Python program to express the instances as return values to define a class RECTANGLE with parameters *height, width, corner_x,* and *corner_y* and member functions to find center, area, and perimeter of an instance. (10)

(b) Explain inheritance in Python. Give examples for each type of inheritance. (4)

OR

18. (a) Write a Python class named ***Circle*** constructed by a radius and two methods which will compute the area and the perimeter of a given circle (6)

(b) Write Python program to create a class called as **Complex** and implement *__add__( )* method to add two complex numbers. Display the result by overloading the + Operator. (8)

19. (a) Write a Python program to add two matrices and also find the transpose of the resultant matrix. (8)

(b) Given a file "auto.csv" of automobile data with the fields *index, company, body-style, wheel-base, length, engine-type, num-of-cylinders, horsepower, average-mileage,* and *price***,** write Python codes using Pandas to (6)
1) Clean and Update the CSV file
2) Print total cars of all companies
3) Find the average mileage of all companies
4) Find the highest priced car of all companies.

OR

20. (a) Write Python program to write the data given below to a CSV file. (5)

SN	Name	Country	Contribution	Year
1	Linus Torvalds	Finland	Linux Kernel	1991
2	Tim Berners-Lee	England	World Wide Web	1990
3	Guido van Rossum	Netherlands	Python	1991

(b) Given the sales information of a company as CSV file with the following fields *month_number, facecream, facewash, toothpaste, bathingsoap, shampoo, moisturizer, total_units, total_profit*. Write Python codes to visualize the data as follows (9)

1) Toothpaste sales data of each month and show it using a scatter plot
2) Face cream and face wash product sales data and show it using the bar chart
3) Calculate total sale data for last year for each product and show it using a Pie chart.

(14X5=70)

Teaching Plan

Module 1: Programming Environment and Python Basics		**(10 hours)**
1.1	Getting Started with Python Programming: Running code in the interactive shell Editing, Saving, and Running a script	**1 hour**
1.2	Using editors: IDLE	**1 hour**
1.3	Jupyter	**1 hour**
1.4	The software development process: Case Study.	**1 hour**
1.5	Basic coding skills: Working with data types, Numeric data types and Character sets, Keywords, Variables and Assignment statement, Operators, Expressions,	**1 hour**
1.6	Working with numeric data, Type conversions, Comments in the program	**1 hour**
1.7	Input, Processing, and Output, Formatting output – How Python works	**1 hour**
1.8	How Python works – Detecting and correcting syntax errors	**1 hour**
1.9	Using built in functions and modules: Case – Using math module	**1 hour**
1.10	Using built in functions and modules: Case – Using math module (Examples)	**1 hour**

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Module 2: Building Python Programs		**(8 hours)**
2.1	Control statements: Selection structure (if-else, switch-case),	**1 hour**
2.2	Iteration structure(for, while), Testing the control statements, Lazy evaluation	**1 hour**
2.3	Functions: Hiding redundancy and complexity, Arguments and return values,	**1 hour**
2.4	Variable scopes and parameter passing	**1 hour**
2.5	Named arguments, Main function,	**1 hour**
2.6	Working with recursion, Lambda functions	**1 hour**
2.7	Strings and number systems: String function	**1 hour**
2.8	Handling numbers in various format	**1 hour**
Module 3: Data Representation		**(9 hours)**
3.1	Lists: Basic list Operations and functions, List of lists	**1 hour**
3.2	Slicing, Searching and sorting list	**1 hour**
3.3	List comprehension	**1 hour**
3.4	Work with tuples, Sets	**1 hour**
3.5	Work with dates and times	**1 hour**
3.6	Dictionaries: Dictionary functions,	**1 hour**
3.7	Dictionary literals, adding and removing keys, accessing & replacing values	**1 hour**
3.8	Traversing dictionaries, reverse lookup	**1 hour**
3.9	Case Study: Data Structure Selection	**1 hour**
Module 4: Object Oriented Programming		**(8 hours)**
4.1	Design with classes : Objects and Classes, Methods, Instance Variables	**1 hour**
4.2	Constructor, Accessors and Mutators	**1 hour**
4.3	Structuring classes with Inheritance	**1 hour**
4.4	Polymorphism	**1 hour**
4.5	Abstract Classes	**1 hour**
4.6	Abstract Classes	**1 hour**
4.7	Exceptions : Handle a single exception	**1 hour**

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4.8	handle multiple exceptions	**1 hour**
Module 5: Data Processing		**(10 hours)**
5.1	The *os* and *sys* modules	**1 hour**
5.2	Introduction to file I/O: Reading and writing text files	**1 hour**
5.3	Manipulating binary files	**1 hour**
5.4	NumPy : Basics, Creating arrays, Arithmetic, Slicing	**1 hour**
5.5	Matrix Operations, Random numbers.	**1 hour**
5.6	Matplotlib : Basic plot	**1 hour**
5.7	Matplotlib - Ticks, Labels, and Legends	**1 hour**
5.8	Working with CSV files	**1 hour**
5.9	Pandas : Reading, Manipulating	**1 hour**
5.10	Pandas : Processing Data and Visualize.	**1 hour**

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CST 285	DATA COMMUNICATION	Category	L	T	P	Credit	Year of Introduction
		VAC	3	1	0	4	2019

Preamble: This is a basic course in communication for awarding B. Tech. Minor in Computer Science and Engineering with specialization in ***Networing***. The purpose of this course is to prepare learners to understand the communication entities and the associated issues in the field of Computer Science. This course covers fundamental concepts of data transmission & media, digital & analog transmissions, multiplexing & spread spectrum, error detection & correction and switching. Concepts in data communication help the learner to understand the concepts in networking and mobile communication.

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO1	Describe the characteristics of signals used for Analog and Digital transmissions (**Cognitive knowledge: Understand**)
CO2	Discuss the features and issues in data transmission (**Cognitive knowledge: Understand**)
CO3	Select transmission media based on characteristics and propagation modes (**Cognitive knowledge: Apply**)
CO4	Use appropriate signal encoding techniques for a given scenario (**Cognitive knowledge: Apply**)
CO5	Illustrate multiplexing and spread spectrum technologies (**Cognitive knowledge: Understand**)
CO6	Explain error detection & correction techniques and switching techniques used in data communication (**Cognitive knowledge: Understand**)

ELECTRONICS AND COMPUTER ENGINEERING

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓								✓		✓
CO2	✓	✓								✓		✓
CO3	✓											✓
CO4	✓	✓	✓	✓								✓
CO5	✓	✓	✓	✓						✓		✓
CO6	✓	✓	✓	✓						✓		✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	Test 1 (Marks in percentage)	Test 2 (Marks in percentage)	End Semester Examination (Marks in percentage)
Remember	30	30	30
Understand	40	40	40
Apply	30	30	30
Analyse			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test : 25 marks
Continuous Assessment Assignment : 15 marks

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

Syllabus

Module 1

Data Transmission Basics

Communication model - Simplex, Half duplex, Full duplex transmission. Periodic Analog signals - Sine wave, Amplitude, Phase, Wavelength, Time and frequency domain, Bandwidth. Analog & digital data and signals. Transmission impairments - Attenuation, Delay distortion, Noise. Data rate limits - Noiseless channel, Nyquist bandwidth, Noisy channel, Shannon's capacity formula.

Module 2

Transmission Media

Guided Transmission Media - Twisted pair, Coaxial cable, Optical fiber. Unguided media - Radio waves, Terrestrial microwave, Satellite microwave, Infrared. Wireless Propagation - Ground wave propagation, Sky Wave propagation, Line-of-Sight (LoS) Propagation.

Module 3

Digital Transmission and Analog Transmission

Digital data to Digital signal – Non-Return-to-Zero (NRZ), Return-to-Zero (RZ), Multilevel

binary, Biphase. Analog data to Digital signal - Sampling theorem, Pulse Code Modulation (PCM), Delta Modulation (DM). Digital data to Analog signal: Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), Phase Shift Keying (PSK). Analog data to Analog signal: Amplitude Modulation (AM), Frequency Modulation (FM), Phase Modulation (PM).

Module 4

Multiplexing and Spread Spectrum

Multiplexing - Frequency Division Multiplexing (FDM), Wave length Division Multiplexing (WDM), Time Division Multiplexing (TDM), Characteristics, Synchronous TDM, Statistical TDM. Spread Spectrum Techniques - Direct Sequence Spread Spectrum (DSSS), Frequency Hopping Spread Spectrum (FHSS), Code Division Multiplexing, Code Division Multiple Access (CDMA).

Module 5

Error Detection, Correction and Switching

Digital data communication techniques - Asynchronous transmission, Synchronous transmission. Detecting and correcting errors - Types of Errors, Parity check, Checksum, Cyclic Redundancy Check (CRC), Forward Error Correction (FEC), Hamming Distance, Hamming Code. Basic principles of Switching - Circuit Switching, Packet Switching, Message Switching.

Text Books

1. Forouzan B. A., Data Communications and Networking, 5/e, McGraw Hill, 2013.
2. William Stallings, Data and Computer Communication 9/e, Pearson Education, Inc.

Reference Books

1. Schiller J., Mobile Communications, 2/e, Pearson Education, 2009.
2. Curt M. White, Fundamentals of Networking and Communication 7/e, Cengage learning.

Sample Course Level Assessment Questions

Course Outcome 1 (CO1): What is a periodic analog signal? List the main properties of a periodic analog signal.

Course Outcome 2 (CO2): What is attenuation? How can it be handled?

Course Outcome 3 (CO3): How can interference be reduced using optical fiber?

Course Outcome 4(CO4): Encode the data sequence 101011100 using Multilevel binary and Biphase schemes.

Course Outcome 5(CO5): Explain direct sequence spread spectrum with a neat diagram.

Course Outcome 6(CO6): Using Cyclic Redundancy Check (CRC), given the data-word 11110000 and the divisor 10011, show the generation of the codeword at the sender and the checking of the codeword at the receiver.

Model Question Paper

QP CODE: PAGES: ___

Reg No:_____
Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
FOURTH SEMESTER B.TECH DEGREE (MINOR) EXAMINATION, MONTH & YEAR

Course Code: CST 285
Course name : DATA COMMUNICATION

Max Marks: 100 **Duration: 3 Hours**

PART-A
(Answer All Questions. Each question carries 3 marks)

1. What is bandwidth? Find the lowest frequency, if a periodic signal has a bandwidth of 20 Hz and the highest frequency is 60 Hz. Draw the Spectrum if the signal contains all frequencies of same amplitude.
2. Assume that a TV picture is to be transmitted over a channel with 4.5 MHz bandwidth and a 35 dB Signal-to-Noise-Ratio. Find the capacity of the channel.
3. What is the purpose of cladding in optical fibres?
4. Which wireless propagation is suitable for satellite communication? Justify your answer.
5. Explain the working of Delta Modulation with an example.
6. Illustrate the equivalent square wave pattern of the bit string 01001101 using Non-Return-to-Zero(NRZ) - Level and NRZ-Invert encoding schemes.
7. Distinguish between synchronous and statistical Time Division Multiplexing.
8. Apply Direct Sequence Spread Spectrum to the data 101 using the Barker sequence 10110111000. Show the encoding and decoding steps.
9. Find the minimum hamming distance for the following cases:
    a) Detection of two errors
    b) Correction of two errors
    c) Detection of 3 errors or correction of 2 errors
    d) Detection of 6 errors or correction of 2 errors
10. Find the parity bit for simple even parity check for the following.
    a) 1001010
    b) 0001100
    c) 1000000
    d) 1110111

PART-B

(Answer ANY one full question from each module. Each question carries 14 marks)

11. a) With the help of suitable figures, distinguish between time domain and frequency domain. (4)

    b) Describe the different types of transmission impairments. (10)

OR

12. a) Calculate the bandwidth, if a periodic signal is decomposed into 4 sine waves with frequencies 50 Hz, 100 Hz, 150 Hz and 200Hz. Draw the spectrum, assuming all components having amplitude in the range 6-12 V and all are multiple of two in the increasing order.

    (6)

    b) Distinguish between Nyquist bandwidth and Shannon capacity. Consider a noiseless channel with a bandwidth of 3000 Hz transmitting a signal with (i) Two signal levels and (ii) Four signal levels. Determine the maximum bit rate in both these cases.

    (8)

13. a) For a parabolic reflective antenna operating at 12 GHz with a diameter of 2 m, calculate the effective area and the antenna gain.

    (6)

    b) List any four advantages and disadvantages of twisted pair, coaxial cable and fiber optic cable.

    (8)

OR

14. a) Compare the features of terrestrial microwave and satellite microwave.

    (6)

    b) With the help of suitable diagrams, differentiate Multi-mode and Single-mode optical fibres. How the rays are propagated in Step-index and Graded-index Multi-mode fibres.

    (8)

15. a) Distinguish between data rate and signal rate. (4)

b) What is polar encoding? Encode the pattern 010011001110 using the two Biphase schemes.

(10)

OR

16. a) Show the equivalent analog sine wave pattern of the bit string 010011010 using Amplitude Shift Keying, Frequency Shift Keying and Phase Shift Keying.

(4)

b) State Sampling theorem. Explain Pulse Code Modulation with suitable figures.

(10)

17. a) Four channels are multiplexed using Time Division Multiplexing. If each channel sends 100 bytes/sec and we multiplex one byte per channel, determine the frame size, duration of a frame, frame rate and bit rate of the link.

(6)

b) With the help of an example, explain the working of Frequency Hopping Spread Spectrum.

(8)

OR

18. a) Explain the different techniques by which the disparity in input data rate is handled by Time Division Multiplexing.

(4)

b) Suppose Alice and Bob are communicating using Code Division Multiple Access. Alice uses the code [+1 +1] and Bob uses the code [+1 -1]. Alice sends the data bit 0 and Bob sends the data bit 1. Show the data in the channel and how they can detect what the other person has sent.

(10)

19. a) Explain parity check with examples.

(4)

b) Describe the need for a switch. What are the different phases in circuit switching?

(10)

OR

20. a) With the help of a suitable example, explain the virtual circuit approach of packet switching. (6)

b) Find the Hamming code for the data-word 1011001. Assume odd parity. (8)

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Teaching Plan

Module 1 : Data Transmission Basics		**(8 Hours)**
1.1	Introduction, Communication model - Simplex, Half duplex, Full duplex transmission	1
1.2	Periodic Analog signals - Sine wave, Amplitude, Phase, Wavelength	1
1.3	Time and frequency domain, Bandwidth	1
1.4	Analog data and signals	1
1.5	Digital data and signals	1
1.6	Transmission impairments - Attenuation, Delay distortion, Noise	1
1.7	Data rate limits - Noiseless channel, Nyquist bandwidth	1
1.8	Noisy channel, Shannon's capacity formula	1
Module 2: Transmission media		**(7 Hours)**
2.1	Guided Transmission Media - Twisted pair, Coaxial cable	1
2.2	Optical fiber	1
2.3	Unguided media - Radio waves	1
2.4	Terrestrial microwave, Satellite microwave	1
2.5	Infrared	1
2.6	Wireless Propagation - Ground wave propagation	1
2.7	Wave propagation, Line-of-Sight (LoS) Propagation	1
Module 3: Digital Transmission and Analog Transmission		**(10 Hours)**
3.1	Digital data to Digital signal – Non-Return-to-Zero (NRZ)	1
3.2	Return-to-Zero (RZ), Multilevel binary	1

3.3	Biphase	1
3.4	Analog data to Digital signal - Sampling theorem	1
3.5	Pulse Code Modulation (PCM)	1
3.6	Delta Modulation (DM)	1
3.7	Digital data to Analog signal: Amplitude Shift Keying (ASK)	1
3.8	Frequency Shift Keying (FSK), Phase Shift Keying (PSK)	1
3.9	Analog data to Analog signal: Amplitude Modulation (AM)	1
3.10	Frequency Modulation (FM), Phase Modulation (PM)	1
Module 4: Multiplexing and Spread Spectrum		**(9 Hours)**
4.1	Multiplexing - Frequency Division Multiplexing (FDM)	1
4.2	Wave length Division Multiplexing (WDM), Time Division Multiplexing (TDM)	1
4.3	Synchronous TDM, Statistical TDM	1
4.4	Spread Spectrum Techniques	1
4.5	Direct Sequence Spread Spectrum (DSSS)	1
4.6	Frequency Hopping Spread Spectrum (FHSS)	1
4.7	Code Division Multiplexing	1
4.8	Code Division Multiple Access (CDMA)	1
4.9	CDMA	1
Module 5: Error Detection, Correction and Switching		**(11 Hours)**
5.1	Digital data communication techniques - Asynchronous & Synchronous transmission	1
5.2	Detecting and correcting errors - Types of Errors	1
5.3	Parity check, Checksum	1
5.4	Cyclic Redundancy Check (CRC)	1
5.5	CRC	1
5.6	Forward Error Correction (FEC)	1
5.7	Hamming Distance, Hamming Code	1
5.8	Hamming Code	1
5.9	Basic principles of Switching - Circuit Switching	1

5.10	Packet Switching	1
5.11	Message Switching	1

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SEMESTER IV

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CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
MAT204	PROBABILITY, RANDOM PROCESSES AND NUMERICAL METHODS	BSC	3	1	0	4

Preamble: This course introduces students to the modern theory of probability and statistics, covering important models of random variables and analysis of random processes using appropriate time and frequency domain tools. A brief course in numerical methods familiarises students with some basic numerical techniques for finding roots of equations, evaluating definite integrals solving systems of linear equations and solving ordinary differential equations which are especially useful when analytical solutions are hard to find.

Prerequisite: A basic course in one-variable and multi-variable calculus**.**

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand the concept, properties and important models of discrete random variables and, using them, analyse suitable random phenomena.
CO 2	Understand the concept, properties and important models of continuous random variables and, using them, analyse suitable random phenomena.
CO 3	Analyse random processes using autocorrelation, power spectrum and Poisson process model as appropriate.
CO 4	Compute roots of equations, evaluate definite integrals and perform interpolation on given numerical data using standard numerical techniques
CO 5	Apply standard numerical techniques for solving systems of equations, fitting curves on given numerical data and solving ordinary differential equations.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	2	2	2	2					2		1
CO 2	3	2	2	2	2					2		1
CO 3	3	2	2	2	2					2		1
CO 4	3	2	2	2	2					2		1
CO 5	3	2	2	2	2					2		1

Assessment Pattern

Bloom's Category	Continuous Assessment Tests(%)		End Semester Examination(%)
	1	2	
Remember	10	10	10
Understand	30	30	30
Apply	30	30	30
Analyse	20	20	20
Evaluate	10	10	10
Create			

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Let X denote the number that shows up when an unfair die is tossed. Faces 1 to 5 of the die are equally likely, while face 6 is twice as likely as any other. Find the probability distribution, mean and variance of X.

2. An equipment consists of 5 components each of which may fail independently with probability 0.15. If the equipment is able to function properly when at least 3 of the components are operational, what is the probability that it functions properly?

3. X is a binomial random variable $B(n,p)$with $n = 100$and $p = 0.1$. How would you approximate it by a Poisson random variable?

4. Three balls are drawn at random without replacement from a box containing 2 white, 3 red and 4 black balls. If X denotes the number of white balls drawn and Y denotes the number of red balls drawn, find the joint probability distribution of (X,Y)

Course Outcome 2 (CO2)

1. What can you say about $P(X = a)$for any real number $a$when $X$is (i) a discrete random variable? (ii) a continuous random variable?

2. A string, 1 meter long, is cut into two pieces at a random point between its ends. What is the probability that the length of one piece is at least twice the length of the other?

3. A random variable has a normal distribution with standard deviation 10. If the probability that it will take on a value less than 82.5 is 0.82, what is the probability that it will take on a value more than 58.3?

4. X and Y are independent random variables with X following an exponential distribution with parameter μ and Y following and exponential distribution with parameterλ. Find $P(X+Y \leqslant 1)$

Course Outcome 3(CO3):

1. A random process $X(t)$ is defined by $acos(\omega t+\Theta)$where a and ω are constants and Θ is uniformly distributed in$[0,2\pi]$. Show that $X(t)$ is WSS

2. How are the autocorrelation function and power spectral density of a WSS process are related to each other?

3. Find the power spectral density of the WSS random process $X(t)$, given the autocorrelation function $R_X(\tau)=9e^{-|\tau|}$

4. A conversation in a wireless ad-hoc network is severely disturbed by interference signals according to a Poisson process of rate $\lambda=0.01$ per minute. (a) What is the probability that no interference signals occur within the first two minutes of the conversation? (b) Given that the first two minutes are free of disturbing effects, what is the probability that in the next minute precisely 1 interfering signal disturbs the conversation? (c) Given that there was only 1 interfering signal in the first 3 minutes, what is the probability that there would be utmost 2 disturbances in the first 4 minutes?

Course Outcome 4(CO4):

1. Use Newton-Raphson method to find a real root of the equation $f(x)=e^{2x}-x-6$correct to 4 decimal places.

2. Compare Newton's divided difference method and Lagrange's method of interpolation.

3. Use Newton's forward interpolation formula to compute the approximate values of the function $f$at $x=0.25$from the following table of values of $x$and $f(x)$

x	0	0.5	1	1.5	2
f(x)	1.0000	1.0513	1.1052	1.1618	1.2214

4. Find a polynomial of degree 3 or less the graph of which passes through the points (-1, 3), (0,-4), (1,5) and (2,-6)

Course Outcome 5 (CO5):

1. Apply Gauss-Seidel method to solve the following system of equations
$$4x_1 - x_2 - x_3 = 3$$
$$-2x_1 + 6x_2 + x_3 = 9$$
$$-x_1 + x_2 + 7x_3 = -6$$

2. Using the method of least squares fit a straight line of the form $y = ax + b$to the following set of ordered pairs (x, y) :
(2,4), (3,5), (5,7), (7,10), (9,15)

3. Write the normal equations for fitting a curve of the form $y = a_0 + a_1x^2$to a given set of pairs of data points.

4. Use Runge-Kutta method of fourth order to compute $y(0.25)$and $y(0.5)$, given the initial value problem
$$y' = x + xy + y, y(0) = 1$$

Syllabus

Module 1 (Discrete probability distributions) 9 hours

(Text-1: *Relevant topics* from sections-3.1-3.4, 3.6, 5.1)

Discrete random variables and their probability distributions, Expectation, mean and variance, Binomial distribution, Poisson distribution, Poisson approximation to the binomial distribution, Discrete bivariate distributions, marginal distributions, Independent random variables, Expectation (multiple random variables)

Module 2 (Continuous probability distributions) 9 hours

(Text-1:*Relevant topics* from sections-4.1-4.4, 3.6, 5.1)

Continuous random variables and their probability distributions, Expectation, mean and variance, Uniform, exponential and normal distributions, Continuous bivariate distributions, marginal distributions, Independent random variables, Expectation (multiple random variables), i. i. d random variables and Central limit theorem (without proof).

Module 3 (Random Processes) 9 hours

(Text-2: *Relevant topics* from sections-8.1-8.5, 8.7, 10.5)

Random processes and classification, mean and autocorrelation, wide sense stationary (WSS) processes, autocorrelation and power spectral density of WSS processes and their properties, Poisson process-distribution of inter-arrival times, combination of independent Poisson processes(merging) and subdivision (splitting) of Poisson processes (**results without proof**).

Module 4 (Numerical methods -I) 9 hours

(Text 3- *Relevant topics* from sections 19.1, 19.2, 19.3, 19.5)

Errors in numerical computation-round-off, truncation and relative error, Solution of equations – Newton-Raphson method and Regula-Falsi method. Interpolation-finite differences, Newton's forward and backward difference method, Newton's divided difference method and Lagrange's method. Numerical integration-Trapezoidal rule and Simpson's 1/3rd rule (**Proof or derivation of the formulae not required for any of the methods in this module**)

Module 5 (Numerical methods -II) 9 hours

(Text 3- *Relevant topics* from sections 20.3, 20.5, 21.1)

Solution of linear systems-Gauss-Seidel and Jacobi iteration methods. Curve fitting-method of least squares, fitting straight lines and parabolas. Solution of ordinary differential equations-Euler and Classical Runge-Kutta method of second and fourth order, Adams-Moulton predictor-correction method (**Proof or derivation of the formulae not required for any of the methods in this module**)

Text Books

1. (Text-1) Jay L. Devore, *Probability and Statistics for Engineering and the Sciences*, 8th edition, Cengage, 2012
2. (Text-2) Oliver C. Ibe, *Fundamentals of Applied Probability and Random Processes,* Elsevier, 2005.
3. (Text-3) Erwin Kreyszig, *Advanced Engineering Mathematics*, 10 th Edition, John Wiley & Sons, 2016.

Reference Books

1. Hossein Pishro-Nik, *Introduction to Probability, Statistics and Random Processes*, Kappa Research, 2014 (Also available online at www.probabilitycourse.com)
2. V.Sundarapandian, *Probability, Statistics and Queueing theory*, PHI Learning, 2009
3. Gubner, *Probability and Random Processes for Electrical and Computer Engineers*, Cambridge University Press,2006.
4. B.S. Grewal, *Higher Engineering Mathematics*, Khanna Publishers, 36 Edition, 2010.

Assignments

Assignments should include specific problems highlighting the applications of the methods introduced in this course in physical sciences and engineering.

Course Contents and Lecture Schedule

ELECTRONICS AND COMPUTER ENGINEERING

No	Topic	No. of Lectures
1	**Discrete Probability distributions**	**9 hours**
1.1	Discrete random variables and probability distributions, expected value, mean and variance (discrete)	3
1.2	Binomial distribution-mean, variance, Poisson distribution-mean, variance, Poisson approximation to binomial	3
1.3	Discrete bivariate distributions, marginal distributions, Independence of random variables (discrete), Expected values	3
2	**Continuous Probability distributions**	**9 hours**
2.1	Continuous random variables and probability distributions, expected value, mean and variance (continuous)	2
2.2	Uniform, exponential and normal distributions, mean and variance of these distributions	4
2.3	Continuous bivariate distributions, marginal distributions, Independent random variables, Expected values, Central limit theorem.	3
3	**Random processes**	**9 hours**
3.1	Random process -definition and classification, mean , autocorrelation	2
3.2	WSS processes its autocorrelation function and properties	2
3.3	Power spectral density	2
3.4	Poisson process, inter-distribution of arrival time, merging and splitting	3
4	**Numerical methods-I**	**9 hours**
4.1	Roots of equations- Newton-Raphson, regulafalsi methods	2
4.2	Interpolation-finite differences, Newton's forward and backward formula,	3
4.3	Newton's divided difference method, Lagrange's method	2
4.3	Numerical integration-trapezoidal rule and Simpson's 1/3-rd rule	2
5	**Numerical methods-II**	**9 hours**
5.1	Solution of linear systems-Gauss-Siedal method, Jacobi iteration	2

	method	
5.2	Curve-fitting-fitting straight lines and parabolas to pairs of data points using method of least squares	2
5.3	Solution of ODE-Euler and Classical Runge-Kutta methods of second and fourth order	4
5.4	Adams-Moulton predictor-corrector method	1

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Model Question Paper

(**2019 Scheme**)

Reg No: ..... **Total Pages: 3**

Name: .....

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FOURTH SEMESTER B.TECH DEGREE EXAMINATION

(Month & year)

Course Code: MAT 204

Course Name: PROBABILITY, RANDOM PROCESSES AND NUMERICAL METHODS

(For (i) Electrical and Electronics, (ii) Electronics and Communication, (iii) Applied Electronics and Instrumentation Engineering branches)

Max Marks :100 Duration : 3 Hours

PART A

(Answer *all* questions. Each question carries 3 marks)

1. Suppose X is binomial random variable with parameters $n = 100$ and $p = 0.02$. Find $P(X < 3)$ using Poisson approximation to X. (3)

2. The diameter of circular metallic discs produced by a machine is a random variable with mean 6cm and variance 2cm. Find the mean area of the discs. (3)

3. Find the mean and variance of the continuous random variable X with probability density function (3)
$$f(x) = \begin{cases} 2x - 4, & 2 \le x \le 3 \\ 0 & \text{otherwise} \end{cases}$$

4. The random variable X is exponentially distributed with mean 3. Find $P(X > t + 3 | X > t)$ where t is any positive real number. (3)

5. Give any two examples of a continuous time discrete state random processes. (3)

6. How will you calculate the mean, variance and total power of a WSS process from its autocorrelation function? (3)

7. Find all the first and second order forward and backward differences of y for the following set of (x, y) values: (0.5, 1.13), (0.6, 1.19), (0.7, 1.26), (0.8, 1.34) (3)

8. The following table gives the values of a function $f(x)$ for certain values of x. (3)

x	0	0.25	0.50	0.75	1
$f(x)$	1	0.9412	0.8	0.64	0.5

Evaluate $\int_0^1 f(x)dx$ using trapezoidal rule.

9. Explain the principle of least squares for determining a line of best fit to a given data (3)

10. Given the initial value problem $y' = y + x$, $y(0) = 0$, find $y(0.1)$ and $y(0.2)$ using Euler method. (3)

PART B

(Answer one question from each module)

MODULE 1

11. (a) The probability mass function of a discrete random variable is $p(x) = kx, x = 1, 2, 3$ where k is a positive constant. Find (i)the value of k (ii) $P(X \leq 2)$ (iii) $E[X]$ and (iv) var$(1 - X)$. (7)

    (b) Find the mean and variance of a binomial random variable (7)

OR

12. (a) Accidents occur at an intersection at a Poisson rate of 2 per day. what is the probability that there would be no accidents on a given day? What is the probability that in January there are at least 3 days (not necessarily consecutive) without any accidents? (7)

    (b) Two fair dice are rolled. Let X denote the number on the first die and $Y = 0$ or 1, according as the first die shows an even number or odd number. Find (i) the joint probability distribution of X and Y, (ii) the marginal distributions. (iii) Are X and Y independent ? (7)

MODULE 2

13. (a) The IQ of an individual randomly selected from a population is a normal distribution with mean 100 and standard deviation 15. Find the probability that an individual has IQ (i) above 140 (ii) between 120 and 130. (7)

    (b) A continuous random variable X is uniformly distributed with mean 1 and variance 4/3. Find $P(X < 0)$ (7)

OR

14. (a) The joint density function of random variables X and Y is given by (7)

$$f(x, y) = \begin{cases} e^{-(x+y)}, & x > 0, \quad y > 0 \\ 0 & \text{otherwise.} \end{cases}$$

    Find $P(X + Y \leq 1)$. Are X and Y independent? Justify.

    (b) The lifetime of a certain type of electric bulb may be considered as an exponential random variable with mean 50 hours. Using central limit theorem, find the approximate probability that 100 of these electric bulbs will provide a total of more than 6000 hours of burning time. (7)

MODULE 3

15. (a) A random process $X(t)$ is defined by $X(t) = Y(t)\cos(\omega t + \Theta)$ where $Y(t)$ is a WSS process, ω is a constant and Θ is uniformly distributed in $[0, 2\pi]$ and is independent of $Y(t)$. Show that $X(t)$ is WSS (7)

    (b) Find the power spectral density of the random process $X(t) = a\sin(\omega_0 t + \Theta)$, ω_0 constant and Θ is uniformly distributed in $(0, 2\pi)$ (7)

OR

16. Cell-phone calls processed by a certain wireless base station arrive according to a Poisson process with an average of 12 per minute.

    (a) What is the probability that more than three calls arrive in an interval of length 20 seconds? (7)

    (b) What is the probability that more than 3 calls arrive in each of two consecutive intervals of length 20 seconds? (7)

MODULE 4

17. (a) Use Newton-Raphson method to find a non-zero solution of $x = 2\sin x$. Start with $x_0 = 1$ (7)

(b) Using Lagrange's interpolating polynomial estimate $f(1.5)$ for the following data (7)

x	0	1	2	3
$y = f(x)$	0	0.9826	0.6299	0.5532

OR

18. (a) Consider the data given in the following table (7)

x	0	0.5	1	1.5	2
$f(x)$	1.0000	1.0513	1.1052	1.1618	1.2214

Estimate the value of $f(1.80)$ using newton's backward interpolation formula.

(b) Evaluate $\int_0^1 e^{-x^2/2}dx$ using Simpson's one-third rule, dividing the interval [0, 1] into 8 subintervals (7)

MODULE 5

19. (a) Using Gauss-Seidel method, solve the following system of equations (7)

$$20x + y - 2z = 17$$
$$3x + 20y - z = -18$$
$$2x - 3y + 20z = 25$$

(b) The table below gives the estimated population of a country (in millions) for during 1980-1995 (7)

year	1980	1985	1990	1995
population	227	237	249	262

Plot a graph of this data and fit an appropriate curve to the data using the method of least squares. Hence predict the population for the year 2010.

OR

20. (a) Use Runge-Kutta method of fourth order to find $y(0.2)$ given the initial value problem (7)

$$\frac{dy}{dx} = \frac{xy}{1+x^2}, \quad y(0) = 1$$

Take step-size, $h = 0.1$.

(b) Solve the initial value problem (7)

$$\frac{dy}{dx} = x + y, \quad y(0) = 0,$$

in the interval $0 \le x \le 1$, taking step-size $h = 0.2$. Calculate $y(0.2), y(0.4)$ and $y(0.6)$ using Runge-Kutta second order method, and $y(0.8)$ and $y(1.0)$ using Adam-Moulton predictor-corrector method.

****

CST202	COMPUTER ORGANIZATION AND ARCHITECTURE	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		PCC	3	1	0	4	2019

Preamble: The course is prepared with the view of enabling the learners capable of understanding the fundamental architecture of a digital computer. Study of Computer Organization and Architecture is essential to understand the hardware behind the code and its execution at physical level by interacting with existing memory and I/O structure. It helps the learners to understand the fundamentals about computer system design so that they can extend the features of computer organization to detect and solve problems occurring in computer architecture.

Prerequisite : Topics covered under the course Logic System Design (CST 203)

Course Outcomes: After the completion of the course the student will be able to

CO#	CO
CO1	Recognize and express the relevance of basic components, I/O organization and pipelining schemes in a digital computer **(Cognitive knowledge: Understand)**
CO2	Explain the types of memory systems and mapping functions used in memory systems **(Cognitive Knowledge Level: Understand)**
CO3	Demonstrate the control signals required for the execution of a given instruction **(Cognitive Knowledge Level: Apply))**
CO4	Illustrate the design of Arithmetic Logic Unit and explain the usage of registers in it (**Cognitive Knowledge Level: Apply**)
CO5	Explain the implementation aspects of arithmetic algorithms in a digital computer **(Cognitive Knowledge Level:Apply)**
CO6	Develop the control logic for a given arithmetic problem (**Cognitive Knowledge Level: Apply**)

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓								✓
CO2	✓	✓	✓	✓						✓		✓
CO3	✓	✓	✓	✓						✓		✓
CO4	✓	✓	✓	✓						✓		✓
CO5	✓	✓	✓							✓		✓
CO6	✓	✓	✓	✓								✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks (%)
	Test1 (%)	Test2 (%)	
Remember	20	20	30
Understand	40	40	30
Apply	40	40	40
Analyze			

Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	**50**	**100**	**3 hours**

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Tests : 25 marks

Continuous Assessment Assignment : 15 marks

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks

First Internal Examination shall be preferably conducted after completing the first half of the syllabus and the Second Internal Examination shall be preferably conducted after completing remaining part of the syllabus.

There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly covered module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly covered module), each with 7 marks. Out of the 7 questions in Part B, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Syllabus

Module 1

Basic Structure of computers – functional units - basic operational concepts - bus structures. Memory locations and addresses - memory operations,Instructions and instruction sequencing , addressing modes.

Basic processing unit – fundamental concepts – instruction cycle – execution of a complete instruction - single bus and multiple bus organization

Module 2

Register transfer logic: inter register transfer – arithmetic, logic and shift micro operations.

Processor logic design: - processor organization – Arithmetic logic unit - design of arithmetic circuit - design of logic circuit - Design of arithmetic logic unit - status register – design of shifter - processor unit – design of accumulator.

Module 3

Arithmetic algorithms: Algorithms for multiplication and division (restoring method) of binary numbers. Array multiplier , Booth's multiplication algorithm.

Pipelining: Basic principles**,** classification of pipeline processors, instruction and arithmetic pipelines (Design examples not required), hazard detection and resolution.

Module 4

Control Logic Design: Control organization – Hard_wired control-microprogram control – control of processor unit - Microprogram sequencer,micro programmed CPU organization - horizontal and vertical micro instructions.

Module 5

I/O organization: accessing of I/O devices – interrupts, interrupt hardware -Direct memory access.

Memory system: basic concepts – semiconductor RAMs. memory system considerations – ROMs, Content addressable memory, cache memories - mapping functions.

Text Books

1. Hamacher C., Z. Vranesic and S. Zaky, Computer Organization ,5/e, McGraw Hill, 2011
2. Mano M. M., Digital Logic & Computer Design, PHI, 2004
3. KaiHwang, Faye Alye Briggs, Computer architecture and parallel processing McGraw-Hill, 1984

Reference Books

1. Mano M. M., Digital Logic & Computer Design, 3/e, Pearson Education, 2013.
2. Patterson D.A. and J. L. Hennessy, Computer Organization and Design, 5/e, Morgan Kaufmann Publishers, 2013.
3. William Stallings, Computer Organization and Architecture: Designing for Performance, Pearson, 9/e, 2013.
4. Chaudhuri P., Computer Organization and Design, 2/e, Prentice Hall, 2008.
5. Rajaraman V. and T. Radhakrishnan, Computer Organization and Architecture, Prentice Hall, 2011

Sample Course Level Assessment Questions

Course Outcome1(CO1): Which are the registers involved in a memory access operation and how are they involved in it?

Course Outcome 2(CO2): Explain the steps taken by the system to handle a write miss condition inside the cache memory.

Course Outcome 3(CO3): Generate the sequence of control signals required for the execution of the instruction MOV [R1],R2 in a threebus organization.

Course Outcome 4(CO4): Design a 4-bit combinational logic shifter with 2 control signals H0 and H1 that perform the following operations :

H1	H0	Operation
0	0	Transfer 1's to all output line
0	1	No shift operation
1	0	Shift left
1	1	Shift right

Course Outcome 5(CO5): Explain the restoring algorithm for binary division. Also trace the algorithm to divide $(1001)_2$ by $(11)_2$

Course Outcome 6(CO6): Design a software control logic based on microprogramed control to perform the addition of 2 signed numbers represented in sign magnitude form.

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2014

Model Question Paper

QP CODE: PAGES:2

Reg No:_____

Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FOURTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH &

YEAR Course Code: CST202

Course Name: Computer organization and architecture

Max.Marks:100 **Duration: 3 Hours**

PART A

Answer all Questions. Each question carries 3 Marks

1. Give the significance of instruction cycle.
2. Distinguish between big endian and little endian notations. Also give the significance of these notations.
3. Compare I/O mapped I/O and memory mapped I/O.
4. Give the importance of interrupts in I/O interconnection.
5. Justify the significance of status register.
6. How does the arithmetic circuitry perform logical operations in an ALU.
7. Illustrate divide overflow with an example.
8. Write notes on arithmetic pipeline.
9. Briefly explain the role of micro program sequence.
10. Differentiate between horizontal and vertical micro instructions.

Part B

Answer any one Question from each module. Each question carries 14 Marks

11.

11.(a) What is the significance of addressing modes in computer architecture.

(4)

11.(b) Write the control sequence for the instruction DIV R1,[R2] in a three bus structure. (10)

OR

12. Explain the concept of a single bus organization with help of a diagram. Write the control sequence for the instruction ADD [R1],[R2].

(14)

13. Explain various register transfer logics.

(14)

OR

14.

14.(a) Design a 4 bit combinational logic shifter with 2 control signals H1 and H2 that perform the following operations (bit values given in parenthesis are the values of control variable H1 and H2 respectively.) : Transfer of 0's to S (00), shift right (01), shift left (10), no shift (11).

(5)

14.(b) Design an ALU unit which will perform arithmetic and logic operation with a given binary adder.

(9)

15.

15.(a) Give the logic used behind Booth's multiplication algorithm.

(4)

15.(b) Identify the appropriate algorithm available inside the system to perform the multiplication between -14 and -9. Also trace the algorithm for the above input.

(10)

OR

16.

16.(a) List and explain the different pipeline hazards and their possible solutions

(10)

16.(b) Design a combinational circuit for 3x2 multiplication.

(4)

17. Design a hardwared control unit used to perform addition/subtraction of 2 numbers represented in sign magnitude form.

(14)

OR

18. Give the structure of the micro program sequencer and its role in sequencing the micro instructions.

(14)

19.

19.(a) Explain the different ways in which interrupt priority schemes can be implemented

(10)

19.(b) Give the structure of SRAM cell.

(4)

OR

20.

20.(a) Explain the various mapping functions available in cache memory.

(9)

20.(b) Briefly explain content addressable memory.

(5)

TEACHING PLAN

No	Contents	No of Lecture Hrs
Module 1 : (Basic Structure of computers) (9 hours)		
1.1	Functional units,basic operational concepts,bus structures (introduction)	1
1.2	Memory locations and addresses , memory operations	1
1.3	Instructions and instruction sequencing	1
1.4	Addressing modes	1
1.5	Fundamental concepts of instruction execution, instruction cycle	1
1.6	Execution of a complete instruction - single bus organization (Lecture 1)	1
1.7	Execution of a complete instruction - single bus organization (Lecture 2)	1
1.8	Execution of a complete instruction - multiple bus organization (Lecture 1)	1
1.9	Execution of a complete instruction - multiple bus organization (Lecture 2)	1
Module 2 :(Register transfer logic and Processor logic design) (10 hours)		
2.1	Inter register transfer – arithmetic micro operations	1
2.2	Inter register transfer – logic and shift micro operations	1
2.3	Processor organization	1
2.4	Design of arithmetic circuit	1
2.5	Design of logic circuit	1
2.6	Design of arithmetic logic unit	1
2.7	Design of status register	1
2.8	Design of shifter - processor unit	1

2.9	Design of accumulator (Lecture 1)	1
2.10	Design of accumulator (Lecture 2)	1
Module 3 : (Arithmetic algorithms and Pipelining) (9 hours)		
3.1	Algorithm for multiplication of binary numbers	1
3.2	Algorithm for division (restoring method) of binary numbers	1
3.3	Array multiplier	1
3.4	Booth's multiplication algorithm	1
3.5	Pipelining: Basic principles	1
3.6	Classification of pipeline processors (Lecture 1)	1
3.7	Classification of pipeline processors (Lecture 2)	1
3.8	Instruction and arithmetic pipelines (Design examples not required)	1
3.9	Hazard detection and resolution	1
Module 4 :(Control Logic Design) (9 hours)		
4.1	Control organization –design of hardwired control logic (Lecture 1)	1
4.2	Control organization –design of hardwired control logic (Lecture 2)	1
4.3	Control organization –design of hardwired control logic (Lecture 3)	1
4.4	Design of microprogram control logic–control of processor unit (Lecture1)	1
4.5	Design of microprogram control logic–control of processor unit (Lecture2)	1
4.6	Design of microprogram control logic–control of processor unit (Lecture3)	1
4.7	Microprogram sequencer	1
4.8	Micro programmed CPU organization	1
4.9	Microinstructions –horizontal and vertical micro instructions	1
Module 5 : (Basic processing units, I/O and memory) (8 hours)		
5.1	Accessing of I/O devices –interrupts	1
5.2	Interrupt hardware	1

5.3	Direct memory access	1
5.4	Memory system: basic concepts –semiconductor RAMs	1
5.5	Memory system considerations – ROMs	1
5.6	Content addressable memory	1
5.7	Cache memories -mapping functions (Lecture 1)	1
5.8	Cache memories -mapping functions (Lecture 2)	1

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KTU
Estd. 2014

ERT 204	OBJECT ORIENTED PROGRAMMING USING JAVA	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		PCC	3	1	0	4	2021

Preamble: The purpose of this course is to enable learners to solve problems by breaking it down to object level while designing software and to implement it using Java. This course covers Object Oriented Principles, Object Oriented Programming in Java, Inheritance, Exception handling, Event handling, multithreaded programming and working with window-based graphics. This course helps the learners to develop Desktop GUI Applications, Mobile applications, Enterprise Applications, Scientific Applications and Web based Applications.

Prerequisite: Topics covered under the course PROGRAMMING IN C (EST 102)

Course Outcomes: After the completion of the course the student will be able to

CO1	Write Java programs using the object oriented concepts - classes, objects, constructors, data hiding, inheritance and polymorphism (Cognitive Knowledge Level: **Apply**)
CO2	Utilize datatypes, operators, control statements, built in packages & interfaces, Input/ Output Streams and Files in Java to develop programs (Cognitive Knowledge Level: **Apply**)
CO3	Illustrate how robust programs can be written in Java using exception handling mechanism (Cognitive Knowledge Level: **Understand**)
CO4	Write application programs in Java using multithreading and database connectivity (Cognitive Knowledge Level: **Apply**)
CO5	Write Graphical User Interface based application programs by utilizing event handling features and Swing in Java (Cognitive Knowledge Level: **Apply**)

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✔	✔	✔	✔								✔
CO2	✔	✔	✔	✔								✔
CO3	✔	✔	✔	✔						✔		✔
CO4	✔	✔	✔	✔								✔
CO5	✔	✔	✔	✔								✔

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks (%)
	Test1 (Marks %)	Test2 (Marks %)	
Remember	30	30	30
Understand	30	30	30
Apply	40	40	40
Analyse			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Tests : 25 marks
Continuous Assessment Assignment : 15 marks

Internal Examination Pattern:
Each of the two internal examinations has to be conducted out of 50 marks

First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus.

There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly covered module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly covered module), each with 7 marks. Out of the 7 questions in Part B, a student should answer any 5.

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

SYLLABUS

Object Oriented Programming Using Java

Module 1 (Introduction):

Basic Object-Oriented concepts -Object Modeling Using Unified Modeling Language (UML) – UML diagrams, Use case model, Class diagram, Activity diagram.

Introduction to Java - Java programming and Runtime Environment, Development Platforms- Java Virtual Machine (JVM), Java compiler, Bytecode, Java Buzzwords, Java program structure, Comments.

Primitive Data types - Integers, Floating Point Types, Characters, Boolean. Literals, Type Conversion and Casting, Variables, Arrays, Strings, Vector class.

Operators - Arithmetic Operators, Bitwise Operators, Relational Operators, Boolean Logical Operators, Assignment Operator, Conditional (Ternary) Operator, Operator Precedence.

Control Statements - Selection Statements, Iteration Statements and Jump Statements.

Module 2 (Core Java Fundamentals):

Object Oriented Programming in Java - Class Fundamentals, Declaring Objects, Introduction to Methods, Constructors, ***this*** Keyword, Method Overloading, Using Objects as Parameters, Returning Objects, Recursion, Access Control, Static Members, Final Variables, Inner Classes, Command-Line Arguments, Variable Length Arguments

Inheritance - Super Class, Sub Class, The Keyword ***super***, protected Members, Calling Order of Constructors, Method Overriding, the Object class, Abstract Classes and Methods, using ***final*** with Inheritance.

Module 3 (More features of Java):

Packages and Interfaces - Defining Package, CLASSPATH, Access Protection, Importing Packages, Interfaces.

Exception Handling - Checked Exceptions, Unchecked Exceptions, ***try*** Block and ***catch*** Clause, Multiple ***catch*** Clauses, Nested ***try*** Statements, ***throw***, ***throws*** and ***finally***.

Input/output - I/O Basics, Reading Console Input, Writing Console Output, Print Writer Class,

Object Streams and Serialization, Working with Files.

Module 4 (Advanced features of Java):

Java Library - String Handling – String Constructors, String Length, Special String Operations - Character Extraction, String Comparison, Searching Strings, Modifying Strings, using value of(). Collections framework - Collection Interface, List Interface -Collections Class – Array List class. Accessing a Collection via an Iterator.

Multithreaded Programming - The Java Thread Model, The Main Thread, Creating Thread, Creating Multiple Threads, Synchronization, Suspending, Resuming and Stopping Threads.

Module 5 (Graphical User Interface and Database support of Java):

Event handling - Event Handling Mechanisms, Delegation Event Model, Event Classes, Sources of Events, Event Listener Interfaces

Swings fundamentals-Swing Controls, Components and Containers, Swing Packages, Event Handling in Swings, Swing Layout Managers, Exploring Swings –JFrame, JLabel , Swing Buttons, JText Field.

Java Database Connectivity **(**JDBC) - JDBC overview, Creating and Executing Queries – create table, delete, insert, select.

Text Books:

1. Herbert Schildt, Java: The Complete Reference, 8/e, Tata McGraw Hill, 2011.
2. Rajib Mall, Fundamentals of Software Engineering, 4th edition, PHI, 2014.
3. Paul Deitel, Harvey Deitel, Java How to Program, Early Objects 11th Edition, Pearson, 2018.

Reference Books:

1. Y. Daniel Liang, Introduction to Java Programming, 7/e, Pearson, 2013.
2. Nageswararao R., Core Java: An Integrated Approach, Dreamtech Press, 2008.
3. Flanagan D., Java in A Nutshell, 5/e, O'Reilly, 2005.
4. Barclay K., J. Savage, Object Oriented Design with UML and Java, Elsevier, 2004.
5. Sierra K., Head First Java, 2/e, O'Reilly, 2005.
6. Balagurusamy E., Programming JAVA a Primer, 5/e, McGraw Hill, 2014.

Sample Course Level Assessment Questions

Course Outcome1(CO1): For the following passage develop UML diagrams and then implement it as a Java program in accordance with your UML design.

Passage: College Office collects semester fee and college bus fee for each student. A clerk at the college office collects the fees from each student. The bus fee is calculated depending on the distance of the corresponding bus stop from the college. The semester fee varies depending upon the semester as well as branch of each student. Students are supposed to pay the fees in full. Economically backward students are eligible for 50% discount in semester fee. The consolidated fees receipt is issued to each student by the clerk, which contains the student name, admission number, semester and branch of student along with details of fees collected. Students can log in and view the details of fees remitted and dues if any. The system allows students and clerk level login to the system. Clerk is able to view reports of each class showing status of fees payment of each student.

Course Outcome 2(CO2): Write a Java program to evaluate a post fix expression containing two operands and a single operator using stack. Stack should be implemented as a separate entity so as to reflect OOP concepts.

Course Outcome 3(CO3): Write a program to demonstrate the start, run, sleep and join methods in Thread class.

Course Outcome 4(CO4): Write a GUI based program with separate buttons to add, delete and display student details i.e. name, student ID, current semester and branch of study based on student ID.

Course Outcome 5(CO5): Using Swing create a JFrame with a JLabel and two JButtons. Set the texts of JButtons as “Yes” and “No” respectively. Set the JLabel’s text to the text of the button currently being pressed. Initially the JLabel’s text is blank.

Model Question Paper

QP CODE: PAGES:3

Reg No:_____

Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FOURTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: ERT204

Course Name: Object Oriented Programming using Java

Max.Marks:100 **Duration: 3 Hours**

PART A

Answer all Questions. Each question carries 3 Marks

1. Briefly explain the portable, secure and robust features of Java.
2. Describe the concepts of object and class with a suitable Java program.
3. Explain the concept of method overriding with an example.
4. What is the use of the keyword ***final*** in Java?
5. Explain the concept of streams.
6. Explain any two applications of Serialization.
7. Distinguish the usage of "==" and ***equals()*** method when comparing String type?
8. What are Collections in Java? Explain any one Collection interface in Java.
9. Explain any two properties of Swing components in Java.
10. Explain JLabel component. With suitable examples explain any two of its constructors.

Part B

Answer any one question completely from each module

11.

(a) Describe in detail any three Object Oriented Programming principles. Illustrate with suitable examples. (9)

(b) What is Java Runtime Environment? What is the role of Java Virtual Machine in it? (5)

OR

12.

(a) Compare and contrast Java standard edition and Java enterprise edition. (5)

(b) Why is Java considered to be platform independent? What is the role of Bytecode in making Java platform independent? (9)

13.

(a) Explain in detail the primitive data types in Java. (8)

(b) Explain automatic type conversion in Java with an example. What are the two conditions required for it? (6)

OR

14.

(a) Using a suitable Java program explain the difference between ***private*** and ***public*** members in the context of inheritance. (8)

(b) Is it possible to use the keyword ***super*** within a static method? Give justification for your answer. (6)

15.

(a) Explain in detail about byte streams and character streams with suitable code samples. (6)

(b) Describe in detail about exception handling, ***try*** block and ***catch*** clause with the help of a suitable Java program. (8)

OR

16.

(a) Explain object streams in Java. Explain the role of Serializable interface with a suitable code sample. (8)

(b) Explain ***throw***, ***throws*** and ***finally*** constructs with the help of a Java program. (6)

17.

(a) Describe in detail the creation of a thread using the Runnable interface and the Thread class with suitable examples. (10)

(b) Explain List Interface. Mention any two exceptions thrown by its methods. (4)

OR

18.

(a) Explain in detail the Delegation Event model for event handling in Java. (7)

(b) Write a simple program by extending appropriate class to demonstrate the working of threads in java. (7)

19.

(a) Write a Java program to demonstrate the use of JLabel and JButton by adding them to JFrame. (7)

(b) Explain step-by-step procedure of using Java Data Base Connectivity in Java programs. (7)

OR

20.

(a) Explain the class hierarchy of Java Swing components. (7)

(b) Write a Java Program to create a student table and to add student details to it using JDBC. (7)

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Teaching Plan		
Module 1 : Introduction		**(8 hours)**
1.1	Basic Object-Oriented concepts, Java Buzzwords	1 hour
1.2	Object Modeling Using UML – UML diagrams, Use case model	1 hour
1.3	Class diagram, Activity diagram.	1 hour
1.4	Introduction to Java - Java programming and Runtime Environment, Development Platforms- Java Virtual Machine (JVM), Java compiler, Bytecode, Java program structure, Comments	1hour
1.5	Primitive Data types - Integers, Floating Point Types, Characters, Boolean Literals, Type Conversion and Casting, Variables	1hour
1.6	Arrays, Strings, Vector class	1hour
1.7	Operators - Arithmetic Operators, Bitwise Operators, Relational Operators, Boolean Logical Operators, Assignment Operator, Conditional (Ternary) Operator, Operator Precedence.	1hour
1.8	Control Statements - Selection Statements, Iteration Statements and Jump Statements.	1hour
Module 2: Core Java Fundamentals		**(11 hours)**
2.1	Object Oriented Programming in Java - Class Fundamentals, Declaring Objects, Introduction to Methods.	1 hour
2.2	Constructors, ***this*** Keyword, Method Overloading,	1 hour
2.3	Using Objects as Parameters, Returning Objects	1 hour
2.4	Recursion, Access Control,	1 hour
2.5	Static Members, Final Variables	1 hour
2.6	Inner Classes, Command-Line Arguments, Variable Length Arguments	1 hour
2.7	Inheritance - Super Class, Sub Class, The Keyword ***super***,	1 hour
2.8	protected Members , Calling Order of Constructors,	1 hour
2.9	Method Overriding, Final Variables,	1 hour

2.10	Inner Classes, Command-Line Arguments, Variable Length Arguments	1 hour
2.11	the Object class, Abstract Classes and Methods, using ***final*** with Inheritance.	1 hour
Module 3: More features of Java		**(8 hours)**
3.1	Packages and Interfaces: Defining Package, CLASSPATH, Access Protection, Importing Packages	1 hour
3.2	Interfaces	1 hour
3.3	Input / Output: I/O Basics, Reading Console Input, Writing Console Output, Print Writer Class	1 hour
3.4	Object Streams and Serialization	1 hour
3.5	Working with Files	1 hour
3.6	Exception Handling**:** Checked Exceptions, Unchecked Exceptions, ***try*** Block and ***catch*** Clause	1 hour
3.7	Multiple ***catch*** Clauses, Nested ***try*** Statements	1 hour
3.8	***throw***, ***throws*** and ***finally***	1 hour
Module 4:Advanced features of Java		**(8 hours)**
4.1	Java Library: String Handling – String Constructors, String Length, Special String Operations	1hour
4.2	Character Extraction, String Comparison, Searching Strings, Modifying Strings Using value Of()	1hour
4.3	Collections framework – Collections overview, Collections Interfaces-Collection Interface	1hour
4.4	List Interface, Collections Class – Array List Class	1hour
4.5	Accessing Collections via an Iterator.	1hour
4.6	Multithreaded Programming: The Java Thread Model, The Main Thread, Creating Thread	1hour
4.7	Creating Multiple Threads, Synchronization, Suspending, Resuming and Stopping Threads.	1hour
4.8	Suspending, Resuming and Stopping Threads.	1 hour
Module 5: Graphical User Interface and Database support of Java		**(10 hours)**

5.1	Event handling - Event Handling Mechanisms, Delegation Event Model	1hour
5.2	Event Classes, Sources of Events	1hour
5.3	Event Listener Interfaces	1hour
5.4	Swings fundamentals, Swing Controls,	1 hour
5.5	Components and Containers, Swing Layout Managers	1hour
5.6	Swing Packages, Event Handling in Swings.	1hour
5.7	Exploring Swings –JFrame, JLabel, The Swing Buttons, JText Field.	1 hour
5.8	JDBC overview, Creating and Executing Queries – create table, delete, insert, select (Basics only, DBMS course is not a prerequisite).	1 hour
5.9	Creating and Executing Queries – create table, delete, insert, select.	1hour
5.10	Creating and Executing Queries – create table, delete, insert, select.	1 hour

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CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
ERT206	INTEGRATED CIRCUITS	PCC	3	1	0	4	2021

Preamble: To familiarize students with the Integrated Circuits and make them learn to design and analyze circuits using op-amp and also using some specialized ICs, like 555, regulators ICs, ADC, DAC etc.

Prerequisite: Topics covered under the course PROGRAMMING IN C (EST 102)

Course Outcomes: After the completion of the course the student will be able to

CO 1	Discuss about basics of operational amplifier and characteristics (DC and AC) of op amps. **(Cognitive Knowledge Level:Apply)**
CO 2	Design linear and nonlinear circuits using op-amp. **(Cognitive Knowledge Level:Apply)**
CO 3	Deign op-amp oscillators, waveform generators and voltage regulators**(Cognitive Knowledge Level:Apply)**
CO 4	Design circuits using PLL and discuss about DAC and ADC. **(Cognitive Knowledge Level:Apply)**
CO 5	Design active filters and analyze the characteristics of active filters**(Cognitive Knowledge Level:Apply)**

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	✔	✔			✔							✔
CO 2	✔	✔			✔							✔
CO 3	✔	✔			✔							✔
CO 4	✔	✔			✔							✔
CO 5	✔	✔			✔							✔

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks (%)
	Test 1 (%)	Test 2 (%)	
Remember	10	10	20
Understand	20	20	40
Apply	20	20	40
Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3

Continuous Internal Evaluation Pattern:

Attendance	**10 marks**
Continuous Assessment Tests(Average of SeriesTests1& 2)	**25 marks**
Continuous Assessment Assignment	**15 marks**

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 full questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

SYLLABUS

Module 1: Operational amplifiers

Introduction of op amps- block level diagram of op amp –Basic information of op amp (741 op amp) - Power supply requirements. Characteristics of Operational Amplifiers Ideal op amp characteristics-DC characteristics-input bias current, input offset current, input offset voltage, thermal drift, CMRR, PSRR-AC characteristics- frequency response, stability of op amp, slew rate.

Module 2: Applications of Operational amplifiers

Basic applications-inverting amplifier, non-inverting amplifier, differential amplifier, scale changer, summing amplifier, subtractor, adder, voltage follower, V-I converter (grounded load type and floating load type), Howland constant current circuit and I-V converter. Instrumentation amplifier (3 op amp design)-op amp integrator- op amp differentiator- op amp circuit using diodes-rectifier (half and full wave), peak detector, sample and hold circuit, log and antilog amplifier, multiplier and divider. Comparator (inverting and non-inverting type)-applications of comparator-zero crossing detector, window detector, time marker generator

Module 3: Waveform generators and Oscillators using Operational amplifier

Timer IC 555- Functional diagram, Schmitt trigger-. - Astable and mono stable – Design and working. Wave generators- Triangular and saw tooth - RC phase shift and Wien bridge oscillators

Voltage regulator-Introduction, series op amp regulator-IC regulators-78XX and 79XX characteristics-voltage regulator as current source-boosting IC regulator output current- 723 general purpose IC regulator

Module 4: PLL and Data Converters

Phase Locked Loop – Operation, Closed loop analysis, Lock and capture range, Basic building blocks, PLL IC 565, Applications of PLL.

Data Converters: Digital to Analog converters, Specifications, Weighted resistor type and R-2R Ladder type. Analog to Digital Converters: Specifications, ADC-Direct type -Flash type, counter type, Servo type, successive approximation type- Integrating type ADC -Single slope type and dual slope type

Module 5 : Active Filters

Introduction-LPF-first order filter, second order filter (sallen-key Butterworth), higher order filter-HPF- first order filter, second order filter (sallen-key Butterworth), higher order filter-BPF-wide BPF, Narrow band pass filter-BRF-wide BRF, narrow BRF (Twin T Notch design)-All pass filter-Switched capacitor filter. Quality factor–Design.

Text Books

1. D Roy Choudhury and Shail B Jain, “Linear Integrated Circuits”, New Age International Publishers, 4/e.

2. Ramakant A. Gayakwad, “Op-Amps and Linear Integrated Circuits”, Pearson Education; 4/e.

Reference Books

1. Coughlin & Driscoll,“Op amps and Linear Integrated circuits”, Pearson Education Asia.2000.
2. Sergio Franco, “Design with operational Amplifiers &Analog Integrated Circuits”, Mc Graw Hill India, 4/e.
3. Millman & Grabel, “Microelectronics”, McGraw Hill Education, 2/e.
4. K R Botkar, “Integrated Circuits”, Khanna Publishers, 10/e.
5. Gray, “Analysis and Design of Analog Integrated Circuits”, Wiley, 5/e.
6. Horstian, “Micro Electronics”, Prentice Hall of India.
7. Sedra &Smith, “Microelectronic Circuits”, Oxford University Press, 5/e.
8. D A Bell, “Opamps and Linear Integrated Circuits”, Oxford University Press, 3/e.
9. Clayton,“Operational Amplifiers”, Butterworth &Co. (Publishers) Ltd. 5/e.

Course Level Assessment Questions

Course Outcome 1 (CO1)*:*

1. Discuss about basics of operational amplifier.
2. Explain the advantages of designing circuits using op amps.
3. Explain different characteristics of op amp.

Course Outcome 2 (CO2):

1. Explain different amplifiers design using op amps.
2. Explain the working of integrator, differentiator, log amplifier and antilog amplifier with derivations.

Course Outcome 3 (CO3):

1. Explain and design different networks like oscillators and waveform generators
2. Explain the working of voltage regulator.

Course Outcome 4 (CO4):

1. Explain the working of PLL
2. Explain the resolution and accuracy of ADC and DAC

Course Outcome 5 (CO5):

1. Explain the characteristics and requirement of active filters
2. Design different types of filters

Model Question Paper

Reg No.:_____

Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
FOURTH SEMESTER B. TECH DEGREE EXAMINATION
MONTH AND YEAR

Course Code: EST206

Course Name: INTEGRATED CIRCUITS

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all questions, each carries 3 marks

1. List out ideal op amp characteristics.
2. Explain about stability of op-amp?
3. Design a practical differentiator circuit with fa=1KHz and fb=10 KHz.
4. Design an instrumentation amplifier with gain=5.
5. Derive and explain Barkhausen criteria for oscillation.
6. Write a note on IC regulators.
7. Define the following terms with respect to DAC (i) Resolution (ii) Linearity (iii) Full scale output voltage
8. Explain the operation of Phase Locked Loop. What is lock range and capture range?
9. Draw the ideal and actual characteristic graph of LPF and HPF.
10. Design a first order wide BPF with lower cutoff frequency=1KHz and upper cutoff frequency=5KHz.

PART B

Answer any one full question from each module. Each question carries 14 Marks

Module1

11. (a) Write a note on input bias current? Derive the equation for output offset voltage due to the input bias current? Also explain one method to overcome the effect of input bias

current. 10 marks

(b) Explain the term (1) CMRR (2) PSRR. 4 marks

12. (a) Write a note on input offset voltage? Derive the equation for output offset voltage due to input offset voltage? Also explain one method to overcome the effect of input offset voltage. (10 marks) (b) Output of op amp voltage follower circuit is a triangular waveform with Vpp=10V, and frequency= 2MHz, for a square wave input with frequency=2MHz and Vpp=8V, calculate the slew rate of the op amp. (4 marks).

Module2

13. Explain the working of basic integrator circuit with neat circuit diagram? List out the problems in the basic integrator circuit? Explain how this can be overcome by practical integrator circuit. (14 marks)

14. (a) Explain Instrumentation amplifier with neat circuit diagram and derive the equation for the output voltage. (10 marks)

(b) Explain zero crossing detector using op-amp (4 marks)

Module3

15. Explain the working of monostable multivibartor circuit using op amp and derive the equation for off time. Also design a monostable multivibrator circuit using op amp to generate an OFF pulse of duration=5msec. (14 marks)

16. Explain how short circuit, fold back protection and current boosting are done using IC723 voltage regulator. (14 marks)

Module4

17. Design a circuit to multiply the incoming frequency by a factor of 5 using 565 PLL IC?

(14 marks)

18. (a) Explain the working of successive approximation type ADC. (4 marks)

(b) Explain the working of dual slope ADC with neat circuit diagram and graphs. (10 marks)

Module 5

19. Explain the working of a second order low pass butterworth salen key filter, derive the equation and draw the characteristic graphs to prove that the filter exhibits a 40 db attenuation rate. (14 marks)

20. Explain Narrow band pass filter with neat circuit diagram and derive the equation for bandwidth, centre frequency and gain at centre frequency. (14 marks)

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Operational amplifiers**	**8**
1.1	Introduction of op amps- block level diagram of op amp	1
1.2	Basic information of op amp (741 op amp) - Power supply requirements	1
1.3	Characteristics of Operational Amplifiers	1
1.4	Ideal op amp characteristics	1
1.5	DC characteristics-input bias current, input offset current,	1
1.6	input offset voltage, thermal drift, CMRR, PSRR	1
1.7	AC characteristics- frequency response	1
1.8	stability of op amp, slew rate.	1
2	**Applications of Operational amplifiers**	**10**
2.1	Basic applications-inverting amplifier, non-inverting amplifier,	1
2.2	differential amplifier, scale changer	1
2.3	summing amplifier, subtractor, adder, voltage follower, V-I converter (grounded load type and floating load type)	1
2.4	Howland constant current circuit and I-V converter.	1
2.5	Instrumentation amplifier (3 op amp design)	1
2.6	op amp integrator- op amp differentiator-	1
2.7	op amp circuit using diodes-rectifier (half and full wave)	1
2.8	peak detector, sample and hold circuit, log and antilog amplifier, multiplier and divider	1
2.9	Comparator (inverting and non-inverting type)-applications of comparator	1
2.10	zero crossing detector, window detector, time marker generator	1
3	**Wave Shaping Multivibrator and Oscillator Circuits**	**9**
31	Timer IC 555- Functional diagram	1
3.2	Schmitt trigger-. – Astable design and working	1
3.3	Monostable design and working	1
3.4	Wave generators- Triangular and saw tooth	1

3.5	RC phase shift and Wien bridge oscillators	1
3.6	Voltage regulator-Introduction, series op amp regulator	1
3.7	IC regulators-78XX and 79XX characteristics	2
3.8	voltage regulator as current source-boosting IC regulator output current	
3.9	723 general purpose IC regulator	1
4	**PLL and Data Converters**	**9**
4.1	Phase Locked Loop – Operation	1
4.2	Closed loop analysis, Lock and capture range	1
4.3	, Basic building blocks	1
4.4	PLL IC 565, Applications of PLL.	1
4.5	Data Converters: Digital to Analog converters, Specifications	1
4.6	Weighted resistor type and R-2R Ladder type.	1
4.7	Analog to Digital Converters: Specifications, ADC-Direct type -Flash type, counter type	1
4.8	Servo type, successive approximation type- Integrating type ADC -	1
4.9	Single slope type and dual slope type	1
5	**Active Filters**	**9**
5.1	Introduction-LPF-first order filter	1
5.2	second order LP filter (sallen-key Butterworth), higher order filter	1
5.3	HPF- first order filter, second order filter (sallen-key Butterworth)	1
5.4	higher order filters	1
5.5	BPF-wide BPF	1
5.6	Narrow band pass filter-BRF-wide BRF,	1
5.7	narrow BRF (Twin T Notch design)	1

5.6	All pass filter-Switched capacitor filter	1
5.7	Quality factor–Design.	1

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ERL 202	INTEGRATED CIRCUITS LAB	CATEGORY	L	T	P	CREDITS
		PCC	0	0	3	2

Course Outcomes: After the completion of the course the student will be able to:

CO 1	Use the various electronic instruments and for conducting experiments. (Cognitive Knowledge Level: **Apply**)
CO 2	Design and develop various electronic circuits using diodes and Zener diodes. (Cognitive Knowledge Level: **Apply**)
CO 3	Design and implement amplifier and oscillator circuits using BJT and JFET. (Cognitive Knowledge Level: **Apply**)
CO 4	Design and implement basic circuits using IC (OPAMP and 555 timers). (Cognitive Knowledge Level: **Apply**)

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	✓								✓			
CO 2	✓	✓	✓						✓			
CO 3	✓	✓	✓						✓			
CO 4	✓	✓	✓						✓			

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO1 0**	Communication
PO5	Modern tool usage	**PO1 1**	Project Management and Finance
PO6	The Engineer and Society	**PO1 2**	Life long learning

LIST OF EXPERIMENTS

1. Measurement of current, voltage, frequency and phase shift of signal in a RC network using oscilloscope. *
2. Rectifier circuits. *
3. Clipping and clamping circuits using diodes. *
4. RC coupled amplifier using BJT in CE Configuration-Measurement of gain, BW and plotting of frequency response. *
5. Op-amp circuits – Design and set up of inverting and non-inverting amplifier, scale changer, adder, integrator, and differentiator. *
6. Op-amps circuits – Scale changer, adder, integrator, and differentiator. *
7. Precision rectifier using Op-amps.
8. Phase shift oscillator and Wein's Bridge oscillator using Op-amps. *
9. Waveform generation– Square, triangular and saw tooth waveform generation using OPAMPs.*
10. Basic comparator and Schmitt trigger circuits using Op-amp (Use comparator ICs such as LM311).
11. Design and testing of series voltage regulator using Zener diode.
12. Astable and Monostable circuit using 555 IC. *
13. A/D converters- counter ramp and flash type.
14. D/A Converters - R-2R ladder circuit, *
15. Study of PLL IC: free running frequency lock range capture range

** Mandatory

Reference Books

1. R E Boylstead and L Nashelsky: Electronic Devices and Circuit Theory, 9/e, Pearson Education.
2. Allan Mottershead, Electronic Devices &Circuits, Prentice Hall of India, NewDelhi, 2003.
3. Millman and Taub, Pulse, digital and Switching Waveforms, Tata McGrawHill, 2007.
4. Choudhury R., Linear Integrated Circuits, New Age International Publishers. 2008.

Course Project

Students have to do a mandatory course project (group size not more than 4 students)

using to realise a functional analog circuit on PCB.

A maximum of 15 marks shall be awarded for this project (to be evaluated along with the final internal test). Report to be submitted.

Assessment Pattern

Mark distribution:

Total Marks	CIE	ESE	ESE Duration
150	75	75	2.5 hours

Continuous Internal Evaluation (CIE) Pattern:

Attendance	Continuous Evaluation including Viva	Internal Test	Course Project	Total
15	30	15	15	75

End Semester Examination Pattern:

The following guidelines should be followed regarding award of marks:

(a) Preliminary work: 15 Marks
(b) Implementing the work/Conducting the experiment: 10 Marks
(c) Performance, result and inference (usage of equipment and troubleshooting): 25 Marks
(d) Viva voce: 20 marks
(e) Record: 5 Marks

General instructions: Practical examination to be conducted immediately after the second series test covering entire syllabus given below. Evaluation is a serious process that is to be conducted under the equal responsibility of both the internal and external examiners. The number of candidates evaluated per day should not exceed 20. Students shall be allowed for the University examination only on submitting the duly certified record. The external examiner shall endorse the record.

ERL 204	OBJECT ORIENTED PROGRAMMING LAB (IN JAVA)	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		PCC	0	0	3	2	2021

Preamble: The aim of the course is to provide hands-on experience to the learners on various object oriented concepts in Java Programming. This course helps the learners to enhance the capability to design and implement various Java applications for real world problems.

Prerequisite: Topics covered under the course Programming in C (EST 102)

Course Outcomes: At the end of the course, the student should be able to

CO1	Implement the Object Oriented concepts - constructors, inheritance, method overloading & overriding and polymorphism in Java (Cognitive Knowledge Level: **Apply**)
CO2	Implement programs in Java which use data types, operators, control statements, built in packages & interfaces, Input/Output streams and Files (Cognitive Knowledge Level: **Apply**)
CO3	Implement robust application programs in Java using exception handling (Cognitive Knowledge Level: **Apply**)
CO4	Implement application programs in Java using multithreading and database connectivity (Cognitive Knowledge Level: **Apply**)
CO5	Implement Graphical User Interface based application programs by utilizing event handling features and Swing in Java (Cognitive Knowledge Level: **Apply**)

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	☑	☑	☑	☑	☑			☑		☑		☑
CO2	☑	☑	☑	☑	☑			☑		☑		☑
CO3	☑	☑	☑	☑	☑			☑		☑		☑
CO4	☑	☑	☑	☑	☑			☑		☑		☑
CO5	☑	☑	☑	☑	☑			☑		☑		☑

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	Continuous Assessment Test - Internal Exam (Percentage)	End Semester Examination (Percentage)
Remember	20	20
Understand	20	20
Apply	60	60
Analyse		
Evaluate		
Create		

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	**75**	**75**	**3 hours**

Continuous Internal Evaluation Pattern:

Attendance	Continuous Evaluation including Viva	Internal Test	Course Project	Total
15	30	15	15	75

Internal Examination Pattern: The marks will be distributed as Algorithm 30 marks, Program 20 marks, Output 20 marks and Viva 30 marks. Total 100 marks which will be con- verted out of 15 while calculating Internal Evaluation marks.

End Semester Examination Pattern: The marks will be distributed as Algorithm 30 marks, Program 20 marks, Output 20 marks and Viva 30 marks. Total 100 marks will be converted out of 75 for End Semester Examination.

Course Project:

Students have to do a mandatory course project (group size not more than 4 students) using Java Programming. A maximum of 15 marks shall be awarded for this project (to be evaluated along with the final internal test). Report to be submitted.

Operating System to Use in Lab **:** Linux

Compiler/Software to Use in Lab **:** gcc, javac, jdk, jre, Eclipse, NetBeans, MySQL / PostgreSQL.

Programming Language to Use in Lab **:** Java

Fair Lab Record:

All Students attending the Object Oriented Programming Lab (in Java) should have a Fair Record. The fair record should be produced in the University Lab Examination. Every experiment conducted in the lab should be noted in the fair record. For every experiment in the fair record the right hand page should contain Experiment Heading, Experiment Number, Date of Experiment, Aim of Experiment, Operations Performed, Details of Experiment including algorithm and Result of Experiment. The left hand page should contain a print out of the code used for the experiment and sample output obtained for a set of input.

SYLLABUS

The syllabus contains six sessions (A, B, C, D, E, F). Session A-E consists of three concrete Java exercises, out of which at least two questions are mandatory. Session F consists of a mandatory course project with report preparation.

(A) Basic programs using data types, operators, and control statements in Java.

1) Write a Java program that checks whether a given string is a palindrome or not.
   Ex: MALAYALAM is palindrome.
2) Write a Java Program to find the frequency of a given character in a string. **
3) Write a Java program to multiply two given matrices. **

(B) Object Oriented Programming Concepts: Problem on the use of constructors, inheritance, method overloading & overriding, polymorphism and garbage collection:

4) Write a Java program which creates a class named 'Employee' having the following members: Name, Age, Phone number, Address, Salary. It also has a method named 'print-Salary( )' which prints the salary of the Employee. Two classes 'Officer' and 'Manager' inherits the 'Employee' class. The 'Officer' and 'Manager' classes have data members 'specialization' and 'department' respectively. Now, assign name, age, phone number, address and salary to an officer and a manager by making an object of both of these classes and print the same. (Exercise to understand inheritance). **
5) Write a java program to create an abstract class named Shape that contains an empty method named number of Sides( ). Provide three classes named Rectangle, Triangle and Hexagon such that each one of the classes extends the class Shape. Each one of the classes contains only the method number of Sides( ) that shows the number of sides in the given geometrical structures. (Exercise to understand polymorphism). **
6) Write a Java program to demonstrate the use of garbage collector.

(C) Handling different types of files as well as input and output management methods:

7) Write a file handling program in Java with reader/writer.
8) Write a Java program that read from a file and write to file by handling all file related exceptions. **
9) Write a Java program that reads a line of integers, and then displays each integer, and the sum of all the integers (Use String Tokenizer class of java.util).**

(D) Exception handling and multi-threading applications:

10) Write a Java program that shows the usage of try, catch, throws and finally. **
11) Write a Java program that implements a multi-threaded program which has three threads. First thread generates a random integer every 1 second. If the value is even, second thread computes the square of the number and prints. If the value is odd the third thread will print the value of cube of the number.
12) Write a Java program that shows thread synchronization. **

(E) Graphics Programming:

13) Write a Java program that works as a simple calculator. Arrange Buttons for digits and the + - * % operations properly. Add a text field to display the result. Handle any possible exceptions like divide by zero. Use Java Swing. **
14) Write a Java program that simulates a traffic light. The program lets the user select one of three lights: red, yellow, or green. When a radio button is selected, the light is turned on, and only one light can be on at a time. No light is on when the program starts. **
15) Write a Java program to display all records from a table using Java Database Connectivity-(JDBC).

(F) Course Project:

Design a Course project using Java Application Development techniques'.Use Swing class to create GUI based interface for the project.

** Mandatory

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PRACTICE QUESTIONS

1) Write a Java program to reverse a given string.
2) Write a Java program to display the transpose of a given matrix.
3) Write a Java program to find the second smallest element in an array.
4) Write a Java program to check whether a given number is prime or not.
5) Write a Java program to calculate the area of different shapes namely circle, rectangle, and triangle using the concept of method overloading.
6) Write two Java classes Employee and Engineer. Engineer should inherit from Employee class. Employee class to have two methods display() and calcSalary(). Write a program to display the engineer salary and to display from Employee class using a single object instantiation (i.e., only one object creation is allowed).
   - display() only prints the name of the class and does not return any value. Ex. " Name of class is Employee."
   - calcSalary() in Employee displays "Salary of employee is 10000" and calcSalary() in Engineer displays "Salary of employee is 20000."
7) Write a Java program to illustrate Interface inheritance.
8) Write a Java program that shows how to create a user-defined exception.
9) Write a Java program to create two threads: One for displaying all odd number between 1 and 100 and second thread for displaying all even numbers between 1 and 100.
10) Write a Java program that shows thread priorities.
11) Write a Java program that reads a file and displays the file on the screen, with a line number before each line.
12) Write a Java program that displays the number of characters, lines and words in a text file.
13) Write a Java program for handling mouse events.
14) Write a Java program for handling key events using Adapter classes (general).
15) Write a Java program that allows the user to draw lines, rectangles and ovals.
16) Write a Java Swing program to print a wave form on the output screen.
17) Write a program to accept rollno, name, CGPA of "n" students and store the data to a database using JDBC connectivity. Display the list of students having CGPA greater than 7(Use MySQL /PostgreSQL).

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SEMESTER IV

MINOR

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2014

ERT282	MICROPROCESSORS AND MICROCONTROLLERS	CATEGORY	L	T	P	CREDITS
		VAC	3	1	0	4

Preamble:

The purpose of this course is to create awareness in students about the basics of microprocessors and microcontrollers.

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO	CO
CO1	Describe the architecture, pin configuration and bus structure of 8085, also explain the timing diagram. **(Cognitive Knowledge Level: Understand)**
CO2	Discuss the instruction set of 8085 and explain various interfacing IC's with 8085, also Compare different x86 processors. **(Cognitive Knowledge Level: Understand)**
CO3	Describe the architecture, memory organization and instruction set of 8051 microcontroller. **(Cognitive Knowledge Level: Understand)**
CO4	Develop assembly language program of 8051 microcontroller and interface various peripheral devices with 8051. **(Cognitive Knowledge Level: Apply)**
CO5	Realize external communication interface to the microcontroller. **(Cognitive Knowledge Level: Apply)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓	✓	✓									
CO3	✓	✓	✓									
CO4	✓	✓	✓		✓							
CO5	✓	✓	✓		✓							

Abstract POs defined by National Board of Accreditation			
PO	**Broad PO**	**PO**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks (%)
	Test 1 (%)	Test 2 (%)	
Remember	30	30	30
Understand	50	30	30
Apply	20	40	40
Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3

Continuous Internal Evaluation Pattern:

Attendance **10 marks**

Continuous Assessment Test (2 Numbers) **25 marks**

Assignment/Quiz/Course project **15 marks**

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub- divisions and carry 14 marks.

Syllabus

Module – 1 (Basics of Microprocessor 8085)

Microprocessors: Introduction, organization of a microprocessor based system, evolution of microprocessors, 8085 architecture and its operation, microprocessor initiated operations and bus organization, pin configuration and functions, generation of control signals for external operations- fetch, IO/M, read/write. Machine cycles and bus timings.

Module - 2 (8085 instruction set and other microprocessors)

Instruction set of 8085.Simple examples in assembly language programming for 8085 (only for internal examination). Addressing modes. Overview/concept of peripheral IC interfacing with 8085 microprocessor (8255,8279). Introduction to 8086 and comparison between 8086,80286,80386,80486 and Pentium

Module - 3 (8051 microcontroller basics and instruction set)

8051 architecture, pin configuration, registers, internal memory, timers, Port structures, interrupts. Addressing modes, instruction set (brief study of 8051 instruction set is sufficient).

Module - 4 (Programming examples in 8051)

Simple programming examples in assembly language: addition, subtraction, multiplication and division, Programs using loops, interfacing of LCD display, keyboard, stepper motor, DAC, ADC with 8051.

Module - 5 (Open source embedded development boards)

Introduction Atmega 2560 microcontroller block diagram and pin description, Arduino mega 256 board: Introduction and pin description. Simple applications: Solar tracker, 4 digit 7 segment LED display, home security alarm system, digital thermometer, IOT applications.

Text Books

1. Ramesh S. Goankar. 8085 Microprocessors Architecture Application and Programming. Penram International, 5/e.
2. Muhammed Ali Mazidi, The 8051 Microcontroller and Embedded Systems, Pearson Education, 2nd edition.

References

1. Muhammed Ali Mazidi, The 8051 Microcontroller and Embedded Systems, Pearson Education, 2nd edition.
2. Kenneth J. Ayala, The 8051 Microcontroller, Cengage learning, 3/e.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Describe architecture of 8085 with diagram.
2. Describe the pin diagram of 8085.
3. Explain the bus structure of 8085.
4. Compare instruction cycle and machine cycle.
5. Draw the instruction cycle of various instructions.

Course Outcome 2 (CO2):

1. Explain the instruction set of 8085 with example.
2. Explain addressing modes of 8085 with example.

3. Draw the block diagram and explain the interfacing IC's 8279 and 8255.
4. Compare different x86 processors.

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Course Outcome 3 (CO3):

1. Draw and explain the block diagram of 8051 microcontroller.
2. Explain the memory organization of 8051.
3. Discuss the instruction set of 8051 with examples.

Course Outcome 4 (CO4):

1. Write arithmetic and logic programs using 8051.
2. Explain LCD interfacing with 8051.
3. Explain stepper motor interfacing with 8051.
4. Explain keyboard interfacing with 8051.
5. Explain ADC and DAC interfacing with 8051.

Course Outcome 5 (CO5):

1. Draw the block diagram and pin diagram of Atmega 2560 microcontroller and Arduino mega 256 board.
2. Explain the following applications using Arduino mega 256 board: Solar tracker, 4 digit 7 segment LED display, home security alarm system, digital thermometer, IOT applications

Model Question Paper

QP CODE:
Reg No:_____
Name :_____ **PAGES : 3**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FOURTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR Course Code: ERT 282

Course Name: Microprocessors and Microcontrollers

Max.Marks :100 **Duration: 3 Hrs**

PART A

Answer all Questions. Each question carries 3 Marks

1. Draw the bit pattern of 8085 flag register
2. Bring out the significance of the signals S0, S1 and IO/ M with reference to various operations of 8085 microprocessor
3. Compare the 8086 and 80386 processors

4. List out the addressing modes in 8085
5. Mention the specific features of 8051 microcontroller architecture
6. Compare the instruction CJNE and DJNZ.
7. What is an interrupt? List the interrupt sources of 8051
8. Write a program to subtract two 8 bit numbers present in the location 31h and 32h and store result in the location 33h in 8051.
9. Draw the block diagram of Arduino 256
10. Describe any one application of Arduino mega 256

(10 x 3 = 30 Marks)

PART B

(Answer any one Question from each Module. Each question carries 14 Marks)

11. The internal architecture of 8085 microprocessor has internal units capable to execute a program stored in external memory. Justify with relevant features and diagram.

(14 marks)

OR

12. (a) Illustrate with relevant timing diagram the sequence of operations involved for fetching and executing the instruction MVI C, 08H in 8085 microprocessors. **(7 marks)**

(b) How control signals are generating in 8085

(7 marks)

13. (a) Differentiate the instruction LDA and STA with examples?

(4 marks)

(b) Explain the block diagram and operation of the 8279 Keyboard/Display interface

(10 marks)

OR

14. (a) Explain the architecture of 8086 with a neat diagram **(7 marks)**

(b) Draw and explain the block diagram of 8051 **(7 marks)**

15. (a) Explain RAM organization in 8051 **(7 marks)**

(b) Draw and explain the block diagram of 8051

(7 marks)

OR

16. (a) Explain the addressing modes in 8051

(7 marks)

(b) Describe the data transfer instructions and arithmetic and logic instructions in 8051 with examples

(7 marks)

17. (a) Write a program to add two 16 bit numbers in 8051

(5 marks)

(b) Describe the Interfacing of a 16*2 alphanumeric LCD with 8051 and write the interfacing program.

(9 marks)

OR

18. (a) Write a program to find the sum of first 10 natural numbers.

(7 marks)

(b) Write a program to rotate a stepper motor 180 degree clockwise.

(7 marks)

19. (a) Draw and explain Atmega 2560 microcontroller block diagram.

(5 Marks)

(b) Write a program to interface 4 digit 7 segment LED display with Arduino mega 256 . Also draw the interfacing diagram.

(9 Marks)

OR

20. (a) Describe the pin diagram of Arduino mega 256 **(7 marks)**

(b) How Arduino mega 256 work as a digital thermometer **(7 Marks)**

TEACHING PLAN

No	Contents	No of Lecture Hrs
Module – 1 (Basics of Microprocessor 8085) (8 hrs)		
1.1	Microprocessors: Introduction, organization of a microprocessor based system, evolution of microprocessors	1
1.2	8085 architecture and its operation	1
1.3	8085 operations	1
1.4	Microprocessor initiated operations and bus organization	1
1.5	Pin configuration and functions	1
1.6	Generation of control signals for external operations- fetch, IO/M, read/write	1
1.7	Machine cycles and bus timings	1
1.8	Timing diagram	1
Module - 2 (8085 instruction set and other microprocessors) (10 hrs)		
2.1	Instruction set of 8085	1
2.2	Instruction set of 8085	1
2.3	Instruction set of 8085	1
2.4	Simple examples in assembly language programming for 8085	1
2.5	Simple examples in assembly language programming for 8085	1
2.6	Addressing modes	1
2.7	Concept of peripheral IC interfacing with 8085-8279	1
2.8	Concept of peripheral IC interfacing with 8085-8255	1
2.9	Introduction to 8086 (architecture and concept of physical memory)	1
2.10	comparison between 8086,80286,80386,80486 and Pentium	1
Module - 3 (8051 microcontroller basics and instruction set) (9 hrs)		
3.1	8051 architecture, registers	1
3.2	Pin configuration	1

3.3	Memory organisation(RAM)	1
3.4	Memory organisation(ROM)	1
3.5	Timers, Port structures	1
3.6	Interrupts	1
3.7	Addressing modes	1
3.8	Instruction set	1
3.9	Instruction set	1
Module - 4 (Programming examples in 8051) (9 hrs)		
4.1	Simple Programming examples in 8051, Addition, Subtraction, multiplication and division	1
4.2	Other simple Programming examples in 8051	1
4.3	Programs using loops.	1
4.4	Programs using loops.	1
4.5	LCD interfacing	1
4.6	Keyboard interfacing	1
4.7	Stepper motor interfacing	1
4.8	ADC interfacing	1
4.9	DAC interfacing	1
Module - 5 (Open source embedded development boards) (9 hrs)		
5.1	Introduction Atmega 2560 microcontroller block diagram	1
5.2	Pin description	1
5.3	Arduino mega 256 board: Introduction	1
5.4	Pin description	1
5.5	Solar tracker	1
5.6	4 digit 7 segment LED display	1
5.7	Home security alarm system	1
5.8	Tilt sensor, digital thermometer	1
5.9	IOT applications	1

CODE	MATHEMATICS FOR MACHINE LEARNING	CATEGORY	L	T	P	CREDIT
CST284		VAC	3	1	0	4

Preamble: This is the foundational course for awarding B. Tech. Honours in Computer Science and Engineering with specialization in ***Machine Learning***. The purpose of this course is to introduce mathematical foundations of basic Machine Learning concepts among learners, on which Machine Learning systems are built. This course covers Linear Algebra, Vector Calculus, Probability and Distributions, Optimization and Machine Learning problems. Concepts in this course help the learners to understand the mathematical principles in Machine Learning and aid in the creation of new Machine Learning solutions, understand & debug existing ones, and learn about the inherent assumptions & limitations of the current methodologies.

Prerequisite: A sound background in higher secondary school Mathematics.

Course Outcomes: After the completion of the course the student will be able to

CO 1	Make use of the concepts, rules and results about linear equations, matrix algebra, vector spaces, eigenvalues & eigenvectors and orthogonality & diagonalization to solve computational problems (Cognitive Knowledge Level: **Apply**)
CO 2	Perform calculus operations on functions of several variables and matrices, including partial derivatives and gradients (Cognitive Knowledge Level: **Apply**)
CO 3	Utilize the concepts, rules and results about probability, random variables, additive & multiplicative rules, conditional probability, probability distributions and Bayes' theorem to find solutions of computational problems (Cognitive Knowledge Level: **Apply**)
CO 4	Train Machine Learning Models using unconstrained and constrained optimization methods (Cognitive Knowledge Level: **Apply**)

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	√	√	√	√								√
CO 2	√	√	√									√
CO 3	√	√	√	√								√
CO 4	√	√	√	√		√						√

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	**2**	
Remember	20%	20%	20%
Understand	40%	40%	40%
Apply	40%	40%	40%
Analyse			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	**50**	**100**	**3 hours**

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Tests : 25 marks
Continuous Assessment Assignment : 15 marks

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks

First Internal Examination shall be preferably conducted after completing the first half of the syllabus and the Second Internal Examination shall be preferably conducted after completing remaining part of the syllabus.

There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly covered module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly covered module), each with 7 marks. Out of the 7 questions in Part B, a student should answer any 5.

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer anyone. Each question can have maximum 2 sub-divisions and carries 14 marks.

Syllabus

Module 1

LINEAR ALGEBRA: Systems of Linear Equations – Matrices, Solving Systems of Linear Equations. Vector Spaces –Vector Spaces, Linear Independence, Basis and Rank. Linear Mappings – Matrix Representation of Linear Mappings, Basis Change, Image and Kernel.

Module 2

ANALYTIC GEOMETRY, MATRIX DECOMPOSITIONS: Norms, Inner Products, Lengths and Distances, Angles and Orthogonality, Orthonormal Basis, Orthogonal Complement, Orthogonal Projections – Projection into One Dimensional Subspaces, Projection onto General Subspaces, Gram-Schmidt Orthogonalization.

Determinant and Trace, Eigenvalues and Eigenvectors, Cholesky Decomposition, Eigen decomposition and Diagonalization, Singular Value Decomposition, Matrix Approximation.

Module 3

VECTOR CALCULUS : Differentiation of Univariate Functions - Partial Differentiation and Gradients, Gradients of Vector Valued Functions, Gradients of Matrices, Useful Identities for Computing Gradients. Back propagation and Automatic Differentiation – Gradients in Deep Network, Automatic Differentiation.Higher Order Derivatives-Linearization and Multivariate TaylorSeries.

Module 4

PROBABILITY AND DISTRIBUTIONS : Construction of a Probability Space - Discrete and Continuous Probabilities, Sum Rule, Product Rule, and Bayes' Theorem. Summary Statistics and Independence – Gaussian Distribution - Conjugacy and the Exponential Family - Change of Variables/Inverse Transform.

Module 5

OPTIMIZATION : Optimization Using Gradient Descent - Gradient Descent With Momentum, Stochastic Gradient Descent. Constrained Optimization and Lagrange Multipliers - Convex Optimization - Linear Programming **-** Quadratic Programming.

Text book:

1.Mathematics for Machine Learning by Marc Peter Deisenroth, A. Aldo Faisal, and Cheng Soon Ong published by Cambridge University Press (freely available at https:// mml - book.github.io)

Reference books:

1. Linear Algebra and Its Applications, 4th Edition by Gilbert Strang
2. Linear Algebra Done Right by Axler, Sheldon, 2015 published bySpringer
3. Introduction to Applied Linear Algebra by Stephen Boyd and Lieven Vandenberghe, 2018 published by Cambridge UniversityPress
4. Convex Optimization by Stephen Boyd and Lieven Vandenberghe, 2004 published by Cambridge UniversityPress
5. Pattern Recognition and Machine Learning by Christopher M Bishop, 2006, published bySpringer
6. Learning with Kernels – Support Vector Machines, Regularization, Optimization, and Beyond by Bernhard Scholkopf and Smola, Alexander J Smola, 2002, published by MIT Press
7. Information Theory, Inference, and Learning Algorithms by David J. C MacKay, 2003 published by Cambridge UniversityPress
8. Machine Learning: A Probabilistic Perspective by Kevin P Murphy, 2012 published by MITPress.
9. The Nature of Statistical Learning Theory by Vladimir N Vapnik, 2000, published by Springer

ELECTRONICS AND COMPUTER ENGINEERING

Sample Course Level Assessment Questions.

Course Outcome 1 (CO1):

1. Find the set ***S*** of all solution sin***x*** of the following in homogeneous linear systems ***Ax*** = ***b***, where ***A*** and ***b*** are defined as follows:

$$A = \begin{bmatrix} 1 & -1 & 0 & 0 & 1 \\ 1 & 1 & 0 & -3 & 0 \\ 2 & -1 & 0 & 1 & -1 \\ -1 & 2 & 0 & -2 & -1 \end{bmatrix}, \quad b = \begin{bmatrix} 3 \\ 6 \\ 5 \\ -1 \end{bmatrix}$$

2. Determine the inverses of the following matrix if possible

$$A = \begin{bmatrix} 1 & 0 & 1 & 0 \\ 0 & 1 & 1 & 0 \\ 1 & 1 & 0 & 1 \\ 1 & 1 & 1 & 0 \end{bmatrix}$$

3. Find the characteristic equation, eigenvalues, and eigenspaces corresponding to each eigenvalue of the following matrix

$$\begin{bmatrix} 2 & 0 & 4 \\ 0 & 3 & 0 \\ 0 & 1 & 2 \end{bmatrix}$$

4. Diagonalize the following matrix, if possible

$$\begin{bmatrix} 3 & 0 & 0 & 0 \\ 0 & 2 & 0 & 0 \\ 0 & 0 & 2 & 0 \\ 1 & 0 & 0 & 3 \end{bmatrix}$$

5. Find the singular value decomposition (SVD) of the following matrix

$$\begin{bmatrix} 0 & 1 & 1 \\ \sqrt{2} & 2 & 0 \\ 0 & 1 & 1 \end{bmatrix}$$

Course Outcome 2 (CO2):

1. For a scalar function $f(x, y, z) = x^2 + 3y^2 + 2z^2$, find the gradient and its magnitude at the point **(1, 2, -1)**.
2. Find the maximum and minimum values of the function $f(x,y)=4x+4y-x^2-y^2$ subject to the condition $x^2 + y^2 <= 2$.
3. Suppose you were trying to minimize $f(x, y) = x^2 + 2y + 2y^2$. Along what vector should you travel from (5,12)?
4. Find the second order Taylor series expansion for $f(x, y) = (x + y)^2$ about **(0 ,0)**.
5. Find the critical points of $f(x, y) = x^2 - 3xy + 5x - 2y + 6y^2 + 8$.
6. Compute the gradient of the Rectified Linear Unit (ReLU) function $ReLU(z) = max(0 , z)$.
7. Let $L = ||Ax - b||^2 2$, where A is a matrix and x and b are vectors. Derive dL in terms of dx.

Course Outcome 3 (CO3):

1. Let J and T be independent events, where $P(J)=0.4$ and $P(T)=0.7$.
   i. Find $P(J \cap T)$
   ii. Find $P(J \square T)$
   iii. Find $P(J \cap T')$
2. Let A and B be events such that $P(A)=0.45$, $P(B)=0.35$ and $P(A \cup B)=0.5$. Find $P(A|B)$.
3. A random variable **R** has the probability distribution as shown in the followingtable:

r	1	2	3	4	5
P(R=r)	0.2	a	b	0.25	0.15

   i. Given that $E(R)=2.85$, find a and b.
   ii. Find $P(R>2)$.
4. A biased coin (with probability of obtaining a head equal to $p> 0$) is tossed repeatedly and independently until the first head is observed. Compute the probability that the first head appears at an even numbered toss.
5. Two players A and B are competing at a trivia quiz game involving a series of questions. On any individual question, the probabilities that A and B give the correct answer are p and q respectively, for all questions, with outcomes for different

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questions being independent. The game finishes when a player wins by answering a question correctly. Compute the probability that A winsif

i. A answers the firstquestion,

ii. B answers the first question.

6. A coin for which ***P(heads) = p*** is tossed until two successive tails are obtained. Find the probability that the experiment is completed on the nth toss.

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Course Outcome 4(CO4):

1. Find the extrema of $f(x, y) = x$ subject to $g(x, y) = x^2 + 2y^2 = 3$.
2. Maximize the function $f(x, y, z) = xy + yz + xz$ on the unit sphere $g(x, y, z) = x^2 + y^2 + z^2 = 1$.
3. Provide necessary and sufficient conditions under which a quadratic optimization problem be written as a linear least squaresproblem.
4. Consider the univariate function $f(x) = x^3 + 6x^2 - 3x - 5$. Find its stationary points and indicate whether they are maximum, minimum, or saddlepoints.
5. Consider the update equation for stochastic gradient descent. Write down the update when we use a mini-batch size ofone.
6. Consider the function

$$f(x) = (x_1 - x_2)^2 + \frac{1}{1 + x_1^2 + x_2^2}.$$

i. Is $f(x)$ a convex function? Justify youranswer.

ii. Is (1 , -1) a local/global minimum? Justify youranswer.

7. Is the function $f(x, y) = 2x^2 + y^2 + 6xy - x + 3y - 7$ convex, concave, or neither? Justify youranswer.
8. Consider the following convex optimization problem

$$\text{minimize } \frac{x^2}{2} + x + 4y^2 - 2y$$

Subject to the constraint $x + y >= 4, x, y >= 1$.

Derive an explicit form of the Lagrangian dual problem.

9. Solve the following LP problem with the simplexmethod.

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$$max\ 5x_1 + 6x_2 + 9x_3 + 8x_4$$

subject to the constraints

$$\begin{aligned} x_1 + 2x_2 + 3x_3 + x_4 &\leq 5 \\ x_1 + x_2 + 2x_3 + 3x_4 &\leq 3 \\ x_1, x_2, x_3, x_4 &\geq 0 \end{aligned}$$

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2014

Model Question paper

ELECTRONICS AND COMPUTER ENGINEERING

	QP Code :		**Total Pages : 5**
Reg No.:_____		Name:_____	

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

IV SEMESTER B.TECH (HONOURS) DEGREE EXAMINATION, MONTH and YEAR

Course Code: CST284

Course Name: MATHEMATICS FOR FOR MACHINE LEARNING

Max. Marks: 100 | Duration: 3 Hours

PART A

		Answer all questions, each carries3 marks.	Marks
1		Show that with the usual operation of scalar multiplication but with addition on reals given by $x \# y = 2(x + y)$ is not a vector space.	
2		Are the following sets of vectors linearly independent? Explain your answer. $x_1 = \begin{bmatrix} 2 \\ -1 \\ 3 \end{bmatrix}$, $x_2 = \begin{bmatrix} 1 \\ 1 \\ -2 \end{bmatrix}$, $x_3 = \begin{bmatrix} 3 \\ -3 \\ 8 \end{bmatrix}$	
3		Find the angle between the vectors $x = \begin{bmatrix} 1 \\ 1 \end{bmatrix}$ and $y = \begin{bmatrix} 1 \\ 2 \end{bmatrix}$.	
4		Find the eigen values of the following matrix in terms of k. Can you find an eigen vector corresponding to each of the eigen values? $\begin{bmatrix} 1 & k \\ 2 & 1 \end{bmatrix}$	
5		Let $f(x, y, z) = xye^r$, where $r = x^2+z^2-5$. Calculate the gradient of f at the point **(1, 3, -2).**	
6		Compute the Taylor polynomials $Tn, n = 0, \ldots, 5$ of $f(x) = \sin(x) + \cos(x)$ at $x_0 = 0$.	
7		Let X be a continuous random variable with probability density function on $0 <= x <= 1$ defined by $f(x) = 3x^2$. Find the pdf of $Y = X^2$.	
8		Show that if two events A and B are independent, then A and B' are independent.	
9		Explain the principle of the gradient descent algorithm.	
10		Briefly explain the difference between (batch) gradient descent and stochastic gradient descent. Give an example of when you might prefer one over the other.	

PART B

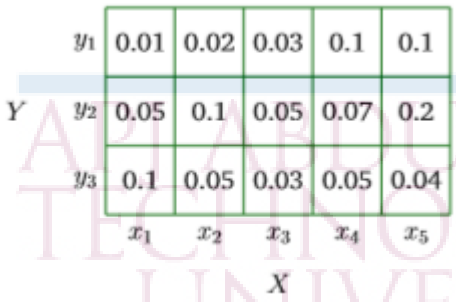
Answer any one Question from each module. Each question carries 14 Marks

11	a)	i.Find all solutions to the system of linearequations $-4x + 5z = -2$ $-3x - 3y + 5z = 3$ $-x + 2y + 2z = -1$	(4)

		ii. Prove that all vectors orthogonal to $[2,-3,1]^T$ forms a subspace **W** of R^3. What is ***dim (W)*** and why?	(4)
	b)	A set of ***n*** linearly independent vectors in R^n forms a basis. Does the set of vectors **(2, 4,−3),(0, 1, 1),(0, 1,−1)** form a basis for R^3? Explain yourreasons.	(6)
		OR	
12	a)	Find all solutions in $x = \begin{bmatrix} x1 \\ x2 \\ x3 \end{bmatrix} \in R^3$ of the equation system $Ax = 12x$, where $A = \begin{bmatrix} 6 & 4 & 3 \\ 6 & 0 & 9 \\ 0 & 8 & 0 \end{bmatrix}$ and $\sum_{i=1}^{3} x_i = 1$.	(7)
	b)	Consider the transformation $T(x, y) = (x + y, x + 2y, 2x + 3y)$. Obtain ***ker T*** and use this to calculate the nullity. Also find the transformation matrix for***T***.	(7)
13	a)	Use the Gramm-Schmidt process to find an orthogonal basis for the column space of the following matrix. $\begin{bmatrix} 2 & 1 & 0 \\ 1 & -1 & 1 \\ 0 & 3 & 1 \\ 1 & 1 & 1 \end{bmatrix}$	(7)
	b)	Find the SVD of the matrix. $\begin{bmatrix} 2 & 2 \\ -1 & -1 \end{bmatrix}$	(7)
		OR	
14	a)	i. Let ***L*** be the line through the origin in R^2 that is parallel to the vector $[3, 4]^T$. Find the standard matrix of the orthogonal projection onto L. Also find the point on ***L*** which is closest to the point **(7, 1)** and find the point on ***L*** which is closest to the point ***(-3 , 5)***.	(6)
		ii. Find the rank-1 approximation of $\begin{bmatrix} 3 & 2 & 2 \\ 2 & 3 & -2 \end{bmatrix}$	
	b)	i. Find an orthonormal basis of R^3 consisting of eigenvectors for the following matrix. $\begin{bmatrix} 1 & 0 & -2 \\ 0 & 5 & 0 \\ -2 & 0 & 4 \end{bmatrix}$	(8)
		ii. Finda3×3orthogonalmatrix***S***anda3×3diagonalmatrix***D*** such that $A = SDS^T$	

15	a)	Askierisonamountainwithequation$z=100-0.4x^2-0.3y^2$,wherez denotes height. i. The skier is located at the point with xy-coordinates **(1, 1),** and wants to ski downhill along the steepest possible path. In which direction (indicated by a vector **(a, b**) in the xy-plane) should the skier beginskiing. **ii.** The skier begins skiing in the direction given by the xy-vector (**a, b)** you found in part (i), so the skier heads in a direction in space given by the vector **(a, b, c**). Find the value of **c**.	(8)
	b)	Find the linear approximation to the function $f(x,y) = 2 - \sin(-x - 3y)$ at the point $(0, \pi)$, and then use your answer to estimate $f(0.001, \pi)$.	(6)
		OR	
16	a)	Let ***g*** be the function given by $$g(x,y) = \begin{cases} \dfrac{x^2y}{x^2+y^2} & \text{if } (x,y) \neq (0,0); \\ 0 & \text{if } (x,y) = (0,0). \end{cases}$$ i. Calculate the partial derivatives of ***g*** at **(0,0)**. ii. Show that ***g*** is not differentiable at **(0,0)**.	(8)
	b)	Find the second order Taylor series expansion for $f(x,y) = e^{-(x^2+y^2)} \cos(xy)$ about **(0 , 0)**.	(6)
17	a)	There are two bags. The first bag contains four mangos and two apples; the second bag contains four mangos and four apples. We also have a biased coin, which shows “heads” with probability 0.6 and “tails” with probability 0.4. If the coin shows “heads”. we pick a fruitat random from bag 1; otherwise we pick a fruit at random from bag 2. Your friend flips the coin (you cannot see the result), picks a fruit at random from the corresponding bag, and presents you a mango. What is the probability that the mango was picked from bag 2?	(6)
	b)	Suppose that one has written a computer program that sometimes compiles and sometimes not (code does not change). You decide to model the apparent stochasticity (success vs. no success) x of the compiler using a Bernoulli distribution with parameter μ: $p(x \mid \mu) = \mu^x (1-\mu)^{1-x}, \quad x \in \{0,1\}$ Choose a conjugate prior for the Bernoulli likelihood and compute the posterior distribution $p(\mu \mid x_1, \ldots, x_N)$.	(8)
		OR	
18	a)	Two dice are rolled. A = ‘sum of two dice equals 3’ B = ‘sum of two dice equals 7’ C = ‘at least one of the dice shows a 1’	(6)

ELECTRONICS AND COMPUTER ENGINEERING

		i. What is P(A|C)? ii. What is P(B|C)? iii. Are A and C independent? What about B and C?	
	b)	Consider the following bivariate distribution p(x,y) of two discrete random variables X and Y .  Compute: i. The marginal distributions p(x) and p(y). ii. The conditional distributions p(x|Y = y_1) and p(y|X = x_3).	(8)
19	a)	Find the extrema of $f(x,y,z) = x - y + z$ subject to $g(x,y,z) = x^2 + y^2 + z^2 = 2$.	(8)
	b)	Let $P = \begin{bmatrix} 13 & 12 & -2 \\ 12 & 17 & 6 \\ -2 & 6 & 12 \end{bmatrix}$, $q = \begin{bmatrix} -22.0 \\ -14.5 \\ 13.0 \end{bmatrix}$, and $r = 1$. Show that $x^* = (1, 1/2, -1)$ is optimal for the optimization problem $\min \quad \frac{1}{2}x^T Px + q^T x + r$ $\text{s.t.} \quad -1 \le x_i \le 1,\ i = 1, 2, 3.$	(6)
		OR	
20	a)	Derive the gradient descent training rule assuming that the target function is represented as $o_d = w_0 + w_1x_1 + \ldots + w_nx_n$. Define explicitly the cost/ error function E, assuming that a set of training examples D is provided, where each training example d D is associated with the target output t_d.	(8)
	b)	Find the maximum value of $f(x,y,z) = xyz$ given that $g(x,y,z) = x + y + z = 3$ and $x,y,z >= 0$.	(6)
		***	

ELECTRONICS AND COMPUTER ENGINEERING

Teaching Plan		
No	**Topic**	**No. of Lectures (49)**
	Module-I (LINEAR ALGEBRA)	**8**
1.1	Matrices, Solving Systems of Linear Equations	1
1.2	Vector Spaces	1
1.3	Linear Independence	1
1.4	Basis and Rank (Lecture – 1)	1
1.5	Basis and Rank (Lecture – 2)	1
1.6	Linear Mappings	1
1.7	Matrix Representation of Linear Mappings	1
1.8	Images and Kernel	1
	Module-II (ANALYTIC GEOMETRY, MATRIX DECOMPOSITIONS)	**11**
2.1	Norms, Inner Products	1
2.2	Lengths and Distances, Angles and Orthogonality	1
2.3	Orthonormal Basis, Orthogonal Complement	1
2.4	Orthogonal Projections – Projection into One Dimensional Subspaces	1
2.5	Projection onto General Subspaces.	1
2.6	Gram-Schmidt Orthogonalization	1
2.7	Determinant and Trace, Eigen values and Eigenvectors.	1
2.8	Cholesky Decomposition	1
2.9	Eigen decomposition and Diagonalization	1
2.10	Singular Value Decomposition	1
2.11	Matrix Approximation	1
	Module-III (VECTOR CALCULUS)	**9**
3.1	Differentiation of Univariate Functions, Partial Differentiation and Gradients	1
3.2	Gradients of Vector Valued Functions (Lecture 1)	1
3.3	Gradients of Vector Valued Functions (Lecture 2)	1

ELECTRONICS AND COMPUTER ENGINEERING

3.4	Gradients of Matrices	1
3.5	Useful Identities for Computing Gradients	1
3.6	Backpropagation and Automatic Differentiation – Gradients in deep Netwok	1
3.7	Automatic Differentiation	1
3.8	Higher Order Derivatives	1
3.9	Linearization and Multivariate Taylor Series	1
	Module-IV (PROBABILITY AND DISTRIBUTIONS)	**10**
4.1	Construction of a Probability Space	1
4.2	Discrete and Continuous Probabilities (Probability Density Function, Cumulative Distribution Function)	1
4.3	Sum Rule, Product Rule	1
4.4	Bayes' Theorem	1
4.5	Summary Statistics and Independence (Lecture 1)	1
4.6	Summary Statistics and Independence (Lecture 2)	1
4.7	Bernoulli, Binomial, Uniform (Discrete) Distributions	1
4.8	Uniform (Continuous), Poisson Distributions	1
4.9	Gaussian Distribution	1
4.10	Conjugacy and the Exponential Family (Beta – Bernoulli, Beta – Binomial Conjugacies)	1
	Module-V (OPTIMIZATION)	7
5.1	Optimization Using Gradient Descent.	1
5.2	Gradient Descent With Momentum, Stochastic Gradient Descent	1
5.3	Constrained Optimization and Lagrange Multipliers (Lecture 1)	1
5.4	Constrained Optimization and Lagrange Multipliers (Lecture 2)	1
5.5	Convex Optimization	1
5.6	Linear Programming	1
5.7	Quadratic Programming	1

CST 286	INTRODUCTION TO COMPUTER NETWORKS	Category	L	T	P	Credit	Year of Introduction
		VAC	3	1	0	4	2019

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Preamble: This is the second course for awarding B. Tech. Minor in Computer Science and Engineering with specialization in ***Networking***. Study of this course provides the learners a clear understanding of how computer networks from local area networks to the massive and global Internet are built and how they allow the usage of computers to share information and communicate with one another. This course covers the layers of OSI Reference models and inter-networking. This course helps the learners to compare and analyze the existing network technologies and to choose a suitable network design for a given system.

Prerequisite: Data Communication **(CST 255)**

Course Outcomes: After the completion of the course the student will be able to

CO 1	Explain the features of computer networks, protocols and network design models **(Cognitive Knowledge : Understand)**
CO 2	Discuss the design issues of data link layer, data link layer protocols, bridges and switches **(Cognitive Knowledge : Understand)**
CO 3	Illustrate wired LAN protocols (IEEE 802.3/4/5) and wireless LAN protocols (IEEE 802.11a/b/g/n, 802.15) **(Cognitive Knowledge : Understand)**
CO 4	Select appropriate routing algorithms, congestion control techniques and Quality of Service requirements for a network **(Cognitive Knowledge : Apply)**
CO 5	Illustrate the functions and protocols of network layer, transport layer and application layer in inter-networking **(Cognitive Knowledge : Understand)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓								✓		✓
CO2	✓	✓	✓							✓		✓
CO3	✓	✓	✓							✓		✓
CO4	✓	✓	✓									✓
CO5	✓	✓	✓			✓				✓		✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	Test 1 (Marks in percentage)	Test 2 (Marks in percentage)	End Semester Examination (Marks in percentage)
Remember	40	30	30
Understand	60	50	50
Apply		20	20
Analyse			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3

Continuous Internal Evaluation Pattern:
Attendance : 10 marks
Continuous Assessment Test : 25 marks
Continuous Assessment Assignment : 15 marks

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

End Semester Examination Pattern:
There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

Syllabus

Module 1

Introduction – Uses of Computer Networks, Network Hardware, Network Software, Reference Models – The OSI Reference Model, The TCP/IP Reference Model, Comparison of OSI and TCP/IP Reference models.

Module 2

The Data Link Layer - Data Link layer Design Issues, Error Detection and Correction, Elementary Data Link Protocols, Sliding Window Protocols, HDLC (High-Level Data Link Control) Protocol. The Medium Access Control (MAC) Sub layer – The Channel Allocation Problem, Multiple Access Protocols, Ethernet, Wireless LANs - 802.11 a/b/g/n, Bridges & Switches.

Module 3

Network Layer Design Issues. Routing Algorithms - The Optimality Principle, Shortest path routing, Flooding, Distance Vector Routing, Link State Routing, Multicast Routing, Routing for Mobile Hosts. Congestion Control Algorithms, Quality of Service (QoS) - Requirements, Techniques for Achieving Good QoS.

Module 4

Network Layer in Internet – The IP Protocol, IP Addresses, Internet Control Message Protocol (ICMP), Address Resolution Protocol (ARP), Reverse Address Resolution Protocol (**RARP**), Bootstrap Protocol (**BOOTP**), Dynamic Host Configuration Protocol (DHCP). Open Shortest Path First (**OSPF**) Protocol, Border Gateway Protocol (**BGP**), Internet Multicasting, IPv6, ICMPv6.

Module 5

Transport Layer – The Transport Service – Services Provided to the Upper Layers, Transport Service Primitives. The User Datagram Protocol (UDP), Transmission Control Protocol (TCP) – Overview of TCP, TCP Segment Header, Connection Establishment & Release, Connection Management Modeling, TCP Retransmission Policy, TCP Congestion Control.

Application Layer – File Transfer Protocol (FTP), Domain Name System (DNS), Electronic mail, MIME, Simple Network Management Protocol (SNMP), World Wide Web – Architectural Overview.

Text Book

Andrew S. Tanenbaum, Computer Networks, 4/e, PHI (Prentice Hall India).

Reference Books

1. Behrouz A Forouzan, Data Communication and Networking, 4/e, Tata McGraw Hill
2. Larry L Peterson and Bruce S Dave, Computer Networks – A Systems Approach, 5/e, Morgan Kaufmann.
3. Fred Halsall, Computer Networking and the Internet, 5/e.
4. James F. Kurose, Keith W. Ross, Computer Networking: A Top-Down Approach, 6/e.
5. Keshav, An Engineering Approach to Computer Networks, Addison Wesley, 1998.
6. W. Richard Stevens. TCP/IP Illustrated volume 1, Addison-Wesley, 2005.
7. William Stallings, Computer Networking with Internet Protocols, Prentice-Hall, 2004.
8. Request for Comments (RFC) Pages - IETF -https://www.ietf.org/rfc.html

Sample Course Level Assessment Questions

CourseOutcome1 (CO1): Compare TCP/IP Reference model and OSI Reference model.

CourseOutcome2 (CO2): Distinguish between switches and bridges.

CourseOutcome3 (CO3): Draw and explain the frame format for Ethernet.

CourseOutcome5 (CO4): Discuss remedies for count to infinity problem in routing.

CourseOutcome4 (CO5): Subnet the Class C IP Address 206.16.2.0 so that you have 30 subnets. What is the subnet mask for the maximum number of hosts? How many hosts can each subnet have?

Model Question Paper

QP CODE: PAGES: ___

Reg No:_____
Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
FOURTH SEMESTER B.TECH DEGREE (MINOR) EXAMINATION, MONTH & YEAR

Course Code: CST 286

Course name : INTRODUCTION TO COMPUTER NETWORKS

Max Marks: 100 **Duration: 3 Hours**

PART-A

(Answer All Questions. Each question carries 3 marks)

1. Why Layered Architecture is used in Computer Networks? Define the terms protocol and interface?
2. What are the different service primitives in Computer Networks?
3. Draw and explain Ethernet frame format.
4. What is the output string when the bit string 0111101111101111110 is subjected to bit stuffing?
5. Discuss the count to infinity problem in routing.
6. What is flooding? Describe any two situations where flooding is advantageous.
7. What is IP (Internet Protocol) subnetting? Illustrate with example.
8. How many octets does the smallest possible IPv6 (IP version 6) datagram contain?
9. Can TCP (Transmission Control Protocol) be used directly over a network (e.g. an Ethernet) without using IP? Justify your answer
10. What is the role of SNMP (Simple Network Management Protocol)?

(10x3=30)

Part B

(Answer any one Question from each module. Each question carries 14 Marks)

Module I

11. (a) With a neat diagram, explain the OSI (Open Systems Interconnection) reference Model. **(8)**
(b) Compare OSI Reference model and the TCP/IP model **(6)**

OR

12. (a) Consider two networks providing reliable connection-oriented service. One of them offers a reliable byte stream and the other offers a reliable message stream. Are they identical? Justify your answer. **(8)**
(b) Compare LAN (Local Area Networks), MAN (Metropolitan Area Networks) and WAN (Wide Area Networks). **(6)**

Module II

13. (a) Discuss the different strategies used to avoid collisions in CSMA/CA (Carrier Sense Multiple Access/Collision Avoidance) . **(8)**
(b) Briefly explain the working of HDLC (High-Level Data Link Control). **(6)**

OR

14. (a) Explain the working of IEEE 802.11. **(10)**
(b) Distinguish between Bridges and Switches. **(4)**

Module III

15. (a) Illustrate Distance Vector Routing Algorithm with an example. **(8)**
(b) Explain the characteristics of RIP (Routing Information Protocol). **(6)**

OR

16. (a) Explain an Interior Gateway protocol that uses a link state algorithm to propagate routing information. **(6)**
(b) Explain how routing is performed in a Mobile network. **(8)**

Module IV

17. (a) Explain address resolution problem and RARP (Reverse Address Resolution Protocol) with an example network. **(10)**

(b) How IGMP (Internet Group Management Protocol) supports internet multicasting? Explain. **(4)**

OR

18. (a) Subnet the class C IP address 195.1.1.0 so that you have 10 subnets with a maximum of 12 hosts in each subnet. **(6)**

(b) Draw IPv6 Datagram format and explain its features **(8)**

Module V

19. (a) Distinguish between TCP and UDP (User Datagram Protocol) header formats. **(8)**

(b) Explain the principal DNS (Domain Name System) resource record types for IPv4. **(6)**

OR

20. (a) What is the role of SMTP (Simple Mail Transfer Protocol) in E-mail? **(6)**

(b) With the help of a basic model explain the working of WWW (World Wide Web). **(8)**

Teaching Plan

	Module 1	**(8 Hours)**
1.1	Introduction – Uses of Computer Networks.	1
1.2	Network Hardware – Local Area Networks (LAN), Metropolitan Area Networks (MAN), Wide Area Networks (WAN).	1
1.3	Network Hardware – Wireless Networks, Home Networks, Internetworks	1
1.4	Network Software — Protocol Hierarchies.	1
1.5	Network Software — Design issues for the layers.	1
1.6	Network Software – Connection Oriented and Connectionless Services, Service Primitives, Relationship of Services to Protocols.	1
1.7	Reference Models – The OSI Reference Model	1

1.8	Reference Models – The TCP/IP Reference Model, Comparison of OSI and TCP/IP Reference models	1
Module 2		**(11 Hours)**
2.1	Data Link layer Design Issues.	1
2.2	Error Detection and Correction - Error Correcting Codes	1
2.3	Error Detection and Correction - Error Detecting Codes	1
2.4	Elementary Data link Protocols.	1
2.5	Sliding Window Protocols.	1
2.6	HDLC (High-Level Data Link Control) Protocol	1
2.7	The Medium Access Control (MAC) Sub layer – The Channel Allocation Problem, Multiple Access Protocols.	1
2.8	Ethernet - Ethernet Cabling, Manchester Encoding, The Ethernet MAC Sub layer Protocol, The Binary Exponential Backoff Algorithm.	1
2.9	Ethernet - Ethernet Performance, Switched Ethernet, Fast Ethernet, Gigabit Ethernet, IEEE 802.2: Logical Link Control.	1
2.10	Wireless LANs - 802.11 a/b/g/n.	1
2.11	Bridges & Switches.	1
Module 3		**(9 Hours)**
3.1	Network Layer Design Issues.	**1**
3.2	Routing Algorithms - The Optimality Principle, Shortest path routing, Flooding.	**1**
3.3	Distance Vector Routing, Link State Routing.	**1**
3.4	Link State Routing.	**1**
3.5	Multicast Routing, Routing for Mobile Hosts	**1**
3.6	Distance Vector Routing, Link State Routing	**1**

3.7	Congestion control algorithms - General Principles of Congestion Control, Congestion Prevention Policies, Congestion Control in Virtual-Circuit Subnets	**1**
3.8	Congestion control algorithms - Congestion Control in Datagram Subnets, Load Shedding, Jitter Control	**1**
3.9	Quality of Service – Requirements, Techniques for Achieving Good Quality of Service.	**1**
Module 4		**(9 Hours)**
4.1	Network layer in internet, IP Protocol	1
4.2	IP Addresses – Subnets, Classless Inter Domain Routing (CIDR)	1
4.3	IP Addresses - Network Address Translation (NAT)	1
4.4	Internet Control Message Protocol (ICMP), Address Resolution Protocol (ARP), Reverse Address Resolution Protocol (RARP),	1
4.5	Bootstrap Protocol (BOOTP), Dynamic Host Configuration Protocol (DHCP)	1
4.6	Open Shortest Path First (**OSPF**) Protocol	1
4.7	Border Gateway Protocol (**BGP**)	1
4.8	Internet Multicasing.	1
4.9	IPv6, Internet Control Message Protocol version 6 (ICMPv6).	1
Module 5		**(8 Hours)**
5.1	The Transport Service – Services Provided to the Upper Layers, Transport Service Primitives. The User Datagram Protocol (UDP)	1
5.2	Transmission Control Protocol (TCP) – Overview of TCP, TCP Segment Header, Connection Establishment & Release, Connection Management Modeling.	1
5.3	TCP Retransmission Policy, TCP Congestion Control.	1
5.4	Application Layer – File Transfer Protocol (FTP).	1
5.5	Domain Name System (DNS).	1

5.6	Electronic Mail.	1
5.7	Simple Network Management Protocol (SNMP)	1
5.8	World Wide Web – Architectural Overview	1

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KTU
Estd.
2014

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEMESTER IV

HONOURS

KTU
Estd.
2014

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
ERT292	DIGITAL SYSTEM DESIGN	VAC	3	1	0	4

Preamble: The objective of the course is to familiarize basic digital concepts and digital system design. This covers the basic concepts of Quine Mc Clusky algorithm and design of combinational and sequential circuits. The course also gives an insight into Verilog programming of combinational and sequential modules.

Prerequisite: Fundamentals of Digital Systems and VLSI Design (ERT 203) course.

Course Outcomes: After the completion of the course the student will be able to

CO 1	Design combinational circuits. (Cognitive Knowledge Level: **Apply**)
CO 2	Design synchronous sequential circuits. (Cognitive Knowledge Level - **Apply**)
CO 3	Understand the concept of ASM charts and state reduction tables. (Cognitive Knowledge Level -**Understand**)
CO 4	Understand programming concepts in Verilog. (Cognitive Knowledge Level - **Understand**)
CO 5	Write various programs using Verilog programming Language. (Cognitive Knowledge Level- **Apply**)

Mapping of course outcomes with program outcomes

	PO 1	PO2	PO3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	✔	✔	✔	✔								✔
CO 2	✔	✔	✔	✔								✔
CO 3	✔	✔	✔									✔
CO 4	✔	✔	-									-
CO 5	✔	✔	✔	✔								✔

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	20	20	40
Understand	20	20	40
Apply	10	10	20
Analyse	-	-	-
Evaluate	-	-	-
Create	-	-	-

Mark Distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:
Attendance: 10 marks
Continuous Assessment Test (2 Numbers): 25 marks
Assignment/Quiz/Course project: 15 marks

End Semester Examination Pattern : There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub- divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Give the relevance of combinational circuit design

2. Explain concept of Quine Mc Cluskey method.

Course Outcome 2 (CO2):

1. Give the relevance of sequential circuit design

2. Study and design FSM using Mealy and Moore models

Course Outcome 3 (CO3):

1. Explain the relevance of ASM.

2. Explain importance of reduction of state tables.

Course Outcome 4 (CO4):

1. List different operators in Verilog

2. write Verilog programs on simple combinational circuits

Course Outcome 5 (CO5):

1. Explain different programming concepts in verilog
2. Write Verilog programs on sequential circuits and test benches to simulate the program .

Syllabus

Module 1 (Combinational Circuit Design Overview)

Combinational circuit implementation using Quine Mc Cluskey algorithm, decoder, encoder, multiplexers, ROM and PLA ,Implementation of multi output gate implementation.

Module 2 (Finite State Machine)

Finite State machine: State diagram, State Table, State assignmemts, state graphs, capabilities and limitations of FSM, Metastability, clock skew, Mealy and Moore machines, Modelling of clocked synchronous circuits as Mealy and Moore machines: Serial binary adder , sequence detector design examples.

Module 3 (Arithmetic State Machine)

Digital System Design Hierarachy: state assignments, reduction of state tables, equivalent states, determination of state equivalence using implication table, Algorithm state machine, ASM charts,Design example.

Module 4 (Verilog Overview)

Introduction to Verilog HDL:Design units,Data objects, signal drivers, Delays,Data types, Language elements, operators, user defined primitives, modelling dataflow, behavioural, structural,Verilog implementation of simple combinational circuits, adder, code converter, decoder, encoder, multiplexer, demultiplexer.

Module 5 (Verilog Programming)

Verilog HDL implementation of binary multiplier, divider, barrel shifter, FSM, linear feedback shift register, simple test bench for combinational circuits.

Text Book:

1. Fundamentals of Digital Design (5 th Edition)- Charles H. Roth, Course Technology.

Reference Books:

1. Fundamentals of Digital Logic with Verilog HDL -S Brown &Z. Varanestic, Mc Graw Hill.
2. Verilog HDL a guide to digital design & synthesis -Samir Palitkar, Pearson.
3. Digital Principles of Design- Donald D Givone, McGraw Hill.

Model Question Paper

Reg

No.:_____Name:

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY FOURTH SEMESTER B. TECH DEGREE EXAMINATION,

MONTH AND YEAR **Course Code: ERT292**

Course Name: DIGITAL SYSTEM DESIGN

Max. Marks: 100 **Duration: 3 Hours**

PART A

Answer all questions, each carries 3 marks

1. What are equivalent states?
2. Implement the function $F(A,B,C,D)=\sum_m(1,3,10,15)$using 4 bit input mux and NOR gates.
3. What is FSM?
4. What are the different types of sequential machines?
5. Design a priority encoder.
6. Draw ASM chart for 3 bit binary upcounter .
7. Write Verilog code for 2:1 mux and test bench for the same.
8. Explain data flow modelling with an example.
9. Explain Linear feedback shift register.
10. Write a Verilog for SISO shift register.

PART B

Answer any one full question from each module.
Each question carries 14 Marks

Module1

11. Impement the function f(a,b,c,d)=)=$\sum_m(0,1,2,5,6,7,8,9,10,14)$ using Quine Mc Cluskey Method. (14 marks)

12. A) Implement the function $F=\sum_m(0,2,5,7,8,10,12,15)$ using 8:1 mux. (7 marks)

B) Implement using PLA 1) $F_0=\sum_m(1,4)$ 2) $F_1=\sum_m(0,2)$ (7 Marks)

Module 2

13. What are the steps involved in deriving state table ,state graph & state diagram. Derive state diagram. (14 marks)

PS(Q(t)	J(t)K(t)			
	00	01	10	11
0	0	0	1	1
1	1	0	1	0
	NS Q(t+1)			

14. Design a Serial binary Adder using Mealy Machine. (14 Marks)

Module 3

15.Design a sequence detector that produces an output '1' whenever the non – overlapping sequence 1011 is detected. (14 Marks)

16. Draw the state diagram, state table,ASM chart for a 2 bit binary counter having one
17. Enabled ' E' such that E=1, counting enabled, and E=0, counting disabled. (14 Marks)

Module 4

18. Design a 4 bit full adder using dataflow modelling .Also write its test bench. (14 Marks)

19. a) What are blocking and Non-blocking assignments.? (5 marks)

b) What are different operators in Verilog. (9marks)

Module 5

20. Write a Verilog Code for Barrel shifter . (14 marks)

21. Write a Verilog code binary multiplier . (14 marks)

Course Contents and Lecture Schedule ELECTRONICS AND COMPUTER ENGINEERING

No	Topic	No. of Lectures
1	**Combinational circuit Design Overview**	**9**
1.1	Combinational circuit implementation using Quine Mc Cluskey algorithm	1
1.2	Combinational circuit implementation using Quine Mc Cluskey algorithm	1
1.3	decoder	1
1.4	encoder	1
1.5	multiplexers	1
1.6	ROM	1
1.7	PLA	1
1.8	Implementation of multi output gate implementation	1
1.9	Implementation of multi output gate implementation	1
2	**FSM**	**11**
2.1	Finite State machine: State diagram	1
2.2	State Table, State assignments	1
2.3	state graphs,	1
2.4	capabilities and limitations of FSM	1
2.5	Metastability, clock skew	1
2.6	Mealy machine	1
2.7	Moore machines	1
2.8	Modelling of clocked synchronous circuits as Mealy and Moore machines	1
2.9	Modelling of clocked synchronous circuits as Mealy and Moore machines	1
2.10	Serial binary adder	1
2.11	sequence detector design examples	1
3	**ASM**	**8**
3.1	Digital System Design Hierarchy: state assignments,	1
3.2	reduction of state tables	1

3.3	equivalent states	1
3.4	Determination of state equivalence using implication table.	1
3.5	Algorithm state machine,	1
3.6	ASM charts	1
3.7	Design example	1
3.8	Design example	1
4	**Verilog overview**	**9**
4.1	Introduction to Verilog HDL: Design units,	1
4.2	Data objects, signal drivers	1
4.3	Delays, Data types, Language elements	1
4.4	operators, user defined primitives	1
4.5	Modelling dataflow, behavioural, structural	1
4.6	Verilog implementation of simple combinational circuits	1
4.7	adder,code converter	1
4.8	decoder, encoder	1
4.9	multiplexer, demultiplexer.	
5	**Verilog Programming**	**8**
5.1	Verilog HDL implementation of binary multiplier	1
5.2	Verilog HDL implementation of binary multiplier	1
5.3	Divider	1
5.4	Divider	1
5.5	Barrel shifter	1
5.6	FSM	1
5.7	linear feedback shift register	1
5.8	Simple test bench for combinational circuits.	1

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT	Year of Introduction
CST292	NUMBER THEORY	VAC	4	0	0	4	2019

Preamble: This is the foundational course for awarding B. Tech. Honours in Computer Science and Engineering with specialization in ***Security in Computing***. The purpose of this course is to create awareness among learners about the important areas of number theory used in computer science. This course covers Divisibility & Modular Arithmetic, Primes & Congruences, Euler's Function, Quadratic Residues and Arithmetic Functions, Sum of Squares and Continued fractions. Concepts in Number Theory help the learner to apply them eventually in practical applications in Computer organization & Security, Coding & Cryptography, Random number generation, Hash functions and Graphics.

Prerequisite: A sound background in Higher Secondary School Mathematics

Course Outcomes: After the completion of the course the student will be able to

CO1	Illustrate modular arithmetic operations, methods and techniques **(Cognitive Knowledge Level:Understand)**
CO2	Use the methods - Induction, Contraposition or Contradiction to verify the correctness of mathematical assertions (**Cognitive Knowledge Level: Apply)**
CO3	Utilize theorems and results about prime numbers, congruences, quadratic residues and integer factorization for ensuring security in computing systems (**Cognitive Knowledge Level: Analyse)**
CO4	Illustrate uses of Chinese Remainder Theorem & Euclidean algorithm in Cryptography and Security (**Cognitive Knowledge Level: Apply)**
CO5	Explain applications of arithmetic functions in Computer Science **(Cognitive Knowledge Level:Understand)**
CO6	Implement Number Theoretic Algorithms using a programming language (**Cognitive Knowledge Level: Apply)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓						✓		✓
CO2	✓	✓	✓	✓								✓
CO3	✓	✓	✓	✓		✓						✓
CO4	✓	✓	✓	✓		✓						✓
CO5	✓	✓	✓	✓						✓		✓
CO6	✓	✓	✓	✓	✓			✓				✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks (Percentage)
	Test1 (Percentage)	Test2 (Percentage)	
Remember	30	30	30
Understand	30	30	30
Apply	40	40	40
Analyse			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	**50**	**100**	**3 hours**

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Tests : 25 marks

Continuous Assessment Assignment : 15 marks

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks

First Internal Examination shall be preferably conducted after completing the first half of the syllabus and the Second Internal Examination shall be preferably conducted after completing remaining part of the syllabus.

There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly covered module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly covered module), each with 7 marks. Out of the 7 questions in Part B, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

SYLLABUS

Module 1

Divisibility and Modular Arithmetic:

Finite Fields – Groups, Rings and Fields.

Divisibility - Divisibility and Division Algorithms, Well ordering Principle,Bezout's Identity.

Modular Arithmetic- Properties, Euclid's algorithm for the greatest common divisor, Extended Euclid's Algorithm, Least Common multiple, Solving Linear Diophantine Equations, Modular Division.

Module 2

Primes and Congruences:

Prime Numbers-Prime Numbers andprime-powerfactorization, Fermat and Mersenne primes., Primality testing and factorization.

Congruences-Linear congruences, Simultaneous linear congruences, Chinese Remainder Theorem, Fermat's little theorem, Wilson's theorem.

Module 3

Congruences with a Prime-Power Modulus&Euler's Function:

Congruences with a Prime-Power Modulus-Arithmetic modulo p, Pseudoprimes and Carmichael numbers, Solving congruences modulo prime powers.

Euler's Function-Euler's Totient function, Applications of Euler's Totient function, Traditional Cryptosystem, Limitations.

The Group of units- The group U_n,Primitive roots, Existence of primitive roots, Applications of primitive roots.

Module 4

Quadratic Residues & Arithmetic Functions :

Quadratic Residues- Quadratic Congruences, The group of Quadratic residues, Legendre symbol, Jacobi Symbol, Quadratic reciprocity.

Arithmetic Functions- Definition and examples, Perfect numbers, Mobius function and its properties, Mobius inversion formula, The Dirichlet Products.

Module 5

Sum of Squares and Continued Fractions:

Sum of Squares- Sum of two squares, The Gaussian Integers, Sum of three squares, Sum of four squares.

Continued Fractions -Finite continued fractions, Infinite continued fractions, Pell's Equation, Solution of Pell's equation by continued fractions.

Text Books

1. G.A. Jones & J.M. Jones, Elementary Number Theory, Springer UTM, 2007.

2. Joseph Silverman, A Friendly introduction to Number Theory, Pearson Ed. 2009.

Reference Books

1. William Stallings, Cryptography and Network Security Principles and Practice, Pearson Ed.

2. Tom M.Apostol, 'Introduction to Analytic Number Theory', Narosa Publishing House Pvt. Ltd, New Delhi, (1996).

3. Neal Koblitz, A course in Number Theory and Cryptography, 2nd Edition, Springer ,2004.

Sample Course Level Assessment Questions

Course Outcome 1 (CO1): Describe the properties of modular arithmetic and modulo operator.

Course Outcome 2 (CO2): Prove that the equation $y^2 = x^3 - 2$ has only the integer solution $(3, \pm 5)$.

Course Outcome 3 (CO3): State the law of reciprocity for Jacobi symbols and use it to determine whether 888 is a quadratic residue or non residue of the prime 1999.

Course Outcome 4 (CO4): Using Chinese remainder theorem, solve the system of congruence $x \equiv 2 \pmod 3$, $x \equiv 3 \pmod 5$, $x \equiv 2 \pmod 7$

Course Outcome 5(CO5): State and prove Dirichlet product.

Course Outcome 6 (CO6): Use extended Euclid's algorithm to solve Diophantine equations efficiently. Given three numbers $a>0$, $b>0$, and c, the algorithm should return some x and y such that $a x + b y = c$.

Model Question Paper

QP CODE: PAGES: 03

RegNo : …..... Name :……..……

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
FOURTH SEMESTER BTECH (HONOURS) DEGREE EXAMINATION, MONTH &YEAR

Course Code:CST 292 Course
Name: Number Theory

Max.Marks:100 **Duration: 3 Hours**

PART A

Answer all Questions. Each question carries 3 Marks (10x3=30)

1. State and prove well ordering principle.
2. Find gcd d of x=525 and y=231 and express d as ax + by where a and b are integers.
3. Solve the congruence equation 103 x≡ 57 (mod 211).
4. Use Fermat's Little theorem to show that 91 is not a prime.
5. If m is relatively prime to n , show that $\Phi(mn) = \Phi(m)\,\Phi(n)$.
6. Explain how public key cryptography can be used for digital signatures.
7. Define Mobius function and prove Mobius function is a multiplicative.
8. State and prove Dirichlet product.
9. Show that every prime of the form 4k+1 canbe represented uniquely as the sum of two squares.
10. Find the continued fraction representation of the rational number 55/89.

Part B

Answer any one Question from each module.
Each question carries 14 Marks

11. (a) State the Euclidean algorithm and its extension with an example. (7)
    (b) Find all the solutions of 24x + 34 y = 6. (7)

OR

12. (a) Describe the properties of modular arithmetic and modulo operator. (7)
    (b) Explain Extended Euclidean algorithm. Using the algorithm find the

multiplicative inverse of 135 mod 61 (7)

13. (a) State and prove Wilson's theorem . (7)

(b) Explain Fermat's factorization method and use it to factor 809009 (7)

OR

14. (a) Using Chinese remainder theorem, solve the system of congruences, $x \equiv 2 (\text{mod } 3)$, $x \equiv 3 (\text{mod } 5)$, $x \equiv 2 (\text{mod } 7)$ (7)

(b) Define Fermat primes. Show that any two distinct Fermat numbers are Relatively prime. (7)

15. (a) Distinguish between public key and private key encryption techniques. Also point out the merits and demerits of both. (7)

(b) Define Carmichael number and show that a Carmichael number must be the product of at least three distinct primes. (7)

OR

16. (a)Define a pseudo prime to a base and find all non trivial bases for which 15 is a pseudo prime. (6)

(b) Find an element of

i) order 5 modulo 11 ii) order 4 modulo 13

iii) order 8 modulo 17 iv) order 6 modulo 19 (8)

17. (a) Determine the quadratic residues and non residues modulo 17. Also determine whether 219 is a quadratic residue or non residue of the prime 383. (8)

(b) State the law of quadratic reciprocity. Determine those odd primes p for which 3 is a quadratic residue and those for which it is a non residue. (6)

OR

18. (a) State and prove properties of Legendre's symbol. (7)

(b) State the law of reciprocity for Jacobi symbols and using it determine whether 888 is a quadratic residue or non residue of the prime 1999. (7)

19. (a) Prove that the equation $y^2 = x^3 - 2$ has only the integer solution $(3, \pm 5)$. (7)

(b) Define a Gaussian integer. Factorize the Gaussian integer 440 − 55i. (7)

OR

20. (a) If *m*, and *n* can be expressed as sum of four squares, then show that *mn* can also be expressed the sum of four squares. (7)

(b) Find all the solutions of the Diophantine equation $x^2 - 6y^2 = 1$. (7)

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Teaching Plan

Module 1: Divisibility and Euclidean Algorithm		**9 hours**
1.1	Finite Fields – Groups and Rings.	1 hour
1.2	Finite Fields – Fields.	1 hour
1.3	Divisibility and Division Algorithms, Well ordering Principle.	1 hour
1.4	Decimal Expansion of a positive Integer, Greatest Common Divisor, Bezout's Theorem.	1 hour
1.5	Modular Arithmetic- Properties of congruences, Modular Arithmetic Operations, Properties of Modular Arithmetic.	1 hour
1.6	Euclid's algorithm for the greatest common divisor, Extended Euclid's Algorithm.	1 hour
1.7	Solving Linear Diophantine Equations.	1 hour
1.8	Least Common multiple and Modular Division.	1 hour
1.9	Implementation of Euclid's algorithm, Extended Euclid's Algorithm and solution of Linear Diophantine Equations.	1 hour
Module 2: Primes and Congruences		**9 hours**
2.1	Prime Numbersand prime-powerFactorization.	1 hour
2.2	Fermat and Mersenne primes.	1 hour
2.3	Primality testing and factorization, Miller -Rabin Test for Primality.	1 hour
2.4	Pollard's Rho Method for Factorization, Fermat's Factorization.	1 hour

2.5	Linear congruences, Simultaneous linear congruences.	1 hour
2.6	Chinese Remainder Theorem.	1 hour
2.7	Implementation of Chinese Remainder Theorem.	1 hour
2.8	Fermat's little theorem.	1 hour
2.9	Wilson's theorem.	1 hour
Module 3: Congruences with a Prime-Power Modulus &Euler's Function		**9 hours**
3.1	Congruences with a Prime-Power Modulus, Arithmetic modulo p.	1 hour
3.2	Pseudo-primes and Carmichael numbers.	1 hour
3.3	Solving congruences modulo prime powers.	1 hour
3.4	Definition of Euler Totient function, Examples and properties.	1 hour
3.5	Multiplicativity of Euler's Totient function.	1 hour
3.6	Applications of Euler’s function, Euler’s Theorem.	1 hour
3.7	Traditional Cryptosystem, Limitations, Public Key Cryptography.	1 hour
3.8	The Group of Units, Primitive Roots.	1 hour
3.9	Existence of primitive roots for Primes, Applications of primitive roots.	1 hour
Module 4: Quadratic Residues and Arithmetic Functions		**9 hours**
4.1	Quadratic congruences, The group of Quadratic Residues.	1 hour
4.2	Legendre symbol, Jacobi Symbol.	1 hour
4.3	Quadratic reciprocity.	1 hour
4.4	Quadratic residues for prime-power moduli.	1 hour
4.5	Arithmetic Functions: Definition and examples.	1 hour

4.6	Perfect numbers, Definition and proposition.	1 hour
4.7	Mobius inversion formula., application of the Mobius inversion formula.	1 hour
4.8	Mobius function and its properties.	1 hour
4.9	The Dirichlet Product, Definition and proof.	1 hour
Module 5: Sum of Squares and Continued Fractions		**9 hours**
5.1	Sum of Squares, Sum of two squares.	1 hour
5.2	The Gaussian Integers.	1 hour
5.3	Sum of three squares.	1 hour
5.4	Sum of four squares.	1 hour
5.5	Continued Fractions, Finite continued fractions.	1 hour
5.6	Continued Fractions, Finite continued fractions.	1 hour
5.7	Infinite continued fractions.	1 hour
5.8	Pell's Equation, Definition.	1 hour
5.9	Solution of Pell's equation by continued fractions.	1 hour

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
KTU
Estd
2014

CODE CST294	COMPUTATIONAL FUNDAMENTALS FOR MACHINE LEARNING	CATEGORY	L	T	P	CREDIT
		VAC	3	1	0	4

Preamble: This is the foundational course for awarding B. Tech. Honours in Computer Science and Engineering with specialization in ***Machine Learning***. The purpose of this course is to introduce mathematical foundations of basic Machine Learning concepts among learners, on which Machine Learning systems are built. This course covers Linear Algebra, Vector Calculus, Probability and Distributions, Optimization and Machine Learning problems. Concepts in this course help the learners to understand the mathematical principles in Machine Learning and aid in the creation of new Machine Learning solutions, understand & debug existing ones, and learn about the inherent assumptions & limitations of the current methodologies.

Prerequisite: A sound background in higher secondary school Mathematics.

Course Outcomes: After the completion of the course the student will be able to

CO 1	Make use of the concepts, rules and results about linear equations, matrix algebra, vector spaces, eigenvalues & eigenvectors and orthogonality & diagonalization to solve computational problems (Cognitive Knowledge Level: **Apply**)
CO 2	Perform calculus operations on functions of several variables and matrices, including partial derivatives and gradients (Cognitive Knowledge Level: **Apply**)
CO 3	Utilize the concepts, rules and results about probability, random variables, additive & multiplicative rules, conditional probability, probability distributions and Bayes' theorem to find solutions of computational problems (Cognitive Knowledge Level: **Apply**)
CO 4	Train Machine Learning Models using unconstrained and constrained optimization methods (Cognitive Knowledge Level: **Apply**)

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	√	√	√	√								√
CO 2	√	√	√									√
CO 3	√	√	√	√								√
CO 4	√	√	√	√		√						√

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	**2**	
Remember	20%	20%	20%
Understand	40%	40%	40%
Apply	40%	40%	40%
Analyse			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	**50**	**100**	**3 hours**

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Tests : 25 marks
Continuous Assessment Assignment : 15 marks

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks

First Internal Examination shall be preferably conducted after completing the first half of the syllabus and the Second Internal Examination shall be preferably conducted after completing remaining part of the syllabus.

There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly covered module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly covered module), each with 7 marks. Out of the 7 questions in Part B, a student should answer any 5.

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer anyone. Each question can have maximum 2 sub-divisions and carries 14 marks.

Syllabus

Module 1

LINEAR ALGEBRA: Systems of Linear Equations – Matrices, Solving Systems of Linear Equations. Vector Spaces –Vector Spaces, Linear Independence, Basis and Rank. Linear Mappings – Matrix Representation of Linear Mappings, Basis Change, Image and Kernel.

Module 2

ANALYTIC GEOMETRY, MATRIX DECOMPOSITIONS: Norms, Inner Products, Lengths and Distances, Angles and Orthogonality, Orthonormal Basis, Orthogonal Complement, Orthogonal Projections – Projection into One Dimensional Subspaces, Projection onto General Subspaces, Gram-Schmidt Orthogonalization.

Determinant and Trace, Eigenvalues and Eigenvectors, Cholesky Decomposition, Eigen decomposition and Diagonalization, Singular Value Decomposition, Matrix Approximation.

Module 3

VECTOR CALCULUS : Differentiation of Univariate Functions - Partial Differentiation and Gradients, Gradients of Vector Valued Functions, Gradients of Matrices, Useful Identities for Computing Gradients. Back propagation and Automatic Differentiation – Gradients in Deep Network, Automatic Differentiation.Higher Order Derivatives-Linearization and Multivariate TaylorSeries.

Module 4

Probability and Distributions : Construction of a Probability Space - Discrete and Continuous Probabilities, Sum Rule, Product Rule, and Bayes' Theorem. Summary Statistics and Independence – Gaussian Distribution - Conjugacy and the Exponential Family - Change of Variables/Inverse Transform.

Module 5

Optimization : Optimization Using Gradient Descent - Gradient Descent With Momentum, Stochastic Gradient Descent. Constrained Optimization and Lagrange Multipliers - Convex Optimization - Linear Programming **-** Quadratic Programming.

Text book:

1.Mathematics for Machine Learning by Marc Peter Deisenroth, A. Aldo Faisal, and Cheng Soon Ong published by Cambridge University Press (freely available at https:// mml - book.github.io)

Reference books:

1. Linear Algebra and Its Applications, 4th Edition by Gilbert Strang
2. Linear Algebra Done Right by Axler, Sheldon, 2015 published bySpringer
3. Introduction to Applied Linear Algebra by Stephen Boyd and Lieven Vandenberghe, 2018 published by Cambridge UniversityPress
4. Convex Optimization by Stephen Boyd and Lieven Vandenberghe, 2004 published by Cambridge UniversityPress
5. Pattern Recognition and Machine Learning by Christopher M Bishop, 2006, published bySpringer
6. Learning with Kernels – Support Vector Machines, Regularization, Optimization, and Beyond by Bernhard Scholkopf and Smola, Alexander J Smola, 2002, published by MIT Press
7. Information Theory, Inference, and Learning Algorithms by David J. C MacKay, 2003 published by Cambridge UniversityPress
8. Machine Learning: A Probabilistic Perspective by Kevin P Murphy, 2012 published by MITPress.
9. The Nature of Statistical Learning Theory by Vladimir N Vapnik, 2000, published by Springer

Sample Course Level Assessment Questions.

Course Outcome 1 (CO1):

1. Find the set S of all solutions in x of the following inhomogeneous linear systems $Ax = b$, where A and b are defined as follows:

$$A = \begin{bmatrix} 1 & -1 & 0 & 0 & 1 \\ 1 & 1 & 0 & -3 & 0 \\ 2 & -1 & 0 & 1 & -1 \\ -1 & 2 & 0 & -2 & -1 \end{bmatrix}, \quad b = \begin{bmatrix} 3 \\ 6 \\ 5 \\ -1 \end{bmatrix}$$

2. Determine the inverses of the following matrix if possible

$$A = \begin{bmatrix} 1 & 0 & 1 & 0 \\ 0 & 1 & 1 & 0 \\ 1 & 1 & 0 & 1 \\ 1 & 1 & 1 & 0 \end{bmatrix}$$

3. Find the characteristic equation, eigenvalues, and eigenspaces corresponding to each eigenvalue of the following matrix

$$\begin{bmatrix} 2 & 0 & 4 \\ 0 & 3 & 0 \\ 0 & 1 & 2 \end{bmatrix}$$

4. Diagonalize the following matrix, if possible

$$\begin{bmatrix} 3 & 0 & 0 & 0 \\ 0 & 2 & 0 & 0 \\ 0 & 0 & 2 & 0 \\ 1 & 0 & 0 & 3 \end{bmatrix}$$

5. Find the singular value decomposition (SVD) of the following matrix

$$\begin{bmatrix} 0 & 1 & 1 \\ \sqrt{2} & 2 & 0 \\ 0 & 1 & 1 \end{bmatrix}$$

Course Outcome 2 (CO2):

1. For a scalar function $f(x, y, z) = x^2 + 3y^2 + 2z^2$, find the gradient and its magnitude at the point **(1, 2, -1)**.
2. Find the maximum and minimum values of the function $f(x,y)=4x+4y-x^2-y^2$ subject to the condition $x^2 + y^2 <= 2$.
3. Suppose you were trying to minimize $f(x, y) = x^2 + 2y + 2y^2$. Along what vector should you travel from (5,12)?
4. Find the second order Taylor series expansion for $f(x, y) = (x + y)^2$ about **(0 ,0)**.
5. Find the critical points of $f(x, y) = x^2 - 3xy + 5x - 2y + 6y^2 + 8$.
6. Compute the gradient of the Rectified Linear Unit (ReLU) function $ReLU(z) = max(0 , z)$.
7. Let $L = ||Ax - b||^2 2$, where A is a matrix and x and b are vectors. Derive dL in terms of dx.

Course Outcome 3 (CO3):

1. Let J and T be independent events, where $P(J)=0.4$ and $P(T)=0.7$.
   i. Find $P(J \cap T)$
   ii. Find $P(J \square T)$
   iii. Find $P(J \cap T')$
2. Let A and B be events such that $P(A)=0.45$, $P(B)=0.35$ and $P(A \cup B)=0.5$. Find $P(A|B)$.
3. A random variable **R** has the probability distribution as shown in the following table:

r	1	2	3	4	5
P(R=r)	0.2	a	b	0.25	0.15

   i. Given that $E(R)=2.85$, find a and b.

ii. Find ***P(R>2)***.

4. A biased coin (with probability of obtaining a head equal to ***p> 0***) is tossed repeatedly and independently until the first head is observed. Compute the probability that the first head appears at an even numbered toss.
5. Two players A and B are competing at a trivia quiz game involving a series of questions. On any individual question, the probabilities that A and B give the correct answer are ***p*** and ***q*** respectively, for all questions, with outcomes for different questions being independent. The game finishes when a player wins by answering a question correctly. Compute the probability that A winsif

   i. A answers the firstquestion,

   ii. B answers the first question.
6. A coin for which ***P(heads) = p*** is tossed until two successive tails are obtained. Find the probability that the experiment is completed on the nth toss.

Course Outcome 4(CO4):

1. Find the extrema of $f(x, y) = x$ subject to $g(x, y) = x^2 + 2y^2 = 3$.
2. Maximize the function $f(x, y, z) = xy + yz + xz$ on the unit sphere $g(x, y, z) = x^2 + y^2 + z^2 = 1$.
3. Provide necessary and sufficient conditions under which a quadratic optimization problem be written as a linear least squaresproblem.
4. Consider the univariate function $f(x) = x^3 + 6x^2 - 3x - 5$. Find its stationary points and indicate whether they are maximum, minimum, or saddlepoints.
5. Consider the update equation for stochastic gradient descent. Write down the update when we use a mini-batch size ofone.
6. Consider the function

$$f(x) = (x_1 - x_2)^2 + \frac{1}{1 + x_1^2 + x_2^2}.$$

   i. Is ***f(x)*** a convex function? Justify youranswer.

   ii. Is (1 , -1) a local/global minimum? Justify youranswer.
7. Is the function $f(x, y) = 2x^2 + y^2 + 6xy - x + 3y - 7$ convex, concave, or neither? Justify youranswer.
8. Consider the following convex optimization problem

$$\text{minimize } \frac{x^2}{2} + x + 4y^2 - 2y$$

Subject to the constraint ***x + y >= 4, x, y >= 1***.

Derive an explicit form of the Lagrangian dual problem.

9. Solve the following LP problem with the simplexmethod.

$$max\ 5x_1 + 6x_2 + 9x_3 + 8x_4$$

subject to the constraints

$$\begin{aligned} x_1 + 2x_2 + 3x_3 + x_4 &\leq 5 \\ x_1 + x_2 + 2x_3 + 3x_4 &\leq 3 \\ x_1, x_2, x_3, x_4 &\geq 0 \end{aligned}$$

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY KTU Estd. 2014

Model Question paper

	QP Code :		**Total Pages : 5**
Reg No.:_____		Name:_____	

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
IV SEMESTER B.TECH (HONOURS) DEGREE EXAMINATION, MONTH and YEAR

Course Code: CST294

Course Name: COMPUTATIONAL FUNDAMENTALS FOR MACHINE LEARNING

Max. Marks: 100 | Duration: 3 Hours

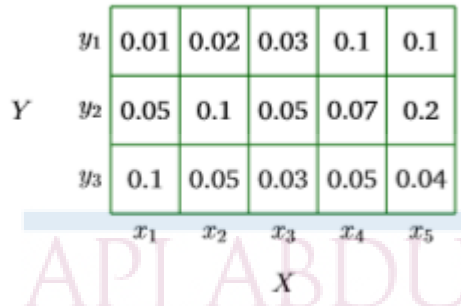
PART A

		Answer all questions, each carries3 marks.	Marks
1		Show that with the usual operation of scalar multiplication but with addition on reals given by $x \# y = 2(x + y)$ is not a vector space.	
2		Are the following sets of vectors linearly independent? Explain your answer. $x_1 = \begin{bmatrix} 2 \\ -1 \\ 3 \end{bmatrix}, \quad x_2 = \begin{bmatrix} 1 \\ 1 \\ -2 \end{bmatrix}, \quad x_3 = \begin{bmatrix} 3 \\ -3 \\ 8 \end{bmatrix}$	
3		Find the angle between the vectors $x = \begin{bmatrix} 1 \\ 1 \end{bmatrix}$ and $y = \begin{bmatrix} 1 \\ 2 \end{bmatrix}$.	
4		Find the eigen values of the following matrix in terms of k. Can you find an eigen vector corresponding to each of the eigen values? $\begin{bmatrix} 1 & k \\ 2 & 1 \end{bmatrix}$	
5		Let $f(x, y, z) = xye^r$, where $r = x^2+z^2-5$. Calculate the gradient of f at the point **(1, 3, -2).**	
6		Compute the Taylor polynomials $T_n, n = 0, \ldots, 5$ of $f(x) = \sin(x) + \cos(x)$ at $x_0 = 0$.	
7		Let X be a continuous random variable with probability density function on $0 <= x <= 1$ defined by $f(x) = 3x^2$. Find the pdf of $Y = X^2$.	
8		Show that if two events A and B are independent, then A and B' are independent.	
9		Explain the principle of the gradient descent algorithm.	
10		Briefly explain the difference between (batch) gradient descent and stochastic gradient descent. Give an example of when you might prefer one	

		over the other.	
PART B			
Answer any one Question from each module. Each question carries 14 Marks			
11	a)	i.Find all solutions to the system of linearequations $-4x + 5z = -2$ $-3x - 3y + 5z = 3$ $-x + 2y + 2z = -1$	(4)
		ii. Prove that all vectors orthogonal to $[2,-3,1]^T$ forms a subspace **W** of R^3. What is ***dim (W)*** and why?	(4)
	b)	A set of ***n*** linearly independent vectors in R^n forms a basis. Does the set of vectors **(2, 4,−3),(0, 1, 1),(0, 1,−1)** form a basis for R^3? Explain yourreasons.	(6)
		OR	
12	a)	Find all solutions in $x = \begin{bmatrix} x1 \\ x2 \\ x3 \end{bmatrix} \in R^3$ of the equation system $Ax = 12x$, where $A = \begin{bmatrix} 6 & 4 & 3 \\ 6 & 0 & 9 \\ 0 & 8 & 0 \end{bmatrix}$ and $\sum_{i=1}^{3} x_i = 1$.	(7)
	b)	Consider the transformation ***T (x, y) = (x + y, x + 2y, 2x + 3y)***. Obtain ***ker T*** and use this to calculate the nullity. Also find the transformation matrix for***T***.	(7)
13	a)	Use the Gramm-Schmidt process to find an orthogonal basis for the column space of the following matrix. $\begin{bmatrix} 2 & 1 & 0 \\ 1 & -1 & 1 \\ 0 & 3 & 1 \\ 1 & 1 & 1 \end{bmatrix}$	(7)
	b)	Find the SVD of the matrix. $\begin{bmatrix} 2 & 2 \\ -1 & -1 \end{bmatrix}$	(7)

		OR	
14	a)	i. Let L be the line through the origin in R^2 that is parallel to the vector $[3, 4]^T$. Find the standard matrix of the orthogonal projection onto L. Also find the point on L which is closest to the point **(7, 1)** and find the point on L which is closest to the point ***(-3 , 5)***.	(6)
		ii. Find the rank-1 approximation of $\begin{bmatrix} 3 & 2 & 2 \\ 2 & 3 & -2 \end{bmatrix}$	
	b)	i. Find an orthonormal basis of R^3 consisting of eigenvectors for the following matrix. $\begin{bmatrix} 1 & 0 & -2 \\ 0 & 5 & 0 \\ -2 & 0 & 4 \end{bmatrix}$	(8)
		ii. Find a 3×3 orthogonal matrix S and a 3×3 diagonal matrix D such that $A = SDS^T$	
15	a)	Ask ier is on a mountain with the equation $z=100–0.4x^2–0.3y^2$, where z denotes height. i. The skier is located at the point with xy-coordinates **(1, 1),** and wants to ski downhill along the steepest possible path. In which direction (indicated by a vector **(a, b)** in the xy-plane) should the skier begin skiing. **ii.** The skier begins skiing in the direction given by the xy-vector **(a, b)** you found in part (i), so the skier heads in a direction in space given by the vector **(a, b, c)**. Find the value of **c**.	(8)
	b)	Find the linear approximation to the function $f(x,y) = 2 - \sin(-x - 3y)$ at the point $(0 , \pi)$, and then use your answer to estimate $f(0.001 , \pi)$.	(6)
		OR	
16	a)	Let g be the function given by $$g(x,y) = \begin{cases} \dfrac{x^2y}{x^2+y^2} & \text{if } (x,y) \neq (0,0); \\ 0 & \text{if } (x,y) = (0,0). \end{cases}$$	(8)

		i. Calculate the partial derivatives of ***g*** at **(0,0)**. ii. Show that ***g*** is not differentiable at **(0,0)**.	
	b)	Find the second order Taylor series expansion for $f(x,y) = e^{-(x2+y2)} \cos(xy)$ about **(0 , 0)**.	(6)
17	a)	There are two bags. The first bag contains four mangos and two apples; the second bag contains four mangos and four apples. We also have a biased coin, which shows "heads" with probability 0.6 and "tails" with probability 0.4. If the coin shows "heads". we pick a fruitat random from bag 1; otherwise we pick a fruit at random from bag 2. Your friend flips the coin (you cannot see the result), picks a fruit at random from the corresponding bag, and presents you a mango. What is the probability that the mango was picked from bag 2?	(6)
	b)	Suppose that one has written a computer program that sometimes compiles and sometimes not (code does not change). You decide to model the apparent stochasticity (success vs. no success) x of the compiler using a Bernoulli distribution with parameter μ: $p(x \mid \mu) = \mu^x (1-\mu)^{1-x}, \quad x \in \{0,1\}$ Choose a conjugate prior for the Bernoulli likelihood and compute the posterior distribution $p(\mu \mid x_1, \ldots, x_N)$.	(8)
		OR	
18	a)	Two dice are rolled. A = 'sum of two dice equals 3' B = 'sum of two dice equals 7' C = 'at least one of the dice shows a 1' i. What is P(A|C)? ii. What is P(B|C)? iii. Are A and C independent? What about B and C?	(6)
	b)	Consider the following bivariate distribution p(x,y) of two discrete random	(8)

		variables X and Y .  Compute: i. The marginal distributions p(x) and p(y). ii. The conditional distributions p(x|Y = y_1) and p(y|X = x_3).	
19	a)	Find the extrema of $f(x,y,z) = x - y + z$ subject to $g(x,y,z) = x^2 + y^2 + z^2 = 2$.	(8)
	b)	Let $P = \begin{bmatrix} 13 & 12 & -2 \\ 12 & 17 & 6 \\ -2 & 6 & 12 \end{bmatrix}$, $q = \begin{bmatrix} -22.0 \\ -14.5 \\ 13.0 \end{bmatrix}$, and $r = 1$. Show that $x^* = (1, 1/2, -1)$ is optimal for the optimization problem $\min \quad \frac{1}{2}x^T Px + q^T x + r$ $\text{s.t.} \quad -1 \le x_i \le 1,\ i = 1,2,3.$	(6)
		OR	
20	a)	Derive the gradient descent training rule assuming that the target function is represented as $o_d = w_0 + w_1x_1 + \ldots + w_nx_n$. Define explicitly the cost/ error function E, assuming that a set of training examples D is provided, where each training example d D is associated with the target output t_d.	(8)
	b)	Find the maximum value of $f(x,y,z) = xyz$ given that $g(x,y,z) = x + y + z = 3$ and $x,y,z>=0$.	(6)
		***	

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Teaching Plan		
No	**Topic**	**No. of Lectures (49)**
	Module-I (LINEAR ALGEBRA)	**8**
1.1	Matrices, Solving Systems of Linear Equations	1
1.2	Vector Spaces	1
1.3	Linear Independence	1
1.4	Basis and Rank (Lecture – 1)	1
1.5	Basis and Rank (Lecture – 2)	1
1.6	Linear Mappings	1
1.7	Matrix Representation of Linear Mappings	1
1.8	Images and Kernel	1
	Module-II (ANALYTIC GEOMETRY, MATRIX DECOMPOSITIONS)	**11**
2.1	Norms, Inner Products	1
2.2	Lengths and Distances, Angles and Orthogonality	1
2.3	Orthonormal Basis, Orthogonal Complement	1
2.4	Orthogonal Projections – Projection into One Dimensional Subspaces	1
2.5	Projection onto General Subspaces.	1
2.6	Gram-Schmidt Orthogonalization	1
2.7	Determinant and Trace, Eigen values and Eigenvectors.	1
2.8	Cholesky Decomposition	1
2.9	Eigen decomposition and Diagonalization	1
2.10	Singular Value Decomposition	1
2.11	Matrix Approximation	1

	Module-III (VECTOR CALCULUS)	**9**
3.1	Differentiation of Univariate Functions, Partial Differentiation and Gradients	1
3.2	Gradients of Vector Valued Functions (Lecture 1)	1
3.3	Gradients of Vector Valued Functions (Lecture 2)	1
3.4	Gradients of Matrices	1
3.5	Useful Identities for Computing Gradients	1
3.6	Backpropagation and Automatic Differentiation – Gradients in deep Netwok	1
3.7	Automatic Differentiation	1
3.8	Higher Order Derivatives	1
3.9	Linearization and Multivariate Taylor Series	1
	Module-IV (PROBABILITY AND DISTRIBUTIONS)	**10**
4.1	Construction of a Probability Space	1
4.2	Discrete and Continuous Probabilities (Probability Density Function, Cumulative Distribution Function)	1
4.3	Sum Rule, Product Rule	1
4.4	Bayes' Theorem	1
4.5	Summary Statistics and Independence (Lecture 1)	1
4.6	Summary Statistics and Independence (Lecture 2)	1
4.7	Bernoulli, Binomial, Uniform (Discrete) Distributions	1
4.8	Uniform (Continuous), Poisson Distributions	1
4.9	Gaussian Distribution	1
4.10	Conjugacy and the Exponential Family (Beta – Bernoulli, Beta – Binomial Conjugacies)	1
	Module-V (OPTIMIZATION)	7
5.1	Optimization Using Gradient Descent.	1
5.2	Gradient Descent With Momentum, Stochastic Gradient Descent	1
5.3	Constrained Optimization and Lagrange Multipliers (Lecture 1)	1

5.4	Constrained Optimization and Lagrange Multipliers (Lecture 2)	1
5.5	Convex Optimization	1
5.6	Linear Programming	1
5.7	Quadratic Programming	1

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
KTU
Estd.
2014

SEMESTER V

SCHEME : B TECH -2019

PROGRAMME : ELECTRONICS AND COMPUTER ENGINEERING

ERT 301	DIGITAL SIGNAL PROCESSING	CATEGORY	L	T	P	CREDIT
		PCC	3	1	0	4

Preamble: This course aims to provide an understanding of the principles, algorithms an Applications of Digital Signal Processing.

Prerequisites: Linear Algebra

Course Outcomes: After the completion of the course the student will be able to

CO 1	Summarize the fundamental concepts of discrete-time signals and systems and obtain the transfer function of system using Z-transform. **(Cognitive Knowledge Level: Understand)**
CO 2	Illustrate thefundamental concepts of DFT and compute DFT and IDFT. **(Cognitive Knowledge Level: Understand)**
CO 3	Design FIR filters and IIR filters for the given specifications. **(Cognitive Knowledge Level: Apply)**
CO 4	Realize the various FIR and IIR filter structures for given the system function. **(Cognitive Knowledge Level: Apply)**
CO 5	Explain the architecture of DSP processor (TMS320C67xx) and the finite word length effects in digital filtering. **(Cognitive Knowledge Level: Understand)**

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	✓	✓	✓		✓							✓
CO2	✓	✓	✓		✓							✓
CO3	✓	✓	✓		✓							✓
CO4	✓	✓	✓		✓							✓
CO5	✓	✓	✓		✓							✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work

PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Lifelong learning

Assessment Pattern

Bloom's Category		**Continuous Assessment Tests**		**End Semester Examination**
		1	2	
Remember	K1	10	10	20
Understand	K2	20	20	40
Apply	K3	20	20	40
Analyse	K4			
Evaluate				
Create				

Mark distribution

Total Marks	**CIE**	**ESE**	**ESE Duration**
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10marks

Continuous Assessment Test (2 numbers) : 25 marks

Assignment/Quiz/Tutorial : 15marks

Internal Examination Pattern: Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

End Semester Examination Pattern: There will be two parts: Part-A and Part-B. Part-A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part-B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

CO 1: Summarize the fundamental concepts of discrete-time signals and systems and obtain the transfer function of system using Z-transform.

(i) Discuss the elementary discrete time signals

(ii) A discrete time LTI system is given by $y[n] - \frac{1}{2}y[n-1] = x[n] + x[n-1]$. Determine the transfer function of the system

CO 2: Illustrate the fundamental concepts of DFT and compute DFT and IDFT.

(i) Determine the N-point DFT X(k) of the N point sequences given by $x_1(n) = sin(2\pi n/N)$

(ii) Find the 8-point DFT of a real sequence $x(n) = \{1,2,2,2,1,0,0,0,0\}$ using Decimation in frequency algorithm?

(iii) Find out the number of complex multiplications require to perform 1024-point DFT using (a) direct computation and (b) using radix 2 FFT algorithm?

CO3: Design FIR filters and IIR filters for the given specifications

(i) Design a linear phase Low pass FIR filter with order $N = 11$ and cut-off frequency $\pi/6$ .Use a Hanning Window.

(ii) Design a low pass digital butter-worth filter using bilinear transformation for the given specifications. Passband ripple ≤1dB, Passband edge: 4kHz, Stopband Attenuation: ≥40 dB, Stopband edge: 6kHz, Sampling frequency: 24 kHz

CO4: Realize the various FIR and IIR filter structures for given the system function.

(i) Obtain the direct form-I and direct form-II of the transfer function given below.

H(z)= (0.44 z2+ 0.362 z +0.02)/((z2+ 0.8z +.0.5)(z -0.4))

(ii) Realize an FIR system with the given difference equation,

$y(n) = x(n) - 0.5x(n-1) + 0.25x(n-2) + 0.5x(n-3) - 0.4x(n-4) + 0.2x(n-5)$

CO5: Explain the architecture of DSP processor TMS320C67xx and the finite word length effects

(i) Derive the variance of quantization noise in an ADC with step size A, assuming uniformly distributed quantization noise with zero mean?

(ii) Bring out the architectural features of TMS320C67xx digital signal processor?

Module-1

Introduction to Signals & Systems: Continuous and Discrete Time Signals, Generation of Discrete Time Signals – Sampling, Elementary Discrete Time Signals. Classification of signals- Periodic and Non-Periodic Signals, Energy and Power Signals, Even and odd signals. Operations on Discrete Time Signals- Shifting, Folding, Scaling.

Discrete Time Systems-Properties of Discrete Time Systems-Linearity, Time invariance, Causality, Stability. Linear Time Invariant (LTI) Systems – Convolution sum, Impulse response. Difference Equation representation of LTI Systems.

Z-transform-Properties of Z-transform, Inverse Z-transform, System Transfer function.

Module-2

Frequency Domain Representation of Discrete-Time Signals: Discrete Time Fourier Transform (DTFT), Discrete Fourier Transform (DFT)-Properties. Relationship between DTFT and DFT

Efficient Computation of DFT: Fast Fourier Transform (FFT) Algorithms-Radix-2 Decimation in Time (DIT) and Decimation in Frequency (DIF) FFT Algorithms, IDFT computation using Radix-2 FFT Algorithms

Module-3

Design of Digital Filters: Classification of Digital filters: FIR Filter , IIR Filter. Types of filters-LPF, HPF, BPF, BSF

Design of FIR Filters: Linear Phase FIR filters-Symmetric and Anti-symmetric FIR Filters, Gibbs Phenomenon, Design of linear phase FIR filters using Window method (Rectangular, Hamming and Hanning).

Design of IIR Digital Filters: Analog Filters (Butterworth), Analog Butterworth Prototype LPF filter design, IIR Filter Design using Impulse Invariance, and Bilinear Transformation, Frequency Transformations in the Analog and Digital Domain. (LPF and HPF only)

Module-4

Realization of Digital Filters: Structures for the realization of Discrete Time Systems: Block diagram and signal flow graph representations of filters.

FIR Filter Structures: Linear Phase realization, Direct Form, Cascade Form.

IIR Filter Structures: Direct Form, Cascade Form and Parallel Form.

Module-5

Hardware architecture for signal processing: Harvard Architecture, pipelining, MAC, Introduction to TMS320C67xx digital signal processor, Functional Block Diagram and Description.

Finite word length effects in DSP systems: Introduction (analysis not required), fixed-point and floating-point DSP arithmetic, ADC quantization noise, Round-off error

Finite word length effects in IIR digital filters: coefficient quantization errors.

Text Books

1. Proakis J. G. and Manolakis D. G., Digital Signal Processing, 4/e, Pearson Education, 2007.
2. Alan V Oppenheim, Ronald W. Schafer , Discrete-Time Signal Processing, 3rd Edition, Pearson, 2014.
3. Mitra S. K., Digital Signal Processing: A Computer Based Approach, 4/e McGraw Hill (India) 2014

Reference Books

4. Ifeachor E.C. and Jervis B. W., Digital Signal Processing: A Practical Approach, 2/e Pearson Education, 2009.
5. Lyons, Richard G., Understanding Digital Signal Processing, 3/e. Pearson Education India, 2004.
6. Salivahanan S, Digital Signal Processing,4e, Mc Graw —Hill Education New Delhi, 2019

7. Chassaing, Rulph., DSP applications using C and the TMS320C6x DSK. Vol. 13. John Wiley & Sons, 2003.
8. Vinay.K. Ing1e, John.G.Proakis, Digital Signal Processing: Bookware Companion Series,Thomson,2004
9. Chen, C.T., "Digital Signal Processing: Spectral Computation & Filter Design", Oxford Univ. Press, 2001.

Course Contents and Lecture Schedule

No.	Topic	No. of Lecture Hours
	Module-1	**10 hrs**
1.1	Introduction to Signals & Systems:- Continuous and Discrete Time Signals, Generation of Discrete Time Signals – Sampling	1
1.2	Elementary Discrete Time Signals. Classification of signals	1
1.3	Periodic and Non-Periodic Signals, Energy and Power Signals, Even and odd signals.	1
1.4	Operations on Discrete Time Signals- Shifting, Folding, Scaling.	1
1.5	Discrete Time Systems-Properties of Discrete Time Systems-Linearity,	1
1.6	Time invariance, Causality, Stability.	1
1.7	Linear Time Invariant (LTI) Systems – Convolution sum, Impulse response.	1
1.8	Difference Equation representation of LTI Systems	1
1.9	Z-transform-Properties of Z-transform	1
1.10	Inverse Z-transform, System Transfer function	1
	Module-2	**8 hrs**
2.1	Frequency Domain Representation of Discrete Time Signals: Discrete Time Fourier Transform (DTFT)	1
2.2	Discrete Fourier Transform (DFT)-Properties	1
2.3	Discrete Fourier Transform (DFT)-Properties	1
2.4	Relationship between DTFT and DFT	1
2.5	Efficient Computation of D FT: Fast Fourier Transform (FFT) Algorithms	1
2.6	Radix-2 Decimation in Time (DIT)	1
2.7	Decimation in Frequency (DIF) FFT Algorithms	1
2.8	IDFT computation using Radix-2 FFT Algorithms	1
	Module-3	**10 hrs**
3.1	Design of Digital Filters: Classification of Digital filters: FIR Filter, IIR Filter. Types of filters-LPF, HPF, BPF, BSF	1
3.2	Design of FIR Filters: Linear Phase FIR filters	1
3.3	Symmetric and Anti-symmetric FIR Filters.	1
3.4	Design of linear phase FIR filters using Window method (Rectangular, Hamming and Hanning).	1
3.5	Design of IIR Digital Filters: Analog Filters (Butterworth),	1

3.6	Analog Butterworth Prototype LPF filter design	1
3.7	IIR Filter Design by Impulse Invariance, and Bilinear Transformation	1
3.8	IIR Filter Design by Impulse Invariance, and Bilinear Transformation	1
3.9	Frequency Transformations in the Analog and Digital Domain. (LPF and HPF only)	1
3.10	Frequency Transformations in the Analog and Digital Domain. (LPF and HPF only)	1
	Module-4	**8 hrs**
4.1	Realization of Digital Filters: Structures for the realization of Discrete Time Systems	1
4.2	Block diagram and signal flow graph representations of filters.	1
4.3	FIR Filter Structures: Linear Phase realization	1
4.4	Direct Form,	1
4.5	Cascade Form	1
4.6	IIR Filter Structures: Direct Form,	1
4.7	Cascade Form and Parallel Form	1
4.8	Cascade Form and Parallel Form	1
	Module-5	**6 hrs**
5.1	Hardware architecture for signal processing: Harvard Architecture, pipelining, MAC	1
5.2	Introduction to TMS320C67xx digital signal processor, Functional Block Diagram and Description.	1
5.3	Finite word length effects in DSP systems: Introduction (analysis not required)	1
5.4	Fixed-point and floating-point DSP arithmetic,	1
5.5	ADC quantization noise, Round-off error	1
5.6	Finite word length effects in IIR digital filters: coefficient quantization errors	1

Simulation Assignments

The following simulations to be done in Scilab/ Matlab/ Python/GNU Octave:

1. Plot the elementary discrete time signals
2. Compute the output of an LTI system using Linear Convolution assuming

   $x(n) = \{1, 2, -1, 2\} \quad h(n) = \{1, 2, 1\}$

3. Consider a signal given by $x(n) = \{1,1,1,1\}$.
   i. Compute the DTFT of the given sequence and plot its magnitude and phase
   ii. Compute the 4 point DFT of the above signal and plot its magnitude and phase
   iii. Compare the above plots and obtain the relationship?
4. Zero pad the sequence x(n) by 4 and compute the 8-point DFT and find the corresponding magnitude and phase plots. Compare the spectra with that in (b) and comment on it.
5. The first five values of the 8 point DFT of a real valued sequence x(n) are given by {0.25, 0.125-j0.3, 0, 0.125-j0.06, 0.5}. Determine the DFT of each of the following sequences using properties. Hint :IDFT may not be computed. $i.\, x_1(n) = x((2-n))_8$ ii. $x_2(n) = x^2(n)$ iii. $x_3(n) = x(n)e^{-j\pi n4/N}$
6. A filter is described by the following difference equation

$$16y(n) + 12y(n-1) + 2y(n-2) - 4y(n-3) - y(n-4)]$$
$$= x(n) - 3x(n-1) + 11x(n-2) - 27x(n-3) + 18x(n-4)$$

i. Determine the Direct form filter structure

ii. Using the Direct form structure, obtain the cascade form filter structure

7. Simulate the following FIR filter and obtain the frequency response

$$H_d(\omega) = 1 \ for \ \frac{\pi}{4} \leq |\omega| \leq \pi$$

$$0 \ for \ |\omega| \leq \frac{\pi}{4}$$

Find the value of h(n) for N=11 and plot frequency response

Model Question Paper

A P J Abdul Kalam Technological University

Fifth Semester B Tech Degree Examination

Branch: Electronics and Computer Science Engineering

Course: ERT 301 DIGITAL SIGNAL PROCESSING

Time: 3 Hrs Max. Marks: 100

PART A

Answer All Questions. Each question carry 3 marks

1. Describe and sketch any three standard discrete time signals. (3) K1

2. Define Z-Transform. Compute the Z-Transform of $x(n) = u(n)$ (3) K2

3. Determine the frequency response of the LTI system given by the difference equation,

$y(n) = 0.15x(n) + 0.25x(n-1) + x(n-3)$. (3) K2

4. Illustrate the basic butterfly computation used in decimation in time radix-2 FFT algorithm? (3) K1

5. Explain Gibbs phenomenon.

6. Compare and Contrast IIR and FIR filters. (3) K2

7. Obtain the realization with minimum number of multipliers.

$$H(z) = \frac{1}{2} + \frac{1}{4} z^{-1} + \frac{1}{4} z^{-2} + \frac{1}{2} z^{-3}$$ (3) K3

8. Obtain the cascade-form realization of the third order IIR filter transfer function given by

$H(z) = (0.44 z^2 + 0.362 z + 0.02)/((z^2 + 0.8z + .0.5)(z - 0.4))$ (3) K3

9. Differentiate between Harvard architecture and Von-Nuemann Architecture used in processors? (3) K2

10. Describe round-off error (3) K2

PART-B

Answer any one Question from each module. Each question carries 14 Marks

11. a) Find the convolution of the following sequences using matrix multiplication method (4) K2

$x(n) = \{1, -2, 3, 1\}$ $y(n) = \{2, -3, -2\}$

b) Find the Z-transform and plot ROC of the $x(n) = a^n u(n)$ (4) K2

c) State and prove any four properties of Z transform (6) K2

OR

12. a) Define energy and power signals. Give an example for each category. (3) K2

b) A system has input - output relation given by $y(n) = nx(n)$. Determine whether the system is memoryless, causal, linear, time invariant or stable (6) K2

c) State sampling theorem? A signal is given by $x(t) = 2cos(400\pi t) + 4\cos(640\pi t)$. Determine the Nyquist sampling rate (5) K2

13. a.) The first eight points of 14-point DFT of a real valued sequence are

{12, -1+j3, 3+j4, 1-j5, -2+j2, 6+j3, -2-j3, 10}

i) Determine the remaining points

ii) Evaluate x[0] without computing the IDFT of X(k)? (4) K2

b) Compute the 4-point DFT of the sequence x(n) = {0, 2, 4, 6} using Matrix method (6) K2

c) Obtain the relation ship between DFT and Z- Transform (4) K2

OR

14. a) Explain the following properties of DFT i) Linearity ii) Complex conjugate property iii) Time Reversal (5) K2

b) Compute the 8 point DFT of x(n) = (2,1,-1,3,5,2,4,1} using radix-2 decimation in time FFT algorithm. (9) K2

15. a. Design an ideal FIR high pass filter with frequency response

$$H_d(\omega) = 1 \ for \ \frac{\pi}{4} \leq |\omega| \leq \pi$$

$$0 \ for \ |\omega| \leq \frac{\pi}{4}$$

Find the value of h(n) for N=11 (8) K3

b. Write short note on Hamming Window and Hanning Window (6) K2

OR

16. a. Design a digital Butterworth low pass filter with $\omega_p = \pi/6$ $\omega_s = \pi/4$, minimum pass band gain = -2 dB and minimum stop band attenuation = 8 dB. Use bilinear transformation. (Take T = 1 second) (10) K3

b. What is warping effect in bilinear transformation and how it can be eliminated? (4) K2

17. a) Derive and draw the direct form-I, direct form-II and cascade form realization of the given filter, whose difference equation is given as

$y(n) = 0.1\, y(n-1) + 0.2\, y(n-2) + 3\, x(n) + 3.6\, x(n-1) + 0.6\, x(n-2)$ (9) K3

b) Draw the direct form II Structure of the system given by the difference equation

$y(n) = 05.\, y(n-1) - 0.25y(n-2) + x(n) + x(n-1)$. (5) K3

OR

18.a) A filter is described by the following difference equation

$$16y(n) + 12y(n-1) + 2y(n-2) - 4y(n-3) - y(n-4)]$$
$$= x(n) - 3x(n-1) + 11x(n-2) - 27x(n-3) + 18x(n-4$$

i. Determine the Direct form filter structure

ii. Using the Direct form structure, obtain the cascade form filter structure (10) K3

b) Obtain the cascade realization of the system function

$$H(z) = 1 + \frac{5}{2} z^{-1} + 2z^{-2} + 2z^{-3}$$ (4) K3

19. a. With the help of a functional block diagram, explain the architecture of TMS320C67xx DSP processor? (10) K2

b. Describe ADC quantization noise (4) K2

OR

20. a) Explain how to minimize the effect of finite word length in IIR digital filters? (7) K2

b) Explain the roundoff error (4) K2

c) Express the fraction 7/8 and -7/8 in sign magnitude, 2's complement and 1's complement form (3) K2

CST 303	COMPUTER NETWORKS	Category	L	T	P	Credit	Year of Introduction
		PCC	3	1	0	4	2019

Preamble: Study of this course provides the learners a clear understanding of how computer networks from local area networks to the massive and global Internet are built, how they allow computers to share information and communicate with one another. This course covers the physical aspects of computer networks, layers of OSI Reference model, and inter-networking. The course helps the learners to compare and analyze the existing network technologies and choose a suitable network design for a given system.

Prerequisite: Nil

Course Outcomes: After the completion of the course, the student will be able to

CO#	Course Outcomes
CO1	Explain the features of computer networks, protocols, and network design models **(Cognitive Knowledge: Understand)**
CO2	Describe the fundamental characteristics of the physical layer and identify the usage in network communication **(Cognitive Knowledge: Apply)**
CO3	Explain the design issues of data link layer, link layer protocols, bridges and switches **(Cognitive Knowledge: Understand)**
CO4	Illustrate wired LAN protocols (IEEE 802.3) and wireless LAN protocols (IEEE 802.11) **(Cognitive Knowledge: Understand)**
CO5	Select appropriate routing algorithms, congestion control techniques, and Quality of Service requirements for a network **(Cognitive Knowledge: Apply)**
CO6	Illustrate the functions and protocols of the network layer, transport layer, and application layer in inter-networking **(Cognitive Knowledge: Understand)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓										✓
CO2	✓	✓	✓									✓
CO3	✓	✓	✓									✓
CO4	✓	✓	✓									✓
CO5	✓	✓	✓	✓								✓
CO6	✓	✓	✓			✓						✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	PO7	Environment and Sustainability
PO2	Problem Analysis	PO8	Ethics
PO3	Design/Development of solutions	PO9	Individual and teamwork
PO4	Conduct investigations of complex problems	PO10	Communication
PO5	Modern tool usage	PO11	Project Management and Finance
PO6	The Engineer and Society	PO12	Lifelong learning

Assessment Pattern

Bloom's Category	Test 1 (Marks in percentage)	Test 2 (Marks in percentage)	End Semester Examination (Marks in percentage)
Remember	40	30	30

Understand	**50**	**50**	**50**
Apply	**10**	**20**	**20**
Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	**CIE Marks**	**ESE Marks**	**ESE Duration**
150	**50**	**100**	**3**

Continuous Internal Evaluation Pattern:

Attendance : **10 marks**
Continuous Assessment Test : **25 marks**
Continuous Assessment Assignment : **15 marks**

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. The first series test shall be preferably conducted after completing the first half of the syllabus. The second series test shall be preferably conducted after completing the remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer anyone. Each question can have maximum 2 sub-divisions and carries 14 marks.

Syllabus

Module - 1 (Introduction and Physical Layer)

Introduction – Uses of computer networks, Network hardware, Network software. Reference models – The OSI reference model, The TCP/IP reference model, Comparison of OSI and TCP/IP reference models.

Physical Layer – Modes of communication, Physical topologies, Signal encoding, Repeaters and hub, Transmission media overview. Performance indicators – Bandwidth, Throughput, Latency, Queuing time, Bandwidth–Delay product.

Module - 2 (Data Link Layer)

Data link layer - Data link layer design issues, Error detection and correction, Sliding window protocols, High-Level Data Link Control(HDLC)protocol. Medium Access Control (MAC) sublayer –Channel allocation problem, Multiple access protocols, Ethernet, Wireless LANs - 802.11, Bridges & switches - Bridges from 802.x to 802.y, Repeaters, Hubs, Bridges, Switches, Routers and Gateways.

Module - 3 (Network Layer)

Network layer design issues. Routing algorithms - The Optimality Principle, Shortest path routing, Flooding, Distance Vector Routing, Link State Routing, Multicast routing, Routing for mobile hosts. Congestion control algorithms. Quality of Service (QoS) - requirements, Techniques for achieving good QoS.

Module - 4 (Network Layer in the Internet)

IP protocol, IP addresses, Internet Control Message Protocol (ICMP), Address Resolution Protocol (ARP), Reverse Address Resolution Protocol (RARP), Bootstrap Protocol (BOOTP), Dynamic Host Configuration Protocol (DHCP). Open Shortest Path First(OSPF) Protocol, Border Gateway Protocol (BGP), Internet multicasting, IPv6, ICMPv6.

Module – 5 (Transport Layer and Application Layer)

Transport service – Services provided to the upper layers, Transport service primitives. User Datagram Protocol (UDP). Transmission Control Protocol (TCP) – Overview of TCP, TCP segment header, Connection establishment &release, Connection management modeling, TCP retransmission policy, TCP congestion control.

Application Layer –File Transfer Protocol (FTP), Domain Name System (DNS), Electronic mail, Multipurpose Internet Mail Extension (MIME), Simple Network Management Protocol

(SNMP), World Wide Web(WWW) – Architectural overview.

Text Books

1. Andrew S. Tanenbaum, Computer Networks, 4/e, PHI (Prentice Hall India).
2. Behrouz A Forouzan, Data Communication and Networking, 4/e, Tata McGraw Hill

Reference Books

1. Larry L Peterson and Bruce S Dave, Computer Networks – A Systems Approach, 5/e, Morgan Kaufmann.
2. Fred Halsall, Computer Networking and the Internet, 5/e.
3. James F. Kurose, Keith W. Ross, Computer Networking: A Top-Down Approach, 6/e.
4. Keshav, An Engineering Approach to Computer Networks, Addison Wesley, 1998.
5. W. Richard Stevens. TCP/IP Illustrated Volume 1, Addison-Wesley, 2005.
6. William Stallings, Computer Networking with Internet Protocols, Prentice-Hall, 2004.
7. Request for Comments (RFC) Pages - IETF -https://www.ietf.org/rfc.html

Course Level Assessment Questions

Course Outcome1 (CO1)

1. Compare TCP/IP and OSI reference model.
2. The purpose of physical layer is to transport a raw bit stream from one machine to another. Justify.

Course Outcome2 (CO2)

1. Write the physical and transmission characteristics of Optical Fibre Cable guided transmission media.
2. The distance between the sender and receiver systems is about 200 KM. The speed of transmission is 2GB/s. Find out the propagation time?

Course Outcome3 (CO3)

1. Ethernet frames must be at least 64 bytes long to ensure that the transmitter is still going in the event of a collision at the far end of the cable. Fast Ethernet has the same 64-byte minimum frame size but can get the bits out ten times faster. How is it possible to maintain the same minimum frame size?
2. What do you mean by bit stuffing?

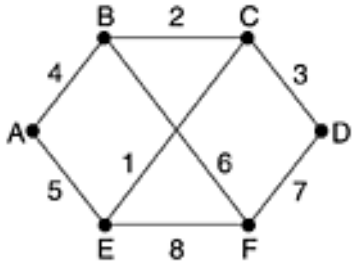
Course Outcome4 (CO4)

1. Draw and explain the frame format for Ethernet.
2. Give the differences between CSMA/CD and CSMA/CA protocol.

Course Outcome5 (CO5)

1. Consider the given subnet in which distance vector routing is used, and the vectors just come in to router C as follows: from B: (5, 0, 8, 12, 6, 2); from D: (16, 12, 6, 0, 9, 10);

and from E: (7, 6, 3, 9, 0, 4). The measured delays from C to B, D, and E, are 6, 3, and 5, respectively. What is C's new routing table? Give both the outgoing line to use and the expected delay.



2. Illustrate the leaky bucket congestion control technique.

Course Outcome 6 (CO6)

1. How do you subnet the Class C IP Address 206.16.2.0 so as to have 30 subnets. What is the subnet mask for the maximum number of hosts? How many hosts can each subnet have?
2. Give the architecture of World Wide Web.

Model Question Paper

QP CODE: **PAGES:**

Reg No:_____

Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIFTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: CST 303

Course Name : Computer Networks

Max Marks: 100 **Duration: 3 Hours**

PART-A

(Answer All Questions. Each question carries 3 marks)

1. What does "negotiation" mean when discussing network protocols in a layered architecture? Give an example.

2. Define simplex, half-duplex, and full-duplex transmission modes. Give one example for each.

3. Data link protocols almost always put the CRC in a trailer rather than in a header. Why?

4. An 8-bit byte with binary value 10101111 is to be encoded using an even-parity Hamming code. What is the binary value after encoding?

5. Illustrate the Count to Infinity problem in routing.

6. Describe two major differences between the warning bit method and the Random Early Detection (RED) method.

7. The Protocol field used in the IPv4 header is not present in the fixed IPv6 header. Why?

8. How many octets does the smallest possible IPv6 (IP version 6) datagram contain?

9. Can Transmission Control Protocol(TCP) be used directly over a network (e. g. an Ethernet) without using IP? Justify your answer.

10. When Web pages are sent out, they are prefixed by MIME headers. Why?

(10x3=30)

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11. (a) With a neat diagram, explain Open Systems Interconnection (OSI) Reference Model. **(8)**

    (b) Compare Twisted Pair, Coaxial Cable and Optical Fibre guided transmission media. **(6)**

OR

12. (a) Consider two networks providing reliable connection-oriented service. One of them offers a reliable byte stream and the other offers a reliable message stream. Are they identical? Justify your answer. **(8)**

    (b) Sketch the waveform in Manchester and Differential Manchester Encoding for the bitstream 11000110010. **(6)**

13. (a) A bit stream 10011101 is transmitted using the standard CRC method. The generator polynomial is $□^3 + 1$. Show the actual bit string transmitted. Suppose the third bit from the left is inverted during transmission. Show that this error is detected at the receiver's end. **(8)**

(b) Explain the working of High-Level Data Link Control (HDLC) protocol. **(6)**

OR

14. (a) Explain the working of IEEE 802.11 MAC sublayer. **(10)**

(b) Distinguish between Bridges and Switches. **(4)**

15. (a) Illustrate Distance Vector Routing algorithm with an example. **(8)**

(b) Explain the characteristics of Routing Information Protocol (RIP). **(6)**

OR

16. (a) A computer on a 6-Mbps network is regulated by a token bucket. The token bucket is filled at a rate of 1 Mbps. It is initially filled to capacity with 8 megabits. How long can the computer transmit at the full 6 Mbps? **(8)**

(b) Explain how routing is performed for mobile hosts. **(6)**

17. (a) Explain the address resolution problem using Address Resolution Protocol (ARP) and Reverse Address Resolution Protocol (RARP)with an example network. **(10)**

(b) A network on the Internet has a subnet mask of 255.255.240.0. What is the maximum number of hosts it can handle? **(4)**

OR

18. (a) How do you subnet the Class C IP address 195.1.1.0 so as to have 10 subnets with a maximum of 12 hosts in each subnet. **(6)**

(b) Draw IPv6 Datagram format and explain its features. **(8)**

19. (a) Distinguish the header formats of Transmission Control protocol (TCP) and User Datagram Protocol (UDP). **(8)**

(b) Explain the principal Domain Name System (DNS) resource record types for **(6)**

IPv4.

OR

20. (a) What is the role of Simple Mail Transfer Protocol (SMTP) in E- mail? **(6)**

(b) With the help of a basic model, explain the working of World Wide Web (WWW). **(8)**

Teaching Plan

No	Contents	No of Lecture Hrs
Module – 1 (Introduction and Physical Layer) (10 hrs)		
1.1	Introduction, Uses of computer networks.	1 hour
1.2	Network Hardware, Local Area Networks (LAN), Metropolitan Area Networks (MAN), Wide Area Networks (WAN), Wireless networks, Home networks, Internetworks.	1 hour
1.3	Network Software, Protocol hierarchies, Design issues for the layers.	1 hour
1.4	Connection-oriented and Connectionless services, Service primitives, Relationship of services to protocols.	1 hour
1.5	Reference models, The OSI reference model.	1 hour
1.6	The TCP/IP reference model, Comparisonof OSI and TCP/IP reference models.	1 hour
1.7	Physical layer, Modes of communication, Simplex, Half-duplex, and Full-duplex, Physical topologies, Mesh, Star, Bus, Ring, Hybrid.	1 hour
1.8	Signal encoding, Manchester, Differential Manchester.	1 hour
1.9	Transmission media overview, Guided media (twisted pair, coaxial and fiber optic media), Unguided/wireless media (radio, microwave, and infrared).	1 hour
1.10	Performance indicators, Bandwidth (in Hertz and in Bits per Seconds),	1 hour

	Throughput, Latency (Delay), Queuing time, Bandwidth-Delay product.	
Module 2 – (Data Link Layer) (10 hrs)		
2.1	Data link layer design issues.	1 hour
2.2	Error detection and correction, Error correcting codes	1 hour
2.3	Error detecting codes.	1 hour
2.4	Sliding window protocols.	1 hour
2.5	High-Level Data Link Control(HDLC) protocol.	1 hour
2.6	Medium Access Control (MAC) sublayer, Channel allocation problem, Multiple access protocols.	1 hour
2.7	Ethernet, Ethernet cabling, Manchester encoding, Ethernet MAC sublayer protocol, Binary Exponential Backoff algorithm.	1 hour
2.8	Ethernet performance, Switched Ethernet, Fast Ethernet, Gigabit Ethernet, IEEE 802.2: Logical Link Control.	1 hour
2.9	Wireless LANs, 802.11 protocol stack, Physical layer, MAC Sublayer protocol, Frame structure.	1 hour
2.10	Bridges &switches, Bridges from 802.x to 802.y, Repeaters, Hubs, Bridges, Switches, Routers, and Gateways.	1 hour
Module 3 - (Network Layer) (8 hrs)		
3.1	Network layer design issues.	1 hour
3.2	Routing algorithms, The Optimality Principle, Shortest path routing, Flooding.	1 hour
3.3	Distance Vector Routing.	1 hour
3.4	Link State Routing.	1 hour
3.5	Multicast routing, Routing for mobile hosts.	1 hour

3.6	General principles of congestion control, Congestion prevention policies, Congestion control in virtual circuit subnets.	1 hour
3.7	Congestion control algorithms, Congestion control in Datagram subnets, Load shedding, Jitter control.	1 hour
3.8	Quality of Service, Requirements, Techniques for achieving good Quality of Service.	1 hour
Module 4 – (Network Layer in the Internet) (9 hrs)		
4.1	Network layer in the Internet, Internet Protocol (IP).	1 hour
4.2	IP Addresses, Subnets, Classless Inter-Domain Routing (CIDR).	1 hour
4.3	IP Addresses, Network Address Translation (NAT).	1 hour
4.4	Internet Control Message Protocol (ICMP), Address Resolution Protocol (ARP), Reverse Address Resolution Protocol (RARP).	1 hour
4.5	Bootstrap Protocol (BOOTP), Dynamic Host Configuration Protocol (DHCP).	1 hour
4.6	Open Shortest Path First (OSPF) protocol.	1 hour
4.7	Border Gateway Protocol (BGP).	1 hour
4.8	Internet multicasting.	1 hour
4.9	IPv6, Header format, Extension headers, Internet Control Message Protocol version 6 (ICMPv6).	1 hour
Module 5 - (Transport Layer and Application Layer) (8 hrs)		
5.1	Transport Service, Services provided to the upper layers, Transport service primitives. User Datagram Protocol (UDP).	1 hour
5.2	Transmission Control Protocol (TCP), TCP segment header, Connection establishment &release, Connection management modeling.	1 hour
5.3	TCP retransmission policy, TCP congestion control.	1 hour
5.4	Application layer, File Transfer Protocol (FTP).	1 hour

5.5	Domain Name System (DNS).	1 hour
5.6	Electronic Mail, Multipurpose Internet Mail Extension (MIME).	1 hour
5.7	Simple Network Management Protocol (SNMP).	1 hour
5.8	World Wide Web, Architectural overview.	1 hour

ERT305	DATABASE MANAGEMENT SYSTEMS	CATEGORY	L	T	P	CREDIT
		PCC	3	1	0	4

Preamble: This course provides a clear understanding of fundamental principles of Database Management Systems (DBMS) with special focus on relational databases to the learners. The topics covered in this course are basic concepts of DBMS, Entity Relationship (ER) model, Relational Database principles, Relational Algebra, Structured Query Language (SQL), Physical Data Organization, Normalization and Transaction Processing Concepts. The course also gives a glimpse of the alternative data management model, NoSQL. This course helps the learners to manage data efficiently by identifying suitable structures to maintain data assets of organizations and to develop applications that utilize database technologies.

Prerequisite: Topics covered under the course Data Structures (CST 201), Exposure to a High-Level Language like C/python.

Course Outcomes: After the completion of the course the student will be able to

CO1	Summarize and exemplify fundamental nature and characteristics of database systems **(Cognitive Knowledge Level: Understand)**
CO2	Model real word scenarios given as informal descriptions, using Entity Relationship diagrams. **(Cognitive Knowledge Level: Apply**)
CO3	Model and design solutions for efficiently representing and querying data using relational model (**Cognitive Knowledge Level: Analyze**)
CO4	Demonstrate the features of indexing and hashing in database applications **(Cognitive Knowledge Level: Apply**)
CO5	Discuss and compare the aspects of Concurrency Control and Recovery in Database systems **(Cognitive Knowledge Level: Apply**)
CO6	Explain various types of NoSQL databases (**Cognitive Knowledge Level: Understand**)

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓									✓
CO2	✓	✓	✓	✓								✓
CO3	✓	✓	✓	✓								✓
CO4	✓	✓	✓							✓		✓
CO5	✓	✓	✓							✓		✓
CO6	✓	✓	✓		✓					✓		✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Lifelong learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks (%)
	Test1 (%)	Test2 (%)	
Remember	30	30	30
Understand	40	40	40
Apply	30	30	30

Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	**50**	**100**	**3 hours**

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Tests : 25 marks

Continuous Assessment Assignment : 15 marks

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks

First Internal Examination shall be preferably conducted after completing the first half of the syllabus and the Second Internal Examination shall be preferably conducted after completing remaining part of the syllabus.

There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly covered module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly covered module), each with 7 marks. Out of the 7 questions in Part B, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

Syllabus

Module 1: Introduction & Entity Relationship (ER) Model

Concept & Overview of Database Management Systems (DBMS) - Characteristics of Database system, Database Users, structured, semi-structured and unstructured data. Data Models and Schema - Three Schema architecture. Database Languages, Database architectures and classification.

ER model - Basic concepts, entity set & attributes, notations, Relationships and constraints, cardinality, participation, notations, weak entities, relationships of degree 3.

Module 2: Relational Model

Structure of Relational Databases - Integrity Constraints, Synthesizing ER diagram to relational schema

Introduction to Relational Algebra - select, project, cartesian product operations, join - Equi-join, natural join. query examples, introduction to Structured Query Language (SQL), Data Definition Language (DDL), Table definitions and operations – CREATE, DROP, ALTER, INSERT, DELETE, UPDATE.

Module 3: SQL DML (Data Manipulation Language), Physical Data Organization

SQL DML (Data Manipulation Language) - SQL queries on single and multiple tables, Nested queries (correlated and non-correlated), Aggregation and grouping, Views, assertions, Triggers, SQL data types.

Physical Data Organization - Review of terms: physical and logical records, blocking factor, pinned and unpinned organization. Heap files, Indexing, Singe level indices, numerical examples, Multi-level-indices, numerical examples, B-Trees & B+-Trees (structure only, algorithms not required), Extendible Hashing, Indexing on multiple keys – grid files.

Module 4: Normalization

Different anomalies in designing a database, the idea of normalization, Functional dependency, Armstrong's Axioms (proofs not required), Closures and their computation, Equivalence of Functional Dependencies (FD), Minimal Cover (proofs not required). First Normal Form (1NF), Second Normal Form (2NF), Third Normal Form (3NF), Boyce Codd Normal Form (BCNF), Lossless join and dependency preserving decomposition, Algorithms for checking Lossless Join (LJ) and Dependency Preserving (DP) properties.

Module 5: Transactions, Concurrency and Recovery, Recent Topics

Transaction Processing Concepts - overview of concurrency control, Transaction Model, Significance of concurrency Control & Recovery, Transaction States, System Log, Desirable Properties of transactions.
Serial schedules, Concurrent and Serializable Schedules, Conflict equivalence and conflict serializability, Recoverable and cascade-less schedules, Locking, Two-phase locking and its variations. Log-based recovery, Deferred database modification, check-pointing.

Introduction to NoSQL Databases, Main characteristics of Key-value DB (examples from: Redis), Document DB (examples from: MongoDB)

Main characteristics of Column - Family DB (examples from: Cassandra) and Graph DB (examples from : ArangoDB)

Text Books

1. Elmasri R. and S. Navathe, Database Systems: Models, Languages, Design and Application Programming, Pearson Education, 2013.
2. Sliberschatz A., H. F. Korth and S. Sudarshan, Database System Concepts, 6/e, McGraw Hill, 2011.

Reference Books:

1. Adam Fowler, NoSQL for Dummies, John Wiley & Sons, 2015
2. NoSQL Data Models: Trends and Challenges (Computer Engineering: Databases and Big Data), Wiley, 2018
3. Web Resource: https://www.w3resource.com/redis/
4. Web Resource: https://www.w3schools.in/category/mongodb/
5. Web Resource: https://www.tutorialspoint.com/cassandra/cassandra_introduction.htm
6. Web Resource : https://www.tutorialspoint.com/arangodb/index.htm

Sample Course Level Assessment Questions

Course Outcome1 (CO1):

1. List out any three salient features of database systems, which distinguish it from a file system.
2. Give one example each for logical and physical data independence.

Course Outcome 2(CO2):

1. What facts about the relationships between entities EMPLOYEE and PROJECT are conveyed by the following ER diagram?



2. Design an ER diagram for the following scenario:
   There is a set of teams, each team has an ID (unique identifier), name, main stadium, and to which city this team belongs. Each team has many players, and each player belongs to one team. Each player has a number (unique identifier), name, DoB, start year, and shirt number that he uses. Teams play matches, in each match there is a host team and a guest team.

Course Outcome 3(CO3):

1. For the SQL query, SELECT *A, B FROM R WHERE B='apple' AND C = 'orange'* on the table R(A, B, C, D), where A is a key, write any three equivalent relational algebra expressions.
2. Given the FDs P→Q, P→R, QR→S, Q→T, QR→U, PR→U, write the sequence of *Armstrong's Axioms* needed to arrive at the following FDs: (a) P → T (b) PR → S (c) QR → SU
3. Consider a relation PLAYER (PLAYER-NO, PLAYER-NAME, PLAYER-POSN, TEAM, TEAM-COLOR, COACH-NO, COACH-NAME, TEAM-CAPTAIN). Assume that PLAYER-NO is the *only* key of the relation and that the following dependencies hold: TEAM→{TEAM-COLOR, COACH-NO, TEAM-CAPTAIN}COACH-NO→COACH-NAME.
   i) Is the relation in 2NF? If not, decompose to 2NF.
   ii) Is the relation in 3NF? If not, decompose to 3NF.

4. In the following tables foreign keys have the same name as primary keys except DIRECTED-BY, which refers to the primary key ARTIST-ID. Consider only *single-director* movies.

MOVIES(MOVIE-ID, MNAME, GENRE, LENGTH, DIRECTED-BY)
ARTIST(ARTIST-ID, ANAME)
ACTING(ARTIST-ID, MOVIE-ID)

Write SQL expressions for the following queries:

(a) *Name(s) and director name(s) of movie(s) acted by 'Jenny'.*
(b) *Names of actors who have never acted with 'Rony'*
(c) *Count of movies genre-wise.*
(d) *Name(s) of movies with maximum length.*

Course Outcome 4(CO4):

1. Consider an EMPLOYEE file with 10000 records where each record is of size 80 bytes. The file is sorted on employee number (15 bytes long), which is the primary key. Assuming un-spanned organization, block size of 512 bytes and block pointer size of 5 bytes. Compute the number of block accesses needed for retrieving an employee record based on employee number if (i) No index is used (ii) Multi-level primary index is used.

Course Outcome 5(CO5):

1. Determine if the following schedule is *recoverable*. Is the schedule *cascade-less*? Justify your answer. *r1(X), r2(Z), r1(Z), r3(X), r3(Y), w1(X), c1, w3(Y), c3, r2(Y), w2(Z), w2(Y), c2*. (*Note: ri(X)/wi(X)* means transaction *Ti* issues read/write on item X; *ci* means transaction *Ti* commits.)
2. Two-phase locking protocol ensures serializability. Justify.

Course Outcome 6(CO6):

1. List out any three salient features of NoSQL databases. Give example of a document in MongoDB.

Model Question paper

QPCODE

Reg No:_____

Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIFTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: ERT 305

Course Name: **Database Management Systems**

Max.Marks:100 **Duration: 3 Hours**

PART A

Answer all Questions. Each question carries 3 Marks

1 List out any three salient features of a database systems.

2 When is multi-valued composite attribute used in ER modelling?

3 For the SQL query, SELECT *A, B FROM R WHERE B='apple' AND C = 'orange'* on the table R(A, B, C, D), where A is a key, write any two equivalent relational algebra expressions.

4 Outline the concept of *theta*-join.

5 How is the purpose of *where* clause is different from that of having clause?

6 What is the use of a trigger?

7 When do you say that a relation is not in 1NF?

8 Given the FDs P→Q, P→R, QR→S, Q→T, QR→U, PR→U, write the sequence of Armstrong's Axioms needed to arrive at a. P → T b. PR → S

9 What is meant by the lost update problem?

10 What is meant by check pointing?

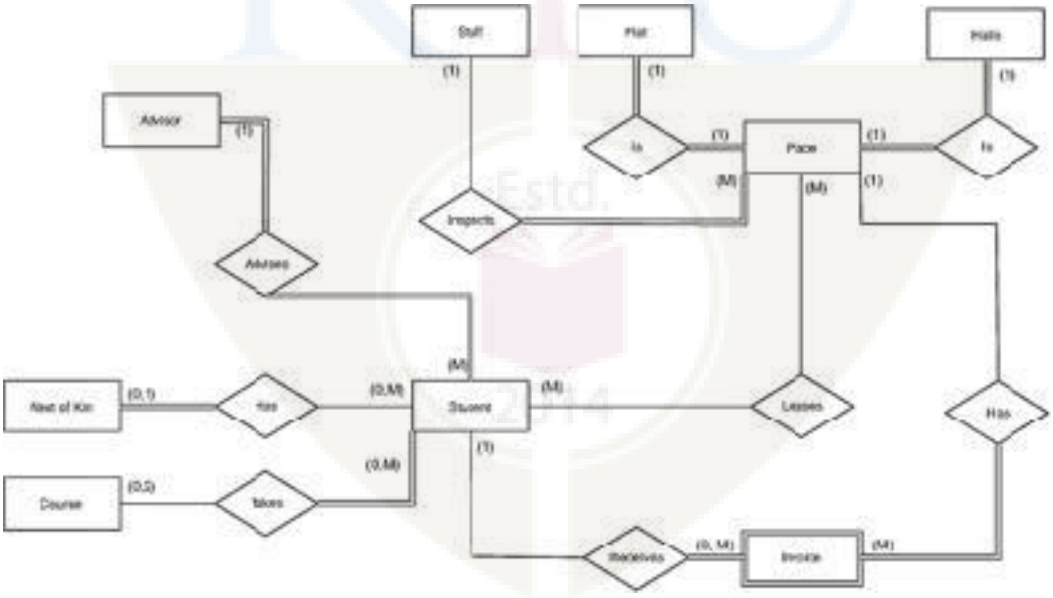
PART B

Answer any one Question from each module. Each question carries 14 Marks (14)

11 a. Design an ER diagram for the following scenario: There is a set of teams, each team has an ID (unique identifier), name, main stadium, and to which city this team belongs. Each team has many players, and each player belongs to one team. Each player has a number (unique identifier), name, DoB, start year, and shirt number that he uses. Teams play matches, in each match there is a host team and a guest team. The match takes place in the stadium of the host team. For each match we need to keep track of the following: The date on which the game is played The final result of the match. The players participated in the match. For each player, how many goals he scored, whether or not he took yellow card, and whether or not he took red card. During the match, one player may substitute another player. We want to capture this substitution and the time at which it took place. Each match has exactly three referees. For each referee we have an ID (unique identifier), name, DoB, years of experience. One referee is the main referee and the other two are assistant referee.

OR

12 a. Interpret the the following ER diagram. (8)



b. Distinguish between physical data independence and logical data independence with suitable examples. (6)

13 EMPLOYEE(ENO, NAME, ADDRESS, DOB, AGE, GENDER, SALARY, DNUM, SUPERENO) (14)

DEPARTMENT(DNO, DNAME, DLOCATION, DPHONE, MGRENO)

PROJECT(PNO, PNAME, PLOCATION, PCOST, CDNO)

DNUM is a foreign key that identifies the department to which an employeebelongs. MGRENO is a foreign key identifying the employee who manages the department. CDNO is a foreign key identifying the department that controls the project. SUPERENO is a foreign key identifying the supervisor of each employee.

Write relational algebra expressions for the following queries:-

(a) Names of female employees whose salary is more than 20000.
(b) Salaries of employee from 'Accounts' department
(c) Names of employees along with his/her supervisor's name
(d) For each employee return name of the employee along with his department name and the names of projects in which he/she works
(e) Names of employees working in all the departments

OR

14 a. Write SQL DDL statements for the following (Assume suitable domain types): (10)

i. Create the tables STUDENT(ROLLNO, NAME, CLASS, SEM, ADVISER), FACULTY(FID, NAME, SALARY, DEPT). Assume that ADVISER is a foreign key referring FACUTY table.

ii. Delete department with name 'CS' and all employees of the department.

iii. Increment salary of every faculty by 10%.

b. Illustrate foreign key constraint with a typical example. (4)

15 For the relation schema below, give an expression in SQL for each of the queries that follows: (14)

employee(employee-name, street, city)
works(employee-name, company-name, salary)
company(company-name, city)
manages(employee-name, manager-name)

a) Find the names, street address, and cities of residence for all employees who work for the Company 'RIL Inc.' and earn more than $10,000.
b) Find the names of all employees who live in the same cities as the companies for which they work.
c) Find the names of all employees who do not work for 'KYS Inc.'. Assume that all people work for exactly one company.
d) Find the names of all employees who earn more than every employee of 'SB Corporation'. Assume that all people work for at most one company.
e) List out number of employees company-wise in the decreasing order of number of employees.

OR

16 a. Consider an EMPLOYEE file with 10000 records where each record is of size 80 bytes. The file is sorted on employee number (15 bytes long), which is the primary key. Assuming un-spanned organization and block size of 512 bytes compute the number of block accesses needed for selecting records based on employee number if, (9)

i. No index is used
ii. Single level primary index is used
iii. Multi-level primary index is used

Assume a block pointer size of 6 bytes.

b. Illustrate correlated and non-correlated nested queries with real examples. (5)

17 a.Illstrate3NF and BCNF with suitable real examples. (6)

b. Given a relation R(A1,A2,A3,A4,A5) with functional dependencies A1→A2A4 and A4→A5, check if the decomposition R1(A1,A2,A3), R2(A1,A4), R3(A2,A4,A5) is lossless. (8)

OR

18 a. Consider the un-normalized relation R(A, B, C, D, E, F, G) with the FDs A→B , AC→G, AD→EF, EF→G, CDE→AB. Trace the normalization process to reach 3NF relations. (7)

b. Illustrate Lossless Join Decomposition and Dependency Preserving Decomposition with typical examples. (7)

19 a. Discuss the four ACID properties and their importance. (7)

b. Determine if the following schedule is conflict serializable. Is the schedule recoverable? Is the schedule cascade-less? Justify your answers. (7)

r1(X), r2(Z), r1(Z), r3(X), r3(Y), w1(X), c1, w3(Y), c3, r2(Y), w2(Z), w2(Y), c2

(Note: ri(X)/wi(X) means transaction Ti issues read/write on item X; ci means transaction Ti commits.)

OR

20 a. Discuss the main characteristics of Key-value DB and Graph DB. (7)

b. Illustrate two-phase locking with a schedule containing three transactions. Argue that 2PL ensures serializability. Also argue that 2Pl can lead to deadlock. (7)

Teaching Plan

	Course Name	Hours (48)
	Module 1: Introduction & ER Model	**8**
1.1	Concept & Overview of DBMS, Characteristics of DB system, Database Users.	1
1.2	Structured, semi-structured and unstructured data. Data Models and Schema	1
1.3	Three-Schema-architecture. Database Languages	1
1.4	Database architectures and classification	1
1.5	ER model: basic concepts, entity set & attributes, notations	1
1.6	Relationships and constraints – cardinality, participation, notations	1
1.7	Weak entities, relationships of degree 3	1
1.8	ER diagram – exercises	1
	Module 2: Relational Model	**7**
2.1	Structure of relational Databases, Integrity Constraints	1
2.2	Synthesizing ER diagram to relational schema, Introduction to relational algebra.	1
2.3	Relational algebra: select, project, Cartesian product operations	1
2.4	Relational Algebra: join - Equi-join, Natural join	1
2.5	Query examples	1
2.6	Introduction to SQL, important data types	1
2.7	DDL, Table definitions and operations – CREATE, DROP, ALTER, INSERT, DELETE, UPDATE	1
	Module 3: SQL DML, Physical Data Organization	**11**
3.1	SQL DML, SQL queries on single and multiple tables	1
3.2	Nested queries (correlated and non-correlated)	1
3.3	Aggregation and grouping	1

	Course Name	Hours (48)
3.4	Views, assertions (with examples)	1
3.5	Triggers (with examples), SQL data types	1
3.6	Review of terms: physical and logical records, blocking factor, pinned and unpinned organization. Heap files, Indexing	1
3.7	Singe level indices, numerical examples	1
3.8	Multi-level-indices, numerical examples	1
3.9	B-Trees and B+Trees (structure only, algorithms not required)	1
3.10	Extendible Hashing	1
3.11	Indexing on multiple keys – grid files	1
	Module 4: Normalization	**8**
4.1	Different anomalies in designing a database, The idea of normalization	1
4.2	Functional dependency, Armstrong's Axioms (proofs not required)	1
4.3	Closures and their computation, Equivalence of FDs, minimal Cover (proofs not required).	1
4.4	1NF, 2NF	1
4.5	3NF, BCNF	1
4.6	Lossless join and dependency preserving decomposition	1
4.7	Algorithms for checking Lossless Join and Dependency preserving properties (Lecture 1)	1
4.8	Algorithms for checking Lossless Join and Dependency preserving properties (Lecture 2)	1
	Module 5: Transactions, Concurrency and Recovery, Recent Topics	**14**
5.1	Transaction Processing Concepts: Transaction Model	1
5.2	Overview of concurrency control, Significance of concurrency Control & Recovery	1
5.3	Transaction States, System Log	1

	Course Name	Hours (48)
5.4	Desirable Properties of transactions, Serial schedules	1
5.5	Concurrent and Serializable Schedules	1
5.6	Conflict equivalence and conflict serializability	1
5.7	Recoverable and cascade-less schedules	1
5.8	Locking, Two-phase locking, strict 2PL.	1
5.9	Log-based recovery	1
5.10	Deferred database modification (serial schedule), example	1
5.11	Deferred database modification (concurrent schedule) example, check-pointing	1
5.12	Introduction to NoSQL Databases	1
5.13	Main characteristics of Key-value DB (examples from: Redis), Document DB (examples from: MongoDB) [detailed study not expected]	1
5.14	Main characteristics of Column-Family DB (examples from: Cassandra) and Graph DB (examples from : ArangoDB) [detailed study not expected]	1

ERT307	MICROPROCESSORS AND ADVANCED MICROCONTROLLERS	Category	L	T	P	Credit
		PCC	3	1	0	4

Preamble: The course enables the learners capable of understanding the fundamental architecture of microprocessors and micro controllers. This course focuses on the architecture, assembly language programming, interrupt handling and its programming. It helps the learners to extend the study of latest processors and develop hardware-based solutions.

Prerequisite: Sound knowledge in Digital System Design and Computer organization & architecture.

Course Outcomes: After the completion of the course the student will be able to:

CO#	Course Outcomes
CO1	Illustrate the **architecture**, modes of operation and addressing modes of microprocessors **(Cognitive knowledge: Understand)**
CO2	Develop 8086 **assembly** language programs. **(Cognitive Knowledge Level: Apply**)
CO3	Demonstrate **interrupts**, its handling and programming in 8086. **(Cognitive KnowledgeLevel: Apply**)
CO4	Outline features of **microcontrollers** and develop low level programs. **(Cognitive Knowledge Level: Understand)**
CO5	Describe the building blocks of RISC processors and ARM microcontrollers. **(CognitiveKnowledge Level: Understand)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓									✓
CO2	✓	✓	✓	✓								✓
CO3	✓	✓	✓	✓								✓
CO4	✓	✓	✓	✓								✓
CO5	✓	✓	✓	✓								✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination Marks (%)**
	Test1 (%)	**Test2 (%)**	
Remember	**20**	**20**	**20**
Understand	**40**	**40**	**40**
Apply	**40**	**40**	**40**
Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	**CIE Marks**	**ESE Marks**	**ESE Duration**
150	**50**	**100**	**3 hours**

Continuous Internal Evaluation Pattern:

Attendance	:	**10 marks**
Continuous Assessment Tests	:	**25 marks**
Continuous Assessment Assignment	:	**15 marks**

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks

First Internal Examination shall be preferably conducted after completing the first half of the syllabus and the Second Internal Examination shall be preferably conducted after completing remaining part of the syllabus.

There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly covered module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly covered module), each with 7 marks. Out of the 7 questions in Part B, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

Syllabus

Module-1: Evolution of microprocessors

8085 microprocessor (Basic Architecture only). 8086 microprocessor – Architecture and signals, Physical Memory organization, Minimum and maximum mode of 8086 system and timings. Comparison of 8086 and 8088.Machine language Instruction format.

Module-2: Addressing modes and instructions

Addressing Modes of 8086. Instruction set – data copy /transfer instructions, arithmetic instructions, logical instructions, string manipulation instructions, branch instructions, unconditional and conditional branch instruction, flag manipulation and processor control instructions. Assembler Directives and operators. Assembly Language Programming with 8086.

Module- 3: Stack and interrupts

Stack structure of 8086, programming using stack- Interrupts - Types of Interrupts and

Interrupt Service Routine- Handling Interrupts in 8086- Interrupt programming. - Programmable Interrupt Controller - 8259, Architecture (Just mention the control word, no need to memorize the control word)- Interfacing Memory with 8086.

Module- 4: Microcontrollers

8051 Architecture- Register Organization- Memory and I/O addressing- Interrupts and Stack- 8051 Addressing Modes- Instruction Set- data transfer instructions, arithmetic instructions, logical instructions, Boolean instructions, control transfer instructions- Simple programs.

Module- 5: ARM Based System

ARM processor fundamentals – Registers, Current Program Status Register, Pipeline, Exceptions, Interrupts, and the Vector Table, Core Extensions, Architecture Revisions.

Introduction to ARM family, ARM7 register architecture, ARM programmer's model. Raspberry pi 4 board - Introduction and brief description.

Text Books

1. Bhurchandi and Ray, Advanced Microprocessors and Peripherals, Third Edition McGraw Hill, 2012.
2. Raj kamal, microcontrollers: architecture, programming, interfacing and system design, Second Edition,2011, Pearson education.
3. Ramesh Gaonkar, Microprocessor Architecture, Programming, and Applications with the 8085, Sixth Edition, 2013, Penram International Publishing Pvt. Ltd.
4. ARM System - on-chip Architecture, Steve Furber, Second Edition, 2001, Pearson Education.
5. Andrew N. Sloss, Dominic Symes, Chris Wright, "ARM System Developer's guide", Morgan Kaufman,2004.

Reference Books

1. Barry B. Brey, The Intel Microprocessors – Architecture, Programming and Interfacing, Eighth Edition, 2008, Pearson Education.
2. A. NagoorKani, Microprocessors and Microcontrollers, Second Edition, 2012 , TataMcGraw Hill.

Sample Course Level Assessment Questions

Course Outcome1 (CO1):

1) Describe how pipelining is implemented in 8086 microprocessor
2) Illustrate maximum mode signals in 8086.

Course Outcome 2(CO2):

1) Write an 8086 assembly language program for sorting a sequence of N, 8 bit numbers. Describe the modifications that can be done on the above program so that it will sort N, 16 bit numbers. Rewrite the program with those modifications also.

Course Outcome 3 (CO3):

1) Design an interface between 8086 CPU and two chips of 16 x 8 EPROM and

two chips of 32K x 8 RAM. Select the starting address of EPROM suitably. The RAM address must start at 00000H.

2) Give the sequence of instructions for setting the IVT for interrupt type 23H. Assume the Interrupt Service Routine, is present in the code segment named CODE.

3) Describe the role of Interrupt Request register and In service register in 8259.

Course Outcome 4(CO4):

1) Write an 8051 assembly language program to count the number of 1's and 0's in a given 8 bit number

2) Write an 8051 assembly language program for computing the square root of an 8 bit number.

Course Outcome 5(CO5):

1) Differentiate between ARM9 five stage pipeline and ARM10 six stage pipeline.
2) What are the different features of ARM instruction set that make it suitable for embedded applications.

Model Question Paper

QP CODE:

Reg No: _____

Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIFTH SEMESTER B.TECH. DEGREE EXAMINATION, MONTH & YEAR

Course Code: ERT 307

Course Name: Microprocessors and Advanced Microcontrollers

Max.Marks:100 **Duration: 3 Hours**

PART A

Answer All Questions. Each Question Carries 3 Marks **(10x3=30)**

1. Describe the functions of following signals in 8086
   a)NMI b)ALE
2. List any three differences between 8085 and 8086 microprocessors.
3. Assume AL register is having the value 7FH. What will be the content of AL after the following instructions are executed
   a)ROR AL,01 b)SAR AL,01
4. Specify the use of following assembler directives - EQU, EVEN
5. Differentiate between maskable and non maskable interrupts?
6. Define Interrupt Service Routine? How to find the address of the ISR corresponding to a given interrupt in 8086?
7. Differentiate between indirect and indexed addressing modes in 8051.
8. Write the sequence of 8051 instructions to store any two numbers at twoconsecutive locations 70H and 71H, multiply them and store the result in location 72H.
9. Give 5 features of ARM processors.
10. What is current program status register.

PART B

(Answer any one question from each module. Each question carries 14 Marks)

11. (a) Specify the significance of segmentation and how it is implemented in 8086 **(5)**

(b) Explain the maximum mode signals in 8086. **(9)**

OR

12. (a) Write down the differences between 8086 and 8088 processors **(4)**

(b) Explain the physical memory organization of 8086 with a neat diagram. How does the 8086 processor access a word from an odd memory location? How many memory cycles does it take? **(10)**

13. (a) Write an 8086-assembly language program for finding the sum of the squares of first N natural numbers. Calculate the squares of each number using a subroutine SQUARE. **(10)**

(b) Describe any four control transfer instructions in 8086. **(4)**

OR

14. (a) Write an 8086 assembly language program for printing the reverse of a given input string. **(5)**

(b) Explain the addressing modes for sequential control flow instructions in 8086. **(9)**

15. (a) Give the stack structure of 8086. **(5)**

(b) Explain the architecture of 8259 with diagram **(9)**

OR

16. (a) Interface 32Kx8 RAM using four numbers of 8Kx8 memory chips and 16Kx8 ROM using two numbers of 8Kx8 EPROM chips. The address map is given as RAM starts at 00000H and ROM ends at FFFFFH **(10)**

(b) Describe the predefined interrupts in 8086 **(4)**

17. Explain the architecture of 8051 microcontroller. **(9)**

(b) Write an 8051-assembly language program for adding two matrices whose elements are stored sequentially in some memory location. Assume suitable locations. **(5)**

OR

18. (a) Explain the internal data memory organization of 8051. **(9)**

(b) Describe the control transfer instructions of 8051 microcontroller. **(5)**

19. (a) Draw the ARM-7 register architecture and explain**.** **(7)**

(b) Draw and explain the programming model of an ARM processor. **(7)**

OR

20. Draw the architectural block diagram of ARM and explain data flow referring each unit. **(14)**

Teaching Plan

No	Contents	Hours (45)
Module 1 : (Evolution of microprocessors) (9 hours)		
1.1	Overview of 8085 microprocessor	1 hour
1.2	Architecture of8085	1 hour
1.3	Architecture of 8086	1hour
1.4	Signals in 8086	1hour
1.5	Physical Memory organization	1hour
1.6	Minimum and maximum mode 8086 system and timings (Lecture 1)	1hour
1.7	Minimum and maximum mode 8086 system and timings (Lecture 2)	1hour
1.8	Comparison of 8086 and 8088	1hour
1.9	Machine language Instruction format	1hour
Module 2 :(Programming of 8086) (9 hours)		
2.1	Addressing Modes of 8086	1 hour
2.2	Instruction set – data copy/transfer instructions	1hour
2.3	arithmetic instructions, logical instructions	1hour
2.4	string manipulation instructions, branch instructions	1hour
2.4	unconditional and conditional branch instruction	1hour
2.5	flag manipulation and processor control instructions	1hour
2.6	Assembler Directives and operators	1hour
2.7	Assembly Language Programming with 8086(Lecture 1)	1hour
2.8	Assembly Language Programming with 8086(Lecture 2)	1hour
2.9	Assembly Language Programming with 8086(Lecture 3)	1hour
Module 3 : (Stack and Interrupts) (9 hours)		
3.1	Stack structure of 8086, programming using stack.	1hour
3.2	Types of Interrupts and Interrupt Service Routine.	1hour
3.3	Handling Interrupts in 8086(Lecture 1)	1hour
3.4	Handling Interrupts in 8086(Lecture 2)	1hour

3.5	Interrupt programming.	1hour
3.6	Programmable Interrupt Controller -8259 (Lecture 1)	1hour
3.7	Programmable Interrupt Controller -8259 (Lecture 2)	1hour
3.8	Interfacing Memory with 8086 (Lecture 1)	1hour
3.9	Interfacing Memory with 8086 (Lecture 2)	1hour
Module 4 :(Interfacing chips) (11 hours)		
4.1	8051 Architecture (Lecture 1)	1hour
4.2	8051 Architecture (Lecture 2)	1hour
4.3	Register Organization, Memory and I/O addressing	1hour
4.4	Interrupts and Stack	1hour
4.5	Addressing Modes	1hour
4.6	Data transfer instructions, Arithmetic instructions	1hour
4.7	Logical instructions,	1hour
4.8	Boolean instructions	1hour
4.9	Control transfer instructions	1hour
4.10	Programming of 8051 (Lecture 1)	1hour
4.11	Programming of 8051(Lecture 2)	1hour
Module 5 : (Microcontrollers) (7 hours)		
5.1	ARM processor fundamentals – Registers	1hour
5.2	Current Program Status Register, Pipeline	1hour
5.3	Exceptions, Interrupts, and the Vector Table	1hour
5.4	Core Extensions, Architecture Revisions.	1hour
5.5	Introduction to ARM family, ARM7 register architecture	1hour
5.6	ARM programmer's model.	1hour
5.7	Raspberry pi 4 board - Introduction and brief description.	1hour

CST 309	MANAGEMENT OF SOFTWARE SYSTEMS	Category	L	T	P	Credit	Year of Introduction
		PCC	3	0	0	3	2019

Preamble: This course provides fundamental knowledge in the Software Development Process. It covers Software Development, Quality Assurance, Project Management concepts and technology trends. This course enables the learners to apply state of the art industry practices in Software development.

Prerequisite: Basic understanding of Object Oriented Design and Development.

Course Outcomes: After the completion of the course the student will be able to

CO1	Demonstrate Traditional and Agile Software Development approaches **(Cognitive Knowledge Level: Apply)**
CO2	Prepare Software Requirement Specification and Software Design for a given problem. **(Cognitive Knowledge Level**: **Apply**)
CO3	Justify the significance of design patterns and licensing terms in software development, prepare testing, maintenance and DevOps strategies for a project. **(Cognitive Knowledge Level: Apply**)
CO4	Make use of software project management concepts while planning, estimation, scheduling, tracking and change management of a project, with a traditional/agile framework**. (Cognitive Knowledge Level: Apply**)
CO5	Utilize SQA practices, Process Improvement techniques and Technology advancements in cloud based software models and containers & microservices. **(Cognitive Knowledge Level: Apply**)

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓		✓						✓
CO2	✓	✓	✓	✓		✓				✓	✓	✓
CO3	✓	✓	✓	✓				✓		✓	✓	✓
CO4	✓	✓	✓	✓		✓			✓	✓	✓	✓
CO5	✓	✓	✓	✓		✓						✓

	Abstract POs defined by National Board of Accreditation		
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Lifelong learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks
	Test1 (Percentage)	Test2 (Percentage)	
Remember	**30**	**30**	**30**
Understand	**40**	**40**	**50**
Apply	**30**	**30**	**20**
Analyse			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	**50**	**100**	**3 hours**

Continuous Internal Evaluation Pattern:

Attendance : **10 marks**

Continuous Assessment Tests : **25 marks**

Continuous Assessment Assignment : **15 marks** (Each student shall identify a software development problem and prepare Requirements Specification, Design Document, Project Plan and Test case documents for the identified problem as the assignment.)

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks.

First Internal Examination shall be preferably conducted after completing the first half of the syllabus and the Second Internal Examination shall be preferably conducted after completing the remaining part of the syllabus.

There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly covered module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly covered module), each with 7 marks. Out of the 7 questions in Part B, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have a maximum of 2 subdivisions and carries 14 marks.

Syllabus

Module 1 : Introduction to Software Engineering (7 hours)

Introduction to Software Engineering - Professional software development, Software engineering ethics. Software process models - The waterfall model, Incremental development. Process activities - Software specification, Software design and implementation, Software validation, Software evolution. Coping with change - Prototyping, Incremental delivery, Boehm's Spiral Model. Agile software development - Agile methods, agile manifesto - values and principles. Agile development techniques, Agile Project Management. Case studies : An insulin pump control system. Mentcare - a patient information system for mental health care.

Module 2 : Requirement Analysis and Design (8 hours)

Functional and non-functional requirements, Requirements engineering processes. Requirements elicitation, Requirements validation, Requirements change, Traceability Matrix. Developing use cases, Software Requirements Specification Template, Personas, Scenarios, User stories, Feature identification. Design concepts - Design within the context of software engineering, Design Process, Design concepts, Design Model. Architectural Design - Software Architecture, Architectural Styles, Architectural considerations, Architectural Design Component level design - What is a component?, Designing Class-Based Components, Conducting Component level design, Component level design for web-apps. Template of a Design Document as per “IEEE Std 1016-2009 IEEE Standard for Information Technology Systems Design Software Design Descriptions”. Case study: The Ariane 5 launcher failure.

Module 3 : Implementation and Testing (9 hours)

Object-oriented design using the UML, Design patterns, Implementation issues, Open-source development - Open-source licensing - GPL, LGPL, BSD. Review Techniques - Cost impact of Software Defects, Code review and statistical analysis. Informal Review, Formal Technical Reviews, Post-mortem evaluations. Software testing strategies - Unit Testing, Integration Testing, Validation testing, System testing, Debugging, White box testing, Path testing, Control Structure testing, Black box testing, Testing Documentation and Help facilities. Test automation, Test-driven development, Security testing. Overview of DevOps and Code Management - Code management, DevOps automation, Continuous Integration, Delivery, and Deployment (CI/CD/CD). Software Evolution - Evolution processes, Software maintenance.

Module 4 : Software Project Management (6 hours)

Software Project Management - Risk management, Managing people, Teamwork. Project Planning, Software pricing, Plan-driven development, Project scheduling, Agile planning. Estimation techniques, COCOMO cost modeling. Configuration management, Version management, System building, Change management, Release management, Agile software management - SCRUM framework. Kanban methodology and lean approaches.

Module 5 : Software Quality, Process Improvement and Technology trends (6 hours)

Software Quality, Software Quality Dilemma, Achieving Software Quality Elements of Software Quality Assurance, SQA Tasks , Software measurement and metrics. Software Process Improvement(SPI), SPI Process CMMI process improvement framework, ISO 9001:2000 for Software. Cloud-based Software - Virtualisation and containers, Everything as a service(IaaS, PaaS), Software as a service. Microservices Architecture - Microservices, Microservices architecture, Microservice deployment.

Text Books

1. Book 1 - Ian Sommerville, Software Engineering, Pearson Education, Tenth edition, 2015.
2. Book 2 - Roger S. Pressman, Software Engineering : A practitioner’s approach, McGraw Hill publication, Eighth edition, 2014
3. Book 3 - Ian Sommerville, Engineering Software Products: An Introduction to Modern Software Engineering, Pearson Education, First Edition, 2020.

References

1. IEEE Std 830-1998 - IEEE Recommended Practice for Software Requirements SpeciÞcations
2. IEEE Std 1016-2009 IEEE Standard for Information Technology—Systems Design—Software Design Descriptions

3. David J. Anderson, Kanban, Blue Hole Press 2010
4. David J. Anderson, Agile Management for Software Engineering, Pearson, 2003
5. Walker Royce, Software Project Management : A unified framework, Pearson Education, 1998
6. Steve. Denning, The age of agile, how smart companies are transforming the way work gets done. New York, Amacom, 2018.
7. Satya Nadella, Hit Refresh: The Quest to Rediscover Microsoft's Soul and Imagine a Better Future for Everyone, Harper Business, 2017
8. Henrico Dolfing, Project Failure Case Studies: Lessons learned from other people's mistakes, Kindle edition
9. Mary Poppendieck, Implementing Lean Software Development: From Concept to Cash, Addison-Wesley Signature Series, 2006
10. StarUML documentation - https://docs.staruml.io/
11. OpenProject documentation - https://docs.openproject.org/
12. BugZilla documentation - https://www.bugzilla.org/docs/
13. GitHub documentation - https://guides.github.com/
14. Jira documentation - https://www.atlassian.com/software/jira

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. What are the advantages of an incremental development model over a waterfall model?
2. Illustrate how the process differs in agile software development and traditional software development with a socially relevant case study. (Assignment question)

Course Outcome 2 (CO2):

1. How to prepare a software requirement specification?
2. Differentiate between Architectural design and Component level design.
3. How does agile approaches help software developers to capture and define the user requirements effectively?
4. What is the relevance of the SRS specification in software development?
5. Prepare a use case diagram for a library management system.

Course Outcome 3 (CO3):

1. Differentiate between the different types of software testing strategies.
2. Justify the need for DevOps practices?
3. How do design patterns help software architects communicate the design of a complex system effectively?

4. What are the proactive approaches one can take to optimise efforts in the testing phase?

Course Outcome 4 (CO4):

1. Illustrate the activities involved in software project management for a socially relevant problem?
2. How do SCRUM, Kanban and Lean methodologies help software project management?
3. Is rolling level planning in software project management beneficial? Justify your answer.
4. How would you assess the risks in your software development project? Explain how you can manage identified risks?

Course Outcome 5 (CO5):

1. Justify the importance of Software Process improvement?
2. Explain the benefits of cloud based software development, containers and microservices.
3. Give the role of retrospectives in improving the software development process.
4. Illustrate the use of project history data as a prediction tool to plan future socially relevant projects.

Model Question Paper

QP CODE:

Reg No:_____

Name :_____ **PAGES : 3**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIFTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: CST 309

Course Name: Management of Software Systems

Duration: 3 Hrs **Max. Marks :100**

PART A

Answer all Questions. Each question carries 3 marks

1. Why professional software that is developed for a customer is not simply the programs that have been developed and delivered.
2. Incremental software development could be very effectively used for customers who do not have a clear idea about the systems needed for their operations. Justify.
3. Identify any four types of requirements that may be defined for a software system
4. Describe software architecture
5. Differentiate between GPL and LGPL?
6. Compare white box testing and black box testing.
7. Specify the importance of risk management in software project management?
8. Describe COCOMO cost estimation model.
9. Discuss the software quality dilemma
10. List the levels of the CMMI model? **(10x3=30)**

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11. (a) Compare waterfall model and spiral model **(8)**

(b) Explain Agile ceremonies and Agile manifesto **(6)**

12. (a) Illustrate software process activities with an example. **(8)**

(b) Explain Agile Development techniques and Agile Project Management **(6)**

13. (a) What are functional and nonfunctional requirements? Imagine that you are developing a library management software for your college, list eight functional requirements and four nonfunctional requirements. **(10)**

(b) List the components of a software requirement specification? **(4)**

OR

14. (a) Explain Personas, Scenarios, User stories and Feature identification? **(8)**

(b) Compare Software Architecture design and Component level design **(6)**

15. (a) Explain software testing strategies. **(8)**

(b) Describe the formal and informal review techniques. **(6)**

OR

16. (a) Explain Continuous Integration, Delivery, and Deployment CI/CD/CD) **(8)**

(b) Explain test driven development **(6)**

17. (a) What is a critical path and demonstrate its significance in a project schedule with the help of a sample project schedule. **(8)**

(b) Explain plan driven development and project scheduling. **(6)**

OR

18. (a) Explain elements of Software Quality Assurance and SQA Tasks. **(6)**

(b) What is algorithmic cost modeling? What problems does it suffer from when **(8)**

compared with other approaches to cost estimation?

19. (a) Explain elements of Software Quality Assurance and SQA Tasks. **(8)**

(b) Illustrate SPI process with an example. **(6)**

OR

20. (a) Compare CMMI and ISO 9001:2000. **(8)**

(b) How can Software projects benefit from Container deployment and Micro service deployment? **(6)**

Teaching Plan

No	Contents	No of Lecture Hrs
Module 1 : Introduction to Software Engineering (7 hours)		
1.1	Introduction to Software Engineering.[Book 1, Chapter 1]	1 hour
1.2	Software process models [Book 1 - Chapter 2]	1 hour
1.3	Process activities [Book 1 - Chapter 2]	1 hour
1.4	Coping with change [Book 1 - Chapter 2, Book 2 - Chapter 4]	1 hour
1.5	Case studies : An insulin pump control system. Mentcare - a patient information system for mental health care. [Book 1 - Chapter 1]	1 hour
1.6	Agile software development [Book 1 - Chapter 3]	1 hour
1.7	Agile development techniques, Agile Project Management.[Book 1 - Chapter 3]	1 hour
Module 2 : Requirement Analysis and Design (8 hours)		
2.1	Functional and non-functional requirements, Requirements engineering processes [Book 1 - Chapter 4]	1 hour
2.2	Requirements elicitation, Requirements validation, Requirements change, Traceability Matrix [Book 1 - Chapter 4]	1 hour
2.3	Developing use cases, Software Requirements Specification Template [Book 2 - Chapter 8]	1 hour

2.4	Personas, Scenarios, User stories, Feature identification [Book 3 - Chapter 3]	1 hour
2.5	Design concepts [Book 2 - Chapter 12]	1 hour
2.6	Architectural Design [Book 2 - Chapter 13]	1 hour
2.7	Component level design [Book 2 - Chapter 14]	1 hour
2.8	Design Document Template. Case study: The Ariane 5 launcher failure. [Ref - 2, Book 2 - Chapter 16]	1 hour
Module 3 : Implementation and Testing (9 hours)		
3.1	Object-oriented design using the UML, Design patterns [Book 1 - Chapter 7]	1 hour
3.2	Implementation issues, Open-source development - Open-source licensing - GPL, LGPL, BSD [Book 1 - Chapter 7]	1 hour
3.3	Review Techniques - Cost impact of Software Defects, Code review and statistical analysis. [Book 2 - Chapter 20]	1 hour
34	Informal Review, Formal Technical Reviews, Post-mortem evaluations. [Book 2 - Chapter 20]	1 hour
3.5	Software testing strategies - Unit Testing, Integration Testing, Validation testing, System testing and Debugging (basic concepts only). [Book 2 - Chapter 22]	1 hour
3.6	White box testing, Path testing, Control Structure testing, Black box testing. Test documentation [Book 2 - Chapter 23]	1 hour
3.7	Test automation, Test-driven development, Security testing. [Book 3 - Chapter 9]	1 hour
3.8	DevOps and Code Management - Code management, DevOps automation, CI/CD/CD. [Book 3 - Chapter 10]	1 hour
3.9	Software Evolution - Evolution processes, Software maintenance. [Book 1 - Chapter 9]	1 hour
Module 4 : Software Project Management (6 hours)		
4.1	Software Project Management - Risk management, Managing people, Teamwork [Book 1 - Chapter 22]	1 hour
4.2	Project Planning - Software pricing, Plan-driven development, Project scheduling, Agile planning [Book 1 - Chapter 23]	1 hour
4.3	Estimation techniques [Book 1 - Chapter 23]	1 hour
4.4	Configuration management [Book 1 - Chapter 25]	1 hour

4.5	Agile software management - SCRUM framework [Book 2 - Chapter 5]	1 hour
4.6	Kanban methodology and lean approaches.[Ref 9 - Chapter 2]	1 hour
Module 5 : Software Quality, Process Improvement and Technology trends (6 hours)		
5.1	Software Quality, Software Quality Dilemma, Achieving Software Quality. [Book 2 - Chapter 19]	1 hour
5.2	Elements of Software Quality Assurance, SQA Tasks , Software measurement and metrics. [Book 3 - Chapter 21]	1 hour
5.3	Software Process Improvement (SPI), SPI Process [Book 2 - Chapter 37]	1 hour
5.4	CMMI process improvement framework, ISO 9001:2000 for Software. [Book 2 - Chapter 37]	1 hour
5.5	Cloud-based Software - Virtualisation and containers, IaaS, PaaS, SaaS.[Book 3 - Chapter 5]	1 hour
5.6	Microservices Architecture - Microservices, Microservices architecture, Microservice deployment [Book 3 - Chapter 6]	1 hour

ERL331	COMPUTER NETWORKING LAB	CATEGORY	L	T	P	Credit
		PCC	0	0	3	2

Preamble:

The course enables the learners to get hands-on experience in network programming using Linux System calls and network monitoring tools. It covers implementation of network protocols and algorithms, configuration of network services and familiarization of network simulators. This helps the learners to develop, implement protocols and evaluate its performance for real world networks.

Prerequisite: Sound knowledge in Programming in C, Data Structures and Computer Networks

Course Outcomes: After the completion of the course the student will be able to

CO#	Course Outcomes
CO1	Use network related commands and configuration files in Linux Operating System. **(Cognitive Knowledge Level: Understand).**
CO2	Develop network application programs and protocols. **(Cognitive Knowledge Level: Apply)**
CO3	Analyze network traffic using network monitoring tools. **(Cognitive Knowledge Level: Apply)**
CO4	Design and setup a network and configure different network protocols. **(Cognitive Knowledge Level: Apply)**
CO5	Develop simulation of fundamental network concepts using a network simulator. **(Cognitive Knowledge Level: Apply)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓					✓		✓		✓
CO2	✓	✓	✓	✓				✓		✓		✓
CO3	✓	✓	✓	✓	✓			✓		✓		✓

CO4	✓	✓	✓	✓	✓	✓		✓		✓		✓
CO5	✓	✓	✓	✓	✓			✓		✓		✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and teamwork
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Lifelong learning

Assessment Pattern

Bloom's Category	**Continuous Assessment Test (Internal Exam) Marks in percentage**	**End Semester Examination Marks in percentage**
Remember	**20**	**20**
Understand	**20**	**20**
Apply	**60**	**60**
Analyze		
Evaluate		
Create		

Mark Distribution

Total Marks	**CIE Marks**	**ESE Marks**	**ESE Duration**
150	**75**	**75**	**3 hours**

Continuous Internal Evaluation Pattern:

Attendance	: **15 marks**
Continuous Evaluation in Lab	: **30 marks**
Continuous Assessment Test	: **15 marks**
Viva voce	: **15 marks**

Internal Examination Pattern:

The Internal examination shall be conducted for 100 marks, which will be converted to out of 15, while calculating Internal Evaluation marks. The marks will be distributed as, Algorithm - 30 marks, Program - 20 marks, Output - 20 marks and Viva - 30 marks.

End Semester Examination Pattern:

The End Semester Examination will be conducted for a total of 75 marks and shall be distributed as, Algorithm - 30 marks, Program - 20 marks, Output - 20 marks and Viva- 30 marks.

Operating System to Use in Lab	: Linux
Compiler/Software to Use in Lab	: gcc, NS2
Programming Language to Use in Lab	: Ansi C

Fair Lab Record:

All the students attending the Networking Lab should have a Fair Record. Every experiment conducted in the lab should be noted in the fair record. For every experiment, in the fair record, the right-hand page should contain experiment heading, experiment number, date of experiment, aim of the experiment, procedure/algorithm followed, other such details of the experiment and final result. The left-hand page should contain a print out of the respective code with sample input and corresponding output obtained. All the experiments noted in the fair record should be verified by the faculty regularly. The fair record, properly certified by the faculty, should be produced during the time of End Semester Examination for the verification by the examiners.

Syllabus

*Mandatory

(Note: At least one program from each topic in the syllabus should be completed in the Lab)

1. 1. Getting started with the basics of network configuration files and networking commands in Linux.*
2. To familiarize and understand the use and functioning of system calls used for network programming in Linux.*
3. Implement client-server communication using socket programming and TCP as transport layer protocol*
4. Implement client-server communication using socket programming and UDP as transport layer protocol*
5. Simulate sliding window flow control protocols.* (Stop and Wait, Go back N, Selective Repeat ARQ protocols)
6. Implement and simulate algorithm for Distance Vector Routing protocol or Link State Routing protocol.*
7. Implement Simple Mail Transfer Protocol.
8. Implement File Transfer Protocol.*
9. Understanding the Wireshark tool.*
10. Implement congestion control using a leaky bucket algorithm.*
11. Study of NS2 simulator*
12. Design and configure a network with multiple subnets with wired and wireless LANs using required network devices. Configure commonly used services in the network.

Networking Lab-Practice Questions

1 a) View the configuration, including addresses of your computers network interfaces.

b) Test the network connectivity between your computer and several other computers.

c) View the active TCP connections in the computer after visiting a website.

d) Find the hardware/MAC address of another computer in the network using ARP.

2 Write the system calls used for creating sockets and transferring data between two nodes.

3 a) Implement a multi-user chat server using TCP as transport layer protocol.

b) Implement a simple web proxy server that accepts HTTP requests and forwarding to remote servers and returning data to the client using TCP

4 Implement a Concurrent Time Server application using UDP to execute the programat a remote server. Client sends a time request to the server, server sends its system time back to the client. Client displays the result.

5 a) Implement Stop-and-Wait ARQ flow control protocol.

a. Implement Go-Back--N ARQ flow control protocol.

b. Implement Selective Repeat ARQ flow control protocol.

6 Implement Distance Vector Routing algorithm or Link State Routing algorithm..

7 Implement Simple Mail Transfer Protocol.

8 Develop a concurrent file server which will provide the file requested by a client if it exists. If not, the server sends appropriate message to the client. Server should also send its process ID (PID) to clients for display along with the file or the message.

9 Implement leaky bucket algorithm for congestion control.

10 a) Using Wireshark, Capture packets transferred while browsing a selected website. Investigate the protocols used in each packet, the values of the header fields and the size
of the packet.

a. Using Wireshark, observe three way handshaking connection establishment, three way handshaking connection termination and Data transfer in client server communication using TCP.

b. Explore at least the following features of Wireshark: filters, Flow graphs (TCP), statistics, and protocol hierarchies.

11 Design and configure a network (wired and wireless LANs) with multiple subnets using required network devices. Configure at least three of the following services in the network- TELNET, SSH, FTP server, Web server, File server, DHCP server and DNS server.

12 a) The network consists of TCP source node (n0) and destination node (n1) over an area size of 500m x 500m. Node (n0) uses Agent/TCP/Reno as the sending TCP agent and FTP traffic source. Node (n1) is the receiver of FTP transfers, and it uses Agent/TCP sink as its TCP-agent for the connection establishment. Run the simulation for 150 seconds and show the TCP window size in two static nodes scenario with any dynamic routing protocol. Run the script and analyze the output graph for the given scenario.

b) Simulate the transmission of ping messages over a star network topology consisting of 'n' nodes and find the number of packets dropped due to congestion using NS2simulator.

c) Simulate Link State Protocol or Distance Vector Routing protocol in NS2.

Reference Books:

1. W. Richard Stevens, Bill Fenner, Andy Rudoff, UNIX Network Programming: Volume 1, The Sockets Networking API, 3rd Edition, Pearson, 2015
2. Lisa Bock, Learn Wireshark: Confidently navigate the Wireshark interface and solvereal-world networking problems, Packt Publishing, 2019
3. Teerawat Issariyakul, Ekram Hossain, Introduction to Network Simulator NS2,2ndEdition, Springer,2019

CSL 333	DATABASE MANAGEMENT SYSTEMS LAB	Category	L	T	P	Credits	Year of introduction
		PCC	0	0	4	2	2019

Preamble:

The Database Management Systems course is intended to impart the elementary concepts of a database management system to students and equip them to design and implement a database application based on those concepts. This course helps the learners to get practical exposure on database creation, SQL queries creation, transaction processing and NoSQL & MongoDB based operations. The course enables the students to create, manage and administer the databases, develop necessary tools for the design and development of the databases, and to understand emerging technologies to handle Big Data.

Prerequisite: A sound knowledge of the basics of relational DBMS.

Course Outcomes: After the completion of the course the student will be able to

CO#	Course Outcomes
CO1	Design database schema for a given real world problem-domain using standard design and modeling approaches. **(Cognitive Knowledge Level: Apply)**
CO2	Construct queries using SQL for database creation, interaction, modification, and updation. **(Cognitive Knowledge Level: Apply)**
C03	Design and implement triggers and cursors. (Cognitive Knowledge Level: **Apply**)
C04	Implement procedures, functions, and control structures using PL/SQL**. (Cognitive Knowledge Level: Apply)**
CO5	Perform CRUD operations in NoSQL Databases. **(Cognitive Knowledge Level: Apply)**
C06	Develop database applications using front-end tools and back-end DBMS. **(Cognitive Knowledge Level: Create)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓		✓			✓		✓		✓
CO2	✓	✓	✓		✓			✓		✓		✓
CO3	✓	✓	✓	✓	✓			✓		✓		✓
CO4	✓	✓	✓	✓	✓			✓		✓		✓
CO5	✓	✓	✓		✓			✓		✓		✓
CO6	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern:

Bloom's Category	**Continuous Assessment Test (Internal Exam)Percentage**	**End Semester Examination Percentage**
Remember	**20**	**20**
Understand	**20**	**20**
Apply	**60**	**60**
Analyse		
Evaluate		
Create		

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	75	75	3 hours

Continuous Internal Evaluation Pattern:

Attendance : **15 marks**
Continuous Evaluation in Lab : **30 marks**
Continuous Assessment Test : **15 marks**
Viva-voce : **15 marks**

Internal Examination Pattern : The marks will be distributed as Schema/Logic: 30 marks, Program/Queries: 20 marks, Output: 20 marks, and Viva: 30 marks. Total 100 marks which will be converted out of 15 while calculating Internal Evaluation marks.

End Semester Examination Pattern:

The marks will be distributed as Schema/Logic: 30 marks,
Program/Queries: 20 marks, Output: 20 marks, and Viva: 30 marks. Total 100 marks will be converted out of 75 for the End Semester Examination.

DBMS software: Oracle, MySQL, SQL Server, PostgreSQL, MongoDB.
Front end Tool: Java

Fair Lab Record:

All Students attending the DBMS Lab should have a Fair Record. The fair record should be produced in the University Lab Examination. Every experiment conducted in the lab should be noted in the fair record. For every experiment in the fair record, the right hand page should contain Experiment Heading, Experiment Number, Date of Experiment, Aim of Experiment, Schemas/Menu & Form Design, and Query questions. The left hand page should contain Queries and sample output(relations created, Form, and Menu Output) obtained for a set of input.

Syllabus

1. Design a database schema for an application with ER diagram from a problem description **.
2. Creation, modification, configuration, and deletion of databases using UI and SQL Commands **.
3. Creation of database schema - DDL (create tables, set constraints, enforce relationships, create indices, delete and modify tables). Export ER diagram from the database and verify relationships** (with the ER diagram designed in step 1).

4. Database initialization - Data insert, Data import to a database (bulk import using UI and SQL Commands)**.
5. Practice SQL commands for DML (insertion, updating, altering, deletion of data, and viewing/querying records based on condition in databases)**.
6. Implementation of built-in functions in RDBMS**.
7. Implementation of various aggregate functions in SQL**.
8. Implementation of Order By, Group By & Having clause **.
9. Implementation of set operators nested queries, and join queries **.
10. Implementation of queries using temp tables.
11. Practice of SQL TCL commands like Rollback, Commit, Savepoint **.
12. Practice of SQL DCL commands for granting and revoking user privileges **.
13. Practice of SQL commands for creation of views and assertions ** .
14. Implementation of various control structures like IF-THEN, IF-THEN-ELSE, IF-THEN-ELSIF, CASE, WHILE using PL/SQL **.
15. Creation of Procedures, Triggers and Functions**.
16. Creation of Packages **.
17. Creation of Cursors **.
18. Creation of PL/SQL blocks for exception handling **.
19. Database backup and restore using commands.
20. Query analysis using Query Plan/Show Plan.
21. Familiarization of NoSQL Databases and CRUD operations**.
22. Design a database application using any front end tool for any problem selected. The application constructed should have five or more tables**.

** mandatory

Text Books

1. Elmasri R. and S. Navathe, Database Systems: Models, Languages, Design and Application Programming, Pearson Education, 2013.
2. Sliberschatz A., H. F. Korth and S. Sudarshan, Database System Concepts, 6/e, McGraw Hill, 2011.

References

1. Adam Fowler, NoSQL for Dummies, John Wiley & Sons, 2015
2. NoSQL Data Models: Trends and Challenges (Computer Engineering: Databases and Big Data), Wiley, 2018

Practice Questions

Design a normalized database schema for the following requirement.

The requirement: A library wants to maintain the record of books, members, book issue, book return, and fines collected for late returns, in a database. The database can be loaded with book information. Students can register with the library to be a member. Books can be issued to students with a valid library membership. A student can keep an issued book with him/her for a maximum period of two weeks from the date of issue, beyond which a fine will be charged. Fine is calculated based on the delay in days of return. For 0-7 days: Rs 10, For 7 – 30 days: Rs 100, and for days above 30 days: Rs 10 will be charged per day.

Sample Database Design

BOOK (**Book_Id**, Title, Language_Id, MRP, Publisher_Id, Published_Date, Volume, Status) // Language_Id, Publisher_Id are FK (Foreign Key)

AUTHOR(Author_Id, Name, Email, Phone_Number, Status)

BOOK_AUTHOR(Book_Id, Author_Id) // many-to-many relationship, both columns are PKFK (Primary Key and Foreign Key)

PUBLISHER(Publisher_id, Name, Address)

MEMBER(Member_Id, Name, Branch_Code, Roll_Number, Phone_Number, Email_Id, Date_of_Join, Status)

BOOK_ISSUE(Issue_Id, Date_Of_Issue, Book_Id, Member_Id, Expected_Date_Of_Return, Status) // Book+Id and Member_Id are FKs

BOOK_RETURN(Issue_Id, Actual_Date_Of_Return, LateDays, LateFee) // Issue_Id is PK and FK

LANGUAGE(Language_id, Name) //Static Table for storing permanent data

LATE_FEE_RULE(FromDays, ToDays, Amount) // Composite Key

EXERCISES

1. Create a normalized database design with proper tables, columns, column types, and constraints
2. Create an ER diagram for the above database design.
3. Write SQL commands to
    a. Create a database by name *Library*. Drop the database and re-create it.
    b. Create DDL statements and create the tables and constraints (from the design) in the database created in step-a (*Library*)

Notes: [Create a script file and execute it. Create the script file in such a way that,,if the table exists, drop the tables and recreate)]

c. Create and execute DROP TABLE command in tables with and without FOREIGN KEY constraints.
d. Create and execute ALTER TABLE command in tables with data and without data.
e. Create and execute SQL commands to build indices on Member_Id and Book_Id on table Book_Issue.
f. Create and execute GRANT/REVOKE commands on tables.
g. Create and execute SQL commands to insert data into each of the tables designed
h. Learn and execute bulk import of data to tables from CSV files (insert 1000 records of books into the BOOK table from a CSV file).
i. Create and execute UPDATE/DELETE commands on tables. Try to update/delete rows with Primary and Foreign Keys. Try bulk updates or deletes using SQL UPDATE statement

4. Write SQLQuery to retrieve the following information
    a. Get the number of books written by a given author
    b. Get the list of publishers and the number of books published by each publisher
    c. Get the names of authors who jointly wrote more than one book.
    d. Get the list of books that are issued but not returned
    e. Get the list of students who reads only 'Malayalam' books
    f. Get the total fine collected for the current month and current quarter
    g. Get the list of students who have overdue (not returned the books even on due date)
    h. Calculate the fine (as of today) to be collected from each overdue book.
    i. Members who joined after Jan 1 2021 but has not taken any books
5. Book return should insert an entry into the Book_Return table and also update the status in Book_Issue table as 'Returned'. Create a database *TRANSACTION* to do this operation (stored procedure).
6. Create a database view 'Available_Books', which will list out books that are currently available in the library
7. Create a database procedure to add, update and delete a book to the Library database (use parameters).
8. Use cursors and create a procedure to print Books Issue Register (page wise – 20 rows in a page)
9. Create a history table (you may use the same structure without any keys) for the MEMBER table and copy the original values of the row being updated to the history table using a TRIGGER.
10. NoSQL Exercise
    a. Practice Mongo DB CRUD operations. Refer: https://docs.mongodb.com/manual/crud/

b. You may use a MongoDB local installation or cloud MongoDB services like MongoDB Atlas for this exercise
c. For documentation: Refer: https://docs.mongodb.com/manual/introduction/

11. Application Development Problem examples:
    1) Inventory Control System.
    2) Material Requirement Processing.
    3) Hospital Management System.
    4) Railway Reservation System.
    5) Personal Information System.
    6) Web Based User Identification System.
    7) Timetable Management System.
    8) Hotel Management System.

SEMESTER V

MINOR

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
ERT381	EMBEDDED SYSTEMS	VAC	3	1	0	4

Prerequisite: ERT 281 Logic Circuit Design, ERT 282 Microprocessors and Microcontrollers

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand the embedded system fundamentals and system Design**(Cognitive Knowledge Level: Understand)**
CO 2	Understand the peripheral devices and their interfacing with the processor. **(Cognitive Knowledge Level: Understand)**
CO 3	Study the ARM processor Architecture, pipeline processor organization and assembly language programming using ARM.**(Cognitive Knowledge Level: Apply)**
CO4	Understand the THUMB instructon set and architectural support for high level languages. **(Cognitive Knowledge Level: Apply)**
CO5	Explain the basics of operating systems, concept of task scheduling and issue related with multitasking. **(Cognitive Knowledge Level: Understand)**

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	✓	✓	✓		✓			✓				✓
CO 2	✓	✓	✓		✓			✓				✓
CO 3	✓	✓	✓		✓			✓	✓			✓
CO 4	✓	✓	✓		✓			✓				✓
CO 5	✓	✓	✓		✓			✓				✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and teamwork
PO4	Conduct investigations of complexproblems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Lifelong learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	20
Understand	20	20	40
Apply	20	20	40
Analyse	-	-	-
Evaluate	-	-	-
Create	-	-	-

Mark Distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance: 10 marks
Continuous Assessment Test (2 Numbers): 25 marks
Assignment/Quiz/Course project: 15 marks

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub- divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): **Understand the embedded system fundamentals and system design. (K2)**

1. Give the challenges of embedded computing.
2. Give the structural description of embedded system.
3. What are the phases of EDLC?

Course Outcome 2 (CO2): **Understand the peripheral devices and their interfacing with the processor. (K2)**

1. Compare and contrast the PCI bus and PCI-X bus.
2. How the ROM memories are classified? Explain.
3. How the peripheral devices are connected with processors?

Course Outcome 3 (CO3):Study the ARM processor architecture and pipeline processor organization. (K3)

1. Give the architecture of the ARM processor and explain the registers.
2. Explain the pipelined architecture of ARM processor.
3. Write an ARM assembly language program to print the sum of two numbers.

Course Outcome 4 (CO4): To write programs in assembly and high level languages for ARM processor. (K3)

1. Write a note on Thumb single register in ARM processor.
2. Briefly discuss about the Advanced Microcontroller Bus Architecture (AMBA).
3. What are the data types supported by ARM programming high level languages?

Course Outcome 5(CO5): To explain the basics of real time operating systems and their use in embedded systems. (K2)

1. Discuss the importance of kernel in an operating system.
2. Compare process and thread.
3. Explain the role of events in inter task communication

SYLLABUS

Module 1: Introduction to Embedded Systems

Complex Systems and Microprocessors: Embedding Computers, Characteristics of Embedded Computing Applications, Application of Microprocessors, The Physics of Software, Challenges in Embedded Computing System, Characteristics and quality attributes of an embedded system, Performance in Embedded Computing. The Embedded System Design Process: Requirements, Specification, Architecture Design, Designing Hardware and Software Components, System Integration. Formalisms for System Design: Structural Description, Behavioral Description, An embedded system design example. Embedded product development cycle (EDLC): Different phases of EDLC, EDLC models

Module 2: Embedded system interfacing and peripherals

Communication devices: Serial Communication Standards and Devices - UART, HDLC and SPI. Serial Bus Protocols - I 2C Bus, CAN Bus and USB Bus. Parallel communication standards ISA, PCI and PCI-X Bus. Memory: Memory devices and systems – ROM-Flash, EEPROM, RAM-SRAM, DRAM, Cache memory, memory mapping and addresses, memory management unit– DMA. I/O Device: Interrupts-Interrupt sources, recognizing an interrupt, ISR – Device drivers for handling ISR, Shared data problem, Interrupt latency.

Module 3: ARM Processor fundamentals

ARM Processor architecture: The Acorn RISC Machine, Architectural inheritance, The ARM programmer's model, ARM development tools. ARM Assembly Language: Programming Data processing instructions, Data transfer instructions, Control flow instructions, writing simple assembly language programs. ARM Organization and Implementation: Three stage pipeline ARM organization, Five stage pipeline ARM organization, ARM instruction execution, ARM implementation, The ARM coprocessor interface.

Module 4: ARM Programming

Architectural Support for High-Level Languages: Abstraction in software design, Data types, Floating-point data types, The ARM floating-point architecture, Expressions, Conditional statements, Loops, Functions and procedures, Use of memory, Run-time environment. The Thumb Instruction Set: The Thumb bit in the CPSR, The Thumb programmer's model, Thumb branch instructions, Thumb software interrupt instruction, Thumb data processing instructions, Thumb single register data transfer instructions, Thumb multiple register data transfer instructions, Thumb breakpoint instruction, Thumb implementation, Thumb applications.

Architectural Support for System Development: The ARM memory interface, The Advanced Microcontroller Bus Architecture (AMBA). Programming: Assembly and C language programming applications of embedded systems.

Module 5: Real Time Operating Systems

Operating system basics: Kernel, types of operating systems. Real time operating systems: Tasks, process, threads, multiprocessing and multi-tasking, task scheduling, types, threads and process scheduling, task communication, task synchronization, device drivers, choosing an RTOS.

Text Books

1. Raj kamal, Embedded Systems Architecture, Programming and Design, TMH, 2003
2. K.V. Shibu, Introduction to Embedded Systems, 2e, McGraw Hill Education India, 2016.
3. Wayne Wolf, Computers as Components: Principles of Embedded Computing System Design, Morgan Kaufman Publishers - Elsevier 3ed, 2008
4. Steve Furber, ARM system-on-chip architecture, Addison Wesley, Second Edition, 2000

Reference Books

1. David E. Simon, An Embedded Software Primer, Pearson Education Asia, First Indian Reprint 2000.
2. Steve Heath, Embedded Systems Design, Newnes – Elsevier 2ed, 2002
3. Andrew N. Sloss, Dominic Symes, Chris Wright, ARM System Developer's Guide Designing and Optimizing System Software, Morgan Kaufmann Publishers 2004
4. Frank Vahid and Tony Givargis, Embedded Systems Design – A Unified Hardware / Software Introduction, John Wiley, 2002.
5. Tammy Noergaard, Embedded Systems Architecture, A Comprehensive Guide for Engineers and Programmers, Newnes – Elsevier 2ed, 2012
6. Iyer - Embedded Real time Systems, 1e, McGraw Hill Education New Delhi, 2003
7. Lyla B. Das, Embedded Systems: An Integrated Approach, 1/e, Lyla B. Das, Embedded Systems, 2012

Model Question Paper

Reg No.: **Name:**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY FIFTH SEMESTER B. TECH DEGREE EXAMINATION,

MONTH AND YEAR

Course Code: ERT381

Course Name: EMBEDDED SYSTEMS

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all questions, each carries 3 marks

1. Define an embedded system
2. Write any 3 challenges of embedded system design
3. Explain how an RS232 device is interfaced to a processor
4. What is interrupt latency?
5. Write the contents of CPSR register of ARM processor and their use.
6. Draw the five-stage pipeline architecture of ARM processor
7. What is the use of thumb instruction set in ARM processor?
8. What a note on ARM memory interface
9. What is a real time operating system?
10. What are tasks, processes and threads? [10 X 3= 30]

PART B

Answer any one full question from each module. Each question carries 14 Marks

Module1

11. (a) What are the characteristics of an embedded system? Explain. [07 Marks]
(b) Explain the different phases of EDLC. [07 Marks]

OR

12. (a) Write different steps involved in the embedded system design process. [07 Marks]
(b) Explain the structural description of embedded system design. [07 Marks]

Module2

13.(a) What is serial and parallel port communication? Explain with the help of necessary diagrams. [07 Marks]
(b) What is interrupt? How interrupts are handled in a processor? Explain ISR. [07 Marks]

OR

14. (a) With the help of a diagram show how ROM and RAM are interfaced to a processor. Explain the read/write processes. [07 Marks]

(b) Explain how a memory management unit is used in a processor. What are its uses? What is DMA? [07 Marks]

Module3

15. (a) Write a note on ARM processor architecture and its registers. [07 Marks]

(b) Write a note on data processing and data transfer instructions with the help of examples [07 Marks]

OR

16. (a) What is pipeline architecture? Explain how an ARM instruction is executed in a 5 stage pipeline processor with the help of an example. [08 Marks]

(b) Write an ARM assembly language program to print text string "Hello World". [06 Marks]

Module-4

17. (a) Explain ARM floating point architecture and discuss how floating-point numbers are handled [07 Marks]

(b) Write a note on Thumb single register and multiple register data transfer instructions with the help of examples. [07 Marks]

OR

18.(a) What is Thumb instruction set? Why it is used? Explain Thumb programmers model. [07 Marks]

(b) Draw the block diagram of AMBA architecture. What are the different types of buses used in the architecture? [07 Marks]

Module 5

19. (a) What are the different services of Kernel? Explain different types of Kernels. [07Marks]

(b) Explain pre-emptive and non-pre-emptive scheduling algorithms with the help of an example. [07 Marks]

OR

20. (a) What are the basic functions of real time Kernel? Explain. [07 Marks]

(b) Write a note on the following (a) shared memory (b) message passing

(c) deadlock [07 Marks]

Course Contents and Lecture Schedule:

No	Topic	No. of Lectures
1	**Introduction to Embedded Systems**	**8**
1.1	Complex Systems and Microprocessors: Embedding Computers, Characteristics of Embedded Computing Applications, Application of Microprocessors.	1

1.2	The Physics of Software, Challenges in Embedded Computing System, Characteristics and quality attributes of an embedded system, Performance in Embedded Computing.	1
1.3	The Embedded System Design Process: Requirements, Specification, Architecture Design,	1
1.4	Designing Hardware and Software Components, System Integration.	1
1.5	Formalisms for System Design: Structural Description	1
1.6	Behavioral Description, An embedded system design example.	1
1.7	Embedded product development cycle (EDLC): Different phases of EDLC,	1
1.8	EDLC models	1
2	**Embedded system interfacing and peripherals**	**9**
2.1	Communication devices: Serial Communication Standards and Devices - UART, HDLC and SPI.	1
2.2	Serial Bus Protocols - I 2C Bus, CAN Bus and USB Bus.	1
2.3	Parallel communication standards ISA, PCI and PCI-X Bus.	1
2.4	Memory: Memory devices and systems – ROM-Flash, EEPROM, RAM-SRAM	1
2.5	DRAM, Cache memory, memory mapping and addresses,	1
2.6	memory management unit– DMA.	1
2.7	I/O Device: Interrupts-Interrupt sources, recognizing an interrupt	1
2.8	ISR – Device drivers for handling ISR	1
2.9	Shared data problem, Interrupt latency	1
3	**ARM Processor fundamentals**	**9**
.3.1	ARM Processor architecture: The Acorn RISC Machine	1
3.2	Architectural inheritance, The ARM programmer's model,	1
3.3	ARM development tools.	1
3.4	ARM Assembly Language: Programming Data processing instructions.	1
3.5	Data transfer instructions, Control flow instructions	1
3.6	writing simple assembly language programs.	1

3.7	ARM Organization and Implementation: Three stage pipeline ARM organization,	1
3.8	Five stage pipeline ARM organization, ARM instruction execution,	1
3.9	ARM implementation, The ARM coprocessor interface.	1
4	**ARM Programming**	**10**
4.1	Architectural Support for High-Level Languages: Abstraction in software design, Data types, Floating-point data types	1
4.2	The ARM floating-point architecture, Expressions, Conditional statements, Loops, Functions and procedures, Use of memory, Run-time environment.	1
4.3	The Thumb Instruction Set: The Thumb bit in the CPSR, The Thumb programmer's model, Thumb branch instructions,	1
4.4	Thumb software interrupt instruction, Thumb data processing instructions, Thumb single register data transfer instructions	1
4.5	Thumb multiple register data transfer instructions, Thumb breakpoint instruction, Thumb implementation, Thumb applications.	1
4.6	Architectural Support for System Development: The ARM memory interface.	1
4.7	The Advanced Microcontroller Bus Architecture (AMBA)	1
4.8	Programming: Assembly and C language programming applications of embedded systems. - Lecture 1	1
4.9	Programming: Assembly and C language programming applications of embedded systems. - Lecture 2	1
4.10	Applications of embedded systems.	1
5	**Real Time Operating Systems**	**9**
5.1	Operating system basics: Kernel	1
5.2	Types of operating systems.	1
5.3	Real time operating systems: Tasks, process, threads, process, threads	1
5.4	multiprocessing and multi-tasking,	1
5.5	task scheduling, types,	1
5.6	threads and process scheduling	1
5.7	Task communication, Task synchronization	1
5.8	Device drivers,	1
5.9	Choosing an RTOS.	1

CST 383	CONCEPTS IN MACHINE LEARNING	Category	L	T	P	Credit	Year of introduction
		VAC	3	1	0	4	2019

Preamble: This course enables the learners to understand the fundamental concepts and algorithms in machine learning. The course covers the standard and most popular supervised learning algorithms such as linear regression, logistic regression, decision trees, Bayesian learning & the naive Bayes algorithm, support vector machines& kernels, basic clustering algorithms and dimensionality reduction methods. This course helps the students to provide machine learning based solutions to real world problems.

Prerequisite: Familiarity with basics in linear algebra, probability and Python programming.

	Course Outcomes
CO1	Illustrate Machine Learning concepts and basic parameter estimation methods.**(Cognitive Knowledge Level: Apply)**
CO2	Demonstrate supervised learning concepts (regression, linear classification). **(Cognitive Knowledge Level**: **Apply**)
CO3	Illustrate the concepts of Multilayer neural network and Support Vector Machine **(Cognitive Knowledge Level: Apply**)
CO4	Describe unsupervised learning concepts and dimensionality reduction techniques. (**Cognitive Knowledge Level**: **Apply**)
CO5	Solve real life problems using appropriate machine learning models and evaluate the performance measures (**Cognitive Knowledge Level: Apply**)

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO 7	PO8	PO9	PO10	PO11	PO1 2
CO1	✓	✓	✓	✓	✓							✓
CO2	✓	✓	✓	✓	✓							✓
CO3	✓	✓	✓	✓	✓							✓

CO4	✓	✓	✓	✓	✓							✓
CO5	✓	✓	✓	✓	✓	✓						✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination Marks**
	Test1 (Percentage)	**Test2 (Percentage)**	
Remember	**30**	**30**	**30**
Understand	**30**	**30**	**30**
Apply	**40**	**40**	**40**
Analyse			
Evaluate			
Create			

Mark Distribution

Total Marks	**CIE Marks**	**ESE Marks**	**ESE Duration**
150	**50**	**100**	**3 hours**

Continuous Internal Evaluation Pattern:

Attendance : **10 marks**

Continuous Assessment Tests : **25 marks**

Continuous Assessment Assignment : **15 marks**

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks

First Internal Examination shall be preferably conducted after completing the first half of the syllabus and the Second Internal Examination shall be preferably conducted after completing remaining part of the syllabus.

There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly covered module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly covered module), each with 7 marks. Out of the 7 questions in Part B, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Syllabus

Module-1 (Overview of machine learning)

Machine learning paradigms-supervised, semi-supervised, unsupervised, reinforcement learning. Basics of parameter estimation - maximum likelihood estimation(MLE) and maximum a posteriori estimation(MAP). Introduction to Bayesian formulation.

Module-2 (Supervised Learning)

Regression - Linear regression with one variable, Linear regression with multiple variables, solution using gradient descent algorithm and matrix method, basic idea of overfitting in regression. Linear Methods for Classification- Logistic regression, Perceptron, Naive Bayes, Decision tree algorithm ID3.

Module-3 (Neural Networks (NN) and Support Vector Machines (SVM))

NN - Multilayer feed forward network, Activation functions (Sigmoid, ReLU, Tanh), Backpropagation algorithm.

SVM - Introduction, Maximum Margin Classification, Mathematics behind Maximum Margin Classification, Maximum Margin linear separators, soft margin SVM classifier, non-linear SVM, Kernels for learning non-linear functions, polynomial kernel, Radial Basis Function(RBF).

Module-4 (Unsupervised Learning)

Clustering - Similarity measures, Hierarchical Agglomerative Clustering, K-means partitional clustering, Expectation maximization (EM) for soft clustering. Dimensionality reduction – Principal Component Analysis, factor Analysis, Multidimensional scaling, Linear Discriminant Analysis.

Module-5 (Classification Assessment)

Classification Performance measures - Precision, Recall, Accuracy, F-Measure, Receiver Operating Characteristic Curve(ROC), Area Under Curve(AUC. Bootstrapping, Cross Validation, Ensemble methods, Bias-Variance decomposition. Case Study: Develop a classifier for face detection.

Text Book

1. Ethem Alpaydin, Introduction to Machine Learning, 2nd edition, MIT Press 2010.
2. Mohammed J. Zaki and Wagner Meira, Data Mining and Analysis: Fundamental Concepts and Algorithms, Cambridge University Press, First South Asia edition, 2016.
3. Jake VanderPlas, Python Data Science Handbook, O'Reilly Media, 2016
4. Tom Mitchell, Machine Learning, McGraw-Hill, 1997.

Reference Books

1. Christopher Bishop. Neural Networks for Pattern Recognition, Oxford University Press, 1995.
2. Kevin P. Murphy. Machine Learning: A Probabilistic Perspective, MIT Press 2012.
3. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements Of Statistical Learning, Second edition Springer 2007.
4. P. Langley, Elements of Machine Learning, Morgan Kaufmann, 1995.
5. Richert and Coelho, Building Machine Learning Systems with Python.
6. Davy Cielen, Arno DB Meysman and Mohamed Ali. Introducing Data Science: Big Data, Machine Learning, and More, Using Python Tools, Dreamtech Press 2016.

Sample Course Level Assessment Questions

Course Outcome1(CO1):

1. A coin is tossed 100 times and lands heads 62 times. What is the maximum likelihood estimate for θ, the probability of heads.
2. Suppose data $x_1, ..., x_n$ are independent and identically distributed drawn from an exponential distribution $exp(\lambda)$. Find the maximum likelihood for λ.
3. Suppose $x_1, ..., x_n$ are independent and identically distributed(iid) samples from a distribution with density

$$f_X(x \mid \theta) = \begin{cases} \frac{\theta x^{\theta-1}}{3^\theta}, & 0 \le x \le 3 \\ 0, & \text{otherwise} \end{cases}$$

   Find the maximum likelihood estimate(MLE) for θ.
4. Find the maximum likelihood estimator (MLE) and maximum a posteriori (MAP) estimator for the mean of a univariate normal distribution. Assume that we have N samples, $x_1,..., x_N$ independently drawn from a normal distribution with known variance σ^2 and unknown mean μ and the prior distribution for the mean is itself a normal distribution with mean v and variance β^2. What happens to the MLE and MAP estimators as the number of samples goes to infinity.

Course Outcome 2 (CO2):

1. Explain the difference between (batch) gradient descent and stochastic gradient descent. Give an example of when you might prefer one over the other.
2. Suppose that you are asked to perform linear regression to learn the function that outputs y, given the D-dimensional input x. You are given N independent data points, and that all the D attributes are linearly independent. Assuming that D is around 100, would you prefer the closed form solution or gradient descent to estimate the regressor?
3. Suppose you have a three class problem where class label $y \in 0, 1, 2$ and each training example X has 3 binary attributes $X_1, X_2, X_3 \in 0, 1$. How many parameters (probability distribution) do you need to know to classify an example using the Naive Bayes classifier?

Course Outcome 3 (CO3):

1. What are support vectors and list any three properties of the support vector classifier solution?
2. Why do you use kernels to model a projection from attributes into a feature space, instead of simply projecting the dataset directly?
3. Describe how Support Vector Machines can be extended to make use of kernels. Illustrate with reference to the Gaussian kernel $K(x, y) = e^{-z}$, where $z = (x-y)^2$.

4. Briefly explain one way in which using tanh instead of logistic activations makes optimization easier.
5. ReLU activation functions are most used in neural networks instead of the tanh activation function. Draw both activation functions and give a) an advantage of the ReLU function compared to the tanh function. b) a disadvantage of the ReLU function compared to the tanh function.

Course Outcome 4(CO4):

1. Describe cluster analysis? Identify two applications where cluster analysis can be applied to multimedia data?
2. Given two objects represented by the tuples (22, 1, 42, 10) and (20, 0, 36, 8):

   (i) Compute the Euclidean distance between the two objects.

   (ii) Compute the Manhattan distance between the two objects.
3. Use PCA to reduce the dimension from 2 to 1 for the design matrix ***X***.

$$X = \begin{bmatrix} 6 & -4 \\ -3 & 5 \\ -2 & 6 \\ 7 & -3 \end{bmatrix}$$

4. What is Principal Component Analysis (PCA)? Which eigen value indicates the direction of largest variance?
5. Suppose that one runs a principal component analysis on a data set and tells that the percentage of variance explained by the first 3 components is 80%. How is this percentage of variance explained?

Course Outcome 5 (CO5):

1. Suppose that you are contacted by a food processing company that wants you to develop a classifier that detects whether a rat is present in an image. You collect a large dataset of images by crawling the web, and have annotators determine which images contain rats. This set of images can then be used as the training set for your classifier.
   a. Suggest a machine learning method to use for this classification task and evaluate its performance.
   b. After you have delivered your solution to the company, they get back to you and complain that when they evaluate on a new test set, they get precision and recall values that are much lower than what you reported to them. Explain what might have gone wrong and propose remedial measures .
2. A real estate firm would like to build a system that predicts the sale prices of a house. They create a spreadsheet containing information about 1,500 house sales in the Kochi

area. In addition to the price, there are 10 features describing the house, such as number of bedrooms, total indoor area, lot area, a swimming pool, location, etc. Explain how you would implement a machine learning model that would solve this prediction task. Give all steps you would carry out when developing it. Explain why the model you built is probably useless in the long run.

3. For a classifier, the confusion matrix is given by:

	+	-
+	9	9
-	1	5

What is the precision, recall and accuracy of that classifier?

Model Question Paper

QP CODE: PAGES:3

Reg No:_____

Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIFTH SEMESTER B.TECH DEGREE EXAMINATION(MINOR), MONTH & YEAR

Course Code: CST 383

Course Name: CONCEPTS IN MACHINE LEARNING

Max.Marks:100 **Duration: 3 Hours**

PART A

Answer all Questions. Each question carries 3 Marks

1. Define supervised learning? Name special cases of supervised learning depending on whether the inputs/outputs are categorical, or continuous.
2. Differentiate between Maximum Likelihood estimation (MLE) and Maximum a Posteriori (MAP) estimation?
3. What is overfitting and why is it a problem? Give an example of a method to reduce the risk of overfitting.
4. Specify the basic principle of gradient descent algorithm.
5. Suppose that you have a linear support vector machine(SVM) binary classifier. Consider a point that is currently classified correctly, and is far away from the decision boundary. If you

remove the point from the training set, and re-train the classifier, will the decision boundary change or stay the same? Justify your answer.

6. Mention the primary motivation for using the kernel trick in machine learning algorithms?
7. Expectation maximization (EM) is designed to find a maximum likelihood setting of the parameters of a model when some of the data is missing. Does the algorithm converge? If so, do you obtain a locally or globally optimal set of parameters?
8. Illustrate the strength and weakness of k-means algorithm.
9. Classifier A attains 100% accuracy on the training set and 70% accuracy on the test set. Classifier B attains 70% accuracy on the training set and 75% accuracy on the test set. Which one is a better classifier. Justify your answer.
10. How does bias and variance trade-off affect machine learning algorithms?

(10x3=30)

Part B

Answer any one Question from each module. Each question carries 14 Marks

11. a) Suppose that X is a discrete random variable with the following probability mass function: where $0 \leq \theta \leq 1$ is a parameter. The following 10 independent observations

X	0	1	2	3
$P(X)$	$2\theta/3$	$\theta/3$	$2(1-\theta)/3$	$(1-\theta)/3$

were taken from such a distribution: ***(3, 0, 2, 1, 3, 2, 1, 0, 2, 1)***. What is the maximum likelihood estimate of θ. **(6)**

b) A gamma distribution with parameters α, β has the following density function, where $\Gamma(t)$ is the gamma function.

$$p(x) = \frac{\beta^{\alpha}}{\Gamma(\alpha)} x^{\alpha-1} e^{-\beta x}$$

If the posterior distribution is in the same family as the prior distribution, then we say that the prior distribution is the conjugate prior for the likelihood function. Using the Gamma distribution as a prior, show that the Exponential distribution is a conjugate prior of the Gamma distribution. Also, find the maximum a posteriori estimator for the parameter of the Exponential distribution as a function of α and β. **(8)**

OR

12. a) Traffic between 8AM and 9AM at a certain place was measured by counting the number of vehicles that passed at that time. Suppose the counts follow a Poisson process. A random sample of 9 observations was collected, having observed the following number of vehicles: (95, 100, 80, 70, 110, 98, 97, 90, 70). Derive the maximum likelihood estimator for the

average number of vehicles that pass by that place between 8 AM and 9 AM, and compute the corresponding estimate using the given sample. **(7)**

b) Find the maximum a posteriori (MAP) estimator for the mean of a univariate normal distribution. Assume that we have N samples, $x_1,..., x_N$ independently drawn from a normal distribution with known variance σ^2 and unknown mean μ and the prior distribution for the mean is itself a normal distribution with mean ν and variance β^2. **(7)**

13.a) Derive the gradient descent training rule assuming for the target function $o_d = w_0 + w_1x_1 + ... + w_nx_n$. Define explicitly the squared cost/error function E, assuming that a set of training examples D is provided, where each training example $d \in D$ is associated with the target output t_d. **(10)**

b) How can we interpret the output of a two-class logistic regression classifier as a probability? **(4)**

OR

14. a) In a two-class logistic regression model, the weight vector $w = [4, 3, 2, 1, 0]$. We apply it to some object that we would like to classify; the vectorized feature representation of this object is $x = [-2, 0, -3, 0.5, 3]$. What is the probability, according to the model, that this instance belongs to the positive class? **(6)**

b) The following dataset can be used to train a classifier that determines whether a given person is likely to own a car or not. There are three features: education level (primary, secondary, or university); residence (city or country); gender (female, male).

education	residence	gender	has car?
sec	country	female	yes
univ	country	female	yes
prim	city	male	no
univ	city	male	no
sec	city	female	no
sec	country	male	yes
prim	country	female	yes
univ	country	male	yes
sec	city	male	yes
prim	city	female	no
univ	city	female	no
prim	country	male	yes

Find the root attribute and justify your answer **(8)**

15. a) Consider a support vector machine whose input space is 2-D, and the inner products are computed by means of the kernel $K(x, y) = (x.y + 1)^2 - 1$, where $x.y$ denotes the ordinary inner product. Show that the mapping to feature space that is implicitly defined by this kernel is the mapping to 5-D given by **(10)**

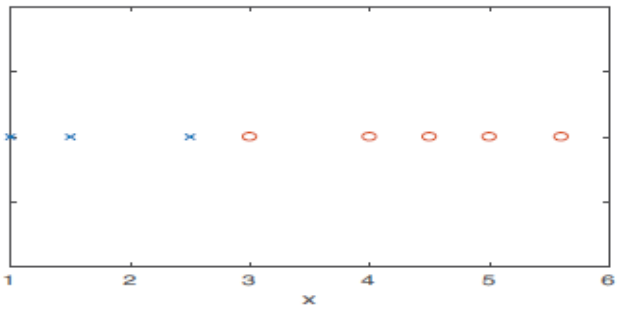
$$\mathbf{x} = \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} \rightarrow \phi(\mathbf{x}) = \begin{bmatrix} x_1^2 \\ x_2^2 \\ \sqrt{2}\, x_1 x_2 \\ \sqrt{2}\, x_1 \\ \sqrt{2}\, x_2 \end{bmatrix}.$$

b) What is the basic idea of a Support Vector Machine? **(4)**

OR

16. a) Explain how back propagation can be used to solve XOR problem which is not linearly separable. **(8)**

b) Consider the following one dimensional training data set, 'x' denotes negative examples and 'o' positive examples. The exact data points and their labels are given in the table. Suppose a SVM is used to classify this data. Indicate which are the support vectors and mark the decision boundary. Find the equation of the hyperplane. (6)



x	1	1.5	2.5	3	4	4.5	5	5.6
y	-1	-1	-1	1	1	1	1	1

17. a)Suppose that we have the following data (one variable). Use single linkage Agglomerative clustering to identify the clusters.
Daa: (2, 5, 9, 15, 16, 18, 25, 33, 33, 45). **(8)**

b) Given two objects represented by the tuples (22, 1, 42, 10) and (20, 0, 36, 8):

(i) Compute the Euclidean distance between the two objects.

(ii) Compute the Manhattan distance between the two objects.

(iii) Compute the Minkowski distance between the two objects, using p = 3 **(6)**

OR

18. a) Suppose that we have the following data:

a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*j*
(2,0)	(1,2)	(2,2)	(3,2)	(2,3)	(3,3)	(2,4)	(3,4)	(4,4)	(3,5)

Identify the cluster by applying the k-means algorithm, with k = 2. Try using initial cluster centers as far apart as possible. **(10)**

b) List the steps involved in Principal Component Analysis. **(4)**

19. a) Suppose the dataset had 9700 cancer-free images from 10000 images from cancer patients. Find precision, recall and accuracy ? Is it a good classifier? Justify. **(8)**

Actual Class\ Predicted class	**cancer = yes**	**cancer = no**	**Total**
cancer = yes	90	210	300
cancer = no	140	9560	9700
Total	230	9770	10000

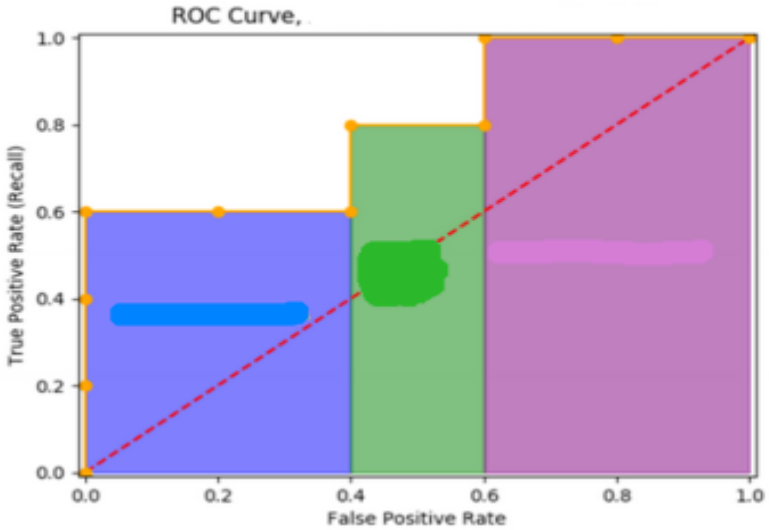
b) Suppose that you have a classification problem where our feature representation contains about 10,000,000 features. We would like to develop a classifier that can be deployed in a mobile phone, so preferably it should have a small memory footprint. Discuss one solution for how this can be done. **(6)**

OR

20. a) What are ROC space and ROC curve in machine learning? In ROC space, which points correspond to perfect prediction, always positive prediction and always negative prediction? Why? **(6)**

b) Suppose there are three classifiers A,B and C. The (FPR, TPR) measures of the three classifiers are as follows – A (0, 1), B (1, 1) , C (1,0.5). Which can be considered as a perfect classifier? Justify your answer. **(4)**

c) Given the following ROC Curve? Find the AUC? **(4)**



Teaching Plan

No	Contents	No of Lecture Hrs
Module 1 :Overview of machine learning (7 hours)		
1.1	Supervised, semi-supervised, unsupervised learning, reinforcement learning (Text Book (TB) 1: Chapter 1)	1hour
1.2	Maximum likelihood estimation(MLE) (TB 1: Section 4.2)	1hour
1.3	Maximum likelihood estimation (MLE)- example (TB 1: Section 4.2)	1hour
1.4	Maximum a posteriori estimation(MAP) (TB 4: Section 6.2)	1hour
1.5	Maximum a posteriori estimation(MAP)-example (TB 4: Section 6.2)	1hour
1.6	Bayesian formulation (TB 1: Section 14.1, 14.2)	1hour
1.7	Bayesian formulation -example (TB 1: Section 14.1, 14.2)	1hour
Module 2 : Supervised Learning (8 hours)		

2.1	Linear regression with one variable (TB 1: Section 2.6)	1hour
2.2	Multiple variables, Solution using gradient descent algorithm and matrix method (No derivation required) (TB 1: Section 5.8)	1hour
2.3	Overfitting in regression, Lasso and Ridge regularization	1hour
2.4	Logistic regression	1hour
2.5	Perceptron	1hour
2.6	Naive Bayes (TB 2: Section 18.2)	1hour
2.7	Decision trees (TB 2: Chapter 19)	1hour
2.8	Decision trees- ID3 algorithm (TB 2: Chapter 19)	1hour
Module 3 : Neural Networks and Support Vector Machines (TB 2: Chapter 21) (11 hours)		
3.1	Multilayer Feed forward Network, Activation Functions (Sigmoid, ReLU, Tanh)	1hour
3.2	Back Propagation Algorithm	1hour
3.3	Illustrative Example for Back Propagation	1hour
3.4	Introduction, Maximum Margin Hyperplane,	1hour
3.5	Mathematics behind Maximum Margin Classification	1hour
3.6	Formulation of maximum margin hyperplane and solution	1hour
3.7	Soft margin SVM	1hour
3.8	Solution of Soft margin SVM	1hour
3.9	Non-linear SVM	1hour
3.10	Kernels for learning non-linear functions and properties of kernel functions.	1hour
3.11	Example Kernels functions- Linear, RBF, Polynomial.	1hour
Module 4 : Unsupervised Learning (10 hours)		
4.1	Similarity measures- Minkowski distance measures(Manhattan, Euclidean), Cosine Similarity	1hour
4.2	Clustering - Hierarchical Clustering (TB 2: Chapter 14)	1hour
4.3	K-means partitional clustering (TB 2: Chapter 13)	1hour
4.4	Expectation maximization (EM) for soft clustering (TB 2: Chapter 13)	1hour
4.5	Expectation maximization (EM) for soft clustering (TB 2: Chapter 13)	1hour

4.6	Dimensionality reduction – Principal Component Analysis (TB 1: Section 6.3)	1hour
4.7	Dimensionality reduction – Principal Component Analysis (TB 1: Section 6.3)	1hour
4.8	Factor Analysis (TB 1: Section 6.4)	1hour
4.9	Multidimensional scaling (TB 1: Section 6.5)	1hour
4.10	Linear Discriminant Analysis (TB 1: Section 6.6)	1hour
Module 5 : Classification Assessment (8 hours)		
5.1	Performance measures - Precision, Recall, Accuracy, F-Measure, ROC, AUC. (TB 2: Chapter 22.1)	1hour
5.2	Boot strapping, Cross validation	1hour
5.3	Ensemble methods- bagging	1hour
5.4	Ensemble methods- boosting	1hour
5.5	Bias-Variance decomposition (TB 2: Chapter 22.3)	1hour
5.6	Bias-Variance decomposition (TB 2: Chapter 22.3)	1hour
5.7	Face detection (TB 3: Chapter 5 Section Application: A Face Detection Pipeline)	1hour
5.8	Face detection (TB 3: Chapter 5 Section Application: A Face Detection Pipeline)	1hour

CST 385	CLIENT SERVER SYSTEMS	Category	L	T	P	Credit	Year of Introduction
		VAC	3	1	0	4	2019

Preamble:

The syllabus is prepared with the view of preparing the Engineering Graduates to build effective Client/Server applications. This course aims at providing a foundation in decentralized computer systems, using the client/server model. The course content is decided to cover the essential fundamentals which can be taught within the given slots in the curriculum.

Prerequisite: **Basic knowledge in Computer**

Course Outcomes: After the completion of the course the student will be able to

	Course Outcomes
CO 1	Identify the basics of client/server systems and the driving force behind the development of client/server systems**(Cognitive Knowledge Level: Understand)**
CO 2	Outline the architecture and classifications of client/server systems**(Cognitive Knowledge Level: Understand)**
CO 3	Summarize the client/server network services for an application**(Cognitive Knowledge Level: Understand)**
CO 4	Identify management services and issues in network **(Cognitive Knowledge Level: Understand)**
CO 5	Outline the Client/Server technology in respect of databases and Client/Server database architecture **(Cognitive Knowledge Level: Understand)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓										✓
CO2	✓	✓										✓
CO3	✓	✓										✓
CO4	✓											✓
CO5	✓	✓										✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks
	Test 1 (Percentage)	Test 2 (Percentage)	
Remember	40	40	40
Understand	40	40	40
Apply	20	20	20
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : **10 marks**

Continuous Assessment Test 1 (for theory, for 2 hrs) : **20 marks**

Continuous Assessment Test 2 (for lab, internal examination, for 2hrs) : **20 marks**

Internal Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 5 questions with 2 questions from each module (2.5 modules x 2 = 5), having 3 marks for each question. Students should answer all questions. Part B also contains 5 questions with 2 questions from each module (2.5 modules

x 2 = 5), of which a student should answer any one. The questions should not have sub-divisions and each one carries 7 marks.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Sample Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Computing in client server architecture over Mainframe architecture has certain advantages and disadvantages. Describe at least three advantages and disadvantages for each architecture.

Course Outcome 2 (CO2):

1. Explain the role of mainframe-centric model in Client/Server computing?

Course Outcome 3(CO3):

1. Describe the client server system development methodology? Explain different phases of System Integration Life-Cycle.

Course Outcome 4 (CO4):

1. Explain about network management and remote system management. How can security be provided to the network?

Course Outcome 5 (CO5):

1. Explain various types of Client/Server Database Architecture

Syllabus

Module – 1 (Introduction)

Introduction to Client/Server computing - Basic Client/Server Computing Model, Server for Every Client- File Server, Print Server, Application Server, Mail Server, Directory Services Server, Web Server, Database Server, Transaction Servers. Client/Server-Fat or Thin, Stateless

or Stateful, Servers and Mainframes, Client/Server Functions. Driving Forces behind Client/Server Computing- Business Perspective, Technology Perspective.

Module -2 (Client/Server Classification)

Client/Server Types-Single Client/Single Server, Multiple Clients/Single Server, Multiple Clients/Multiple Servers, Integration With Distributed Computing, Alternatives To Client/Server Systems. Classification of Client/Server Systems- Two-Tier Computing, Middleware, Three-Tier Computing- Model View Controller (MVC), Principles behind Client/Server Systems.Client/Server Topologies. Existing Client/Server Architecture. Architecture for Business Information System.

Module -3 (Client/Server Application Components)

Client- Services, Request for services, RPC, Windows services, Print services, Remote boot services, other remote services, Utility Services. Server- Detailed server functionality, Network operating system, Available platforms, Server operating system. Organizational Expectations, Improving performance of client/server applications, Single system image, Downsizing and Rightsizing, Advantages and disadvantages of Client/Server computing, Applications of Client/Server.

Module -4 (Client/ Server Systems Services and Support)

Services and Support- System administration, Availability, Reliability, Scalability, Observability, Agility, Serviceability. Software Distribution, Performance, Network management. Remote Systems Management- RDP, Telnet, SSH, Security. LAN and Network Management issues.

Module -5(Client/Server Technology and Databases)

Client/Server Technology and Databases - Storing Data, Database System Architectures. Client/Server In Respect Of Databases- Client/Server Databases, Client/Server Database Computing, Database Computing Vs. Mainframe, PC/File Server Computing. Client/Server Database Architecture - Process-Per-Client Architecture, Multi-Threaded Architecture, Hybrid Architecture. Database Middleware Component - Application Programming Interface, Database Translator, Network Translator.

Text Book

1. Patrick Smith &Steve Guengerich, Client / Server Computing, PHI

2. Subhash Chandra Yadav, Sanjay Kumar Singh, An Introduction to Client/Server Computing, New Age International Publishers

Reference Books

1. Jeffrey D.Schank, "Novell's Guide to Client-Server Application & Architecture" Novell Press

2. Robert Orfali, Dan Harkey, Jeri Edwards, Client/Server Survival Guide, Wiley-India Edition, Third Edition

3. Dawna Travis Dewire, Client Server Computing — McGraw Hill

4. W.H.Inman, Developing Client Server Applications, BPB

Model Question Paper

QP CODE: **PAGES: ___**

Reg No:_____

Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIFTH SEMESTER B.TECH DEGREE EXAMINATION(MINOR), MONTH & YEAR

Course Code: CST 385

Course Name : Client Server Systems

Max Marks: 100 **Duration: 3 Hours**

PART-A

(Answer All Questions. Each question carries 3 marks)

1. Differentiate between Stateful and Stateless servers
2. List the different phases and activities of client/server system development methodology.
3. How does transmission protocol work in client/server applications?
4. List any six services in single system image environment.
5. Specify the role of the client in Client/Server computing and also list any six services provided by the client.
6. Why do most RPC system support call by value semantics for parameter passing?
7. What do you mean by a thin client network? List three advantages of the Thin

Client Network system.

8. How are connectivity and interoperability between .client/server achieved?

9. One disadvantage of the Client/Server system is lack of control in a Database Management environment. Justify.

10. Explain the DBMS concept in client/server architecture.

(10x3=30)

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11. (a) Differentiate between Transaction server and Data server system with examples. **(7)**

(b) Computing in client server architecture over Mainframe architecture has certain advantages and disadvantages. Describe at least three advantages and disadvantages for each architecture. **(7)**

OR

12. (a) Explain various Clients/Server system development tools. **(6)**

(b) Classify and describe the driving forces that drive the move to Client/Server computing. **(8)**

13. (a) Explain the role of mainframe-centric model in Client/Server computing? **(5)**

(b) Describe the three types of Client/Server systems in existence **(9)**

OR

14. (a) List and explain the general forces behind the architecture for business information systems **(7)**

(b) Explain the different distribution styles. **(7)**

15. (a) Illustrate the concept of rightsizing and downsizing in Client/Server Computing **(7)**

(b) What is client server system development methodology? Explain the **(7)**

different phases of System Integration Life-Cycle.

OR

16. (a) In Client/Server computing, explain the following with examples **(10)**
    i. Dynamic Data Exchange
    ii. RPC, Remote Procedure Call
    iii. Remote Boot Service
    iv. Diskless Computer
    v. Object-linking and embedding

    (b) Explain the functions and features of Network Operating System **(4)**

17. (a) Explain about network management and remote system management. How can security be provided to the network ? **(10)**

    (b) In client server architecture, what do you mean by Availability, Reliability, Serviceability and Security? Explain with examples. **(4)**

OR

18. (a) Client server is modular infrastructure, this is intended to improve Usability, Flexibility, Interoperability and Scalability. Explain each term with an example, in each case how it helps to improve the functionality of client server architecture. **(7)**

    (b) Explain about network management and remote system management. How can security be provided to network? **(7)**

19. (a) Explain the different types of Client/Server Database Architecture **(9)**

    (b) List and explain the main components of Database middleware **(5)**

OR

20. (a) Discuss types of database utilities, tools and their functions **(7)**

    (b) Discuss about the role of traditional and web databases in handling client/server based applications. **(7)**

Teaching Plan

Module- 1(Introduction)		**(10 hours)**
1.1	Basic Client/Server Computing Model	1 hour
1.2	Server for Every Client- File Server, Print Server	1 hour
1.3	Application Server, Mail Server, Directory Services Server	1 hour
1.4	Web Server, Database Server	1 hour
1.5	Transaction Servers	1 hour
1.6	Client/Server-Fat or Thin	1 hour
1.7	Stateless or Stateful	1 hour
1.8	Servers and Mainframes	1 hour
1.9	Client/Server Functions	1 hour
1.10	Driving Forces behind Client/Server Computing- Business Perspective, Technology Perspective	1 hour
Module- 2 (Client/Server Classification)		**(10 hours)**
2.1	Client/Server Types-Single Client/Single Server	1 hour
2.2	Multiple Clients/Single Server, Multiple Clients/Multiple Servers	1 hour
2.3	Integration With Distributed Computing	1 hour
2.4	Alternatives To Client/Server Systems	1 hour
2.5	Classification of Client/Server Systems- Two-Tier Computing, Middleware	1 hour
2.6	Three-Tier Computing- Model View Controller (MVC)	1 hour
2.7	Principles behind Client/Server Systems.	1 hour
2.8	Client/Server Topologies	1 hour
2.9	Existing Client/Server Architecture	1 hour
2.10	Architecture for Business Information System	1 hour
Module -3 (Client/Server Application Components)		**(9 hours)**
3.1	The client: Services, Request for services, RPC	1 hour
3.2	Windows services, Print services, Remote boot services	1 hour

3.3	Utility Services & Other Services	1 hour
3.4	Server- Detailed server functionality, Network operating system	1 hour
3.5	Available platforms, Server operating system	1 hour
3.6	Organizational Expectations, Improving performance of client/server applications	1 hour
3.7	Single system image, Downsizing and Rightsizing	1 hour
3.8	Advantages and disadvantages of Client/Server computing	1 hour
3.9	Applications of Client/Server	1 hour
Module -4 (Client/ Server Systems Services and Support)		**(8 hours)**
4.1	Services and Support, System administration	1 hour
4.2	Availability, Reliability	1 hour
4.3	Scalability, Observability, Agility	1 hour
4.4	Serviceability, Software Distribution	1 hour
4.5	Performance	1 hour
4.6	Network management	1 hour
4.7	Remote Systems Management- RDP, Telnet, SSH	1 hour
4.8	Security, LAN and Network Management issues	1 hour
Module -5(Client/Server Technology and Databases)		**(8 hours)**
5.1	Client/Server Technology and Databases - Storing Data	1 hour
5.2	Database System Architectures	1 hour
5.3	Client/Server In Respect Of Databases- Client/Server Databases	1 hour
5.4	Client/Server Database Computing	1 hour
5.5	Database Computing Vs. Mainframe, PC/File Server Computing	1 hour
5.	Client/Server Database Architecture - Process-Per-Client Architecture	1 hour
5.7	Multi-Threaded Architecture, Hybrid Architecture	1 hour
5.8	Database Middleware Component - Application Programming Interface, Database Translator, Network Translator	1 hour

SEMESTER V

HONOURS

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
ERT393	FPGA Based System Design	VAC	3	1	0	4

Preamble: This course aims to develop the skill of FPGA based system design.

Prerequisite: ERT 203 Digital Systems and VLSI Design

Course Outcomes: After the completion of the course the student will be able to

CO 1	Design simple digital systems with programmable logic devices **(Cognitive Knowledge Level: Apply)**
CO 2	Explain the programmable logic devices **(Cognitive Knowledge Level: Understand)**
CO 3	Explain the architecture of FPGA **(Cognitive Knowledge Level: Understand)**
CO 4	Understand the design considerations of FPGA **(Cognitive Knowledge Level: Understand)**
CO 5	Design simple combinational and sequential circuits using FPGA **(Cognitive Knowledge Level: Understand)**

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	✓	✓			✓							✓
CO 2	✓	✓			✓							✓
CO 3	✓	✓			✓							✓
CO 4	✓	✓			✓							✓
CO 5	✓	✓			✓							✓

Abstract POs defined by National Board of Accreditation		
Broad PO	**PO#**	**Broad PO**
Engineering Knowledge	**PO7**	Environment and Sustainability
Problem Analysis	**PO8**	Ethics
Design/Development of solutions	**PO9**	Individual and teamwork
Conduct investigations of complex problems	**PO10**	Communication
Modern tool usage	**PO11**	Project Management and Finance
The Engineer and Society	**PO12**	Lifelong learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	10

Understand	30	30	60
Apply	10	10	30
Analyse	-	-	-
Evaluate	-	-	-
Create	-	-	-

Mark Distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance: 10marks

Continuous Assessment Test (2numbers): 25marks

Assignment/Quiz/Course project: 15marks

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): Design simple digital systems with programmable logic devices

1. Design simple digital systems with programmable logic devices.
2. Design a decade counter using Verilog.
3. Implement a full adder using ROM

Course Outcome 2 (CO2): Explain the programmable logic devices

1. Differentiate PLA with PAL.
2. Design the function F=XYZ'+Y' Z+X Y' using PLA

Course Outcome 3 (CO3): Explain the architecture of FPGA

1. Compare coarse- and fine-grained FPGA.
2. Explain the architecture of logic block of FPGA

Course Outcome 4 (CO4): Understand the design considerations of FPGA

1. What are the vendor specific issues in FPGA design.
2. Compare Timing and Power dissipation in a typical FPGA.

Course Outcome 5 (CO5): Design simple combinational and sequential circuits using FPGA.

1. Implement a counter in Xilinx Virtex.
2. Explain how sequential circuit can be mapped into Xilinx Virtex LUT.

SYLLABUS

Module 1: Introduction

Digital system design options and tradeoffs, Design methodology and technology overview, High Level System Architecture and Specification: Behavioral modelling and simulation, Hardware description languages (emphasis on Verilog), combinational and sequential design, state machine design, synthesis issues, test benches.

Module 2: Programmable logic Devices

ROM, PLA, PAL, CPLD, FPGA Features, Limitations, Architectures and Programming. Implementation of MSI circuits using Programmable logic Devices.

Module 3: FPGA architecture

FPGA Architectural options, granularity of function and wiring resources, coarse V/s fine grained, Logic block architecture: FPGA logic cells, timing models, I/O block architecture: Input and Output cell characteristics, clock input, Timing

Module 4: Placement and Routing

Programmable interconnect - Partitioning and Placement, Routing resources, delays. Applications - Embedded system design using FPGAs, DSP using FPGAs

Module 5: Commercial FPGAs

Xilinx (Different series description only), Case study Xilinx Virtex: implementation of simple combinational and sequential circuits.

Text Books

1. FPGA-Based System Design Wayne Wolf, Verlag: Prentice Hall
2. Modern VLSI Design: System-on-Chip Design (3rd Edition) Wayne Wolf, Verlag

References:

1. Field Programmable Gate Array Technology - S. Trimberger, Edr, 1994, Kluwer Academic
2. Digital Design Using Field Programmable Gate Array, P.K. Chan & S. Mourad, 1994,
3. Prentice Hall
4. Field programmable gate array, S. Brown, R.J. Francis, J. Rose, Z.G. Vranesic, 2007, BS

Model Question Paper

Reg No.:_____ **Name:_____**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
FIFTH SEMESTER B. TECH DEGREE EXAMINATION

MONTH AND YEAR
Course Code: ERT393 FPGA Based System Design

Course Name: EMBEDDED SYSTEMS

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all questions, each carries 3 marks

1. What are the synthesis issues in FPGA design? K2
2. Describe FPGA design methodology. K2
3. Differentiate PLA with PAL K2
4. What are the limitations of FPGA. K2
5. Compare coarse- and fine-grained FPGA architecture. K2
6. What are the timing models in logic block architecture. K2
7. List the applications of FPGA. K2
8. Describe routing resources in FPGA routing. K2
9. Describe how a combinational circuit can be mapped into Xilinx Virtex LUT. K2
10. List different commercially available FPGAs. K2

PART B

Answer any one full question from each module. Each question carries 14 Marks

Module1

11. (a) Design a full adder using Verilog. 7 CO1 K3
    (b) Explain behavioural modelling and simulation with an example. 7 CO1 K2

OR

12. (a) What is FSM? How it is used for FPGA. 7 CO1 K2
    (b) Explain the purpose of test bench and how it is written in a HDL. 7 CO1 K2

Module2

13. (a)Design the function F=XYZ'+Y' Z+X Y' using PLA 8 CO2 K3
    (b) Compare CPLD with FPGA 6 CO2 K2

OR

14. (a) Implement the following Boolean function using PAL: 8 CO2 K3
    $F(w, x, y, z) = \Sigma m (0, 2, 4, 10, 11, 12, 14, 15)$
    (b) Draw the structure of PAL and explain it. 6 CO2 K2

Module3

15. (a) Draw and explain I/O block architecture of FPGA. 7 CO2 K2
    (b) Draw and explain coarse grained FPGA architecture. 7 CO2 K2

OR

16. (a) Explain timing in Logic block and I/O block. 7 CO2 K2
    (b) Draw and explain fine grained FPGA architecture. 7 CO2 K2

Module-4

17. (a) Explain partitioning and placement processes in FPGA 8 CO4 K2
    (b) Explain embedded system design using FPGAs 6 CO4 K2

OR

18. (a) Explain the delays associated with placement and routing 7 CO4 K2
    (b) Explain DSP design using FPGAs 7 CO4 K2

Module 5

19. (a) With neat diagram explain the architecture of Xilinx Virtex IOB. 7 CO3 K2
(b) Design a four bit up counter with parallel load feature using Xilinx Virtex. 7 CO3 K3

OR

20. (a) Explain the mapping of combinational and sequential circuits using LUTs. 5 CO3 K3
(b) Explain the architecture of Xilinx Virtex CLB 9 CO3 K2

Course Contents and Lecture Schedule:

No	Topic	No. of Lectures (40 hours)
1	**Introduction**	**(9 hours)**
1.1	Digital system design options and tradeoffs	1
1.2	Design methodology and technology overview	1
1.3	High Level System Architecture and Specification: Behavioral modelling and simulation – Lecture 1	1
1.4	High Level System Architecture and Specification: Behavioral modelling and simulation - Lecture 2	1
1.5	Hardware description languages, combinational and sequential design - Lecture 1	1
1.6	Hardware description languages, combinational and sequential design - Lecture 2	1
1.7	State machine design, synthesis issues, test benches. - Lecture 1	1
1.8	State machine design, synthesis issues, test benches. - Lecture 2	1
1.9	State machine design, synthesis issues, test benches. - Lecture 3	1
2	**Programmable logic Devices**	**(9 hours)**
2.1	ROM, PLA - Lecture 1	1
2.2	ROM, PLA - Lecture 2	1
2.3	PAL, CPLD - Lecture 1	1
2.4	PAL, CPLD - Lecture 2	1
2.5	FPGA Features, Limitations, Architectures and Programming. - Lecture 1	1
2.6	FPGA Features, Limitations, Architectures and Programming. - Lecture 2	1
2.7	Implementation of MSI circuits using Programmable logic - Lecture 1	1
2.8	Implementation of MSI circuits using Programmable logic - Lecture 2	1
2.9	Implementation of MSI circuits using Programmable logic - Lecture 3	1
3	**FPGA architecture**	**(7 hours)**

3.1	FPGA Architectural options	1
3.2	Granularity of function and wiring resources, coarse V/s fine grained - Lecture 1	1
3.4	Granularity of function and wiring resources, coarse V/s fine grained - Lecture 2	1
3.3	Logic block architecture: FPGA logic cells, timing models - Lecture 1	1
3.5	Logic block architecture: FPGA logic cells, timing models - Lecture 2	1
3.6	I/O block architecture: Input and Output cell characteristics, clock input, Timing - Lecture 1	1
3.7	I/O block architecture: Input and Output cell characteristics, clock input, Timing - Lecture 2	1
4	**Placement and Routing**	**(7 hours)**
4.1	Programmable interconnect - Partitioning and Placement - Lecture 1	1
4.2	Programmable interconnect - Partitioning and Placement - Lecture 2	1
4.3	Routing resources, delays - Lecture 1	1
4.4	Routing resources, delays - Lecture 2	1
4.5	Applications -Embedded system design using FPGAs, DSP using FPGAs – Lecture 1	1
4.6	Applications -Embedded system design using FPGAs, DSP using FPGAs - Lecture 2	1
4.7	DSP using FPGAs	1
5	**Commercial FPGAs**	**(8 hours)**
5.1	Xilinx (Different series description only) - Lecture 1	1
5.2	Xilinx (Different series description only) - Lecture 2	1
5.3	Case study Xilinx Virtex - Lecture 1	1
5.4	Case study Xilinx Virtex - Lecture 2	1
5.5	Case study Xilinx Virtex - Lecture 3	1
5.6	Implementation of simple combinational and sequential circuits - Lecture 1	1
5.7	Implementation of simple combinational and sequential circuits - Lecture 2	1
5.8	Implementation of simple combinational and sequential circuits - Lecture 3	1

CST 393	CRYPTOGRAPHIC ALGORITHMS	Category	L	T	P	Credit	Year of Introduction
		VAC	3	1	0	4	2019

Preamble:

The course on Cryptographic Algorithms aims at exploring various algorithms deployed in offering confidentiality, integrity, authentication and non-repudiation services. This course covers classical encryption techniques, symmetric and public key crypto-system, key exchange and management, and authentication functions. The concepts covered in this course enable the learners in effective use of cryptographic algorithms for real life applications.

Prerequisite: A sound background in Number Theory**.**

Course Outcomes: After the completion of the course the student will be able to

CO1	Identify the security services provided for different types of security attacks. (**Cognitive Knowledge Level : Understand**)
CO2	Summarize the classical encryption techniques for information hiding. (**Cognitive Knowledge Level: Apply**)
CO3	Illustrate symmetric / asymmetric key cryptographic algorithms for secure communication.(**Cognitive Knowledge Level: Apply**)
CO4	Interpret key management techniques for secure communication.(**Cognitive Knowledge Level: Understand)**
CO5	Summarize message authentication functions in a secure communication scenario.(**Cognitive Knowledge Level: Understand**)

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO 9	PO1 0	PO11	PO1 2
CO1	✓	✓	✓									✓

CO2	✓	✓	✓		✓	✓						✓
CO3	✓	✓	✓	✓	✓	✓						✓
CO4	✓	✓	✓	✓	✓	✓						✓
CO5	✓	✓	✓	✓	✓	✓						✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination Marks**
	Test1 (Percentage)	**Test2 (Percent**	

		age)	
Remember	**30**	**30**	**30**
Understand	**30**	**30**	**30**
Apply	**40**	**40**	**40**
Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	**CIE Marks**	**ESE Marks**	**ESE Duration**
150	**50**	**100**	**3 hours**

Continuous Internal Evaluation Pattern:

Attendance **: 10 marks**

Continuous Assessment Tests **: 25 marks**

Continuous Assessment Assignment **: 15 marks**

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks.

First Internal Examination shall be preferably conducted after completing the first half of the syllabus and the Second Internal Examination shall be preferably conducted after completing remaining part of the syllabus.

There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly covered module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly covered module), each with 7 marks. Out of the 7 questions in Part B, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

Syllabus

Module-1 (Introduction to the Concepts of Security)

Need for security, Security approaches, Principles of security, Types of attacks, OSI Security Architecture, Classical encryption techniques - Substitution techniques, Transposition techniques. Stream cipher, Block cipher, Public key cryptosystems vs. Symmetric key cryptosystems, Encrypting communication channels.

Module-2 (Symmetric Key Cryptosystems)

Overview of symmetric key cryptography, Block cipher principles, Data Encryption Standard (DES), Differential and Linear cryptanalysis, Double DES, Triple DES, International Data Encryption Algorithm (IDEA), Advanced Encryption Algorithm (AES),Block cipher modes of operation, Stream cipher, RC4.

Module-3 (Public Key Cryptosystems)

Principles of public key cryptosystems, RSA algorithm, RSA illustration, Attacks, ElGamal cryptographic system, Knapsack algorithm, Diffie-Hellman key exchange algorithm, Elliptical curve cryptosystems.

Module-4 (Key Management)

Symmetric key distribution using symmetric encryption, Symmetric key distribution using asymmetric encryption, Distribution of public keys, Generating keys, transferring keys, Verifying keys, Updating keys, Storing keys, Backup keys, Compromised keys, Public key infrastructure.

Module – 5 (Authentication)

Authentication requirements, Authentication functions, Message authentication codes (MAC), Hash functions, Security of Hash functions and MAC, Message Digest 5 (MD5), Secure Hash Algorithm (SHA)-512, Hash-based Message Authentication Code (HMAC), Cipher-based Message Authentication Code (CMAC), X.509 Authentication services.

Text Books

1. William Stallings, Cryptography and Network Security Principles and Practice, Pearson Edu, 6e.
2. Bruice Schneier, Applied Cryptography Protocols, Algorithms and source code in C, Wiley,2e.

References

1. Behrouz A. Forouzan, Cryptography and Network Security, McGraw Hill, 2e.

2. Johannes A. Buchmann, Introduction to Cryptography, Springer, 2e.

3. DouglasR. Stinson, Cryptography Theory and Practice, 3e,Chapman & Hall/CRC, 2006.

4. Bernard Menezes, Network Security and Cryptography, Cengage Learning, 2011.

Sample Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Consider an automated teller machine (ATM) in which users provide a personal identification number (PIN) and a card for account access. Give examples of confidentiality, integrity, and availability requirements associated with the system and, in each case, indicate the degree of importance of the requirement.

2. Discuss the different security services provided for preventing security attacks.

Course Outcome 2 (CO2):

1. The encryption key in a transposition cipher is (3,2,6,1,5,4). Find the decryption key

2.Discuss the process of encryption in Vernam cipher

Course Outcome 3 (CO3):

1. Devise a meet-in-the-middle attack for a triple DES.

2. Write an algorithm for the InvSubBytes transformation and implement using python (**Assignment**)
3. Consider the following elliptic curve signature scheme. We have a global elliptic curve, prime *p*, and "generator" G. Alice picks a private signing key X_A and forms the public verifying $Y_A = X_AG$. To sign a message *M*:
    - Alice picks a value k
    - Alice sends Bob *M*, k and the signature $S = M - kX_AG$.
    - Bob verifies that $M=S+kY_A$.

    Show that the verification process produces an equality if the signature is valid.
4. Write an algorithm to add two points on an elliptic curve over GF(*p*) and implement using Python. **(Assignment)**
5. Write an algorithm for encryption using knapsack cryptosystem and implement using Java. **(Assignment)**

Course Outcome4 (CO4):

1. List four general categories of schemes for the distribution of public keys.
2. What are the essential ingredients of a public-key directory?

Course Outcome 5 (CO5):

1. State the value of the length field in SHA-512 if the length of the message is 1919 bits and 1920 bits.
2. Write an algorithm in pseudo code for HMAC and implement using Python (**Assignment**)

Model Question Paper

QP CODE:
Reg No:_____
Name :_____ **PAGES : 3**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIFTH SEMESTER B.TECH DEGREE EXAMINATION(HONORS), MONTH & YEAR

Course Code: CST 393

Course Name: Cryptographic Algorithms

Max.Marks:100 **Duration: 3 Hours**

PART A

Answer all Questions. Each question carries 3 Marks

1. State the two approaches in attacking a cipher.

2. Define Substitution Cipher. Encrypt using one time pad M = HONORS and K = CIPHER.

3. Specify the purpose of S-Boxes in Data Encryption Standard (DES).

4. Differentiate between diffusion and confusion.

5. Perform encryption using RSA Algorithm for the following p=7; q=11; e=13; M=5.

6. Is Diffie-Hellman key exchange protocol vulnerable? Justify.

7. List the techniques for distribution of public keys.

8. Define a certificate authority and its relation to public key cryptography.

9. Distinguish between integrity and message authentication.

10. What types of attacks are addressed by message authentication?

(10x3=30)

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11. (a) With a neat sketch, Explain OSI Security architecture model. **(8)**

(b) How does link encryption differ from end-to-end encryption? Explain. **(6)**

OR

12. (a) Encrypt the text "cryptography" using the Hill Cipher with the key $\begin{pmatrix} 9 & 4 \\ 5 & 7 \end{pmatrix}$. Show the calculations. **(8)**

(b) Illustrate the steps involved in encrypting a plain text using playfair cipher with an example. **(6)**

13. (a) With a neat sketch, explain a single round in DES. **10**

(b) Explain encryption and decryption using 2 keys and 3 keys of triple DES. **(4)**

OR

14. (a) Explain the block cipher modes i) Cipher feedback mode ii) Output feedback mode. **(8)**

(b) Describe the four types of transformations in AES. **(6)**

15. (a) Write an algorithm for generating public and private key using Elliptical curve cryptography. **(10)**

(b) The equation $y^2=x^3+x+1$, the calculation is done modulo 13. Add two points R= P+Q, where P= (4,2) and Q= (10,6). **(4)**

OR

16. User A and B use the Diffie-Hellman key exchange technique with a common prime q=71 and primitive root alpha=7.

(a) If user A has private key X_A =3, What is A's public key Y_A? **(7)**

(b) If user B has private key X_B =6, What is A's public key Y_B? **(7)**

17. (a) Define a session key and show how a KDC can create can create a session key between Alice and Bob. **(7)**

(b) What are the requirements for the use of a public-key certificate scheme? **(7)**

OR

18. (a) What are the core components of a PKI? Briefly describe each component. **(8)**

(b) Describe the following (i) Updating keys (ii) Compromised Keys. **(6)**

19. (a) Describe how SHA-512 logic produce message digest **(10)**

(b) Distinguish between HMAC and CMAC **(4)**

OR

20. (a) Specify the format for X.509 certificate. Explain the steps required to obtain user's certificate. **(7)**

(b) With suitable block diagrams, explain the types of functions that may be used to produce an authenticator. **(8)**

Teaching Plan

No	Contents	No of Lecture Hrs
Module - 1 (Introduction to the Concepts of Security) (9 hrs)		
1.1	Need for security, Security approaches	1 hour
1.2	Principles of security, Types of attacks	1 hour
1.3	OSI Security Architecture	1 hour
1.4	Classical encryption techniques: Substitution techniques(Caesar cipher, Monoalphabetic cipher, Playfair cipher)	1 hour
1.5	Classical encryption techniques: Substitution techniques (Hill cipher, Polyalphabetic cipher, One-time pad)	1 hour
1.6	Classical encryption techniques: Transposition techniques	1 hour
1.7	Stream cipher, Block cipher	1 hour
1.8	Public- key cryptosystems vs. Symmetric key cryptosystems	1 hour
1.9	Encrypting communication channels	1 hour
Module - 2 (Symmetric key cryptosystems) (11 hrs)		
2.1	Overview of symmetric key cryptography	1 hour
2.2	Block cipher principles	1 hour
2.3	Data Encryption Standard (DES)	1 hour
2.4	DES design criteria	1 hour
2.5	Differential and Linear cryptanalysis	1 hour
2.6	Double DES, Triple DES	1 hour

2.7	IDEA	1 hour
2.8	Advanced Encryption Algorithm (AES structure)	1 hour
2.9	Advanced Encryption Algorithm (Transformations)	1 hour
2.10	Block cipher modes of operation	1 hour
2.11	Stream cipher, RC4	1 hour
Module - 3 (Public key cryptosystems) (8 hrs)		
3.1	Principles of public key cryptosystems	1 hour
3.2	RSA algorithm	1 hour
3.3	RSA illustration, Attacks	1 hour
3.4	ElGamal cryptographic system	1 hour
3.5	Knapsack algorithm	1 hour
3.6	Diffie-Hellman key exchange algorithm	1 hour
3.7	Elliptical curve cryptosystems(Elliptical curve arithmetic)	1 hour
3.8	Elliptical curve cryptosystems (Elliptical curve algorithm)	1 hour
Module - 4 (Key Management) (8 hrs) [Text book-2]		
4.1	Symmetric key distribution using symmetric encryption	1 hour
4.2	Symmetric key distribution using asymmetric encryption	1 hour
4.3	Distribution of public keys	1 hour
4.4	Generating keys, Transferring keys	1 hour

4.5	Verifying keys, Updating keys	1 hour
4.6	Storing keys, Backup keys	1 hour
4.7	Compromised keys	1 hour
4.8	Public key infrastructure	1 hour
Module - 5 (Authentication) (9 hrs)		
5.1	Authentication requirements	1 hour
5.2	Authentication functions	1 hour
5.3	Message Authentication Codes (MAC)	1 hour
5.4	Hash functions	1 hour
5.5	Security of Hash functions and MAC	1 hour
5.6	MD5	1 hour
5.7	SHA-512	1 hour
5.8	HMAC, CMAC	1 hour
5.9	X.509 Authentication services	1 hour

CST 395	NEURAL NETWORKS AND DEEP LEARNING	Category	L	T	P	Credit	Year of Introduction
		VAC	3	1	0	4	2019

Preamble:

Neural networks is a biologically inspired programming paradigm which enables a computer to learn from observational data and deep learning is a powerful set of techniques for training neural networks. This course introduces the key concepts in neural networks, its architecture and learning paradigms, optimization techniques, basic concepts in deep learning, Convolutional Neural Networks and Recurrent Neural Networks. The students will be able to provide best solutions to real world problems in domains such as computer vision and natural language processing.

Prerequisite: A Sound knowledge in Computational fundamentals of machine learning

Course Outcomes: After the completion of the course the student will be able to

CO1	Demonstrate the basic concepts of machine learning models and performance measures. **(Cognitive Knowledge Level : Understand)**
CO2	Illustrate the basic concepts of neural networks and its practical issues**(Cognitive Knowledge Level : Apply)**
CO3	Outline the standard regularization and optimization techniques for deep neural networks (**Cognitive Knowledge Level : Understand)**
CO4	Build CNN and RNN models for different use cases. **(Cognitive Knowledge Level : Apply)**
CO5	Explain the concepts of modern RNNs like LSTM, GRU **(Cognitive Knowledge Level : Understand)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓								✓
CO2	✓	✓	✓	✓								✓
CO3	✓	✓	✓	✓								✓
CO4	✓	✓	✓	✓	✓	✓						✓
CO5	✓	✓	✓	✓								✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks
	Test1 (%)	Test2 (%)	
Remember	**30**	**30**	**30**
Understand	**40**	**40**	**40**
Apply	**30**	**30**	**30**
Analyse			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	**50**	**100**	**3 hours**

Continuous Internal Evaluation Pattern

Attendance **10 marks**

Continuous Assessment Tests **25 marks**

Continuous Assessment Assignment **15 marks**

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. First Internal Examination shall be preferably conducted after completing the first half of the syllabus and the Second Internal Examination shall be preferably conducted after completing the remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly covered module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly covered module), each with 7 marks. Out of the 7 questions in Part B, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B

contains 2 questions from each module of which a student should answer any one. Each question can have a maximum 2 subdivisions and carry 14 marks.

Syllabus

Module - 1 (Basics of Machine Learning)

Machine Learning basics - Learning algorithms - Supervised, Unsupervised, Reinforcement, Overfitting, Underfitting, Hyper parameters and Validation sets, Estimators -Bias and Variance. Challenges in machine learning. Simple Linear Regression, Logistic Regression, Performance measures - Confusion matrix, Accuracy, Precision, Recall, Sensitivity, Specificity, Receiver Operating Characteristic curve(ROC), Area Under Curve(AUC).

Module -2 (Neural Networks)

Introduction to neural networks -Single layer perceptrons, Multi Layer Perceptrons (MLPs), Representation Power of MLPs, Activation functions - Sigmoid, Tanh, ReLU, Softmax. Risk minimization, Loss function, Training MLPs with backpropagation, Practical issues in neural network training - The Problem of Overfitting, Vanishing and exploding gradient problems, Difficulties in convergence, Local and spurious Optima, Computational Challenges. Applications of neural networks.

Module 3 (Deep learning)

Introduction to deep learning, Deep feed forward network, Training deep models, Optimization techniques - Gradient Descent (GD), GD with momentum, Nesterov accelerated GD, Stochastic GD, AdaGrad, RMSProp, Adam. Regularization Techniques - L1 and L2 regularization, Early stopping, Dataset augmentation, Parameter sharing and tying, Injecting noise at input, Ensemble methods, Dropout, Parameter initialization.

Module -4 (Convolutional Neural Network)

Convolutional Neural Networks – Convolution operation, Motivation, Pooling, Convolution and Pooling as an infinitely strong prior, Variants of convolution functions, Structured outputs, Data types, Efficient convolution algorithms. Practical use cases for CNNs, Case study - Building CNN model AlexNet with handwritten digit dataset MNIST.

Module- 5 (Recurrent Neural Network)

Recurrent neural networks – Computational graphs, RNN design, encoder – decoder sequence to sequence architectures, deep recurrent networks, recursive neural networks, modern RNNs LSTM and GRU, Practical use cases for RNNs. Case study - Natural Language Processing.

Text Book

1. Goodfellow, I., Bengio,Y., and Courville, A., Deep Learning, MIT Press, 2016.
2. Neural Networks and Deep Learning, Aggarwal, Charu C., c Springer International Publishing AG, part of Springer Nature 2018
3. Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms (1st. ed.). Nikhil Buduma and Nicholas Locascio. 2017. O'Reilly Media, Inc.

Reference Books

1. Satish Kumar, Neural Networks: A Classroom Approach, Tata McGraw-Hill Education, 2004.
2. Yegnanarayana, B., Artificial Neural Networks PHI Learning Pvt. Ltd, 2009.
3. Michael Nielsen, Neural Networks and Deep Learning, 2018

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Predict the price of a 1000 square feet house using the regression model generated from the following data.

No.	Square feet	Price(Lakhs)
1	500	5
2	900	10
3	1200	13
4	1500	18
5	2000	25
6	2500	32
7	2700	35

2. Consider a two-class classification problem of predicting whether a photograph contains a man or a woman. Suppose we have a test dataset of 10 records with expected outcomes and a set of predictions from our classification algorithm. Compute the confusion matrix, accuracy, precision, recall, sensitivity and specificity on the following data.

Sl.**No.**	Actual	Predicted
1	man	woman
2	man	man
3	woman	woman
4	man	man

5	man	woman
6	woman	woman
7	woman	man
8	man	man
9	man	woman
10	woman	woman

Course Outcome 2 (CO2):

1. Suppose you have a 3-dimensional input x = (x1, x2, x3) = (2, 2, 1) fully connected with weights (0.5, 0.3, 0.2) to one neuron which is in the hidden layer with sigmoid activation function. Calculate the output of the hidden layer neuron.
2. Consider the case of the XOR function in which the two points {(0, 0),(1, 1)} belong to one class, and the other two points {(1, 0),(0, 1)} belong to the other class. Design a multilayer perceptron for this binary classification problem.

Course Outcome 3 (CO3):

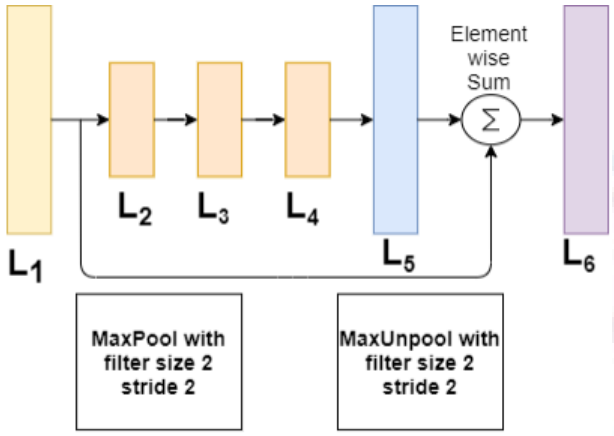
1. Derive a mathematical expression to show L2 regularization as weight decay.
2. Explain how L2 regularization improves the performance of deep feed forward neural networks.
3. Explain how L1 regularization method leads to weight sparsity.

Course Outcome 4 (CO4):

1. Draw and explain the architecture of convolutional neural networks.
2. You are given a classification problem to classify the handwritten digits. Suggest a learning and/or inference machine with its architecture, an objective function, and an optimization routine, along with how input and output will be prepared for the classifier.

3. In a Deep CNN architecture the feature map L_1 was processed by the following operations as shown in the figure. First down sampled using max pool operation of size 2 and stride 2, and three convolution operations and finally max unpool operation and followed by an element wise sum. The feature map L_1 and L_4 are given below. Compute the matrix L6.

$$L_1 = \begin{matrix} 10 & 20 & 15 & 22 \\ 20 & 16 & 28 & 30 \\ 30 & 12 & 20 & 16 \\ 20 & 20 & 40 & 12 \end{matrix} \qquad L_4 = \begin{matrix} 10 & 20 \\ 20 & 30 \end{matrix}$$



4. Illustrate the workings of the RNN with an example of a single sequence defined on a vocabulary of four words.

Course Outcome 5 (CO5):

1. Draw and explain the architecture of LSTM.
2. List the differences between LSTM and GRU

Model Question Paper

QP CODE: **PAGES:4**

Reg No:_____

Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIFTH SEMESTER B.TECH DEGREE EXAMINATION(HONORS), MONTH & YEAR

Course Code: CST 395

Course Name: Neural Networks and Deep Learning

Max.Marks:100 **Duration:3 Hours**

PART A

Answer all Questions. Each question carries 3 Marks

1. List and compare the types of machine learning algorithms
2. Suppose 10000 patients get tested for flu; out of them, 9000 are actually healthy and 1000 are actually sick. For the sick people, a test was positive for 620 and negative for 380. For healthy people, the same test was positive for 180 and negative for 8820. Construct a confusion matrix for the data and compute the

accuracy, precision and recall for the data

3. Illustrate the limitation of a single layer perceptron with an example
4. Specify the advantages of ReLU over sigmoid activation function.
5. Derive weight updating rule in gradient descent when the error function is a) mean squared error b) cross entropy
6. List any three methods to prevent overfitting in neural networks
7. What happens if the stride of the convolutional layer increases? What can be the maximum stride? Justify your answer.
8. Consider an activation volume of size 13×13×64 and a filter of size 3×3×64. Discuss whether it is possible to perform convolutions with strides 2, 3 and 5. Justify your answer in each case.
9. How does a recursive neural network work?
10. List down three differences between LSTM and RNN

(10x3=30)

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11. (a) Prove that the decision boundary of binary logistic regression is linear **(9)**

(b) Given the following data, construct the ROC curve of the data. Compute the AUC. **(5)**

Threshold	**TP**	TN	FP	FN
1	0	25	0	29
2	7	25	0	22
3	18	24	1	11
4	26	20	5	3
5	29	11	14	0

6	29	0	25	0
7	29	0	25	0

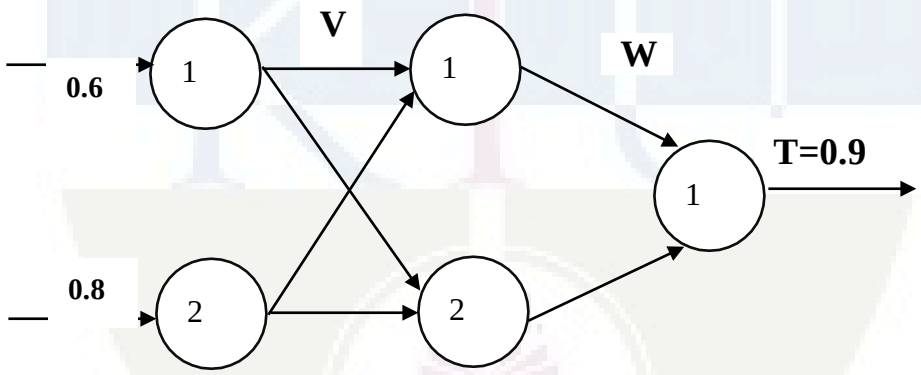
OR

12. (a) With an example classification problem, explain the following terms:
a) Hyper parameters b) Training set c) Validation sets d) Bias e) Variance **(8)**

(b) Determine the regression equation by finding the regression slope coefficient and the intercept value using the following data. **(6)**

x	55	60	65	70	80
y	52	54	56	58	62

13. (a) Update the parameters V_{11} in the given MLP using back propagation with learning rate as 0.5 and activation function as sigmoid. Initial weights are given as V_{11}= 0.2, V_{12}=0.1, V_{21}=0.1, V_{22}=0.3, V_{11}=0.2, W_{11}=0.5, W_{21}=0.2



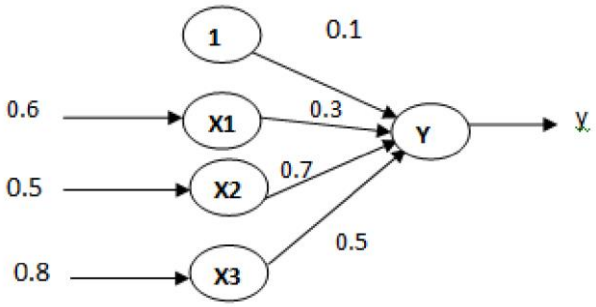
(10)

(b) Explain the importance of choosing the right step size in neural networks **(4)**

OR

14. (a) Explain in detail any four practical issues in neural network training **(8)**

(b) Calculate the output of the following neuron Y with the activation function as a) binary sigmoid b) tanh c)ReLU



(6)

15. (a) Explain, what might happen in ADAGRAD, where momentum is expressed as $\Delta w_{ij} = -\eta g_{ij} / \sqrt{(\sum_{k=1}^{t} g_{ij}^2)}$ where the denominator computes the L2 norm of all previous gradients on a per-dimension basis and η is a global learning rate shared by all dimensions. **(6)**

(b) Differentiate gradient descent with and without momentum. Give equations for weight updation in GD with and without momentum. Illustrate plateaus, saddle points and slowly varying gradients. **(8)**

OR

16. (a) Suppose a supervised learning problem is given to model a deep feed forward neural network. Suggest solutions for the following a) small sized dataset for training b) dataset with both labelled and unlabeled data c) large data set but data from different distribution **(9)**

(b) Describe the effect in bias and variance when a neural network is modified with more number of hidden units followed with dropout regularization. **(5)**

17. (a) Draw and explain the architecture of Convolutional Neural Networks **(8)**

(b) Suppose that a CNN was trained to classify images into different categories. It performed well on a validation set that was taken from the same source as the training set but not on a testing set. What could be the problem with the training of such a CNN? How will you ascertain the problem? How can those problems be solved? **(6)**

OR

18. (a) Explain the following convolution functions a)tensors b) kernel flipping c) down sampling d) strides e) zero padding. **(10)**

(b) What is the motivation behind convolution neural networks? **(4)**

19. (a) Describe how an LSTM takes care of the vanishing gradient problem. Use some hypothetical numbers for input and output signals to explain the concept **(8)**

(b) Explain the architecture of Recurrent Neural Networks **(6)**

OR

20. (a) Explain LSTM based solution for anyone of the problems in the Natural Language Processing domain. **(8)**

(b) Discuss the architecture of GRU **(6)**

Teaching Plan

Module 1 : [Text book 1: Chapter 5, Textbook 2: Chapter 2](9 hours)		
1.1	Introduction, Learning algorithms - Supervised, Unsupervised, Reinforcement	1 hour
1.2	Overfitting, Underfitting, Hyperparameters	1 hour
1.3	Validation sets, Estimators -Bias and Variance. Challenges in machine learning.	1 hour
1.4	Simple Linear Regression	1 hour
1.5	Illustration of Linear Regression	1 hour
1.6	Logistic Regression	1 hour
1.7	Illustration of Logistic Regression	1 hour
1.8	Performance measures - Confusion matrix, Accuracy, Precision, Recall, Sensitivity, Specificity, ROC, AUC.	1 hour
1.9	Illustrative Examples for performance measures	1 hour
Module 2 : Text book 2, Chapter 1 (8 hours)		
2.1	Introduction to neural networks -Single layer perceptrons	1 hour
2.2	Multi Layer Perceptrons (MLPs), Representation Power of MLPs	1 hour
2.3	Activation functions - Sigmoid, Tanh, ReLU, Softmax. Risk minimization, Loss function	1 hour

2.4	Training MLPs with backpropagation	1 hour
2.5	Illustration of back propagation algorithm	1 hour
2.6	Practical issues in neural network training - The Problem of Overfitting, Vanishing and exploding gradient problems	1 hour
2.7	Difficulties in convergence, Local and spurious Optima, Computational Challenges.	1 hour
2.8	Applications of neural networks	1 hour
Module 3 : Text book 1: Chapter 7, 8, Text book 2, Chapter 3, 4 (10 hours)		
3.1	Introduction to deep learning, Deep feed forward network	1 hour
3.2	Training deep models - Introduction, setup and initialization issues	1 hour
3.3	Solving vanishing and exploding gradient problems	1 hour
3.4	Concepts of optimization, Gradient Descent (GD), GD with momentum.	1 hour
3.5	Nesterov accelerated GD, Stochastic GD.	1 hour
3.6	AdaGrad, RMSProp, Adam.	1 hour
3.7	Concepts of Regularization, L1 and L2 regularization.	1 hour
3.8	Early stopping, Dataset augmentation	1 hour
3.9	Parameter sharing and tying, Injecting noise at input, Ensemble methods	1 hour
3.10	Dropout, Parameter initialization.	1 hour
Module 4 : Text book 1, Chapter 9, Text book 2: Chapter 8 (8 hours)		
4.1	Convolutional Neural Networks, architecture	1 hour
4.2	Convolution and Pooling operation with example	1 hour
4.3	Convolution and Pooling as an infinitely strong prior	1 hour
4.4	Variants of convolution functions, structured outputs, data types	1 hour
4.5	Efficient convolution algorithms.	1 hour
4.6	Practical use cases for CNNs	1 hour
4.7	Case study - Building CNN with MNIST and AlexNet.	1 hour
4.8	Case study - Building CNN with MNIST and AlexNet	1 hour
Module 5 : Text book 1 :Chapter 10, 11, Text book 2:Chapter 7 (10 hours)		

5.1	Recurrent neural networks – Computational graphs, RNN design	1 hour
5.2	Encoder – decoder sequence to sequence architectures	1 hour
5.3	Deep recurrent networks- Architecture	1 hour
5.4	Recursive neural networks	1 hour
5.5	Modern RNNs - LSTM	1 hour
5.6	Modern RNNs - LSTM	1 hour
5.7	GRU	1 hour
5.8	Practical use cases for RNNs.	1 hour
5.9	Case study - Natural Language Processing.	1 hour
5.10	Case study - Natural Language Processing.	1 hour

SEMESTER VI

SCHEME : B.TECH 2019

PROGRAMME : ELECTRONICS AND COMPUTER ENGINEERING

ERT 302	OPERATING SYSTEMS	Category	L	T	P	Credit
		PCC	3	1	0	4

Preamble: Study of operating system is an essential to understand the overall working of computer system, tradeoffs between performance and functionality and the division of jobs between hardware and software. This course introduces the concepts of memory management, device management, process management, file management and security & protection mechanisms available in an operating system. The course helps the learner to understand the fundamentals about any operating system design so that they can extend the features of operating system to detect and solve many problems occurring in operating system and to manage the computer resources appropriately.

Prerequisite: Topics covered in the courses Data Structures (CST 201) and Programmingin C (EST 102)

Course Outcomes: After the completion of the course the student will be able to

CO1	Explain the relevance, structure and functions of Operating Systems in computing devices. (**Cognitive knowledge: Understand**)
CO2	Illustrate the concepts of process management and process scheduling mechanisms employed in Operating Systems. (**Cognitive knowledge: Understand**)
CO3	Explain process synchronization in Operating Systems and illustrate process synchronization mechanisms using Mutex Locks, Semaphores and Monitors (**Cognitive knowledge: Understand**)
CO4	Explain any one method for detection, prevention, avoidance and recovery for managing deadlocks in Operating Systems. (**Cognitive knowledge: Understand**)
CO5	Explain the memory management algorithms in Operating Systems. (**Cognitive knowledge: Understand**)
CO6	Explain the security aspects and algorithms for file and storage management in Operating Systems. **(Cognitive knowledge: Understand)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓							✓		✓
CO2	✓	✓	✓	✓						✓		✓
CO3	✓	✓	✓	✓						✓		✓
CO4	✓	✓	✓	✓						✓		✓
CO5	✓	✓	✓	✓						✓		✓
CO6	✓	✓	✓	✓						✓		✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	PO#	**Broad PO**
PO1	Engineering Knowledge	PO7	Environment and Sustainability
PO2	Problem Analysis	PO8	Ethics
PO3	Design/Development of solutions	PO9	Individual and team work
PO4	Conduct investigations of complex problems	PO10	Communication
PO5	Modern tool usage	PO11	Project Management and Finance
PO6	The Engineer and Society	PO12	Life long learning

Assessment Pattern

Bloom's Category	Test 1 (Marks in percentage)	Test 2 (Marks in percentage)	End Semester Examination (Marks in percentage)
Remember	30	30	30
Understand	30	30	30
Apply	40	40	40
Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test : 25 marks
Assignment : 15 marks

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

Syllabus

Module I

Introduction: Operating system overview – Operations, Functions, Service – System calls, Types – Operating System structure - Simple structure, Layered approach, Microkernel, Modules – System boot process.

Module II

Processes - Process states, Process control block, threads, scheduling, Operations on processes - process creation and termination – Inter-process communication - shared memory systems, Message passing systems.

Process Scheduling – Basic concepts- Scheduling criteria -scheduling algorithms- First come First Served, Shortest Job First, Priority scheduling, Round robin scheduling.

Module III

Process synchronization- Race conditions – Critical section problem – Peterson's solution, Synchronization hardware, Mutex Locks, Semaphores, Monitors – Synchronization problems - Producer Consumer, Dining Philosophers and Readers-Writers.

Deadlocks: Necessary conditions, Resource allocation graphs, Deadlock prevention, Deadlock avoidance – Banker's algorithms, Deadlock detection, Recovery from deadlock.

Module IV

Memory Management: Concept of address spaces, Swapping, Contiguous memory allocation, fixed and variable partitions, Segmentation, Paging. Virtual memory, Demand paging, Page replacement algorithms.

Module V

File System: File concept - Attributes, Operations, types, structure – Access methods, Protection. File-system implementation, Directory implementation. Allocation methods.
Storage Management: Magnetic disks, Solid-state disks, Disk Structure, Disk scheduling, Disk formatting.

Text Book

Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, 'Operating System Concepts' 9th Edition, Wiley India 2015.

Reference Books:

1. Andrew S Tanenbaum, "Modern Operating Systems" , 4th Edition, Prentice Hall, 2015.
2. William Stallings, "Operating systems", 6th Edition, Pearson, Global Edition, 2015.
3. Garry Nutt, Nabendu Chaki, Sarmistha Neogy, "Operating Systems", 3rd Edition, Pearson Education.
4. D.M.Dhamdhere, "Operating Systems", 2nd Edition, Tata McGraw Hill, 2011.
5. Sibsankar Haldar, Alex A Aravind, "Operating Systems", Pearson Education.

Sample Course Level Assessment Questions

Course Outcome1 (CO1): What is the main advantage of the micro kernel approach to system design? How do user program and system program interact in a microkernel architecture?

Course Outcome 2 (CO2): Define process. With the help of a neat diagram explain different states of process.

Course Outcome 3 (CO3): What do you mean by binary semaphore and counting semaphore? With C, explain implementation of wait () and signal ().

Course Outcome 4 (CO4): Describe resource allocation graph for the following. a) with a deadlock b) with a cycle but no deadlock.

Course Outcome 5 (CO5): Consider the following page reference string 1, 2, 3, 4, 2, 1, 5, 6, 2, 1, 2, 3, 7, 6, 3, 2, 1, 2, 3, 6. Find out the number of page faults if there are 4-page frames, using the following page replacement algorithms. i) LRU ii) FIFO iii) Optimal

Course Outcome 6 (CO6): Explain the different file allocation methods with advantages and disadvantages.

Model Question Paper

QP CODE: PAGES: ___

Reg No:_____
Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
SIXTH SEMESTER B. TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: ERT 302

Course name: OPERATING SYSTEMS

Max Marks: 100 **Duration: 3 Hours**

PART-A

(Answer All Questions. Each question carries 3 marks)

1. How does hardware find the Operating System kernel after system switch-on?
2. What is the purpose of system call in operating system?
3. Why is context switching considered as an overhead to the system?

4. How is inter process communication implement using shared memory?

5. Describe resource allocation graph for the following.

   a. with a deadlock b. with a cycle but no deadlock.

6. What is critical section? What requirement should be satisfied by a solution to the critical section problem?

7. Consider the reference string 1, 2, 3, 4, 2, 1, 5, 6, 2, 1, 2, 3, 7, 6, 3, 2, 1, 2, 3, 6. How many page faults occur while using FCFS for the following cases.

   a. frame=2 b. frame=3

1. Differentiate between internal and external fragmentations.

2. Compare sequential access and direct access methods of storage devices.

3. Define the terms (i) Disk bandwidth (ii) Seek time.

PART-B (Answer any one question from each module)

4. a) Explain the following structures of operating system (i) Monolithic systems (ii) Layered Systems (iii) Micro Kernel (iv) Modular approach. **(12)**

   b) Under what circumstances would a user be better of using a time-sharing system than a PC or a single user workstation? **(2)**

OR

5. a) What is the main advantage of the micro kernel approach to system design? How do user program and system program interact in a microkernel architecture? **(8)**

   b) Describe the differences between symmetric and asymmetric multiprocessing? What are the advantages and disadvantages of multiprocessor systems? **(6)**

6. a) Define process. With the help of a neat diagram explain different states of process. **(8)**

   b) Explain how a new process can be created in Unix using fork system call. **(6)**

OR

7. a) Find the average waiting time and average turnaround time for the processes given in thetable below using:- i) SRT scheduling algorithm ii) Priority scheduling algorithm **(9)**

Process	Arrival Time (ms)	CPU Burst Time (ms)	Priority
P1	0	5	3
P2	2	4	1
P3	3	1	2
P4	5	2	4

b) What is a Process Control Block? Explain the fields used in a Process Control Block. **(5)**

8. Consider a system with five processes P_0 through P_4 and three resources of type A, B, C. Resource type A has 10 instances, B has 5 instances and C has 7 instances. Suppose at time t_0 following snapshot of the system has been taken:

Process	Allocation	Max	Available
	A B C	A B C	A B C
P_0	0 1 0	7 5 3	3 3 2
P_1	2 0 0	3 2 2	
P_2	3 0 2	9 0 2	
P_3	2 1 1	2 2 2	
P_4	0 0 2	4 3 3	

i) What will be the content of the Need matrix? Is the system in a safe state? If Yes, then what is the safe sequence? **(8)**

iii) What will happen if process P_1 requests one additional instance of resource type A and two instances of resource type C? **(6)**

OR

9. a) State dining philosopher's problem and give a solution using semaphores. **(7)**

b) What do you mean by binary semaphore and counting semaphore? With C struct, explain implementation of wait () and signal() **(7)**

10. a) Consider the following page reference string 1, 2, 3, 4, 2, 1, 5, 6, 2, 1, 2, 3, 7, 6, 3, 2, 1, 2, 3, 6. Find out the number of page faults if there are 4-page frames, using the following page replacement algorithms i) LRU ii) FIFO iii) Optimal **(9)**

b) Explain the steps involved in handling a page fault. **(5)**

OR

11. a) With a diagram, explain how paging is done with TLB. **(5)**

b) Memory partitions of sizes 100 kb, 500 kb, 200 kb, 300 kb, 600 kb are available, how would best, worst and first fit algorithms place processes of size 212 kb, 417 kb, 112 kb, 426 kb in order. Rank the algorithms in terms of how efficiently they use memory. **(9)**

12. a) Suppose that a disk drive has 5000 cylinders, numbered 0 to 4999. the drive currently services a request at cylinder 143, and the previous request was at cylinder 125. the queue of pending request in FIFO order is 86, 1470, 913, 1774, 948, 1509, 1022, 1750, 130. Starting from the current position, what is the total distance (in cylinders) that the disk arm moves to satisfy all pending requests for each of the following algorithms

1. FCFS ii) SSFT iii) SCAN iv) LOOK v) C-SCAN **(10)**

b) What is the use of access matrix in protection mechanism? **(4)**

OR

13. a) Explain the different file allocation operations with advantages and disadvantages. **(8)**

b) Explain the following i) file types ii) file operation iii) file attributes **(6)**

Teaching Plan

	Module 1 - Introduction	**5 Hours**
1.1	Introduction to Operating System	1
1.2	Operating System operations, functions, service	1
1.3	System calls, Types	1
1.4	Operating System Structure: Simple, Layered, Microkernel, Modules	1
1.5	System Boot Process	1
	Module 2 – Processes and Process Scheduling	**9 Hours**
2.1	Processes, Process states	1
2.2	Process Control Block, Threads	1

2.3	Scheduling	1
2.4	Operations on processes: process creation and termination	1
2.5	Inter-process communication: Shared memory systems, Message Passing	1
2.6	Process Scheduling – Basic concepts, Scheduling Criteria	1
2.7	Scheduling algorithms - Basics	1
2.8	First come First Served, Shortest Job First	1
2.9	Priority scheduling, Round Robin Scheduling	1
	Module 3 - Process synchronization and Dead locks	**13 Hours**
3.1	Process synchronization, Race conditions	1
3.2	Critical Section problem, Peterson's solution	1
3.3	Synchronization hardware, Mutex Locks	1
3.4	Semaphores	1
3.5	Monitors	1
3.6	Synchronization problem examples (Lecture 1)	1
3.7	Synchronization problem examples (Lecture 2)	1
3.8	Deadlocks: Necessary conditions, Resource Allocation Graphs	1
3.9	Deadlock prevention	1
3.10	Deadlock avoidance	1
3.11	Banker's algorithm	1
3.12	Deadlock detection	1
3.13	Deadlock recovery	1
	Module 4 - Memory Management	**9 Hours**
4.1	Memory Management: Concept of Address spaces	1
4.2	Swapping	1
4.3	Contiguous memory allocation, fixed and variable partitions	1
4.4	Segmentation.	1
4.5	Paging (Lecture 1)	1
4.6	Paging (Lecture 2)	1
4.7	Virtual memory, Demand Paging	1

4.8	Page replacement algorithms (Lecture 1)	1
4.9	Page replacement algorithms (Lecture 2)	1
	Module 5 - File and Disk management	**9 Hours**
5.1	File concept, Attributes, Operations, types, structure	1
5.2	Access methods	1
5.3	Protection	1
5.4	File-System implementation	1
5.5	Directory implementation	1
5.6	Allocation methods	1
5.7	Magnetic disks, Solid-state disks, Disk structure	1
5.8	Disk scheduling	1
5.9	Disk formatting	1

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
ERT 304	**EMBEDDED SYSTEMS & IoT**	PCC	3	1	0	4

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand the basics of embedded systems, IoT and networking. **(Cognitive knowledge level: Understand)**
CO 2	Illustrate various sensors and actuators for embedded systems and IoT. **(Cognitive knowledge level: Understand)**
CO 3	Comprehend the underlying principles and concepts behind IoT design considerations. **(Cognitive knowledge level: Understand)**
CO 4	Apply the understanding of IoT requirements and constraints to select suitable connectivity and communication technologies for specific IoT applications. **(Cognitive knowledge level: Apply)**
CO 5	Model Interfacing of sensors and actuators with development boards **(Cognitive knowledge level: Apply)**
CO 6	Illustrate various IoT physical servers and cloud offerings. **(Cognitive knowledge level: Understand)**

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	✔											✔
CO 2	✔				✔							✔
CO 3	✔				✔							✔
CO 4	✔		✔	✔	✔							✔
CO 5	✔		✔									✔
CO 6	✔											✔

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	PO#	**Broad PO**
PO1	Engineering Knowledge	PO7	Environment and Sustainability
PO2	Problem Analysis	PO8	Ethics
PO3	Design/Development of solutions	PO9	Individual and team work

PO4	Conduct investigations of complexproblems	PO10	Communication
PO5	Modern tool usage	PO11	Project Management and Finance
PO6	The Engineer and Society	PO12	Life long learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	10
Understand	20	20	50
Apply	20	20	40
Analyze	-	-	-
Evaluate	-	-	-
Create	-	-	-

Mark Distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:
Attendance : 10 marks
Continuous Assessment Test (2 Numbers): 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub- divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. How are PANs different from LANs?
2. Differentiate between microprocessor and microcontroller
3. Write short notes on evolution of IoT

Course Outcome 2 (CO2):

1. What are the main features of shape memory polymers?
2. What are the critical factors to be considered during the design of IoT devices?
3. Explain any 3 Sensor Characteristics

Course Outcome 3 (CO3):

1. What is service discovery protocol (SDP) in Bluetooth?
2. Describe the HART data link layer.
3. What is QUIC? How is the connection latency reduced in QUIC?

Course Outcome 4 (CO4):

1. Modify or Write New Program to make GPIO2 LED blinking.
2. Problem: You want to use an Arduino with multiple sensors built in
   Write a program to find solution to this problem using Arduino
3. Write a program for controlling the lock from the cloud using NodeMCU

Course Outcome 5 (CO5):

1. Write short notes on "Evolution of New IoT Paradigms"
2. Write the various steps for Setting up Raspberry Pi by installing OS and obtaining static IP of Raspberry Pi.
3. What are Amazon Web Services (AWS)? Explain the significance.

SYLLABUS

Module 1: Introduction to Embedded Systems and IoT

Application domain of Embedded systems: Desirable features and general characteristics of Embedded Systems - Model of Embedded systems - Microcontroller Vs Microprocessors.

Introduction of IoT: Evolution of IoT - Enabling IoT and the Complex Interdependence of Technologies - IoT Networking Components - Addressing Strategies in IoT.

Basics of Networking: Network Types - Layered Network Models - Addressing - TCP/IP Transport layer.

Module 2: Embedded systems & IoT- Sensors and Actuators

Sensors: Sensor Characteristics - Sensorial Deviations - Sensing Types - Sensing Considerations

Actuators: Actuator Types - Actuator Characteristics

IoT Processing Topologies and Types: Data Format - Importance of Processing in IoT - Processing Topologies - IoT Device Design and Selection Considerations - Processing Offloading

Module 3: IoT connectivity and communication technologies

IoT Connectivity Technologies: IEEE 802.15.4 - Zigbee - ISA100.11A - Wireless HART - RFID - NFC - Z-Wave - Weightless - LoRa - NB-IoT - Wi-Fi - Bluetooth

IoT Communication Technologies: Introduction - Infrastructure Protocols - Discovery Protocols - Data Protocols - Identification Protocols - Device Management - Semantic Protocols

Module 4: Arduino and NodeMCU

Introduction to the Arduino platform: Hardware features of Arduino - Arduino IDE - Simple programs of Arduino using C++ - LED, switch and LCD interfacing with Arduino.
Understanding the NodeMCU platform: Hardware features of NodeMCU - Programming NodeMCU with Arduino IDE - Interfacing any sensor and actuator with NodeMCU.

Module 5: Raspberry pi and Developing IoT applications

Introduction to Raspberry Pi: Raspberry Pi hardware details - installing OS in Raspberry Pi - Preparing python program to interface any one sensor and actuator using GPIO pins of Raspberry Pi.
Overview of IoT physical servers and cloud offerings: Amazon Web Services (AWS) IoT platform - Microsoft Azure IoT - Blynk (Introduction only for all topics here).
Challenges Associated with IoT: Evolution of New IoT Paradigms.

Textbooks:

1. "Introduction to IoT" by Sudip Misra, Anandarup Mukherjee, Arijit Roy, Cambridge University Press, First edition, 2021, ISBN 9781108842952, ISBN 9781108959742
2. "Arduino Cookbook: Recipes to Begin, Expand, and Enhance Your Projects" by Michael Margolis, 3rd edition, 2020, O'Reilly Media, ISBN: 9781491903520

References:

1. "Internet Of Things with Raspberry Pi and Arduino" by Rajesh Singh, Anita Gehlot, Lovi Raj Gupta, Bhupendra Singh, and Mahendra Swain, CRC press, 1st Edition, ISBN:9780367248215
2. "NodeMCU ESP8266 Communication Methods and Protocols - Programming with Arduino IDE", Manoj R. Thakur, Amazon Media EU S.à r.l. (2018)
3. "Internet of Things - A Hands-On approach" - Arshdeep Bahga, Vijay Madisetti - Universities Press (India) Private Limited (2015)
4. "Embedded Systems – An Integrated approach" by Lyla P Das, Pearson
5. https://docs.aws.amazon.com/whitepapers/latest/aws-overview/introduction.html
6. https://azure.microsoft.com/en-us/explore
7. https://docs.blynk.io/en/

Model Question Paper

Reg No: **Name:**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
SIXTH SEMESTER B. TECH DEGREE EXAMINATION,

MONTH AND YEAR
Course Code: ERT304

Course Name: EMBEDDED SYSTEMS & IoT

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all questions, each carries 3 marks

1. Differentiate between point-to-point and point-to-multipoint connection types.
2. Differentiate between IoT and M2M.
3. How is sensor resolution different from its accuracy?
4. What are the different data formats found in IoT network traffic streams?
5. Differentiate between star and mesh network topologies.
6. Describe the LOADng protocol.
7. Write a program to print "hello, world!" on an LCD display using Arduino
8. Draw a diagram for Connecting a light-dependent resistor to an Arduino
9. What are the various common hardware features of Raspberry Pi hardware?
10. State a few challenges associated with IoT

PART B

Answer any one full question from each module. Each question carries 14 Marks

Module1

11. Discuss the layered architecture of IoT (14)

OR

12. a) Discuss the pros and cons of the following network topologies: (7)
    (i) Star (ii) Ring (iii) Bus (iv) Mesh
    b) "A PC is not considered as an embedded system". Justify. (7)

Module2

13. Write short notes on Processing Offloading (14)

OR

14. Briefly explain the following types of actuators (14)

(i) Hydraulic (ii) pneumatic (iii) electrical (iv) thermal/magnetic

Module3

15. What is a scatternet? Explain the working of a scatternet with a brief description of its various members. (14)

OR

16. Write short notes on Identification Protocols (14)

Module-4

17. Problem: You want to detect when something is moved, tilted, or shaken. (14)
    Write a program to find solution to this problem using Arduino

OR

18. Implement temperature control system by controlling a fan, if the temperature exceeds a limit. (Use arduino as control board) (14)

Module 5

19. Briefly explain the following: (14)
    i. Amazon Web Services (AWS) IoT platform
    ii. Microsoft Azure IoT
    iii. Blynk

OR

20. Write a program to Light an LED by reading status of a switch connected to GPIO of the Raspberry Pi board. (14)

Course Contents and Lecture Schedule:

No	Topic	Hours (45)
1	**Module 1: Introduction to Embedded Systems and IoT**	**(8 hours)**
1.1	**Application domain of Embedded systems**: Desirable features and general characteristics of Embedded Systems	1
1.2	Model of Embedded systems - Microcontroller Vs Microprocessors	1
1.3	**Introduction of IoT:** Evolution of IoT- Enabling IoT and the Complex Interdependence of Technologies	1
1.4	IoT Networking Components	1
1.5	Addressing Strategies in IoT	1
1.6	**Basics of Networking**: Network Types	1
1.7	Layered Network Models	1
1.8	Addressing - TCP/IP Transport layer	1

2	**Module 2: Embedded systems & IoT- Sensors and Actuators**	**(8 hours)**
2.1	**Sensors:** Sensor Characteristics - Sensorial Deviations	1
2.2	Sensing Types - Sensing Considerations	1
2.3	**Actuators:** Actuator Types	1
2.4	Actuator Characteristics	1
2.5	**IoT Processing Topologies and Types:** Data Format- Importance of Processing in IoT	1
2.6	Processing Topologies	1
2.7	IoT Device Design and Selection Considerations	1
2.8	Processing Offloading	1
3	**Module 3: IoT connectivity and communication technologies**	**(10 hours)**
3.1	**IoT Connectivity Technologies:** IEEE 802.15.4 - Zigbee	1
3.2	ISA100.11A - Wireless HART	1
3.3	RFID – NFC	1
3.4	Z-Wave - Weightless	1
3.5	LoRa - NB-IoT	1
3.6	Wi-Fi – Bluetooth	1
3.7	**IoT Communication Technologies:** Introduction - Infrastructure Protocols	1
3.8	Discovery Protocols - Data Protocols	1
3.9	Identification Protocols	1
3.10	Device Management - Semantic Protocols	1
4	**Module 4: Arduino and NodeMCU**	**(11 hours)**
4.1	**Introduction to the Arduino platform:** Hardware features of Arduino	1
4.2	Arduino IDE	1
4.3	Simple programs of Arduino using C++	1
4.4	LED interfacing with Arduino	1
4.5	switch interfacing with Arduino	1
4.6	LCD interfacing with Arduino	1
4.7	**Understanding the NodeMCU platform:** Hardware features of	1

	NodeMCU	
4.8	Programming NodeMCU with Arduino IDE (Lecture 1)	1
4.9	Programming NodeMCU with Arduino IDE (Lecture 2)	1
4.10	Interfacing any sensor and actuator with NodeMCU (Lecture 1)	1
4.11	Interfacing any sensor and actuator with NodeMCU (Lecture 2)	1
5	**Introduction to Raspberry Pi**	**(8 hours)**
5.1	Raspberry Pi hardware details - installing OS in Raspberry Pi	1
5.2	Preparing python program to interface any one sensor and actuator using GPIO pins of Raspberry Pi. (Lecture 1)	1
5.3	Preparing python program to interface any one sensor and actuator using GPIO pins of Raspberry Pi. (Lecture 2)	1
5.4	**Overview of IoT physical servers and cloud offerings**	1
5.5	Amazon Web Services (AWS) IoT platform	1
5.6	Microsoft Azure IoT	1
5.7	Blynk (Introduction only for all topics here).	1
5.8	**Challenges Associated with IoT:** Evolution of New IoT Paradigms	1

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
ERT 306	DATA COMMUNICATION AND NETWORKING	PCC	3	1	0	4

Prerequisite: Fundamentals of TCP/IP protocol and its layer model, operating systems, computer networks

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand data communication and networking using the layered concept, Open System Interconnect (OSI) and the TCP/IP Model. **(Cognitive Knowledge: Understand)**
CO 2	Illustrate various types of encoding techniques and error detection methods used in networks. **(Cognitive Knowledge: Understand)**
CO 3	Use the concept of multiplexing, switching and routing in networks. **(Cognitive Knowledge: Apply)**
CO 4	Discuss the working principles of LAN and the concepts behind congestion in networks. **(Cognitive Knowledge: Understand)**
CO 5	Recognize the principles and operations of internetworking and various protocols used. **(Cognitive Knowledge: Understand)**

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1												
CO 2												
CO 3												
CO 4												
CO 5												

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	PO#	**Broad PO**
PO1	Engineering Knowledge	PO7	Environment and Sustainability
PO2	Problem Analysis	PO8	Ethics
PO3	Design/Development of solutions	PO9	Individual and team work
PO4	Conduct investigations of complexproblems	PO10	Communication
PO5	Modern tool usage	PO11	Project Management and Finance

PO6	The Engineer and Society	PO12	Life long learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	20
Understand	30	30	60
Apply	10	10	20
Analyse	-	-	-
Evaluate	-	-	-
Create	-	-	-

Mark Distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance: 10 marks

Continuous Assessment Test (2 Numbers): 25 marks

Assignment/Quiz/Course project: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub- divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Give the relevance of OSI model in data communication and networking.
2. Explain analog, digital and wireless transmission.

Course Outcome 2 (CO2):

1. Explain different encoding techniques
2. Study various error detection and correction methods

Course Outcome 3 (CO3):

1. Explain different multiplexing methods
2. Explain various switching techniques
3. What is shortest path routing algorithm in computer networks example?

Course Outcome 4 (CO4):

1. List various types of congestion control methods
2. Explain various LAN architecture

Course Outcome 5 (CO5):

1. Discuss the protocols used for internetworking
2. Explain the routing protocols

SYLLABUS

MODULE 1: Data communication and networking overview

A data communication model-data communication - data communications networking - protocol architecture - the need for a protocol architecture - a simple protocol architecture - OSI – TCP/IP protocol architecture. Data transmission - Concepts and terminology - Analog and Digital data transmission-Transmission Impairments – channel capacity - Guided and Wireless transmission – guided transmission media – wireless transmission – wireless propagation.

MODULE 2: Signal encoding and Digital data communication techniques

Digital data, Digital signals & analog signals – analog data, digital signals and analog signals. Asynchronous and synchronous transmission -Types of Error -Error Detection -Error Correction-Line configuration- Interfacing. Data link Control -Flow control-Error Control-HDLC.

MODULE 3: Multiplexing

FDM – Synchronous TDM – statistical TDM – Asymmetric DSL – xDSL. Circuit Switching and packet switching: switching networks - circuit switching networks - circuit switching concepts - control signaling - soft switch architecture-Packet switching principles-X.25-Frame Relay.
Routing in Switched Networks: routing in circuit switched network – routing in packet switched network – least cost algorithms.

MODULE 4: Congestion control in switched Data network

Effect of congestion - Congestion control - Traffic management - Congestion control in packet switching networks - Frame Relay congestion control.
Local Area Network: Background – Topologies and transmission media – LAN protocol architecture – bridges – layer2 and layer3 switches. High speed LANs: the emergence of High-speed LAN's – Ethernet – token ring – fibre channel.

MODULE 5: Internetwork protocols

Basic protocol functions – principles of internetworking – connectionless operation – Internet Protocol operation: multicasting – routing protocols – integrated services architecture – differentiated services. Transport protocol: connection-oriented transport protocol machanisms - TCP – TCP – congestion control - UDP.

Text Book:

1. William Stallings, Data and Computer Communication, Eighth Edition.

Reference Book:

2. Behrouz A. Forouzan, Data Communications and Networking, Second Edition, Tata McGraw-Hill.

Model Question Paper

Reg No.: Name:

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
SIXTH SEMESTER B. TECH DEGREE EXAMINATION,

MONTH AND YEAR
Course Code: ERT 306

Course Name: DATA COMMUNICATION AND NETWORKING

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all questions, each carries 3 marks

1. What are the Functions of Transport, Network and Data Link Layer?
2. What do you mean by Mobile Station Subsystem? Explain?
3. What are the techniques can be employed to encode the data stream when transmitting a digital signal in digital form over a network?
4. What are the various types of error-detection methods?
5. Why does computer network need multiplexing?
6. Which routing strategies are used in packet switched network explain?
7. Which congestion control techniques try to reduce congestion after it happens in the network?
8. What are the 4 types of LAN?
9. How many types of Internet protocols are there?
10. Why TCP is called end-to-end protocol?

PART B

Answer any one full question from each module. Each question carries 14 Marks

Module1

11. Define OSI layers**,** Are there any alternative models to the OSI model? If yes, define it. (14 marks)
12. (A)What key factors affect channel capacity? How the channel capacity can be calculated? (7 marks)

(B) What is the significance of propagation model in wireless communication? (7 Marks)

Module2

13. (A) Why is synchronous transmission typically more efficient than asynchronous transmission? (7 marks)
    (B) What are the 3 types of stations in HDLC? explain (7 Marks)
14. Which sublayer of the data link layer performs data link functions that depend upon the type of medium? Explain. (14 Marks)

Module 3

15. What's the difference between a circuit switched and a packet switched network? (14 Marks)
16. How does routing work? What is the difference between default route and default gateway. (14 Marks)

Module 4

17. What is it goal of congestion control? How the congestion is controlled in packet switched networks? (14 Marks)
18. (A)What is the difference between layer 2 and layer 3 of the OSI model? (8 marks)

    (B)What does an Ethernet frame consist of? (6 marks)

Module5

19. Compare distance vector routing protocol and link state routing protocols. (14 marks)
20. What are the two groups of multicast routing protocols? Explain (14 marks)

Course Contents and Lecture Schedule

No	Topic	Hours (45)
1	**Data communication and networking overview**	**10**
1.1	A communication model-data communication-data communication networking	1
1.2	protocol architecture-the need for a protocol architecture	1
1.3	A simple protocol architecture - OSI – TCP/IP protocol architecture	1
1.4	Data transmission-Concepts and terminology	1
1.5	Analog and Digital data transmission	1
1.6	Transmission Impairments	1

1.7	channel capacity	1
1.8	Guided and Wireless transmission	1
1.9	Guided transmission media	1
1.10	wireless transmission – wireless propagation.	1
2	**Signal encoding techniques**	**8**
2.1	Digital data, Digital signals.	1
2.2	Digital data, analog signals.	1
2.3	Analog data digital signal and analog signals.	1
2.4	Digital data communication techniques: Asynchronous and synchronous transmission – lecture 1	1
2.5	Digital data communication techniques: Asynchronous and synchronous transmission – lecture 2	1
2.6	Types of Error -Error Detection.	1
2.7	Error Correction - Line configuration.	1
2.8	Data link Control -Flow control-Error Control-HDLC.	1
3	**Multiplexing**	**10**
3.1	FDM	1
3.2	Synchronous TDM – statistical TDM	1
3.3	Asymmetric DSL	1
3.4	xDSL	1
3.5	Circuit Switching and packet switching: switching networks -	1
3.6	circuit switching networks - circuit switching concepts	1
3.7	Control signaling - soft switch architecture	1
3.8	Packet switching principles-X.25-Frame Relay.	1
3.9	Routing in Switched Networks: routing in circuit switched network	1
3.10	routing in packet switched network – least cost algorithms.	1
4	**Congestion control in switched Data network**	**8**
4.1	Effect of congestion - Congestion control – Lecture 1	1
4.2	Effect of congestion - Congestion control – Lecture 2	1

4.3	Traffic management - Congestion control in packet switching networks	1
4.4	Frame Relay congestion control.	1
4.5	Local Area Network: Background – Topologies and transmission media – LAN protocol architecture	1
4.6	layer2 and layer3 switches.	1
4.7	High speed LANs: the emergence of High-speed LAN's – Ethernet	1
4.8	token ring – fibre channel.	1
5	**Internetwork protocols**	**9**
5.1	Basic protocol functions – principles of internetworking –	1
5.2	Connectionless internetworking – Internet Protocol.	1
5.3	Internet work operation: multicasting – routing protocols	1
5.4	integrated services architecture – Lecture 1	1
5.5	integrated services architecture– Lecture 2	1
5.6	integrated services architecture– Lecture 3	1
5.7	differentiated services	1
5.8	Transport protocol: connection – oriented TCP – TCP – Congestion control	1
5.9	UDP.	1

SEMESTER VI

PROGRAM ELECTIVE I

ERT 312	SENSORS & ACTUATORS	Category	L	T	P	Credits
		PEC	2	1	0	3

Preamble: Sensors and actuators play a vital role in manufacturing, machinery, aerospace, medicine and robotics. Most of the advancements of present day would be not possible without sensors. The main purpose of offering this course is to elaborate the theoretical and practical aspects of sensors and actuators, their classifications, recent trends and their applications in day today life.

Prerequisite: Nil

Course Outcomes: After the completion of the course, the student will be able to

CO1	Get an exposure to sensors and actuators and its importance in the real world. **(Cognitive Knowledge Level: Understand)**
CO2	Explain the working of magnetic sensors and its applications in real time scenario. **(Cognitive Knowledge Level: Understand)**
CO3	Model linear actuators and differentiate various solenoids. **(Cognitive Knowledge Level: Apply)**
CO4	Explain the working principle of different types of rotary actuators. **(Cognitive Knowledge Level: Understand)**
CO5	Understand the basic idea on the controls in NC machine and fluidic system. **(Cognitive Knowledge Level: Understand)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✔	✔	✔						✔			
CO2	✔	✔	✔						✔			
CO3	✔	✔	✔						✔			
CO4	✔	✔	✔						✔			
CO5	✔	✔	✔						✔			

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Lifelong learning

Assessment Pattern

Bloom's Category	Test 1 (%)	Test 2 (%)	End Semester Examination (%)
Remember	10	10	20
Understand	25	25	50
Apply	15	15	30
Analyse			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3

Continuous Internal Evaluation Pattern:

Attendance : **10 marks**

Continuous Assessment Test : **25 marks**

Continuous Assessment Assignment : **15 marks**

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

Syllabus

Module-1: Introduction

Introduction- Classification of Sensors and Actuators - Magnetic Sensors - Linear and Latching Solenoid Actuators - Stepper Motors - Special Magnetic Devices - Rotary and Linear Actuators - Magnetic Materials and Technology - Soft Magnetic Materials – Hard Magnetic Materials - Coating Technologies - Magnetic Materials Market and Applications

Module-2: Magnetic Sensors

Magnetic Sensors - Theory of Magnetic Sensors - Magnetic Sensor Analysis – VR Sensors - Solid-State Sensors - Magnetic Sensor Applications - Magnetic Speed Sensor Requirements - Magnetic Speed Sensor Applications - Magnetic Position Sensor Applications - VR Sensor Noise

Module-3: Linear Actuators

Linear Actuators - Mathematical Model for Linear Actuators - Fast-Acting Actuators - Disk Solenoids - Plunger Solenoids - Ball Solenoids - Conical Solenoids - Applications of Solenoid Actuators - Long Stroke Solenoid Fuel Pump - Gasoline Injectors - Natural Gas Injectors - Diesel Fuel Injectors - Compressor Solenoid Valves - Transmission Solenoids

Module-4: Rotary Actuators

Rotary Actuators - Disk Rotary Actuators - Disk Rotary Actuator Analysis – Disk Rotary Actuator Design - Disk Rotary Actuator Excitation Electromagnetic Circuit – Disk Rotary Actuator Toothed Magnetic Part - Disk Rotary Actuator PM - Claw Pole Rotary Actuators -

Claw Pole Rotary Actuator Analysis - Claw Pole Rotary Actuator Design -Claw Pole Rotary Actuator Excitation Electromagnetic Circuit - Claw Pole Actuator Toothed Magnetic Part - Claw Pole Actuator PM - Cylindrical Rotary Actuators - Cylindrical Rotary Actuator PM - Cylindrical Rotary Actuator Excitation Electromagnetic Circuit – Cylindrical Rotary Actuator Toothed Magnetic Structure - Rotary Actuator Applications - Disk Rotary Actuator Application - Claw Pole Rotary Actuator Application - Cylindrical Rotary Actuator Application

Module-5: Controls in NC Machines and fluidic control

Controls in NC Machines and fluidic control- stepping motors- feedback devices-encoders - resolvers - induct sync –Tach generators - principles of fluid logic control - Coanda effect - basic fluidic devices - fluidic logic gates - bistable flipflop - OR and NOR gates - exclusive OR gates - fluidic sensors - backpressure sensor - cone jet proximity sensor - interruptible jet sensor.

Text Books

1. Andrzej M. Pawlak, "Sensors and Actuators in Mechatronics, Design and Applications", Taylor & Francis Group, 2006

References

1. Andrew Parr, "Hydraulics and Pneumatics ", Jaico Publishing House, Mumbai
2. Yoram Koren, 'Computer control of Manufacturing Systems', Tata Mc. Graw Hill Publishers, New Delhi
3. Robert H. Bishop, "Mechatronic systems, Sensors and Actuators Fundamentals and Modelling, Taylor & Francis Group, 2007.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. What do you mean by an actuator?
2. Compare Soft Magnetic and Hard Magnetic Materials with suitable example.
3. Identify any 3 applications of Rotary and Linear Actuators in the present scenario.

Course Outcome 2 (CO2)

1. What are the requirements of Magnetic Speed Sensors?
2. Explain Solid-State Sensors with neat sketches.
3. Select any 5 applications of Magnetic Position Sensor.

Course Outcome 3(CO3):

1. What are the applications of Solenoid Actuators?
2. Compare Disk Solenoids and Plunger Solenoids.
3. Construct a mathematical model for a linear actuator

Course Outcome 4 (CO4):

1. List the applications of Disk Rotary Actuator.
2. Explain about Claw Pole Rotary Actuator with necessary sketches.
3. Identify the various applications of Cylindrical Rotary Actuator in the field of mechatronics.

Course Outcome 5 (CO5):

1. Define Coanda effect.
2. Explain about basic fluidic devices.
3. Select the applications of fluidic sensors.

Model Question Paper

QP CODE: **PAGES: ___**

Reg No:_____
Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: ERT 312
Course Name: SENSORS & ACTUATORS

Max Marks: 100 **Duration: 3 Hours**

PART A
(Answer All Questions. Each question carries 3 marks)

1.	What is the difference between a sensor and actuators?	**(3)**
2.	Why stepper motors are widely used in Robotic applications?	**(3)**
3.	What are the applications of Magnetic Speed Sensors?	**(3)**
4.	What do you mean by Solid-State Sensors?	**(3)**
5.	What are the applications of Solenoid Actuators?	**(3)**
6.	Define linear actuator with an example.	**(3)**
7.	List the applications of Claw Pole Rotary Actuator.	**(3)**
8.	What do you mean by Rotary actuator?	**(3)**

9.		Define Coanda effect.	**(3)**
10.		Write a short note on encoders.	**(3)**
		Part B **(Answer any one question from each module. Each question carries 14 Marks)**	
11.		Explain about - Linear and Latching Solenoid Actuators	**(14)**
		OR	
12.		Differentiate between soft and hard magnetic materials with suitable examples.	**(14)**
13.		Explain about VR sensors with suitable sketches.	**(14)**
		OR	
14.		Explain magnetic sensor in detail and identify some of its applications.	**(14)**
15.		Explain the working of Gasoline Injectors with neat sketches.	**(14)**
		OR	
16.		Compare Disk, Plunger and Ball solenoids.	**(14)**
17.		Explain Cylindrical Rotary Actuators with neat sketches.	**(14)**
		OR	
18.		Identify the various applications of Cylindrical Rotary Actuator and Disk Rotary Actuators in the field of mechatronics. Explain the working principle of Disk Rotary Actuators in detail.	**(14)**
19.		Explain the working principle of interruptible jet sensor with necessary sketches. 20. Write short notes on the following: i) Resolver ii) Induct sync	**(14)**
		OR	
20.		Write short notes on the following: i) Resolver ii) Induct sync	**(14)**

TEACHING PLAN

No	Contents	Hours (35)
Module-1 Sensors and Actuators (7hrs)		
1.1	Classification of Sensors and Actuators	1
1.2	Magnetic Sensors	1
1.3	Linear and Latching Solenoid Actuators	1
1.4	Stepper Motors - Special Magnetic Devices	1
1.5	Rotary and Linear Actuators	1
1.6	Magnetic Materials and Technology - Soft Magnetic Materials - Hard Magnetic Materials	1
1.7	Coating Technologies - Magnetic Materials Market and Applications	1
Module-2 Magnetic Sensors (7 hrs)		
2.1	Theory of Magnetic Sensors	1
2.2	Magnetic Sensor Analysis	1
2.3	VR Sensors	1
2.4	Solid-State Sensors	1
2.5	Magnetic Sensor Applications, Magnetic Speed Sensor Requirements	1
2.6	Magnetic Speed Sensor Applications, Magnetic Position Sensor Applications	1
2.7	VR Sensor Noise	1
Module-3 Linear Actuators (7 hrs)		
3.1	Mathematical Model for Linear Actuators	1
3.2	Fast-Acting Actuators	1
3.3	Disk Solenoids - Plunger Solenoids	1
3.4	Ball Solenoids, Conical Solenoids - Applications of Solenoid Actuators	1

3.5	Long Stroke Solenoid Fuel Pump	1
3.6	Gasoline Injectors, Natural Gas Injectors	1
3.7	Diesel Fuel Injectors - Compressor Solenoid Valves - Transmission Solenoids	1
Module-4 Rotary Actuators (7 hrs)		
4.1	Disk Rotary Actuators - Disk Rotary Actuator Analysis - Disk Rotary Actuator Design - Disk Rotary Actuator Excitation	1
4.2	Electromagnetic Circuit - Disk Rotary Actuator Toothed Magnetic Part - Disk Rotary Actuator PM	1
4.3	Claw Pole Rotary Actuators - Claw Pole Rotary Actuator Analysis - Claw Pole Rotary Actuator Design -Claw Pole Rotary Actuator	1
4.4	Excitation Electromagnetic Circuit - Claw Pole Actuator Toothed Magnetic Part - Claw Pole Actuator PM	1
4.5	Cylindrical Rotary Actuators - Cylindrical Rotary Actuator PM - Cylindrical Rotary Actuator Excitation	1
4.6	Electromagnetic Circuit - Cylindrical Rotary Actuator Toothed Magnetic Structure	1
4.7	Rotary Actuator Applications - Disk Rotary Actuator Application Claw Pole Rotary Actuator Application - Cylindrical Rotary Actuator Application.	1
Module-5 Controls in NC Machines and fluidic control (7 hrs)		
5.1	Stepping motors	1
5.2	Feedback devices, encoders, resolvers.	1
5.3	Inductosyn , Tacho generators	1
5.4	Principles of fluid logic control -Coanda effect	1
5.5	Basic fluidic devices, Fluidic logic gates	1
5.6	Bi stable flip flop - OR and NOR gates - exclusive OR gates	1
5.7	Fluidic sensors, Backpressure sensor, Cone jet proximity sensor, Interruptible jet sensor.	1

ERT 322	BIOMEDICAL SIGNAL & TRANSDUCERS	Category	L	T	P	Credits
		PEC	2	1	0	3

Preamble: This course helps the learners to explore various biomedical signals and fundamental measurement techniques using transducers. The course contents will enable the students to understand and design biomedical systems.

Prerequisite: Nil

Course Outcomes: After the completion of the course, the student will be able to

CO1	Understand the Sources and Types of Different Biomedical Signals. **(Cognitive Knowledge Level: Understand)**
CO2	Explain the principle of transducers, classification and the characteristics of different transducers and Biosensors. **(Cognitive Knowledge Level: Understand)**
CO3	Understand the basics of sensors/ transducers and their characteristics. **(Cognitive Knowledge Level: Understand)**
CO4	Describe various temperature and blood flow meter sensors. **(Cognitive Knowledge Level: Understand)**
CO5	Differentiate between sensors used for the measurement of blood pressure and nano sensors. **(Cognitive Knowledge Level: Understand)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✔	✔										✔
CO2	✔	✔										✔
CO3	✔	✔										✔
CO4	✔	✔										✔
CO5	✔	✔										✔

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	Test 1 (%)	Test 2 (%)	End Semester Examination (%)
Remember	20	20	30
Understand	30	30	70
Apply			
Analyse			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3

Continuous Internal Evaluation Pattern:

Attendance : **10 marks**

Continuous Assessment Test : **25 marks**

Continuous Assessment Assignment : **15 marks**

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

Syllabus

Module-1: Introduction to Biomedical Signals

Action Potential and Its Generation, Origin and Waveform Characteristics of Basic Biomedical Signals Like: Electrocardiogram (ECG), Electroencephalogram (EEG), Electromyogram (EMG), Phonocardiogram (PCG), Electroneurogram (ENG), Event-Related Potentials (ERPS), Electrogastrogram (EGG), Objectives of Biomedical Signal Analysis, Difficulties in Biomedical Signal Analysis, Computer-Aided Diagnosis.

Module-2: EEG Signal Processing and Event Detection in Biomedical Signals

EEG Signal and Its Characteristics, EEG Analysis, Linear Prediction Theory, Autoregressive Method, Sleep EEG, Application of Adaptive Filter for Noise Cancellation in ECG and EEG Signals; Detection of P, Q, R, S and T Waves in ECG, EEG Rhythms, Waves and Transients, Detection of Waves and Transients, Correlation Analysis and Coherence Analysis of EEG Channels.

Module-3: Structure of the measurement system

General Structure of the measurement system, Difference between Sensor and Transducer, Classification of Transducer, Static Characteristics, Dynamic Characteristics, Determination

of Absolute Quantity. Introduction to biosensor classification based on bio recognition element.

Module-4: Temperature sensors, blood flow and velocity measurement

Temperature sensors principle of operation- construction details-characteristics of–thermo resistive transducers, - RTD-thermistor, thermoelectric transducers- thermocouple and its cold junction compensation-chemical thermometry-Liquid crystals - Solid liquid transition thermometers. Blood flow and velocity measurement- Electromagnetic blood flowmeter and its types, Ultrasonic blood flowmeters- Doppler shift flow velocity meters

Module-5: Blood Pressure transducer and Nano biosensors

Resistive sensors-Potentiometric-resistive strain gauges, inductive sensors–LVDT- capacitive sensors–hall effect transducers-piezo electric sensors- measurement of blood pressure-sphygmomanometer-Indirect method-based on Korotk off sound, oscillometric method. Nano biosensors-basic concepts, construction of Nano biosensors, Nanomaterials for new bio sensing principles, optical nano biosensors basics and applications of BioMEMS

Text Books

1. Rangayyan, R.M. Biomedical signal analysis (Vol. 33). John Wiley & Sons.
2. Reddy, D.C., 2005. Biomedical signal processing: principles and techniques. McGraw-Hill, 2015.
3. Andrewg Webb, Principle of biomedical Instrumentation, Cambridge University Press 2018.

References

1. Tompkins, W.J.. Biomedical digital signal processing. Editorial Prentice Hall, 1993
2. Sörnmo, L. and Laguna, P Bioelectrical signal processing in cardiac and neurological applications (Vol. 8). Academic Press., 2005.
3. Biomedical Transducers & Instruments, By Tatsuo Togawa, Toshiyo Tamura, P. Ake Oberg. CRC Press, 2011.
4. Principles of Measurement & Transduction of Biomedical Variables, By Vera Lucia Da Silveira Nantes Button. Elsevier Inc, 2015
5. Sensors & Transducers, D. Patranabis, Phi Learning Pvt. Ltd., 01-Jan-2003

Sample Course Level Assessment Questions

Course Outcome 1 (CO1):

1. List out the Objectives of Biomedical Signal Analysis.
2. Explain the terms action potential and Evoked potential.

Course Outcome 2 (CO2):

1. What is correlation Analysis and Coherence Analysis of EEG Channels.
2. What is Autoregressive Method?

Course Outcome 3 (CO3):

1. List out the differences between sensor and transducer.
2. What are the four classifications of transducers?

Course Outcome 4 (CO4):

1. Explain the principle of thermocouple.
2. What are the two types of thermos resistive transducers?
3. Explain the working of blood flow meters.

Course Outcome 5 (CO5):

1. Explain the principle of resistive, capacitive, inductive transducers.
2. What are the transducers used for measuring blood pressure?
3. Explain the working of Hall effect transducers.

Model Question Paper

QP CODE: **PAGES: ___**

Reg No:_____
Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH. DEGREE EXAMINATION, MONTH & YEAR

Course Code: ERT 322
Course Name: BIOMEDICAL SIGNAL & TRANSDUCERS

Max Marks: 100 **Duration: 3 Hours**

PART A
(Answer All Questions. Each question carries 3 marks)

1. State two clinical uses of EEG.
2. What are the difficulties in Biomedical Signal Analysis?
3. What do you mean by Spike and Wave rhythm in EEG signals?
4. What are the two most important and common goals of biomedical signal analysis methods?
5. How does the inductive proximity sensor work?

6. Differentiate between capacitive transducer and resistive transducer.
7. What are the two types of thermos resistive transducers?
8. Illustrate the working of sine wave flow meter.
9. What are inductive transducers
10. Write notes on potentiometer.

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11. A) Explain in detail about the bioelectric signal which is responsible for the electrical activity of Brain. (7 marks)

B) Discuss about the bioelectric signal which is responsible for the electrical activity of Nerves and muscles of the stomach (7 marks)

OR

12. A) How noise cancelling is done in ECG? explain in detail (8 marks)

B) Explain Event-Related Potentials. (6 marks)

13. A) Explain how automated ECG analysis is carried out. (8 marks)

B) Explain the procedure adopted for modeling of EEG signals. (7 marks)

OR

14. A) What is the principle of a general electrode used in biomedical signals? Explain various electrode used for measurement of EEG signal. (8 marks)

B) With a neat diagram explain various segmentation of ECG signal. (6 marks)

15. Explain the working of Ion selective Field effect transistor. (14 marks)

OR

16. Describe the construction and working of silver–silver chloride electrode. (14 marks)

17. What are temperature transducers. Explain any two temperature transducers with diagram. (14 marks)

OR

18. Explain ultrasonic blood flow meter with diagram. (14 marks)

19. Explain the working of capacitive and piezo electric sensors. (14 marks)

OR

20. What are Nano biosensors. Explain its basic concepts, construction of Nano biosensors. (14 marks)

TEACHING PLAN

No	Contents	No.of Lecture Hrs
Module-1 (Authentication Protocols) (7hrs)		
1.1	Action Potential and Its Generation.	1
1.2	Origin and Waveform Characteristics of Basic Biomedical Signals Like: Electrocardiogram (ECG),	1
1.3	Electroencephalogram (EEG), Electromyogram (EMG).	1
1.4	Phonocardiogram (PCG), Electroneurogram (ENG).	1
1.5	Event-Related Potentials (ERPS), Electrogastrogram (EGG).	1
1.6	Objectives of Biomedical Signal Analysis, Difficulties in Biomedical Signal Analysis.	1
1.7	Computer-Aided Diagnosis.	1
Module-2 (E-mail Security) (6 hrs)		
2.1	EEG Signal and Its Characteristics, EEG Analysis.	1
2.2	Linear Prediction Theory, Autoregressive Method, Sleep EEG.	1
2.3	Application of Adaptive Filter for Noise Cancellation in ECG and EEG Signals; Detection of P, Q, R, S and T Waves in ECG.	1
2.4	EEG Rhythms, Waves and Transients.	1
2.5	Detection of Waves and Transients.	1
2.6	Correlation Analysis Ad Coherence Analysis of EEG Channels.	1
Module-3 (Network Layer Security and Web Security) (8 hrs)		

3.1	General Structure of the measurement system.	1
3.2	Difference between Sensor and Transducer.	1
3.3	Classification of Transducer - Lecture 1	1
3.4	Classification of Transducer - Lecture 2	1
3.5	Static Characteristics,	1
3.6	Dynamic Characteristics,	1
3.7	Determination of Absolute Quantity.	1
3.8	Introduction to biosensor classification based on bio recognition element.	1
Module-4 (Real-time Security and Application Layer Security) (8hrs)		
4.1	Temperature sensors principle of operation- construction details.	1
4.2	Characteristics of–thermo resistive transducers.	1
4.3	RTD-thermistor, thermoelectric transducers.	1
4.4	Thermocouple and its cold junction compensation-chemical thermometry.	1
4.5	Liquid crystals - Solid liquid transition thermometers.	1
4.6	Blood flow and velocity measurement.	1
4.7	Electromagnetic blood flowmeter and its types.	1
4.8	Ultrasonic blood flowmeters- Doppler shift flow velocity meters.	1
Module-5 (System Security and Wireless Security) (6 hrs)		
5.1	Resistive sensors-Potentiometric-resistive strain gauges.	1
5.2	Inductive sensors–LVDT- capacitive sensors–hall effect transducers.	1
5.3	Piezo electric sensors- measurement of blood pressure-sphygmomanometer-Indirect method-based on Korotk off sound.	1
5.4	Oscillometric method. Nano biosensors-basic concepts.	1
5.5	Construction of Nano biosensors, Nanomaterials for new bio sensing principles.	1
5.6	optical nano biosensors basics and applications of BioMEMS.	1

ERT 332	ELECTRONIC PRODUCT DESIGN	CATEGORY	L	T	P	CREDITS
		PEC	2	1	0	3

Preamble: This course aims to design and develop of an electronic product that meets the industrial standard.
Prerequisite: EST 200: Design and Engineering

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand the electronic product design life cycle and the guidelines of PCB design. **(Cognitive Knowledge Level: Understand)**
CO 2	Familiar with Integrated development Environment and the basic knowledge about EMI/EMC issues in product development **(Cognitive Knowledge Level: Understand)**
CO 3	Familiar with microsystem packaging and the IC assembly **(Cognitive Knowledge Level: Understand)**
CO 4	Understand the thermal considerations in product design and sealing of microsystems. **(Cognitive Knowledge Level: Understand)**
CO5	Apply the PCB design tools and design a new PCB with all design considerations and assembling the different types of PCBs **(Cognitive Knowledge Level: Apply)**

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	✓	✓										✓
CO 2	✓	✓										✓
CO 3	✓	✓										✓
CO 4	✓	✓										✓
CO 5	✓	✓										✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	PO#	**Broad PO**
PO1	Engineering Knowledge	PO7	Environment and Sustainability
PO2	Problem Analysis	PO8	Ethics
PO3	Design/Development of solutions	PO9	Individual and team work
PO4	Conduct investigations of complexproblems	PO10	Communication
PO5	Modern tool usage	PO11	Project Management and Finance
PO6	The Engineer and Society	PO12	Life long learning

Assessment Pattern

Bloom's Category		Continuous Assessment Tests		End Semester Examination
		1	2	
Remember	K1	10	10	10
Understand	K2	35	35	60
Apply	K3	5	5	30
Analyse				
Evaluate				
Create				

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	**50**	**100**	**3 hours**

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Test (2 numbers) : 25 marks

Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): Understand the electronic product design life cycle and the guidelines of PCB design

1. What are the various activities involved in Analysis Phase of EDLC
2. Explain the guidelines for PCB design

Course Outcome 2 (CO2): familiar with Integrated development Environment and the basic knowledge about EMI/EMC issues in product development

1. What is IDE? Explain any one IDE in detail
2. Discuss effect of shielding on EMC

Course Outcome 3 (CO3): familiar with microsystem packaging and the IC assembly

1. With neat diagrams explain wedge bonding in wire bonding IC assembly Technology.
2. Need of microsystem packaging

Course Outcome 4 (CO4): understand the thermal considerations in product design and sealing of microsystems.

1. Why thermal management is necessary in electronic system?
2. Briefly explain Hermetic sealing process.

Course Outcome 5 (CO5): apply the PCB design tools and design a new PCB with all design considerations and assembling the different types of PCBs

1. List out the PCB design guidelines for EM compatibility.
2. Discuss the different board assembly issues

SYLLABUS

Module 1: (7 Hours)

Product Design and Development: Embedded System product Development Life cycle (EDLC), Objectives of EDLC, Phases of EDLC, EDLC approaches (modeling the EDLC): Linear, fountain, Evolutionary and Spiral models. Component selection, Schematic Design, Guidelines for PCB Design, PCB layout, fabrication and assembly

Module 2: (7 Hours)

Embedded System Development Environment–IDE, Cross compilation, Simulators/Emulators, Hardware Debugging: various types, Target hardware debugging. Hardware testing methods like

Boundary Scan, In Circuit Testing (ICT).

EMI/EMC-EMC standards and regulation, grounding, cabling, shielding and guarding (overview only)

Module 3: (6 Hours)

Microsystems Packaging- Need of packaging, electrical, mechanical and material technologies

IC Assembly – Purpose, Requirements, Technologies, Wire bonding, ball bonding and wedge bonding, Tape Automated Bonding, Flip Chip., Wafer Level Packaging.

Module 4: (8 Hours)

Thermal Considerations in Electronic Product Design: Heat generation and modes of heat transfer in Electronic Products- Selection/Design of Heat Sinks- Factors affecting the design of heat sinks and its cooling effectiveness-Assembly of components on heat sinks- Electrical analogue of thermal circuits- Enclosure design of Electronic Equipment's and thermal considerations- Design guidelines for Ventilations- Forced cooling- Heat pipes for electronic cooling applications.

Sealing and Encapsulation: Necessity, Requirements, Encapsulation Processes, Hermetic Sealing

Module 5: (8 Hours)

PCB design: Requirements in PCB Design- PCB Design elements- PCB design process- advantages of PCBs Design rules for analog, digital, high-frequency, power-electronic and MW PCBs-PCB design guidelines for EM compatibility, Single sided PCB, Double sideed PCB, multi-layer PCB (up to 8 layers).

Board Assembly – Surface Mount Technology, Through-Hole Technology, Assembly Issues

Text Books

1. Shibu K.V , Introduction to Embedded Systems, Tata McGraw Hill, 2009
2. Henry.W.Ott, Electromagnetic Compatibility Engineering, Wiley Interscience,2009
3. Rao R. Tummala: Fundamentals of Microsystem Packaging, McGraw Hill
4. R.G.Kaduskar, V.B Baru, Electronic Product Design, Wiley India, 2/e.

Reference books

1. Karl T. Ulrich & Steven D. Eppinger, Product Design and Development, Tata McGraw Hill,
2. Richard K. Ulrich &William D. Brown Advanced Electronic Packaging - 2nd Edition : IEEE Press
3. Charles A Harper, Electronic Packaging and Interconnection Handbook, McGraw hill, Fourth Edition
4. Walter C. Bosshart, Printed Circuit Boards- Design and Technology, Tata McGraw Hill,1988

5. Kevin Otto, Kristin Wood, Product Design- Techniques in Reverse Engineering and NewProduct Development, Pearson Education, (2004)
6. Richard Stillwell, Electronic Product Design for Automated Manufacturing, Marcel DekkerPublications
7. Bert Haskell, Portable Electronics Product Design and Development, McGraw Hill, (2004)

Course Contents and Lecture Schedule

No	Topic	**Hours (36)**
1	**Product Design and Development (7 hrs) (Text Book – 1)**	
1.1	Embedded System product Development Life cycle (EDLC), Objectives of EDLC – Lecture 1	1
1.2	Embedded System product Development Life cycle (EDLC), Objectives of EDLC - Lecture 2	1
1.3	Phases of EDLC	1
1.4	EDLC approaches (modeling the EDLC): Linear, fountain	1
1.5	Evolutionary and Spiral models.	1
1.6	Component selection, Schematic Design	1
1.7	Guidelines for PCB Design, PCB layout, fabrication and assembly	1
2	**Embedded System Development Environment (7 hrs) (Text Books – 1, 2)**	
2.1	IDE, Cross compilation, Simulators/Emulators	1
2.2	Hardware Debugging: various types – Lecture 1	1
2.3	Hardware Debugging: various types – Lecture 2	1
2.4	Target hardware debugging	1
2.5	Hardware testing methods like Boundary Scan, In Circuit Testing (ICT).	1
2.5	**EMI/EMC**-EMC standards and regulation, grounding, cabling, shielding and guarding (overview only) - Lecture 1	1
2.7	**EMI/EMC**-EMC standards and regulation, grounding, cabling, shielding and guarding (overview only) - Lecture 2	1
3	**Microsystems Packaging & IC assembly (6 hrs) (Text Book – 3)**	

3.1	**Microsystems Packaging**- Need of packaging, electrical, mechanical and material technologies - Lecture 1	1
3.2	**Microsystems Packaging**- Need of packaging, electrical, mechanical and material technologies - Lecture 2	1
3.3	**IC Assembly** – Purpose, Requirements, Technologies	1
3.4	Wire bonding, ball bonding and wedge bonding	1
3.5	Tape Automated Bonding, Flip Chip	1
3.6	Wafer Level Packaging.	1
4	**Thermal Considerations in Electronic Product Design (8 hrs) (Text Books – 3, 4)**	
4.1	Heat generation and modes of heat transfer in Electronic Products	1
4.2	Selection/Design of Heat Sinks- Factors affecting the design of heat sinks and its cooling effectiveness	1
4.3	Assembly of components on heat sinks- Electrical analogue of thermal circuits	1
4.4	Enclosure design of Electronic Equipment's and thermal considerations	1
4.5	Design guidelines for Ventilations- Forced cooling-	1
4.6	Heat pipes for electronic cooling applications	1
4.7	**Sealing and Encapsulation**: Necessity, Requirements, Encapsulation Processes	1
4.8	Hermetic Sealing	1
5	**PCB design (8 hrs) (Text Books – 2, 4)**	
5.1	Requirements in PCB Design- PCB Design element	1
5.2	PCB design process - Lecture 1	1
5.3	PCB design process - Lecture 2	1
5.4	Advantages of PCBs Design rules for analog, digital, high-frequency, power-electronic and MW PCBs	1
5.5	PCB design guidelines for EM compatibility, Single sided PCB	1
5.6	Double sided PCB, multi-layer PCB (up to 8 layers),	1
5.7	**Board Assembly** – Surface Mount Technology	1
5.8	Through-Hole Technology, Assembly Issues	1

Assignment:
At least two assignments should be given

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH DEGREE EXAMINATION

Course Code: ERT332

Program: Electronics and Computer Engineering

Course Name: ELECTRONIC PRODUCT DESIGN

Max. Marks: 100 Duration: 3 Hours

PART A

Answer ALL Questions. Each Carries 3 marks.

1.	What are the various activities involved in Analysis Phase of EDLC	(3)
2	Explain the process of schematic design using EDA tools?	(3)
3	What is In Circuit Emulator (ICE) Based Firmware Debugging	(3)
4	Describe about safety ground.	(3)
5	What you mean by IC assembly? What are the requirements of IC assembly?	(3)
6	Explain the need for packaging	(3)
7	Why thermal management is necessary in electronic system?	(3)
8	What is hermetic sealing? what are the different steps involved in hermetic sealing	(3)
9	List out the PCB design guidelines for EM compatibility.	(3)
10	Discuss the different board assembly issues	(3)

PART – B

Answer one question from each module. Each question carries 14 marks

Module – I

11.a)	Explain the waterfall model of EDLC	8	CO1	K2
11.b)	Explain the guidelines for PCB design	6	CO1	K2

	OR			
12.a)	Explain spiral EDLC model with necessary diagram.	8	CO1	K2
12.b)	Explain the component selection process in PCB design	5	CO1	K2

Module – II

13 a)	Explain the target board debugging in detail.	8	CO2	K2
13 b)	Discuss effect of shielding on EMC	6	CO2	K2
	OR			
14 a)	What are the different tools used for hardware debugging?	8	CO2	K2
14 b)	Discuss in detail about single point ground system.	6	CO2	K2

Module – III

15 a)	With neat diagrams explain Tape Automated Bonding (TAB) Technology	8	CO3	K2
15 b)	Briefly explain the electrical, Mechanical and material technologies of electronic packaging	6	CO3	K2
	OR			
16 a)	With neat diagrams explain wire bonding IC assembly Technology.	8	CO3	K2
16 b)	Consider a television as an example and different levels of microsystem packaging	6	CO3	K2

Module – IV

17 a)	What are the different electronic cooling methods? Explain	8	CO4	K2
17 b)	Briefly explain Hermetic sealing process	6	CO4	K2
	OR			
18 a)	What are the different thermal transport modes in an electronic system? Explain	8	CO4	K2
18 b)	With necessary diagram explain the transfer molding process.	6	CO4	K2

Module – V

19 a)	Apply the knowledge of PCB design and write the steps of designing a 12 V Power supply PCB.	8	CO5	K3
19 b)	Explain the surface mount board assembly	6	CO5	K2
	OR			
20 a)	Apply the knowledge of PCB design and write the steps of designing Inverter PCB .	8	CO5	K3
20 b)	Explain the through hole board assembly	6	CO5	K2

ERT342	GRAPH THEORY	Category	L	T	P	Credit
		PEC	2	1	0	3

Preamble: This course introduces fundamental concepts in Graph Theory, including properties and characterization of graph/trees and graph theoretic algorithms, which are widely used in Mathematical modelling and has got applications across Computer Science and other branches in Engineering

Prerequisite: Basic understanding of Discrete Mathematical Structures

Course Outcomes: After the completion of the course, the students will be able to

CO1	Explain vertices and their properties, types of paths, classification of graphs and trees & their properties. **(Cognitive Knowledge Level: Understand)**
CO2	Demonstrate the fundamental theorems on Eulerian and Hamiltonian graphs. **(Cognitive Knowledge Level: Understand)**
CO3	Illustrate the working of Prim's and Kruskal's algorithms for finding minimum cost spanning tree and Dijkstra's algorithm for finding shortest paths. **(Cognitive Knowledge Level: Apply)**
CO4	Explain planar graphs, their properties and an application for planar graphs. **(Cognitive Knowledge Level: Apply)**
CO5	Illustrate how one can represent a graph in a computer. **(Cognitive Knowledge Level: Apply)**
CO6	Explain the Vertex Color problem in graphs and illustrate an example application for vertex coloring. **(Cognitive Knowledge Level: Apply)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓									✓
CO2	✓	✓	✓	✓								✓
CO3	✓	✓	✓	✓								✓
CO4	✓	✓	✓	✓								✓
CO5	✓	✓	✓									✓
CO6	✓	✓	✓									✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Lifelong learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks (%)
	Test 1 (%)	Test 2 (%)	
Remember	**30**	**30**	**30**
Understand	**30**	**30**	**30**
Apply	**40**	**40**	**40**
Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	**50**	**100**	**3**

Continuous Internal Evaluation Pattern:

Attendance	**10 marks**
Continuous Assessment Tests (Average of Internal Tests 1 & 2)	**25 marks**
Continuous Assessment Assignment	**15 marks**

Internal Examination Pattern

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing the remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 full questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

SYLLABUS

Module – 1: (Introduction to Graphs)

Introduction- Basic definition – Application of graphs – finite, infinite and bipartite graphs – Incidence and Degree – Isolated vertex, pendant vertex and Null graph. Paths and circuits – Isomorphism, sub graphs, walks, paths and circuits, connected graphs, disconnected graphs and components..

Module – 2: (Eulerian and Hamiltonian graphs)

Euler graphs, Operations on graphs, Hamiltonian paths and circuits, Travelling salesman problem. Directed graphs – types of digraphs, Digraphs and binary relation, Directed paths, Fleury's algorithm

Module – 3: (Trees and Graph Algorithms)

Trees – properties, pendant vertex, Distance and centers in a tree - Rooted and binary trees, counting trees, spanning trees, Prim's algorithm and Kruskal's algorithm, Dijkstra's shortest path algorithm.

Module – 4: (Connectivity and Planar Graphs)

Vertex Connectivity, Edge Connectivity, cut set and Cut Vertices, Fundamental circuits, Planar graphs, Kuratowski's theorem (proof not required), Different representations of planar graphs, Euler's theorem, Geometric dual.

Module – 5: (Graph Representations and Vertex Coloring)

Matrix representation of graphs- Adjacency matrix, Incidence Matrix, Circuit Matrix, Path Matrix. Coloring- Chromatic number, Chromatic polynomial, four color problem and Five color theorem. Greedy coloring algorithm.

Text Books

1. Narsingh Deo, Graph theory, PHI,1979

Reference Books

1. R. Diestel, *Graph Theory*, free online edition, 2016: diestel-graph-theory.com/ basic.html.
2. Douglas B. West, Introduction to Graph Theory, Prentice Hall India Ltd.,2001
3. Robin J. Wilson, Introduction to Graph Theory, Longman Group Ltd.,2010
4. J.A. Bondy and U.S.R. Murty. Graph theory with Applications

Course Level Assessment Questions

Course Outcome1 (CO1):

1. Differentiate a walk, path and circuit in a graph.
2. Is it possible to construct a graph with 12 vertices such that two of the vertices have degree3 and the remaining vertices have degree 4? Justify
3. Prove that a simple graph with n vertices must be connected, if it has more than $\frac{(n-1)(n-2)}{2}$ edges.
4. Prove the statement: If a graph (connected or disconnected) has exactly two odd degrees, then there must be a path joining these two vertices.

Course Outcome 2(CO2):

1. Define Hamiltonian circuit and Euler graph. Give one example for each.
2. Define directed graphs. Differentiate between symmetric digraphs and asymmetric digraphs.
3. Prove that a connected graph G is an Euler graph if all vertices of G are of even degree.

4. Prove that a graph G of n vertices always has a Hamiltonian path if the sum of the degrees of every pair of vertices *Vi*, *Vj* in G satisfies the condition $d(Vi)+d(Vj)=n-1$

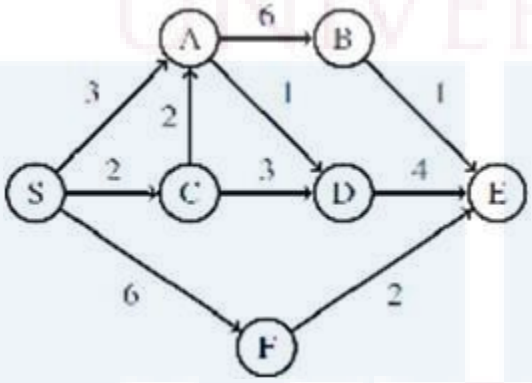
Course Outcome 3(CO3):

i. Discuss the center of a tree with suitable example.

ii. Define binary tree. Then prove that number of pendant vertices in a binary tree is (n+1)/2

iii. Prove that a tree with n vertices has n edges.

iv. Run Dijkstra's algorithm on the following directed graph, starting at vertex ***S***.



Course Outcome 4(CO4): .

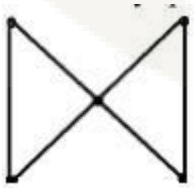
1. Define edge connectivity, vertex connectivity and separable graphs. Give an example for each.
2. Prove the statement: Every cut set in a connected graph G must also contain at least one branch of every spanning tree of G.

Course Outcome 5(CO5):

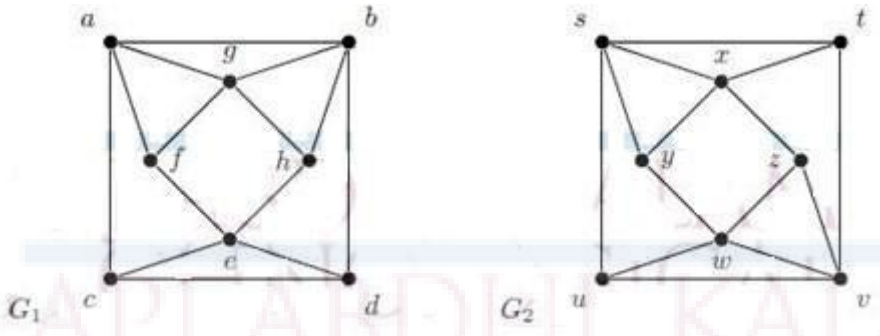
1. Show that if ***A(G)*** is an incidence matrix of a connected graph ***G*** with ***n*** vertices, then rank of ***A(G)*** is ***n−1***.
2. Show that if ***B*** is a cycle matrix of a connected graph ***G*** with ***n*** vertices and ***m*** edges, then rank ***B =m−n+1***.
3. Derive the relations between the reduced incidence matrix, the fundamental cycle matrix, and the fundamental cut-set matrix of a graph ***G***.
4. Characterize simple, self-dual graphs in terms of their cycle and cut-set matrices.

Course Outcome 6 (CO6):

1. Show that an n vertex graph is a tree iff its chromatic polynomial is $Pn(\lambda) = \lambda\,(\lambda-1)n-1$
2. Define Path matrix and Circuit matrix with an example each.

Model Question Paper		
QP CODE:		
Reg No: _____		
Name:_____		**PAGES : 4**
APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY		
SIXTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR		
Course Code: ERT342		
Course Name: Graph Theory		
Max. Marks : 100		**Duration: 3 Hours**
PARTA		
Answer All Questions. Each Question Carries 3 Marks		
1.	Construct a simple graph of 12 vertices with two of them having degree 1, three having degree 3 and the remaining seven having degree10.	**(3)**
2.	What is the largest number of vertices in a graph with 35 edges, if all vertices are of degree at least 3 ?	**(3)**
3.	Define a Euler graph. Give an example of Eulerian graph which is not Hamiltonian	**(3)**
4.	Give an example of a strongly connected simple digraph without a directed Hamiltonian path.	**(3)**
5.	What is the sum of the degrees of any tree of ***n*** vertices?	**(3)**
6.	How many spanning trees are there for the following graph 	**(3)**

7.		Show that in a simple connected planar graph ***G*** having ***V***-vertices, ***E***-edges, and no triangles ***E <= 3V -6***	**(3)**
8.		Let G be the following disconnected planar graph. Draw its dual G*,and the dual of the dual (G*)*.  G	**(3)**
9.		Consider the circuit matrix ***B*** and incidence matrix ***A*** of a simple connected graph whose columns are arranged using the same order of edges. Prove that every row of ***B*** is orthogonal to every row of ***A***?	**(3)**
10.		A graph is *critical* if the removal of any one of its vertices (and the edges adjacent to that vertex) results in a graph with a lower chromatic number. how that ***Kn*** is critical for all ***n > 1***.	**(10x3=30)**
Part B **(Answer any one question from each module. Each question carries 14 Marks)**			
11.	(a)	Prove that for any simple graph with at least two vertices has two vertices of the same degree.	**(6)**
	(b)	Prove that in a complete graph with ***n*** vertices there are **(n-1)/2** edge disjoint Hamiltonian circuits and ***n >= 3***	**(8)**
		OR	
12.	(a)	Determine whether the following graphs ***G1 = (V1, E1)*** and ***G2 = (V2, E2)*** are isomorphic or not. Give justification.	**(6)**

			
	(b)	Prove that a simple graph with n vertices and k components can have at most(n-k)(n-k+1)/2 edges.	**(8)**
13.	(a)	Let ***S*** be a set of 5 elements.Construct a graph ***G*** whose vertices are subsets of ***S*** of size2 and two such subsets are adjacent in ***G*** if they are disjoint. i) Draw the graph ***G***. ii) How many edges must be added to ***G*** in order for ***G*** to have a Hamiltonian cycle?	**(8)**
	(b)	Let ***G*** be a graph with exactly two connected components, both being Eulerian. What is the minimum number of edges that need to be added to ***G*** to obtain an Eulerian graph?	**(6)**
		OR	
14.	(a)	Show that a ***k***-connected graph with no hamiltonian cycle has an independent set of size ***k +1***.	**(8)**
	(b)	i. Let ***G*** be a graph that has exactly two connected components, both being Hamiltonian graphs. Find the minimum number of edges that one needs to add to ***G*** to obtain a Hamiltonian graph. ii. For which values of ***n*** the graph ***Qn*** (hyper-cube on ***n*** vertices) is Eulerian.	**(6)**
15.	(a)	A tree ***T*** has at least one vertex ***v*** of degree 4, and at least one vertex ***w*** of degree 3. Prove that ***T*** has at least 5leaves.	**(5)**
	(b)	Write Dijkstra's shortest path algorithm. Consider the following weighted directed graph ***G.*** Find the shortest path	**(9)**

		between ***a*** and every other vertices in ***G*** using Dijkstra's shortest path algorithm.	
		OR	
16.	(a)	Define pendent vertices in a binary tree? Prove that the number of pendent vertices in a binary tree with ***n*** vertices is ***(n+1)/2***	**(5)**
	(b)	Write Prim's algorithm for finding minimum spanning tree. Find a minimum spanning tree in the following weighted graph, using Prim's algorithm. Determine the number of minimum spanning trees for the given graph.	**(9)**
17.	(a)	1. State and prove Euler's Theorem relating the number of faces, edges andvertices for a planar graph. 2. If ***G*** is a 5-regular simple graph and ***|V| = 10***, prove that ***G*** is non-planar.	**(9)**
	(b)	Let ***G*** be a connected graph and ***e*** an edge of ***G***. Show that ***e*** is a cut-edge if and only if ***e*** belongs to every spanning tree.	**(5)**
18.	(a)	State Kuratowski's theorem, and use it to show that the graph G below is not planar. Draw G on the plane without edges crossing. Your drawing should use the labeling of the vertices given.	**(9)**
	(b)	Let ***G*** be a connected graph and ***e*** an edge of ***G***. Show that ***e*** belongs to a loop if and only if ***e*** belongs to no spanning tree.	**(5)**
19.	(a)	Define the circuit matrix ***B(G)*** of a connected graph ***G*** with ***n*** vertices and ***e*** edgeswith an example. Prove that the rank of ***B(G)*** is ***e-n+1***	**(7)**
	(b)	Give the definition of the chromatic polynomial ***PG(k)***. Directly from the definition, prove that the chromatic polynomials of ***Wn*** and ***Cn*** satisfy the identity ***PWn(k) = k PCn-1 (k – 1).***	**(7)**
		OR	

20.	(a)	Prove that the rank of an incidence matrix of a connected graph with ***n*** vertices is ***n-1.***	**(3)**
	(b)	i. A graph ***G*** has chromatic polynomial ***PG(k) = k4-4k3+5k2-2k***. How many vertices and edges does ***G*** have? Is ***G*** bipartite? Justify your answers. i. State and prove Five Color Theorem.	**(11)**

Teaching Plan

No	Contents	No. of Lecture Hours (36 hrs)
Module-1 (Introduction to Graphs) (5 hours)		
1.1	Introduction- Basic definition – Application of graphs – finite and infinite graphs, bipartite graphs,	1 hour
1.2	Incidence and Degree – Isolated vertex, pendent vertex and Null graph,	1 hour
1.3	Paths and circuits, Isomorphism	1 hour
1.4	Sub graphs, walks, Paths and circuits	1 hour
1.5	Connected graphs, Disconnected graphs and components	1 hour
Module-2 (Eulerian and Hamiltonian graphs) (7 hours)		
2.1	Euler graphs	1 hour
2.2	Operations on graphs	1 hour
2.3	Hamiltonian paths and circuits	1 hour
2.4	Hamiltonian paths and circuits, Travelling salesman problem	1 hour
2.5	Directed graphs – types of digraphs,	1 hour
2.6	Digraphs and binary relation, Directed paths	1 hour
2.7	Fleury’s algorithm	1 hour

Module-3 (Trees and Graph Algorithms) (8 hours)		
3.1	Trees – properties	1 hour
3.2	Trees – properties, pendent vertex	1 hour
3.3	Distance and centers in a tree	1 hour
3.4	Rooted and binary tree	1 hour
3.5	Counting trees	1 hour
3.6	Spanning trees, Fundamental circuits	1 hour
3.7	Prim's algorithm, Kruskal's algorithm	1 hour
3.8	Dijkstra's shortest path algorithm	1 hour
Module-4 (Connectivity and Planar Graphs) (9 hours)		
4.1	Vertex Connectivity, Edge Connectivity	1 hour
4.2	Cut set and Cut Vertices	1 hour
4.3	Fundamental circuits	1 hour
4.4	Fundamental circuits	1 hour
4.5	Planar graphs	1 hour
4.6	Kuratowski's theorem	1 hour
4.7	Different representations of planar graphs	1 hour
4.8	Euler's theorem	1 hour
4.9	Geometric dual	1 hour
Module-5 (Graph Representations and Vertex Coloring) (7 hours)		
5.1	Matrix representation of graphs- Adjacency matrix, Incidence Matrix	1 hour
5.2	Circuit Matrix, Path Matrix	1 hour
5.3	Coloring- chromatic number,	1 hour
5.4	Chromatic polynomial	1 hour
5.5	Four color problem	1 hour
5.6	Five color Theorem and proof	1 hour
5.7	Greedy coloring algorithm.	1 hour

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ERT352	CLOUD COMPUTING	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble: This course helps the learners to understand cloud computing concepts. This course includes basic understanding of virtualization, fundamentals of cloud security, cloud computing based programming techniques and different industry popular cloud computing platforms. This course enables the student to suggest cloud-based solutions to real world problems.

Prerequisite: Basic understanding of computer networks and operating systems.

Course Outcomes: After the completion of the course the student will be able to

CO1	Explain the various cloud computing models and services. **(Cognitive Knowledge Level: Understand)**
CO2	Demonstrate the significance of implementing virtualization techniques. **(Cognitive Knowledge Level: Understand**)
CO3	Explain different cloud enabling technologies and compare private cloud platforms **(Cognitive Knowledge Level: Understand**)
CO4	Apply appropriate cloud programming methods to solve big data problems. (Cognitive Knowledge Level: **Apply**)
CO5	Describe the need for security mechanisms in cloud (**Cognitive Knowledge Level: Understand**)
CO6	Compare the different popular cloud computing platforms **(Cognitive Knowledge Level: Understand**)

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											✓
CO2	✓	✓	✓									✓
CO3	✓											✓
CO4	✓	✓	✓	✓	✓							✓
CO5	✓	✓										✓
CO6	✓				✓							✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks
	Test1 (Percentage)	Test2 (Percentage)	
Remember	30	30	30
Understand	40	40	40
Apply	30	30	30
Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	**50**	**100**	**3 hours**

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Tests : 25 marks

Continuous Assessment Assignment : 15 marks

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks.

First Internal Examination shall be preferably conducted after completing the first half of the syllabus and the Second Internal Examination shall be preferably conducted after completing the remaining part of the syllabus.

There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly covered module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly covered module), each with 7 marks. Out of the 7 questions in Part B, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have a maximum of 2 subdivisions and carries 14 marks.

Syllabus

Module 1: Fundamental Cloud Computing (7 Hours)

Traditional computing- Limitations. Overview of Computing Paradigms-Grid Computing, Cluster Computing, Distributed Computing, Utility Computing, Cloud Computing. NIST reference Model-Basic terminology and concepts. Cloud characteristics, benefits and challenges, Roles and Boundaries. Cloud delivery (service) models-Infrastructure-as-a-Service (IaaS), Platform-as-a-Service(PaaS),Software-as-a-Service (SaaS), XaaS (Anything-as-a-service)-Cloud deployment models- Public cloud, Community cloud, Private cloud, Hybrid cloud.

Module 2: Virtualization (7 Hours)

Introduction to virtualization-Virtualizing physical computing resources, Virtual Machines (Machine virtualization), non-virtualized v/s virtualized machine environments. Types of VMs-process VM v/s system VM, Emulation, interpretation and binary translation. Hardware-level virtualization- Hypervisors/VMM. Types of Hypervisors. Full Virtualization, Para-Virtualization, Hardware-assisted virtualization, OS level virtualization. Basics of Network Virtualization, Storage Virtualization and Desktop Virtualization, Pros and cons of virtualization. Case Study- Xen: Para-virtualization, VMware: full virtualization.

Module 3: Cloud-Enabling Technologies, Private cloud platforms and programming (7Hours)

Broadband networks and internet architecture- Internet Service Providers (ISPs), Data center technology, Web technology, Multitenant technology, Service technology. Resource provisioning techniques-static and dynamic provisioning.

Open-source software platforms for private cloud-OpenStack, CloudStack, Basics of Eucalyptus, Open Nebula, Nimbus.

Cloud Programming- Parallel Computing and Programming Paradigms. Map Reduce – Hadoop Library from Apache, HDFS, Pig Latin High Level Languages, Apache Spark.

Module 4: Fundamental Cloud Security (7 Hours)

Basic terms and concepts in security- Threat agents, Cloud security threats/risks, Trust. Operating system security-Virtual machine security- Security of virtualization- Security Risks Posed by Shared Images, Security Risks Posed by Management OS. Infrastructure security- Network Level Security, Host Level Security, Application level security, Security of the PhysicalSystems. Identity & Access Management- Access Control.

Module 5: Popular Cloud Platforms (9 Hours)

Amazon Web Services(AWS):- AWS ecosystem- Computing services, Amazon machine images, Elastic Compute Cloud (EC2), Advanced compute services. Storage services-Simple Storage System (Amazon S3), Elastic Block Store (Amazon EBS), Database Services, Amazon CDN Services and Communication services.

Google Cloud Platform:- IaaS Offerings: Compute Engine (GCE), Cloud Storage, PaaS Offerings: Google App Engine (GAE), Storage services, Application services, Compute services, Database Services, SaaS Offerings: Gmail, Docs, Google Drive.

Microsoft Azure: Azure Platform Architecture, Hyper-V, Azure Virtual Machine, Compute services, Storage services.

Text Books:

1. Thomas, E., Zaigham M., Ricardo P "Cloud Computing Concepts, Technology &Architecture.", (2013 Edition). Prentice Hall.
2. Buyya, R., Vecchiola, C., & Selvi, S. T. “Mastering cloud computing: foundations and applications programming”, (2017 Edition), Morgan Kaufmann.
3. Bhowmik, S., “Cloud computing”, (2017 Edition). Cambridge University Press.

References

1. Marinescu, D. C., "Cloud computing: theory and practice.", (2017 Edition), Morgan Kaufmann
2. Buyya, R., Broberg, J., & Goscinski, A. M., "Cloud computing: Principles and paradigms" (2011 Edition). John Wiley & Sons.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. "*A hybrid cloud is a combination of two or more other cloud deployment models*". Justify the statement with an example.
2. What are the main characteristics of a Platform-as-a-Service solution?
3. How does cloud computing help to reduce the time to market for applications and to cut down capital expenses?
4. Differentiate public and private clouds in terms of flexibility.

Course Outcome 2 (CO2):

5. Define virtualization. What is the role of VMM in virtualization?
6. Explain various implementation levels of Virtualization.
7. State the differences between a traditional computer and a virtual machine.

Course Outcome 3 (CO3):

8. Differentiate between on-premise and cloud-based inter-networking.
9. What are the benefits of Data Center Technologies?
10. What are the characteristics of Multi-tenant technology?
11. How can virtualization be implemented at the hardware level?

Course Outcome 4 (CO4):

12. Write a Hadoop MapReduce program that counts the number of occurrences of each character in a file.
13. Write a Hadoop MapReduce program to find the maximum temperature in the weather dataset.

Course Outcome 5 (CO5):

14. Why is it harder to establish security in the cloud?
15. Explain in detail about the security issues one should discuss with a cloud-computing vendor.
16. List and Explain major cloud security challenges.

Course Outcome 6 (CO6):

17. Explain the cloud based databases.
18. With a neat diagram, write about Google App Engine for PaaS applications.
19. Differentiate between amazon SimpleDB and Amazon RDS.
2. *"Storage services in the cloud are offered in two different forms as IaaS and as SaaS".* Explain.

Model Question Paper

QP Code: **Total Pages : 3**

Reg No:_____ **Name :_____**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
SIXTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: ERT352
Course Name: Cloud Computing

Duration: 3 Hrs **Max. Marks :100**

PART A
Answer all Questions. Each question carries 3 Marks (10 x 3 = 30 Marks)

1. Is the IT outsourcing model of traditional computing similar to cloud computing? Justify.

2. Why is grid computing considered as the predecessor of cloud computing? Explain.

3. What is virtualization and what are its benefits?

4. Explain why a hypervisor is also called a virtual machine monitor?

5. Differentiate between multi-tenancy and virtualization.

6. "*The field of service technology is a keystone foundation of cloud computing*". Explain.

7. Discuss any two identity management techniques used in cloud computing.

8. Differentiate between mandatory access control (MAC) and discretionary Access Control (DAC).

9. Differentiate between Amazon S3 and Amazon EBS.

10. Explain the database service offered by google cloud.

(10 x3 =30)

PART B

Answer any one Question from each Module. Each question carries 14 Marks

11.	**(a)**	Discuss the cloud computing reference model.	**(8)**
	(b)	Which are the basic components of an IaaS-based solution for cloud computing? Also provide some examples of IaaS implementations.	**(6)**

OR

12.	**(a)**	List down the characteristics and challenges of cloud computing.	**(6)**
	(b)	Classify the various types of clouds.	**(8)**
13.	**(a)**	List anddiscuss various types of virtualization.	**(8)**
	(b)	Differentiate between full virtualization and paravirtualization.	**(6)**

OR

14.	**(a)**	What is Xen? Discuss its elements for virtualization.	**(8)**
	(b)	Explain the design requirements for Virtual Machine Monitor (VMM).	**(6)**
15.	**(a)**	Explain the broadband networks and internet architecture.	**(8)**
	(b)	List and explain the technologies and components of data centers.	**(6)**

OR

16.	**(a)**	What are the major functions of the MapReduce framework? Explain the logical data flow of MapReduce function using a suitable example .	**(8)**
	(b)	Write a Hadoop MapReduce program that counts the number of occurrences of each word in a file.	**(6)**
17.	**(a)**	Explain common threats and vulnerabilities in cloud-based environments with suitable examples.	**(8)**
	(b)	Discuss the security risks posed by shared images with suitable examples.	**(6)**

OR

18.	**(a)**	Explain the operating system security in cloud computing.	**(8)**
	(b)	What do you mean by threat agents?. Explain different types of threat agents.	**(6)**
19.	**(a)**	DescribeAmazon EC2 and its basic features.	**(8)**
	(b)	Illustrate the architecture of Amazon S3.	**(6)**

OR

20.	**(a)**	Describethe core components of Google AppEngine.	**(8)**
	(b)	Explain the architecture of Windows Azure.	**(6)**

Teaching Plan

No	Contents	No. of Lecture Hours (37 hrs)
Module 1 (Fundamental Cloud Computing) (6 hours)		
1.1	Traditional computing: Limitations.	1
1.2	Overview of Computing Paradigms: Grid Computing, Cluster Computing, Distributed Computing, Utility Computing, Cloud Computing.	1
1.3	NIST reference Model, Basic terminology and concepts.	1
1.4	Cloud characteristics and benefits, challenges. Roles and Boundaries.	1
1.5	Cloud delivery (service) models: Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS), Software-as-a-Service (SaaS), XaaS (Anything-as-a-service).	1
1.6	Cloud deployment models: Public cloud, Community cloud, Private cloud, Hybrid cloud.	1

Module 2(Virtualization) (7 Hours)		
2.1	Introduction to virtualization, Virtualizing physical computing resources Virtual Machines (Machine virtualization):- non-virtualized v/s virtualized machine environments.	1
2.2	Types of VMs: process VM v/s system VM, Emulation, interpretation and binary translation.	1
2.3	Hardware-level virtualization: Hypervisors/VMM, Types of Hypervisors.	1
2.4	Full Virtualization, Para-Virtualization, Hardware-assisted virtualization, OS level virtualization.	1
2.5	Basics of Network Virtualization, Storage Virtualization and Desktop Virtualization, Pros and cons of virtualization.	1
2.6	Case Study: Xen: Para-virtualization.	1
2.7	Case Study: VMware: full virtualization.	1
Module 3 (Cloud-Enabling Technologies, Private cloud platforms and programming) (9 Hours)		
3.1	Broadband networks and internet architecture: Internet Service Providers (ISPs), Data center technology, Web technology, Multitenant technology, Service technology.	1
3.2	Resource provisioning techniques: static and dynamic provisioning.	1
3.3	Open-source software platforms for private cloud: OpenStack, CloudStack.	1
3.4	Basics of Eucalyptus, Open-Nebula, Nimbus.	1
3.5	Cloud Programming: Parallel Computing and Programming Paradigms.	1
3.6	Map Reduce.	1
3.7	Hadoop Library from Apache, HDFS.	1
3.8	Pig Latin High Level Languages	1
3.9	Apache Spark.	1

Module 4 (Fundamental Cloud Security) (7 Hours)		
4.1	Basic terms and concepts in security, Threat agents.	1
4.2	Cloud security threats/risks, Trust.	1
4.3	Operating system security, Virtual machine security.	1
4.4	Security of virtualization.	1
4.5	Security Risks posed by Shared Images, Security Risks posed by Management OS.	1
4.6	Infrastructure security: - Network Level Security, Host Level Security, Application level security, Security of the Physical Systems.	1
4.7	Identity & Access Management, Access Control.	1
Module 5 (Popular Cloud Platforms) (8 Hours)		
5.1	Amazon Web Services(AWS):- AWS ecosystem, Computing services: Amazon machine images, Elastic Compute Cloud (EC2).	1
5.2	Advanced computing services, Storage services: Simple Storage System (Amazon S3), Elastic Block Store (Amazon EBS).	1
5.3	Database Services, Amazon CDN Services and Communication services.	1
5.4	Google Cloud Platform:- IaaS Offerings: Compute Engine (GCE), Cloud Storage.	1
5.5	PaaS Offerings: Google App Engine (GAE), Storage services, Application services, Compute services.	1
5.6	Database Services, SaaS Offerings: Gmail, Docs, Google Drive.	1
5.7	Microsoft Azure: Azure Platform Architecture, Hyper-V, Azure Virtual Machine.	1
5.8	Azure Compute services, Storage services.	1

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CST 312	FOUNDATIONS OF MACHINE LEARNING	Category	L	T	P	Credit	Year of Introduction
		PEC	2	1	0	3	2019

Preamble:

This course enables the learners to understand the mathematical foundations of Machine Learning concepts. This course covers Linear Algebra, Probability and Distributions. Concepts in this course help the learners to identify the inherent assumptions & limitations of the current methodologies and develop new Machine Learning solutions.

Prerequisite: A sound background in higher secondary school Mathematics.

Course Outcomes: After the completion of the course the student will be able to

CO 1	Illustrate operations and applications of linear equations, matrix algebra, vector spaces, eigen values & eigenvectors **(Cognitive Knowledge Level: Apply)**
CO 2	Illustrate the concepts of orthogonality & diagonalization. **(Cognitive Knowledge Level: Apply)**
CO 3	Solve computational problems using probability and random variables. **(Cognitive Knowledge Level: Apply)**
CO 4	Identify an appropriate probability distribution for a given discrete or continuous random variable and use its properties. (**Cognitive Knowledge Level: Apply)**
CO 5	Illustrate moment generating function, law of large numbers and central limit theorems (**Cognitive Knowledge Level: Apply)**

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	✓	✓	✓	✓								✓
CO 2	✓	✓	✓	✓								✓
CO 3	✓	✓	✓	✓								✓
CO 4	✓	✓	✓	✓								✓

CO 5	✓	✓	✓	✓								✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1	**2**	
Remember	**30%**	**30%**	**30%**
Understand	**30%**	**30%**	**30%**
Apply	**40%**	**40%**	**40%**
Analyse			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	**50**	**100**	**3 hours**

Continuous Internal Evaluation Pattern:

Attendance **: 10 marks**

Continuous Assessment Tests **: 25 marks**

Continuous Assessment Assignment **: 15 marks**

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks

First Internal Examination shall be preferably conducted after completing the first half of the syllabus and the Second Internal Examination shall be preferably conducted after completing remaining part of the syllabus.

There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly covered module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly covered module), each with 7 marks. Out of the 7 questions in Part B, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer anyone. Each question can have maximum 2 sub-divisions and carry 14 marks.

Syllabus

Module 1 (LINEAR ALGEBRA)

Systems of Linear Equations – Matrices, Solving Systems of Linear Equations. Vector Spaces - Linear Independence, Basis and Rank, Linear Mappings.

Module 2 (LINEAR ALGEBRA)

Norms - Inner Products, Lengths and Distances, Angles and Orthogonality. Orthonormal Basis, Orthogonal Complement, Orthogonal Projections. Matrix Decompositions - Eigenvalues and Eigenvectors, Eigen decomposition and Diagonalization.

Module 3 (PROBABILITY AND DISTRIBUTIONS)

Probability Space - Sample Spaces, Probability Measures, Computing Probabilities, Conditional Probability, Baye's Rule, Independence. Random Variables - Discrete Random Variables (Bernoulli Random Variables, Binomial Distribution, Geometric and Poisson Distribution, Continuous Random Variables (Exponential Density, Gamma Density, Normal Distribution, Beta Density)

Module 4 (RANDOM VARIABLES)

Functions of a Random Variable. Joint Distributions - Independent Random Variables, Conditional Distributions, Functions of Jointly Distributed Random Variables.

Expected Values - Expected Value of a Random Variable, Expectations of Functions of Random Variables, Expectations of Linear Combinations of Random Variables, Variance and Standard Deviation, Covariance and Correlation, Conditional Expectation

Module 5 (LIMIT THEOREMS)

Moment-Generating Function. Limit Theorems(Proof not expected) - Law of Large Numbers, Convergence in Distribution and the Central Limit Theorem. Distributions derived from the Normal Distribution - Chi-square, t, and F Distributions, Sample Mean and the Sample Variance.

Text book:

1. Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, Mathematics for Machine Learning, Cambridge University Press (freely available at https://mml – book.github.io)
2. John A. Rice, Mathematical Statistics and Data Analysis, University of California, Berkeley, Third edition, published by Cengage.

Reference books:

1. Gilbert Strang, Linear Algebra and Its Applications, 4th Edition,
2. Axler, Sheldon, Linear Algebra Done Right, 2015 Springer
3. Stephen Boyd and Lieven Vandenberghe, Introduction to Applied Linear Algebra, 2018 published by Cambridge University Press

Sample Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Find the set ***S*** of all solutions in ***x*** of the following inhomogeneous linear systems ***Ax = b***, where ***A*** and ***b*** are defined as follows:

$$A = \begin{bmatrix} 1 & -1 & 0 & 0 & 1 \\ 1 & 1 & 0 & -3 & 0 \\ 2 & -1 & 0 & 1 & -1 \\ -1 & 2 & 0 & -2 & -1 \end{bmatrix}, \quad b = \begin{bmatrix} 3 \\ 6 \\ 5 \\ -1 \end{bmatrix}$$

2. Determine the inverses of the following matrix if possible

$$A = \begin{bmatrix} 1 & 0 & 1 & 0 \\ 0 & 1 & 1 & 0 \\ 1 & 1 & 0 & 1 \\ 1 & 1 & 1 & 0 \end{bmatrix}$$

3. Are the following sets of vectors linearl independent?

$$x_1 = \begin{bmatrix} 2 \\ -1 \\ 3 \end{bmatrix}, \quad x_2 = \begin{bmatrix} 1 \\ 1 \\ -2 \end{bmatrix}, \quad x_3 = \begin{bmatrix} 3 \\ -3 \\ 8 \end{bmatrix}$$

4. A set of ***n*** linearly independent vectors in $\boldsymbol{R^n}$ forms a basis. Does the set of vectors **(2, 4,−3) (0, 1, 1)** , **(0, 1,−1**) form a basis for $\boldsymbol{R^3}$? Explain your reasons.

Course Outcome 2 (CO2):

1. Determine which of the following sets are orthogonal sets.

$$\left\{\begin{bmatrix}3\\1\\1\end{bmatrix}, \begin{bmatrix}-1\\2\\1\end{bmatrix}, \begin{bmatrix}-1/2\\-2\\7/2\end{bmatrix}\right\} \qquad \left\{\begin{bmatrix}1\\-1\\1\end{bmatrix}, \begin{bmatrix}2\\1\\-1\end{bmatrix}, \begin{bmatrix}3\\0\\-3\end{bmatrix}\right\} \qquad \left\{\begin{bmatrix}3\\-2\\1\\3\end{bmatrix}, \begin{bmatrix}-1\\3\\-3\\4\end{bmatrix}, \begin{bmatrix}3\\8\\7\\0\end{bmatrix}\right\}$$

2. Find the characteristic equation, eigenvalues, and eigenspaces corresponding to each eigenvalue of the following matrix.

$$\begin{bmatrix}2 & 0 & 4\\0 & 3 & 0\\0 & 1 & 2\end{bmatrix}$$

3. Diagonalize the following matrix, if possible

$$\begin{bmatrix}3 & 0 & 0 & 0\\0 & 2 & 0 & 0\\0 & 0 & 2 & 0\\1 & 0 & 0 & 3\end{bmatrix}$$

Course Outcome 2 (CO3):

1. Let ***J*** and ***T*** be independent events, where ***P(J)=0.4*** and ***P(T)=0.7***.
   - ***i.*** Find ***P(J∩T)***
   - ***ii.*** Find ***P(J∪T)***
   - ***iii.*** Find ***P(J∩T')***

2. Let ***A*** and ***B*** be events such that ***P(A)=0.45*** , ***P(B)=0.35*** and ***P(A∪B)=0.5***. Find ***P(A|B)***.

3. A random variable **R** has the probability distribution as shown in the following table:

r	1	2	3	4	5
P(R=r)	0.2	a	b	0.25	0.15

i. Given that ***E(R)=2.85***, find ***a*** and ***b***.
ii. Find ***P(R>2)***.

4. A biased coin (with probability of obtaining a head equal to $p > 0$) is tossed repeatedly and independently until the first head is observed. Compute the probability that the first head appears at an even numbered toss.

5. Two players A and B are competing at a quiz game involving a series of questions. On any individual question, the probabilities that A and B give the correct answer are ***p*** and ***q*** respectively, for all questions, with outcomes for different questions being independent. The game finishes when a player wins by answering a question correctly. Compute the probability that A wins if
   i. A answers the first question,
   ii. B answers the first question.

6. A coin for which ***P(heads) = p*** is tossed until two successive tails are obtained. Find the probability that the experiment is completed on the nth toss.

Course Outcome- 3 (CO4):

1. An urn contains **p** black balls, **q** white balls, and **r** red balls; and **n** balls are chosen without replacement.
   a. Find the joint distribution of the numbers of black, white, and red balls in the sample.
   b. Find the joint distribution of the numbers of black and white balls in the sample.
   c. Find the marginal distribution of the number of white balls in the sample.

2. Suppose that two components have independent exponentially distributed lifetimes, T_1 and T_2, with parameters α and β, respectively. Find (a) $P(T_1 > T_2)$ and (b) $P(T_1 > 2T_2)$.

3. Let Z_1 and Z_2 be independent random variables each having the standard normal distribution. Define the random variables X and Y by $X = Z_1 + 3Z_2$ and $Y = Z_1 + Z_2$. Argue that the joint distribution of (X, Y) is a bivariate normal distribution. What are the parameters of this distribution?

4. Given a continuous random variable x, with cumulative distribution function $F_x(x)$, show that the random variable $y = F_x(x)$ is uniformly distributed.
5. You roll a fair dice twice. Let the random variable X be the product of the outcomes of the two rolls. What is the probability mass function of X? What are the expected values and the standard deviation of X?
6. Let X be a continuous random variable with the density function $f(x) = 2x, 0 \leq x \leq 1$
   a. Find $E(X)$.
   b. Find $E(X^2)$ and $Var(X)$.

Course Outcome 5 (CO5):

1. Find the moment-generating function of a Bernoulli random variable, and use it to find the mean, variance, and third moment.
2. Use moment-generating functions to show that if **X** and **Y** are independent, then $Var(aX + bY) = a^2Var(X) + b^2Var(Y)$.
3. Suppose that you bet Rs 5 on each of a sequence of 50 independent fair games. Use the central limit theorem to approximate the probability that you will lose more than Rs 75.
4. Suppose that the number of insurance claims, N, filed in a year is Poisson distributed with $E(N) = 10,000$. Use the normal approximation to the Poisson to approximate $P(N > 10,200)$.

Model Question paper

QP Code : **Total Pages: 4**

Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH DEGREE EXAMINATION (ELECTIVE), MONTH and YEAR

Course Code: CST 312

Course Name: FOUNDATIONS OF MACHINE LEARNING

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all questions, each carries 3 marks.

1 Show that with the usual operation of scalar multiplication but with addition on reals given by $x \# y = 2(x + y)$ is not a vector space.

2 Are the following vectors linearly independent? Justify your answer.

$$x_1 = \begin{bmatrix} 2 \\ -1 \\ 3 \end{bmatrix}, \quad x_2 = \begin{bmatrix} 1 \\ 1 \\ -2 \end{bmatrix}, \quad x_3 = \begin{bmatrix} 3 \\ -3 \\ 8 \end{bmatrix}$$

3 Find the eigenvalues of the following matrix in terms of k. Can you find an eigenvector corresponding to each of the eigenvalues?

$$\begin{bmatrix} 1 & k \\ 2 & 1 \end{bmatrix}$$

4 Find a unit vector in $\mathbf{R}^2$ that is orthogonal to **(-1 , 2)**.

5 The first three digits of a telephone number are 452. If all the sequences of the remaining four digits are equally likely, what is the probability that a randomly selected telephone number contains seven distinct digits?

6 Show that if two events ***A*** and ***B*** are independent, then ***A*** and ***B'*** are independent.

7 Prove that ***X*** and ***Y*** are independent if and only if $f_{X|Y}(x|y) = f_X(x)$ for all ***x*** and ***y***.

8 If ***X*** is a discrete uniform random variable, i.e., $P(X = k) = 1/n$ for $k = 1, 2, \ldots, n$, find ***E(X)*** and ***Var(X)***.

9 Compare the Poisson cdf and the normal approximation for (a) $\lambda = 10$, (b) $\lambda = 20$, and (c) $\lambda = 40$.

10 State law of large numbers. **10 x 3 = 30**

PART B

Answer any one Question from each module. Each question carries 14 Marks

11 a) Find all solutions to the system of linear equations **(8)**

$$\begin{aligned} -4x + 5z &= -2 \\ -3x - 3y + 5z &= 3 \\ -x + 2y + 2z &= -1 \end{aligned}$$

b) Consider the transformation $T(x, y) = (x + y, x + 2y, 2x + 3y)$. Obtain **ker T** and use this to calculate the nullity. Also find the transformation matrix for **T**. **(6)**

OR

12 a) Consider the following linear mapping **(8)**

$$\Phi : \mathbb{R}^3 \to \mathbb{R}^4$$

$$\Phi\left(\begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}\right) = \begin{bmatrix} 3x_1 + 2x_2 + x_3 \\ x_1 + x_2 + x_3 \\ x_1 - 3x_2 \\ 2x_1 + 3x_2 + x_3 \end{bmatrix}$$

i. Find the transformation matrix T.

ii. Determine rank(T).

iii. Compute the kernel and image of the mapping and find their dimension

b) Prove that all vectors orthogonal to $[2, -3, 1]^T$ forms a subspace W of R^3. What is $dim\ (W)$ and why? **(6)**

13 a) Find an orthonormal basis of R^3 consisting of eigenvectors for the following matrix **(8)**

$$\begin{bmatrix} 1 & 0 & -2 \\ 0 & 5 & 0 \\ -2 & 0 & 4 \end{bmatrix}$$

b) Find a 3 × 3 orthogonal matrix S and a 3 × 3 diagonal matrix D such that $A = SDS^T$ **(6)**

OR

14 a) Find an orthogonal basis for the subspace of R^4 spanned by $\{ w_1 = (1, 1, 3, 2), w_2 = (1, -2, 0, -1), w_3 = (0, 2, 1, 2) \}$. **(8)**

b) Find the characteristic equation, eigenvalues, and eigenspaces corresponding t each eigenvalue of the following matrix **(6)**

$$\begin{bmatrix} 2 & 0 & 4 \\ 0 & 3 & 0 \\ 0 & 1 & 2 \end{bmatrix}$$

15 a) Three players play 10 independent rounds of a game, and each player has probability 1/3 of winning each round. Find the joint distribution of the numbers of games won by each of the three players. **(7)**

b) An experiment consists of throwing a fair coin four times. Find the probability mass function and the cumulative distribution function of the following random variables: **(7)**

i. the number of heads before the first tail

ii. the number of heads following the first tail

iii. the number of heads minus the number of tails

iv. the number of tails times the number of heads.

OR

16 a) A factory runs three shifts. On a given day, 1% of the items produced by the first shift are defective, 2% of the second shift's items are defective, and 5% of the third shift's items are defective. If the shifts all have the same productivity, what percentage of the items produced in a day are defective? If an item is defective, what is the probability that it was produced by the third shift? **(8)**

b) Show that if A and B are two independent events, then $P(A \cup B) = P(A) + P(B) - P(A)P(B)$ **(6)**

17 a) Find the joint density of $X + Y$ and X/Y, where X and Y are independent exponential random variables with parameter λ. Show that $X + Y$ and X/Y are independent. **(8)**

b) Let X be a discrete random variable that takes on values 0, 1, 2 with probabilities 1/2 , 3/8 , 1/8 , respectively. **(6)**

i. Find **E(X)** and **Var(X)**.

ii. Let $Y = X^2$. Find the probability mass function of Y and use it to find **E(Y)**.

18 a) A random square has a side length that is a uniform [0, 1] random variable. Find the expected area of the square. **(7)**

b) Let X be a continuous random variable with probability density function on $0 <= x <= 1$ defined by $f(x) = 3x^2$. Find the pdf of $Y = X^2$. **(7)**

19 a) Using the fact that the mean of the chi-squared distribution is $(n-1)$, prove that $E(S^2) = \sigma^2$. **(7)**

b) i. Random samples of size 36 are taken from an infinite population whose mean is 80 and standard deviation is 18. Find the mean and standard error of the **(7)**

sampling distribution.

ii. Why is the Central Limit Theorem so important to statistical analysis?

OR

20 a) A six-sided die is rolled 100 times. Using the normal approximation, find the probability that the face showing a six turns up between 15 and 20 times. Find the probability that the sum of the face values of the 100 trials is less than 300. **(8)**

b) Determine an interval **(a, b)** such that $P[a \leq t \leq b] = 0.80$, and that 10% of the area is on each side of a and b, assuming that the sample is of size 21. **(6)**

Teaching Plan		
No	**Topic**	**No. of Lectures (35)**
1	**Module-1 (LINEAR ALGEBRA) TB-1(Ch 2,3,4) (6 hours)**	
1.1	Systems of Linear Equations – Matrices, Solving Systems of Linear Equations.	1 hour
1.2	Vector Spaces, sub space	1 hour
1.3	Linear Independence,	1 hour
1.4	Basis and Rank	1 hour
1.5.	Linear Mappings- Kernel, Range	1 hour
1.6.	Linear Mappings- Rank, Nullity	
2	**Module-2 (LINEAR ALGEBRA) (6 hours)**	
2.1.	Norms, Inner Products, Lengths and Distances, Angles and Orthogonality,	1 hour
2.2	Orthonormal Basis, Orthogonal Complement,	1 hour
2.3	Orthogonal Projections	1 hour
2.4.	Eigenvalues and Eigenvectors	1 hour
2.5.	Eigen decomposition	1 hour
2.6.	Eigen Diagonalization	1 hour
3.	**Module-3 (PROBABILITY AND DISTRIBUTIONS) TB-2(Ch 1,2) (9 hours)**	

3.1	Sample Spaces, Probability Measures, Computing Probabilities	1 hour
3.2	Conditional Probability,	1 hour
3.3	Baye's Rule	1 hour
3.4	Independence of events	1 hour
3.5	Discrete Random Variables -Bernoulli Random Variables, Binomial Distribution	1 hour
3.6	Discrete Random Variables -Geometric Distribution	1 hour
3.7	Discrete Random Variables -Poisson Distribution	1 hour
3.8	Continuous Random Variables - Exponential Density, Gamma Density,	1 hour
3.9	Continuous Random Variables - Normal Distribution, Beta Density	1 hour
4.	**Module-4 (RANDOM VARIABLES) TB-2 (Ch 3, 4, 5, 6) (9 hours)**	
4.1	Functions of a Random Variable	1 hour
4.2	Joint Distributions - Independent Random Variables	1 hour
4.3	Conditional Distributions	1 hour
4.4	Functions of Jointly Distributed Random Variables	1 hour
4.5	Expected Value of a Random Variable,	1 hour
4.6	Expectations of Functions of Random Variables,	1 hour
4.7	Expectations of Linear Combinations of Random Variables	1 hour
4.6	Variance and Standard Deviation	1 hour
4.9	Covariance and Correlation	1 hour

5	Module-5 (LIMIT THEOREMS) (6 hours)	
5.1	Conditional Expectation,	1 hour
5.2	Moment-Generating Function	1 hour
5.3	Limit Theorems(Proof not expected) - Law of Large Numbers,	1 hour
5.4	Convergence in Distribution and the Central Limit Theorem.	1 hour
5.5	Distributions derived from the Normal Distribution - Chi-square and, and F Distributions,	1 hour
5.6	Distributions derived from the Normal Distribution - Sample Mean and the Sample Variance.	1 hour

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
ERT308	COMPREHENSIVE COURSE WORK	PCC	1	0	0	1

Preamble: The objective of this Course work is to ensure the comprehensive knowledge of each student in the most fundamental Program core courses in the curriculum. Five core courses credited from Semesters 3, 4 and 5 are chosen for the detailed study in this course work. This course has an End Semester Objective Test conducted by the University for 50 marks. One hour is assigned per week for this course for conducting mock tests of objective nature in all the listed five courses.

Prerequisite:

1. CST 201 Data Structures
2. ERT 204 Object Oriented Programming Using Java
3. ERT 305 Data Base Management Systems
4. ERT 203 Digital Systems & VLSI Design
5. ERT 206 Integrated Circuits

Course Outcomes: After the completion of the course the student will be able to

CO 1	Comprehend the concepts of data structures (Cognitive Knowledge Level: Understand)
CO 2	Comprehend the concepts of logic system design (Cognitive Knowledge Level: Understand)
CO 3	Comprehend the concepts of integrated circuits (Cognitive Knowledge Level: Understand)
CO 4	Comprehend the concepts of data base management system (Cognitive Knowledge Level: Understand)
CO 5	Comprehend the concepts of Object Oriented Programming Using Java (Cognitive Knowledge Level: Understand)

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	✓	✓										✓
CO2	✓	✓										✓
CO3	✓	✓	✓		✓							✓
CO4	✓	✓				✓	✓	✓			✓	✓
CO5	✓	✓	✓		✓							✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	PO#	**Broad PO**
PO1	Engineering Knowledge	PO7	Environment and Sustainability
PO2	Problem Analysis	PO8	Ethics
PO3	Design/Development of solutions	PO9	Individual and team work
PO4	Conduct investigations of complexproblems	PO10	Communication
PO5	Modern tool usage	PO11	Project Management and Finance
PO6	The Engineer and Society	PO12	Life long learning

Assessment Pattern

Bloom's Category	End Semester Examination
Remember	10
Understand	20
Apply	20
Analyze	
Evaluate	
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
50	0	50	1 hour

End Semester Examination Pattern: Objective Questions with multiple choice (Four). Question paper include Fifty Questions of One mark each covering the five identified courses.

Syllabus

Full Syllabus of all Five selected Courses.

Course Contents and LectureSchedule

No	Topic	No. of Lectures
1	**Data Structures**	
1.1	Mock Test on Module 1 and Module 2	1
1.2	Mock Test on Module 3, Module 4 and Module 5	1
1.3	Feedback and Remedial	1
2	**Logic System Design**	
2.1	Mock Test on Module 1, Module 2 and Module 3	1
2.2	Mock Test on Module 4 and Module 5	1
2.3	Feedback and Remedial	1
3	**Integrated Circuits**	
3.1	Mock Test on Module 1 and Module 2	1
3.2	Mock Test on Module 3, Module 4 and Module 5	1
3.3	Feedback and Remedial	1
4	**Data Base Management Systems**	
4.1	Mock Test on Module 1, Module 2 and Module 3	1
4.2	Mock Test on Module 4 and Module 5	1
4.3	Mock Test on Module 1, Module 2 and Module 3	1
5	**Microprocessors and Microcontrollers**	
5.1	Mock Test on Module 1, Module 2 and Module 3	1
5.2	Mock Test on Module 4 and Module 5	1
5.3	Feedback and Remedial	1

ERL 332	SIGNAL PROCESSING LAB	CATEGORY	L	T	P	CREDIT
		LABORATORY	0	0	3	2

Preamble:

The following experiments are designed to make the students able to perform real time DSP computing.

Dedicated DSP hardware (such as TI or Analog Devices development / Any evaluation boards) may be used for realization.

Simulation experiments may be performed using MATLAB/SCILAB/PYTHON/OCTAVE

Prerequisites:

- ERT 301 Digital Signal Processing
- EST 102 Programming in C

Course Outcomes: After the completion of the course the student will be able to:

CO 1	Simulate digital signals. **(Cognitive Knowledge Level: Understand)**
CO 2	Implement LTI systems with linear convolution. **(Cognitive Knowledge Level: Apply)**
CO 3	Familiarize the DSP hardware and interface with computer. **(Cognitive Knowledge Level: Understand)**
CO 4	Implement FFT and use it on real time signals. **(Cognitive Knowledge Level: Apply)**
CO 5	Implement real time FIR and IIR filter and use it on real time audio signals. **(Cognitive Knowledge Level: Apply)**

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	✓	✓	✓		✓				✓			✓
CO 2	✓	✓	✓		✓				✓			✓
CO 3	✓	✓	✓		✓				✓			✓
CO 4	✓	✓	✓		✓				✓			✓
CO 5	✓	✓	✓		✓				✓			✓

Assessment Pattern

Mark distribution

Total Marks	CIE	ESE
150	75	75

Continuous Internal Evaluation Pattern:

Each experiment will be evaluated out of 75 marks

Attribute	Marks
Attendance	15 marks
Continuous Assessment	30 marks
Internal Test	30 mark

End Semester Examination Pattern: The following guidelines should be followed regarding award of marks

Attribute	Marks
Preliminary work	15 marks
Implementing the work/ Conducting the experiment	10 marks
Performance, result and inference	25 marks
Viva voce	20 marks
Record	5 marks

General instructions: Practical examination to be conducted immediately after the second series test covering entire syllabus given below. Evaluation is a serious process that is to be conducted under the equal responsibility of both the internal and external examiners. The number of candidates evaluated per day should not exceed 20. Students shall be allowed for the University examination only on submitting the duly certified record. The external examiner shall endorse the record.

LIST OF EXPERIMENTS (12 Mandatory)

Part -A

Experiments on Digital Signal Processor/ DSP kits

(4 experiments are mandatory)

1. Generation of sine wave and standard test signals. *
2. Convolution: Linear and Circular. *
3. Real time FFT of the signal using a real-time input signal. *
4. Real Time FIR Filter implementation (Low-pass, High-pass) using a real-time input Signal.*
5. Real Time IIR Filter implementation (Low-pass, High-pass) using a real-time input signal

Part-B
Experiments based on MATLAB/PYTHON/SCILAB/OCTAVE
(8 experiments are mandatory)

1. Generation of Waveforms (Continuous and Discrete).*
2. Time and Frequency Response of LTI systems (First and second order). *
3. Linear Convolution, Circular Convolution and Linear Convolution using Circular Convolution. *
4. To find the DFT and IDFT for the given input sequence. *
5. Linear convolution using DFT. *
6. To find FFT and IFFT for the given input sequence. *

7. FIR and IIR filter design using Filter Design Toolbox. *
8. FIR Filter (Low-pass, High-pass and Band-pass) design (Window method). *
9. IIR Filter (Low-pass, High-pass) design (Butterworth).

*Mandatory experiments

Reference Books

1. Vinay K. Ingle, John G. Proakis,"Digital Signal Processing Using MATLAB",2011
2. Allen B. Downey, "Think DSP: Digital Signal Processing using Python.",2016
3. Rulph Chassaing, "DSP Applications Using C and the TMS320C6x DSK", 2003

ERD334	MINIPROJECT	CATEGORY	L	T	P	CREDIT
		PWS	0	0	3	2

Preamble:

The course aims

1. To estimate the ability of the students in transforming the theoretical knowledge studied in to a working model of an electronic system or to apply the fundamental concepts of Software Engineering principles for the effective development of an application/research project.
2. Design and development of electronic project based on hardware or a combination of hardware and software for electronics systems which can be developed to a product.
3. This course helps the learners to practice the different steps to be followed in the mini project such as literature review and problem identification, preparation of Software Requirement Specification & Software Design Document (SDD), testing, development and deployment. Mini project enables the students to boost their skills, widen the horizon of thinking and their ability to resolve real life problems.

Course Plan

In this course, each group consisting of three/four members is expected to design and develop a moderately complex electronic system with practical applications or develop codes/programs to achieve the objectives, this should be a working model. The basic concept of product design may be taken into consideration. Innovative design concepts, performance, scalability, aesthetics/ergonomic, reliability considerations, user experience and security aspects taken care of in the project shall be given due weight.

Students should identify a topic of interest in consultation with Faculty/Advisor. Review the literature and gather information pertaining to the chosen topic. State the objectives and develop a methodology to achieve the objectives. Carryout the design/fabrication or develop codes/programs to achieve the objectives. Demonstrate the novelty of the project through the results and outputs. The progress of the mini project is evaluated based on a minimum of two reviews.

The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The product (hardware/software) has to be demonstrated for its full design specifications.

Course Outcomes : After the completion of the course the student will be able to:

CO1	Apply acquired knowledge within the selected area of technology to develop projects. system (Cognitive Knowledge Level: Apply)
CO2	Apply a systematic approach to analyze, discuss, and justify the technical aspects and design elements of the project. (Cognitive Knowledge Level: Apply)
CO3	Evaluate, reproduce, improve, and refine technical aspects in engineering projects (Cognitive Knowledge Level: Apply)
CO4	Collaborate effectively as a team in the development of technical projects (Cognitive Knowledge Level: Apply)
CO5	Effectively communicate and report project-related activities and findings. (Cognitive Knowledge Level: Apply)

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	✓	✓	✓	✓		✓						✓
CO 2	✓	✓	✓	✓		✓					✓	✓
CO 3	✓	✓	✓	✓		✓					✓	✓
CO 4								✓		✓	✓	✓
CO 5								✓	✓	✓		✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	PO#	**Broad PO**
PO1	Engineering Knowledge	PO7	Environment and Sustainability
PO2	Problem Analysis	PO8	Ethics
PO3	Design/Development of solutions	PO9	Individual and team work
PO4	Conduct investigations of complexproblems	PO10	Communication
PO5	Modern tool usage	PO11	Project Management and Finance
PO6	The Engineer and Society	PO12	Life long learning

Evaluation

The internal evaluation will be made based on the product, the report and a viva- voce examination, conducted by a 3-member committee appointed by Head of the Department comprising HoD or a senior faculty member, Academic coordinator for that program, project guide/coordinator.

The Committee will be evaluating the level of completion and demonstration of functionality/specifications, presentation, oral examination, work knowledge and involvement.

Mark distribution

Total Marks	**CIE**	**ESE**	**ESE Duration**
150	75	75	1 hour

Split-up of CIE

Component	Marks
Attendance	10
Marks awarded based on guide's evaluation	15
Project Report	10
Evaluation by Committee	40

Split-up of ESE

Component	Marks
Level of completion	10
Demonstration of functionality	25
Project Report	10
Viva-voce	20
Presentation	10

SEMESTER VI

MINOR

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
ERT382	INTERNET OF THINGS	VAC	3	1	0	4

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Describe the impact and challenges posed by IoT networks leading to new architectural models. **(Cognitive Knowledge Level: Understand)**
CO 2	Compare and contrast the deployment of smart objects and the technologies to connect them to network. **(Cognitive Knowledge Level: Understand)**
CO 3	Explain the role of IoT protocols for efficient network communication. **(Cognitive Knowledge Level: Understand)**
CO 4	Explain the need for Data Analytics and Security in IoT. **(Cognitive Knowledge Level: Understand)**
CO 5	Illustrate different sensor technologies for sensing real-world entities and develop suitable architectures for applications of IoT in Industry. **(Cognitive Knowledge Level: Apply)**

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	✓	✓		✓	✓							✓
CO 2	✓	✓										✓
CO 3	✓	✓										✓
CO 4	✓	✓			✓			✓				✓
CO 5	✓	✓	✓	✓	✓	✓	✓					✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	PO#	**Broad PO**
PO1	Engineering Knowledge	PO7	Environment and Sustainability
PO2	Problem Analysis	PO8	Ethics
PO3	Design/Development of solutions	PO9	Individual and team work

PO4	Conduct investigations of complexproblems	PO10	Communication
PO5	Modern tool usage	PO11	Project Management and Finance
PO6	The Engineer and Society	PO12	Life long learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	20	20	30
Understand	30	30	70
Apply	-	-	-
Analyse	-	-	-
Evaluate	-	-	-
Create	-	-	-

Mark Distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Test (2 Numbers): 25 marks

Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub- divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. IoT architecture comparison.

2. Data management and compute stack.

Course Outcome 2 (CO2):

1. IoT access technologies.

2. sensors and actuators.

Course Outcome 3 (CO3):

1. IoT different layers.

2. IoT protocols.

Course Outcome 4 (CO4):

1. Data analytics for IoT

2. IoT security

Course Outcome 5 (CO5):

1. Smart city IoT applications.
2. Fundamentals of Arduino programming.

SYLLABUS

Module 1

What is IoT, Genesis of IoT, IoT and Digitization, IoT Impact, Convergence of IT and IoT, IoT Challenges, IoT Network Architecture and Design, Drivers Behind New Network Architectures, Comparing IoT Architectures, A Simplified IoT Architecture, The Core IoT Functional Stack, IoT Data Management and Compute Stack.

Module 2:

Smart Objects: The "Things" in IoT, Sensors, Actuators, and Smart Objects, Sensor Networks, Connecting Smart Objects, Communications Criteria, IoT Access Technologies.

Module 3

IP as the IoT Network Layer, The Business Case for IP, the need for Optimization, Optimizing IP for IoT, Profiles and Compliances, Application Protocols for IoT, The Transport Layer, IoT Application Transport Methods.

Module 4

Data and Analytics for IoT, An Introduction to Data Analytics for IoT, Machine Learning, Big Data Analytics Tools and Technology, Edge Streaming Analytics, Network Analytics, Securing IoT, A Brief History of OT Security, Common Challenges in OT Security, How IT and OT Security Practices and Systems Vary, Formal Risk Analysis Structures: OCTAVE and FAIR, The Phased Application of Security in an Operational Environment

Module 5

IoT Physical Devices and Endpoints - Arduino UNO: Introduction to Arduino, Arduino UNO, Installing the Software, Fundamentals of Arduino Programming. Wireless sensor network, Smart and Connected Cities, An IoT Strategy for Smarter Cities, Smart City IoT Architecture, Smart City Security Architecture, Smart City Use-Case Examples, Automation systems with IoT- Home automation- Block diagram of the system, Develop an algorithm, Develop any programming script for implementing the system, and Industrial automation- Block diagram of the system, Develop an algorithm, Develop any programming script for implementing the system.

Text Books:

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry,"IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", 1stEdition, Pearson Education (Cisco Press Indian Reprint). (ISBN: 978-9386873743)
2. Srinivasa K G, "Internet of Things",CENGAGE Leaning India, 2017

Reference Books:

1. Vijay Madisetti and ArshdeepBahga, "Internet of Things (A Hands-on-Approach)", 1stEdition, VPT, 2014. (ISBN: 978-8173719547)
2. Raj Kamal, "Internet of Things: Architecture and Design Principles", 1st Edition, McGraw Hill Education, 2017. (ISBN: 978-9352605224)

Model Question Paper

Reg No.:_____ Name:_

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
SIXTH SEMESTER B.TECH DEGREE EXAMINATION

MONTH AND YEAR

Course Code: ERT382

Course Name: INTERNET OF THINGS

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all questions, each carries 3 marks

1. What is IoT?
2. Write a note on IoT data management
3. Classify actuators based on energy types.
4. Define sensors and actuators.
5. List and explain the advantages of internet protocol.
6. What is the need for optimisation?
7. What do you mean by data and analytics for IoT? Explain.
8. Discuss Bigdata analytics tool and technology.
9. Give a brief note on Arduino UNO.
10. Explain function and variables with respect to Arduino programming.

PART B

Answer any one full question from each module. Each question carries 14 Marks

Module 1

11. A) Explain detail about genesis of IoT. (8 marks)
    B) Discuss IoT challenges (6 marks)
12. A) with a neat diagram explain the architecture of IoT (8 marks)
    B) Core IoT Functional Stack. (6 marks)

Module 2

13. A) With a neat diagram explain how sensors & actuators interact with physical world. (8 marks)
    B) Explain IoT access technologies. (6 marks)
14. A) List and explain different types of sensors (8 marks)
    B) Define smart objects. Explain its characteristics? (7 Marks)

Module 3

15. A) Explain the working of IP as the IoT networking layer. (8 Marks)

B) Discuss the various methods used in IoT application transport (6 marks)

16. A) Describe application protocol for IoT. (8 Marks)

B) write a note on IoT application transport methods. (6 Marks)

Module 4

17. A) Explain in detail the core functions of edge analytics with necessary diagrams. (7 Marks)

B) Discuss OCTAVE and FAIR formal risk analysis. (7 marks)

18. A) Explain the formal risk analysis structure. (7 marks)

B) With a case study relate the concept of securing IoT. (7 marks)

Module 5

19. A) Explain the different pins/parts of Arduino Uno board. (7 marks)

B) Explain in detail smart city IoT architecture. (7 marks)

20. A) Explain smart city security architecture. (7 marks)

B) Explain the different layers of IoT with suitable example. (7 marks)

Course Contents and Lecture Schedule

No	Topic	Hours(45)
1	**Module 1** **10**	
1.1	What is IoT, Genesis of IoT.	1
1.2	IoT and Digitization	1
1.3	IoT Impact, Convergence of IT and IoT, IoT Challenges	1
1.4	IoT Network Architecture and Design	1
1.5	Drivers Behind New Network Architectures.	1
1.6	Comparing IoT architectures	1
1.7	A Simplified IoT Architecture – Lecture 1	1
1.8	A Simplified IoT Architecture – Lecture 2	1
1.9	The Core IoT Functional Stack	1
1.10	IoT Data Management and Compute Stack.	1

2	**Module 2**	**8**
2.1	Smart Objects: The “Things” in IoT	1
2.2	Sensors, Actuators and Smart Objects - Lecture 1	1
2.3	Sensors, Actuators and Smart Objects - Lecture 2	1
2.4	Sensor Networks - Lecture 1	1
2.5	Sensor Networks - Lecture 2	1
2.6	Communications Criteria	1
2.7	IoT Access Technologies - Lecture 1	1
2.8	IoT Access Technologies - Lecture 2	1
3	**Module 3**	**9**
3.1	IP as the IoT Network Layer	1
3.2	The Business Case for IP	1
3.3	The need for Optimization	1
3.4	Optimizing IP for IoT	1
3.5	Profiles and Compliances	1
3.6	The Transport Layer - Lecture 1	1
3.7	The Transport Layer - Lecture 2	1
3.8	IoT Application Transport Methods - Lecture 1	1
3.9	IoT Application Transport Methods - Lecture 2	1
4	**Module 4**	**10**
4.1	Data and Analytics for IoT - Lecture 1	1
4.2	Data and Analytics for IoT - Lecture 2	1
4.3	An Introduction to Data Analytics for IoT	1
4.4	Machine Learning, Big Data Analytics Tools and Technology	1
4.5	Edge Streaming Analytics, Network Analytics	1
4.6	Securing IoT, A Brief History of OT Security	1

4.7	Common Challenges in OT Security	1
4.8	How IT and OT Security Practices and Systems Vary, Formal Risk Analysis Structures	1
4.9	OCTAVE and FAIR	1
4.10	The Phased Application of Security in an Operational Environment	1
5	**Module 5** **8**	
5.1	IoT Physical Devices and Endpoints - Arduino UNO: Introduction to Arduino	1
5.2	Arduino UNO, Installing the Software	1
5.3	Fundamentals of Arduino Programming.	1
5.4	Smart and Connected Cities	1
5.5	An IoT Strategy for Smarter Cities	1
5.6	Smart City IoT Architecture	1
5.7	Smart City Security Architecture	1
5.8	Smart City Use-Case Examples.	1

CST 384	CONCEPTS IN DEEP LEARNING	Category	L	T	P	Credits	Year of Introduction
		VAC	3	1	0	4	2019

Preamble:

This course aims to introduce the learner to an overview of the concepts and algorithms involved in deep learning. Deep learning is a subfield of machine learning, a subfield of artificial intelligence. Basic concepts and application areas of machine learning, deep networks, convolutional neural network and recurrent neural network are covered here. This is a foundational program that will help students understand the capabilities, challenges, and consequences of deep learning and prepare them to participate in the development of leading-edge AI technology. They will be able to gain the knowledge needed to take a definitive step in the world of AI.

Prerequisite: Sound knowledge in Basics of linear algebra and probability theory.

CO1	Demonstrate basic concepts in machine learning.**(Cognitive Knowledge Level: Understand)**
CO2	Illustrate the validation process of machine learning models using hyper-parameters and validation sets. **(Cognitive Knowledge Level: Understand)**
CO3	Demonstrate the concept of the feed forward neural network and its training process. **(Cognitive Knowledge Level: Apply)**
CO4	Build CNN and Recurrent Neural Network (RNN) models for different use cases. **(Cognitive Knowledge Level: Apply)**
CO5	Use different neural network/deep learning models for practical applications. **(Cognitive Knowledge Level: Apply)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓								✓
CO2	✓	✓	✓	✓								✓
CO3	✓	✓	✓	✓	✓							✓
CO4	✓	✓	✓	✓	✓	✓						✓
CO5	✓	✓	✓	✓	✓	✓						✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks
	Test1 (Percentage)	Test2 (Percentage)	
Remember	30	30	30
Understand	40	40	40
Apply	30	30	30
Analyse			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : **10 marks**

Continuous Assessment Tests : **25 marks**

Continuous Assessment Assignment : **15 marks**

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. First Internal Examination shall be preferably conducted after completing the first half of the syllabus and the Second Internal Examination shall be preferably conducted after completing remaining part of the syllabus.

There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly covered module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly covered module), each with 7 marks. Out of the 7 questions in Part B, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Syllabus

INTRODUCTION TO DEEP LEARNING

(General Instructions: Instructors are to introduce students to any one software platform and demonstrate the working of the algorithms in the syllabus using suitable use cases and public datasets to give a better understanding of the concepts discussed. Tutorial hour may be used for this purpose)

Module-1 (Introduction)

Key components - Data, models, objective functions, optimization algorithms, Learning algorithm. Supervised learning- regression, classification, tagging, web search, page ranking, recommender systems, sequence learning, Unsupervised learning, Reinforcement learning, Historical Trends in Deep Learning. Other Concepts - overfitting, underfitting, hyperparameters and validation sets, estimators, bias and variance.

Module- 2 (Optimization and Neural Networks)

Neural Networks –Perceptron, Gradient Descent solution for Perceptron, Multilayer perceptron, activation functions, architecture design, chain rule, back propagation, gradient based learning. Introduction to optimization– Gradient based optimization, linear least squares. Stochastic gradient descent, Building ML algorithms and challenges.

Module -3 (Convolutional Neural Network)

Convolutional Neural Networks – convolution operation, motivation, pooling, Structure of CNN, Convolution and Pooling as an infinitely strong prior, variants of convolution functions, structured outputs, data types, efficient convolution algorithms. Practical challenges of common deep learning architectures- early stopping, parameter sharing, dropout. Case study: AlexNet, VGG, ResNet.

Module- 4 (Recurrent Neural Network)

Recurrent neural networks – Computational graphs, RNN design, encoder – decoder sequence to sequence architectures, deep recurrent networks, recursive neural networks, modern RNNs LSTM and GRU, Practical use cases for RNNs.

Module-5 (Application Areas)

Applications – computer vision, speech recognition, natural language processing, common word embedding: continuous Bag-of-Words, Word2Vec, global vectors for word representation (GloVe). Research Areas – autoencoders, representation learning, boltzmann machines, deep belief networks.

Text Book

1. Ian Goodfellow, YoshuaBengio, Aaron Courville, Deep Learning, MIT Press 2015 ed.
2. Aston Zhang, Zachary C. Lipton, Mu Li, and Alexander J. Smola, Dive into Deep Learning, August 2019.
3. Neural Networks and Deep Learning, Aggarwal, Charu C., c Springer International Publishing AG, part of Springer Nature 2018

Reference Books

1. Neural Smithing: Supervised Learning in Feedforward Artificial Neural Networks by Russell Reed, Robert J MarksII, A Bradford Book,2014
2. Practical Convolutional Neural Networks by MohitSewak, Md. Rezaul Karim, PradeepPujari,Packt Publishing 2018
3. Hands-On Deep Learning Algorithms with Python by SudharsanRavichandran,Packt Publishing 2019
4. Deep Learning with Python by Francois Chollet,Manning Publications Co.,2018

Sample Course Level Assessment Questions

Course Outcome 1 (CO1):

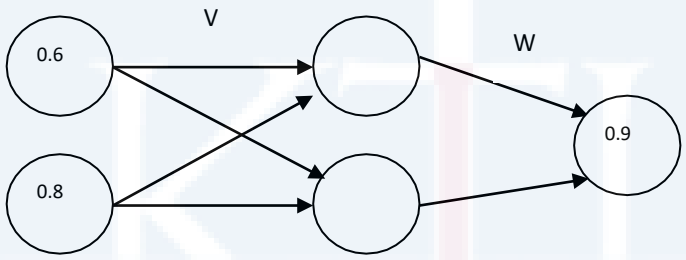
1. Compare regression and classification.
2. Define supervised learning? Distinguish between regression and classification.
3. Discuss the different learning approaches used in machine learning.

Course Outcome 2 (CO2):

1. What are hyperparameters? Why are they needed?
2. What issues are to be considered while selecting a model for applying machine learning in a given problem?

Course Outcome 3 (CO3):

1. Update the parameters V_{11} in the given MLP using back propagation with learning rate as 0.5 and activation function as sigmoid. Initial weights are given as V_{11}= 0.2, V_{12}=0.1, V_{21}=0.1, V_{22}=0.3, V_{11}=0.2, W_{11}=0.5, W_{21}=0.2



2. Draw the architecture of a multi-layer perceptron.
3. Derive update rules for parameters in the multi-layer neural network through the gradient descent.

Course Outcome 4 (CO4):

1. Give two benefits of using convolutional layers instead of fully connected ones for visual tasks.
2. Suppose that a CNN was trained to classify images into different categories. It performed well on a validation set that was taken from the same source as the training set but not on a testing set. What could be the problem with the training of such a CNN? How will you ascertain the problem? How can those problems be solved?
3. Explain how the cell state is updated in the LSTM model from Ct-1 to Ct
4. Show the steps involved in an LSTM to predict stock prices.

Course Outcome 5 (CO5):

1. Explain how the cell state is updated in the LSTM model from Ct-1 to Ct
2. Show the steps involved in an LSTM to predict stock prices.
3. Illustrate the workings of the RNN with an example of a single sequence defined on a vocabulary of four words.

Course Outcome 6 (CO6):

1. Development a deep learning solution for problems in the domain i) natural language processing or ii Computer vision (Assignment
2. Illustrate the workings of the RNN with an example of a single sequence defined on a vocabulary of four words.

Model Question Paper

QP CODE: PAGES:4

Reg No:_____

Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
SIXTH SEMESTER B.TECH DEGREE EXAMINATION(MINOR), MONTH & YEAR

Course Code: CST 384

Course Name: CONCEPTS IN DEEP LEARNING

Max. Marks:100 **Duration: 3 Hours**

PART A
Answer all Questions. Each question carries 3 Marks

1. Distinguish between supervised learning and Reinforcement learning. Illustrate with an example.

2. Differentiate classification and regression.

3. Compare overfitting and underfitting. How it can affect model generalization.

4. Why does a single perceptron cannot simulate simple XOR function? Explain how this limitation is overcome?

5. Illustrate the strengths and weaknesses of convolutional neural networks.

6. Illustrate convolution and pooling operation with an example

7. How many parameters are there in AlexNet? Why the dataset size (1.2 million) is important for the success of AlexNet?

8. Explain your understanding of unfolding a recursive or recurrent computation into a computational graph.

9. Illustrate the use of deep learning concepts in Speech Recognition.

10. What is an autoencoder? Give one application of an autoencoder

(10x3=30)

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11. (a) "A computer program is said to learn from experience E with respect to some class of tasks T and performance measure P, if its performance at tasks in T, as measured by P, improves with experience E." What is your understanding of the terms task, performance and experience. Explain with two example **(10)**

(b) "How does bias and variance trade-off affect machine learning algorithms? **(4)**

OR

12. (a) Illustrate the concepts of Web search, Page Ranking, Recommender systems with suitable examples. **(10)**

(b) List and discuss the different hyper parameters used in fine tuning the **(4)**

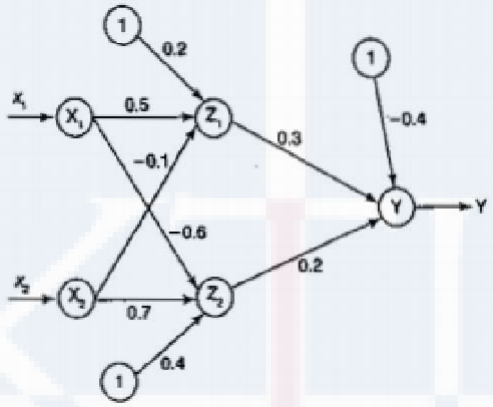
traditional machine learning models

13. (a) How multilayer neural networks learn and encode higher level features from input features. **(7)**

(b) Explain gradient decent and delta rule? Why stochastic approximation to gradient descent is needed? **(7)**

OR

14. (a) Find the new weights for the network using backpropogation algorithm, the network is given with a input pattern[-1,1] and target output as +1, Use learning rate of alpha=0.3 and bipolar sigmoid function. **(7)**



(b) Write an algorithm for backpropgation which uses stochastic gradient descent method. Comment on the effect of adding momentum to the network. **(7)**

15. (a) Input to CNN architecture is a color image of size 112x112x3. The first convolution layer comprises of 64 kernels of size 5x5 applied with a stride of 2 and padding 0. What will be the number of parameters? **(5)**

(b) Let X=[-1, 0, 3, 5] W=[.3 ,.5 .2,.1] be the the input of ith layer of a neural network and to apply softmax function. What should be the output of it? **(4)**

(c) Draw and explain the architecture of convolutional network **(5)**

OR

16. (a) Explain the concept behind i) Early stopping ii) dropout iii) weight decay **(9)**

(b) How backpropagation is used to learn higher-order features in a convolutional Network? **(5)**

17. (a) Explain the working of RNN and discuss how backpropagation through time is used in recurrent networks. **(8)**

(b) Describe the working of a long short term memory in RNNs. **(6)**

OR

18. (a) What is the vanishing gradient problem and exploding gradient problem? **(8)**

(b) Why do RNNs have a tendency to suffer from exploding/vanishing gradient? How to overcome this challenge? **(6)**

19. (a) Explain any two word embedding techniques **(8)**

(b) Explain the merits and demerits of using Auto encoders in Computer Vision. **(6)**

OR

20. (a) Illustrate the use of representation learning in object classification. **(7)**

(b) Compare Boltzmann Machine with Deep Belief Network. **(7)**

Teaching Plan

CONCEPTS IN DEEP LEARNING (45 Hours)		
Module 1 : Introduction (9 hours)		
1.1	Key components - Data, models, objective functions, optimization algorithms. (TB2: Section 1.1-1.2)	1 hour

1.2	Learning algorithm (TB1: Section 5.1), Supervised learning- regression, classification (TB2: Section 1.3.1)	1 hour
1.3	tagging, web search, page ranking (TB2: Section 1.3.1)	1 hour
1.4	Recommender systems, Sequence learning, Unsupervised learning, Reinforcement learning(TB2: Section 1.3.2-1.3.4)	1 hour
1.5	Historical Trends in Deep Learning (TB1: Section 1.2).	1 hour
1.6	Concepts: over-fitting, under-fitting, hyperparameters and validation sets. (TB1: Section 5.2-5.3)	1 hour
1.7	Concepts: Estimators, bias and variance. (TB1: Section 5.4)	1 hour
1.8	Demonstrate the concepts of supervised learning algorithms using a suitable platform.	1 hour
1.9	Demonstrate the concepts of unsupervised using a suitable platform.	1 hour
Module 2 : Optimization and Neural Networks (9 hours)		
2.1	Perceptron, Stochastic Gradient descent, Gradient descent solution for perceptron (TB3: Section 1.1 - 1.2.1)	1 hour
2.2	Multilayer perceptron (TB3: Section 1.2.2), (TB1: Section 6.1,6.3)	1 hour
2.3	Activation functions- Sigmoid, tanh, Softmax, ReLU, leaky ReLU (TB3: Section 1.2.1.3 - 1.2.1.5)	1 hour
2.4	Architecture design (TB1: Section 6.4, TB3: Section 1.6)	1 hour
2.5	Chain rule, back propagation (TB3: Section 1.3)	1 hour

2.6	Gradient based learning (TB1: Section 6.2)	1 hour
2.7	Gradient based optimization (TB1: Section 4.3)	1 hour
2.8	Linear least squares using a suitable platform. (TB1: Section 4.5)	1 hour
2.9	Building ML Algorithms and Challenges (TB3: 1.4, TB1: 5.10-5.11)	1 hour
Module 3 :Convolution Neural Network (10 hours)		
3.1	Convolution operation, Motivation, pooling (TB1:Section 9.1-9.3)	1 hour
3.2	Structure of CNN (TB3: Section 8.2)	1 hour
3.3	Convolution and Pooling as an infinitely strong prior (TB1: Section 9.4)	1 hour
3.4	Variants of convolution functions – multilayer convolutional network, tensors, kernel flipping, downsampling, strides and zero padding. (TB1: Section 9.5)	1 hour
3.5	Variants of convolution functions - unshared convolutions, tiled convolution, training different networks. (TB1: Section 9.5)	1 hour
3.6	Structured outputs, data types (TB1: Section 9.6-9.7)	1 hour
3.7	Efficient convolution algorithms. (TB1: Section 9.8,9.10)	1 hour
3.8	Practical challenges of common deep learning architectures- early Stopping (TB3: 4.6)	1 hour
3.9	Practical challenges of common deep learning architectures- parameter sharing, drop-out (TB3: Section 4.9, 4.5.4)	1 hour
3.10	Case Study: AlexNet,VGG, ResNet. (TB3: Section 8.4.1-8.4.3,8.4.5)	1 hour

Module 4 :Recurrent Neural Network (8 hours)		
4.1	Computational graphs (TB1: Section 10.1)	1 hour
4.2	RNN (TB1: Section 10.2-10.3)	1 hour
4.3	Encoder – decoder sequence to sequence architectures. (TB1: Section 10.4)	1 hour
4.4	Deep recurrent networks (TB1: Section 10.5)	1 hour
4.5	Recursive neural networks , Modern RNNs, (TB1: Section 10.6, 10.10)	1 hour
4.6	LSTM and GRU (TB1: Section 10.10, TB3: Section 7.5-7.6)	1 hour
4.7	Practical use cases for RNNs. (TB1: Section 11.1-11.4)	1 hour
4.8	Demonstrate the concepts of RNN using a suitable platform.	1 hour
Module 5 : Applications and Research (9 hours)		
5.1	Computer vision. (TB1: Section 12.2)	1 hour
5.2	Speech recognition. (TB1: Section 12.3)	1 hour
5.3	Natural language processing. (TB1: Section 12.4)	1 hour
5.4	Common Word Embedding -: Continuous Bag-of-Words, Word2Vec (TB3: Section 2.6)	1 hour
5.5	Common Word Embedding -: Global Vectors for Word Representation(GloVe) (TB3: Section 2.9.1- Pennigton 2014)	1 hour
5.6	Brief introduction on current research areas- Autoencoders, Representation learning. (TB3: Section 4.10)	1 hour

5.7	Brief introduction on current research areas- representation learning. (TB3: Section 9.3)	1 hour
5.8	Brief introduction on current research areas- Boltzmann Machines, Deep belief networks. (TB1: Section 20.1, TB3 Section 6.3)	1 hour
5.9	Brief introduction on current research areas- Deep belief networks. (TB1: Section 20.3)	1 hour

CST 386	WIRELESS NETWORKS AND IoT APPLICATIONS	Category	L	T	P	Credit	Year of Introduction
		VAC	3	1	0	4	2019

Preamble:

This course equips the learners with fundamental wireless technologies for the Internet of Things(IoT) and the IoT ecosystem. It covers the underlying concepts in wireless networks, communication mechanisms, protocols, hardware, software, and the cloud platforms for IoT. The students will be able to design smart IoT applications for real world problems..

Prerequisite: Sound knowledge in Data Communication, Computer Networks and Programming in C

Course Outcomes: After the completion of the course the students will be able to

CO1	Recognize wireless technologies required for IoT ecosystem **(Cognitive Knowledge Level : Understand)**
CO2	Perceive the concept of IoT and M2M architecture, IoT examples, and Data Management in IoT **(Cognitive Knowledge Level :Apply)**
CO3	Outline the hardware components used in IoT including Sensors, Actuators and development boards **(Cognitive Knowledge Level : understand)**
CO4	Explain the software components of IoT **(Cognitive Knowledge Level :Understand)**
CO5	Demonstrate the protocols used in IoT and build IoT Programs **(Cognitive Knowledge Level : Apply)**
CO6	Build IoT-based smart real-time applications such as Smart Healthcare, Smart Agriculture, Smart Environment and Smart Home **(Cognitive Knowledge Level : Apply)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓									✓
CO2	✓	✓	✓									✓

CO3	✓	✓	✓	✓	✓							✓
CO4	✓	✓	✓	✓	✓							✓
CO5	✓	✓	✓	✓	✓							✓
CO6	✓	✓	✓	✓	✓	✓						

Abstract POs Defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and teamwork
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Lifelong learning

Assessment Pattern

Blooms Category	Continuous Assessment Tests		End Semester Examination Marks
	Test 1 (Percentage)	Test 2 (Percentage)	
Remember	30	30	30
Understand	50	40	40
Apply	20	30	30

Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	**50**	**100**	**3 Hours**

Continuous Internal Evaluation Pattern:

Attendance	**10 marks**
Continuous Assessment Tests	**25 marks**
Continuous Assessment Assignment	**15 marks**

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. First Internal Examination shall be preferably conducted after completing the first half of the syllabus, and the Second Internal Examination shall be preferably conducted after completing the remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly covered module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly covered module), each with 7 marks. Out of the 7 questions in Part B, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer anyone. Each question can have a maximum 2 subdivisions and carries 14 marks.

Syllabus

Module- 1 (Introduction to IoT and wireless technologies required for IoT)

Internet of Things, Role of Things and the Internet, Wireless IoT. Wireless Networks - Network Topologies, Types of Networks. Role of Wireless Standards in IoT. Protocol Stack - OSI Model, TCP/IP Model, IEEE 802 Reference Model, Protocols for Wireless IoT. Bluetooth - Transceiver, Frequency Channels, Typical Range, Access and Spread Spectrum, Modulation and Data Rate, Error Correction and Detection, Network Topology. ITU G.9959, Zwave, IEEE 802.15.4, Zigbee Specification, Thread, WiFi, 6LowPAN, IPv6, LoRaWAN.

Module- 2 (IoT architecture, Data and Device management)

Internet of Things - IoT Architectural View, Technology Behind IoT - Server End Technology, Sources of Internet of Things, M2M Communication. IoT Application Areas. IoT Examples. IoT Data Management - Device Management Gateways. Design Principles for Web Connectivity - Web Communication Protocols for Connected Devices, Web Connectivity for Connected Devices using Gateways. Internet Connectivity Principles – Internet Connectivity, Internet based communication, IP addressing in the IoT.

Module- 3 (Data Acquiring and Enabling Technologies)

Data Acquiring and Storage for IoT Sevices- Organization of Data, Big data, Acquiring Methods, Management Techniques, Analytics, Storage Technologies. Cloud Computing for Data storage - IoT Cloud based Services using Xively, Nimbits, and Other Platforms. Sensor Technologies for IoT Devices - Sensor Technology, Participatory Sensing, Industrial IoT and Automotive IoT, Actuators for Various Devices, Sensor Data Communication Protocols, Wireless Sensor network Technology

Module-4 (Prototyping the Embedded Devices for IoT)

Embedded Computing Basics, Embedded Hardware Unit. Embedded Platforms for Prototyping - Arduino, Intel Galileo, Intel Edison, Raspberry Pi, BeagleBone, mBed. Prototyping and Designing the Software for IoT Applications- Introduction, Prototyping Embedded DeviceSoftware- Programming using Arduino, Programming for an Arduino Controlled Traffic Control Lights at a Road Junction, Basic Arduino Programs to Blink LED, Find the Distance using Ultrasonic Sensor, Estimate Room Temperature, Measuring Soil Moisture Level

Module 5 (Business Models and Case Studies)

Business Models and Processes using IoT. Value Creation in the Internet of Things. Cloud PaaS- Xively, Nimbits, IBM Bluemix, CISCO IoT, AWS IoT, TCS Connected AWS Platform, Case studies- Smart Home, Smart Environment, Smart healthcare, Smart agriculture

Text Books

1. Daniel Chew, "Wireless Internet of Things -A Guide to the lower layers", IEEE Standards and Association, IEEE Press, Wiley
2. Rajkamal, "Internet of Things : Architecture and Design Principles", McGraw Hill (India) Private Limited.

References

1. ArshadeepBahga, Vijay Madisetti, "Internet of Things: A hands-on approach", University Press, 2015 (First edition)
2. Dieter Uckelmann, Mark Harrison, Michahelles Florian (Ed.), Architecting the internet of things, Springer, 2011
3. Dr. Ovidiu Vermesan, Dr. Peter Friess, Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems, River Publishers, 2013
4. Simon Monk, "Programming Arduino: Getting Started with Sketches", McGraw Hill Publications

Sample Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Compare Bluetooth and Bluetooth LE power classes
2. Demonstrate Zigbee Specification Protocol Stack

Course Outcome 2 (CO2):

1. What are the major components of IOT system? Briefly explain each
2. Correlate M2M architectural Levels with IOT architectural Levels

Course Outcome 3 (CO3):

1. Describe the use of GPIO pins ?
2. What are actuators ? Mention the roles of actuators in IoT systems

Course Outcome 4(CO4):

1. Identify the role of HBase in Hadoop File System
2. Differentiate Edge computing and Distributed computing
3. Illustrate open protocols, tools and frameworks generally used in M2M

Course Outcome 5(CO5):

1. What do you mean by Arduino sketches?
2. Write an Arduino program to blink LED

Course Outcome 6(CO6):

1. How IoT technology helps TELEMEDICINE in India?
2. How soil moisture can be detected in Smart Agriculture?

Model Question Paper

QP CODE: PAGES :2

Reg No: _____

Name: _____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH DEGREE EXAMINATION(MINOR), MONTH & YEAR

Course Code: CST 386

Course Name: WIRELESS NETWORKS AND IoT APPLICATIONS

Max.Marks:100 **Duration: 3 Hours**

PART A

Answer All Questions. Each Question Carries 3 Marks

1. Illustrate Role of *things* and *internet* in IoT
2. What is Bluetooth? Explain the range and frequency channels of Bluetooth?
3. List any three the features of Constrained Application Protocol (COAP).
4. Compare Raspberry Pi and BeagleBoard boards.
5. Identify the role of HBase in Hadoop File System.
6. Differentiate Edge computing and Distributed computing.
7. Give an example of Raspberry Pi applications for Industrial IoT.
8. What are the on-board functional units in Intel Galileo?
9. Interpret the concept of value creation in IoT.

10. Explain the use of PaaS in IoT Smart applications with any three examples. **(10x3=30)**

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11. (a) Compare various Network topologies used in Wireless Networks. **(8)**

(b) Describe the following wireless technologies on i) *Zigbee* ii)*WiFi* iii) *Thread*. **(6)**

OR

12. (a) Explain protocol stacks used in wireless networks for IoT applications. **(8)**

(b) Illustrate the Architectural design of LoRaWAN. **(6)**

13. (a) Define M2M. Explain M2M architecture. Correlate M2M architectural levels with IoT architectural levels. **(8)**

(b) Compare SOAP and REST protocols. **(6)**

OR

14. (a) Summarize different Online Transactions and Processing techniques. **(8)**

(b) Identify the functions of Device-Management Gateway . **(6)**

15. (a) Define actuators ? Describe the roles of actuators in IoT systems. **(8)**

(b) Explain the usage contexts of analog sensors and digital sensors. **(6)**

OR

16. (a) How data collection, storage & computing services done using Nimbits? **(10)**

(b) List any four features of Xively. **(4)**

17. (a) What do you mean by Arduino sketches? **(4)**

(b) Write an Arduino program to blink LED **(10)**

OR

18. (a) Demonstrate an example of Raspberry Pi applications for Industrial IoT. **(10)**

(b) Compare the features of Arduino-R3 and Arduino Yun boards. **(4)**

19. (a) Explain various tasks of a smart irrigation monitoring service. **(8)**

(b) Demonstrate the tasks of Soil-Moisture monitoring service. **(6)**

OR

20. (a) a) Mr. Kiran Mathew has been a chronic diabetic patient for the past few years. He was under regular check up at the hospital every two weeks. All of a sudden the pandemic like COVID-19 arises in the country and the government issues a lockdown for a period of two months. Illustrate how Mr. Kiran can be monitored by the health care worker using intelligent healthcare techniques. **(10)**

(b) Mention any four sensors used in smart healthcare **(4)**

TEACHING PLAN

No	Contents	No of Lecture Hrs(45)
Module – 1 (Introduction to IoT and wireless technologies required for IoT) (8 hrs) (TB-1, Chapter 1...)		
1.1	Internet Of Things, Role of things and internet ,Wireless IoT	1
1.2	Wireless Networks- Network Topologies-Types of Networks,Role of	1

	Wireless standards in IoT	
1.3	Protocol Stack-OSI Model- TCP/IP Model-IEEE 802 reference model	1
1.4	Protocols for Wireless IoT-Bluetooth-Transceiver, Frequency Channels-Typical Range, Access and Spread Spectrum, Modulation and Data Rate	1
1.5	Error Correction and Detection-Network Topology.	1
1.6	ITU G.9959, Zwave, IEEE 802.15.4, Zigbee Specification	1
1.7	Thread, Wifi, 6LowPAN, IPv6	1
1.8	LoRaWAN	1
Module- 2 (IOT architecture, Data and Device management) (9hrs)		
2.1	Internet of Things -IoT Architectural view	1
2.2	Technology Behind IOT-Server End Technology,Sources of Internet of Things	1
2.3	M2M Communication.	1
2.4	IoT Application Areas. IOT Examples.	1
2.5	IoT Data Management, Device Management Gateways.	1
2.6	Design Principles for Web Connectivity	1
2.7	Web communication protocols for connected devices,	1
2.8	Web connectivity for connected devices using Gateways.	1
2.9	Internet connectivity Principles – Internet Connectivity, Internet based communication, IP addressing in the IoT.	1
Module- 3 (Data Acquiring and Enabling Technologies (8 hrs)		
3.1	Data acquiring and storage for IoT devices- Organization of Data, Big data	1
3.2	Acquiring methods, management techniques, Analytics, Storage technologies.	1
3.3	Cloud computing for Data storage-IoT Cloud based services using Xively,	1

	Nimbits, and other platforms.	
3.4	Cloud computing-Nimbits	1
3.5	Sensor Technologies for IoT Devices-Sensor Technology, Participatory sensing	1
3.6	Industrial IoT and Automotive IoT	1
3.7	Actuators for various devices, Sensor data communication protocols	1
3.8	Wireless Sensor network Technology	1
Module 4(Prototyping the Embedded Devices for IoT)(9hrs)		
4.1	Introduction, Embedded Computing Basics, Embedded Hardware Unit.	1
4.2	Embedded Platforms for Prototyping-Arduino, Intel Galileo	1
4.3	Intel Edison, Raspberry Pi, BeagleBone, mBed	1
4.4	Prototyping and designing the software for IoT applications-Introduction, Prototyping embedded device software	1
4.5	Prototyping and designing the software for IoT applications-Introduction, Prototyping embedded device software	1
4.6	Programming concepts in Arduino	1
4.7	Programming for an arduino controlled traffic control lights at a road junction	1
4.8	Basic Arduino programs to blink LED, Find the distance using ultrasonic sensor	1
4.9	Estimate room temperature, Measuring soil moisture level	1
Module 5 (higher level protocols and case studies)(9 hrs)		
5.1	Business Models and Processes using IOT, Value creation in the Internet of Things.	1

5.2	Xively, Nimbits, IBM Bluemix	1
5.3	CISCO IoT, AWS IoT, TCS Connected AWS Platform	1
5.4	Case Study- Smart Environment	1
5.5	Case Study- Smart Environment	1
5.6	Case study Smart Home	1
5.7	Case study Smart Home	1
5.8	Case study Smart healthcare (Lecture I)	1
5.9	Case study Smart healthcare (Lecture II)	1
5.10	Case study -Smart agriculture (Lecture I)	1
5.11	Case study -Smart agriculture (Lecture II)	1

SEMESTER VI

HONOURS

ERT 394	ELECTRONIC DESIGN AND AUTOMATION TOOLS	Category	L	T	P	Credits
		VAC	3	1	0	4

Preamble: This course helps the learners to understand the basic methodology of Digital and Analog system design and to know the EDA tool concepts used for electronic system design for IC and PCB.

Prerequisite: ERT 203 Digital Systems and VLSI Design

Course Outcomes: After the completion of the course, the student will be able to

CO1	Illustrate the basic concepts of EDA, fault simulation and testability **(Cognitive Knowledge Level: Understand)**
CO2	Understand partitioning and formal verification techniques **(Cognitive Knowledge Level: Understand)**
CO3	Explain the fundamentals of design for Testability **(Cognitive Knowledge Level: Understand)**
CO4	Describe the need for library design, ASICs and geometric verification **(Cognitive Knowledge Level: Understand)**
CO5	Explain various assembly & packaging methods **(Cognitive Knowledge Level: Understand)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✔	✔	✔		✔							✔
CO2	✔	✔	✔		✔							✔
CO3	✔	✔	✔		✔							✔
CO4	✔	✔	✔		✔							✔
CO5	✔	✔	✔		✔							✔

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Lifelong learning

Assessment Pattern

Bloom's Category	Test 1 (%)	Test 2 (%)	End Semester Examination (%)
Remember	10	10	20
Understand	20	20	40
Apply	20	20	40
Analyse			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3

Continuous Internal Evaluation Pattern:

Attendance : **10 marks**

Continuous Assessment Test : **25 marks**

Continuous Assessment Assignment : **15 marks**

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and

1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

Syllabus

Module-1: Concept of EDA

Design Methodology, Development steps, Implementation and Verification, Top Down or Bottom Up, Short history of EDA. Digital Simulation: Why? Simulation Model, SDF, Structure of a Digital Simulator, Fault simulation, Performance & Use of logic simulation, Verification of Testability with Simulation, Limits of Digital Simulation.

Module-2: Synthesis

Introduction, Examples, Partitioning, Modification of Hierarchy, Optimization, Retiming, Technology mapping.

Formal Verification: Model checking, Equivalence checking, Fundamental techniques, Sequential circuits, Correctness of Synthesis steps, Design verification.

Module-3: Design for Testability Fundamentals

Faults in Digital circuits and their modeling, Fault simulation and fault collapsing, Digital test pattern generation–ATPG, ATPG algorithms, ATPG- Vector Formats and Compaction and Compression. Scan Architectures- Testability, Scan Registers, Generic scan-based designs, Boundary Scan-JTAG. Built in Self-Test (BIST) - BIST concepts and test pattern generation

Module-4: Library Design

Digital libraries, Pad cell Libraries, Analogue libraries, Macro Libraries. ASICs: Design goals for ASICs, Design Styles. Geometric layout: Standard cell Layouts, LEF data format, GDSII format. Geometric Verification: Introduction, Layer preprocessing, Design Rule check, Extract, Extraction of parasitic capacitors and resistors, ERC, LVS.

Module-5: Assembly & packaging Methods

Die Assembly, Electrical connections, Packaging Methods. PCB Design: PCB design flow, Schematic entry for PCB design, PCB layout

Text Books

1. Jansen, Dirk, "The Electronic Design Automation Handbook", 2003.
2. Miron Abramovici, Melvin A. Breur, Arthur D. Friedman, "Digital Systems Testing and Testable Design", Jaico Publishing House, 2001.
3. ORCAD: Technical Reference Manual, Orcad, and USA.

References

1. M.J.S.Smith. “Application-Specific Integrated Circuits”, Addison Wesley, 2010.
2. Jan M. Rabaey, A. Chandrakasan, B. Nikolic, “Digital Integrated Circuits- a Design perspective”, Pearson education/ Prentice-Hall India Ltd, 2nd edition, 2003.
3. M.H.Rashid, “SPICE FOR Circuits And Electronics Using PSPICE”, Prentice Hall, 2nd edition, 2011.

Sample Course Level Assessment Questions

Course Outcome 1 (CO1):

1. What is Implementation in ASIC design flow

2. Explain the Setup of a simulation system for digital simulation

3. What are the limits of Digital Simulation

Course Outcome 2 (CO2):

1. Write short notes on Optimization strategies
2. fundamental techniques are presented which are used by verification tools
3. Identify and explain the process used to establish the correctness of first design at a high level of abstraction

Course Outcome 3 (CO3):

1. What is fault collapsing
2. Write short notes on Vector Formats and Compaction
3. What is fault simulation

Course Outcome 4 (CO4):

1. What is LEF data format
2. Explain Design Rule check
3. What are Design Styles in ASICs

Course Outcome 5 (CO5):

1. What are the special advantages of eutectic die bonding
2. What are the several requirements to accomplish Packaging?
3. Explain the significance of PCB Design

Model Question Paper

QP CODE: **PAGES: ___**

Reg No:_____
Name:_____

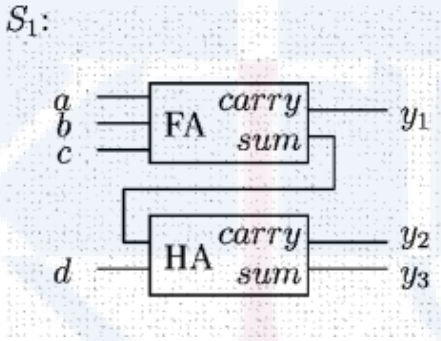
APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B.TECH. DEGREE EXAMINATION, MONTH & YEAR

Course Code: ERT 394
Course Name: ELECTRONIC DESIGN AND AUTOMATION TOOLS
Max Marks: 100 **Duration: 3 Hours**

PART A
(Answer All Questions. Each question carries 3 marks)

1. What is Verification in ASIC design flow
2. What is the significance of Digital simulation for design verification
3. Differentiate between Ungroup Command and group command
4. Draw S2 , which is a refinement of cell S1 from the 4 to 2 reducer from figure below



5. What are Scan Registers?
6. Briefly explain Fault simulation?
7. List the tasks performed by Pad cells for a chip
8. Illustrate the various design goals for ASICs
9. List the substances that are used as hardeners for adhesives
10. Which are main three kinds of manufacturing processes used? Explain.

Part B
(Answer any one question from each module. Each question carries 14 Marks)

11. Explain the 7 different steps in development

OR

12. Explain the Structure of a Digital Simulator, with diagrams

13. Write short notes on partitioning of the design

OR

14. Identify the method which can be used to prove the correctness of a design by comparing the implemented circuit against another circuit which is known to be correct. Explain the method in Detail
15. What is Built in Self-Test? Explain in detail with diagram.

OR

16. Write short notes on ATPG algorithms
17. Explain the following: (i) Analogue Libraries (ii) macro libraries

OR

18. Briefly explain: (i) ERC (ii) LVS
19. What is Wire Bonding? Name the 2 welding methods used and explain one method in detail with figures.

OR

20. Explain PCB design flow in detail

TEACHING PLAN

No	Contents	No.of Lecture Hrs (42 hrs)
Module-1: Concept of EDA		**(9 hrs)**
1.1	Design Methodology, Development steps	1
1.2	Implementation and Verification, Top Down or Bottom Up	1
1.4	Short history of EDA	1
1.5	Digital Simulation: Why? Simulation Model	1
1.6	SDF, Structure of a Digital Simulator	1
1.7	Fault simulation, Performance & Use of logic simulation	1
1.8	Verification of Testability with Simulation	1
1.9	Limits of Digital Simulation.	1
Module-2:Synthesis		**(8 hrs)**
2.1	Introduction, Examples	1
2.2	Partitioning, Modification of Hierarchy	1
2.3	Optimization, Retiming, Technology mapping	1
2.4	Formal Verification: Model checking	1
2.5	Equivalence checking, Fundamental techniques,	1

2.6	Sequential circuits	1
2.7	Correctness of Synthesis steps	1
2.8	Design verification.	1
	Module-3: Design for Testability Fundamentals	**(9 hrs)**
3.1	Faults in Digital circuits and their modeling	1
3.2	Fault simulation and fault collapsing	1
3.3	Digital test pattern generation–ATPG	1
3.4	ATPG algorithms, ATPG- Vector Formats and Compaction and Compression	1
3.5	Scan Architectures- Testability	1
3.6	Scan Registers, Generic scan-based designs	1
3.7	Boundary Scan-JTAG	1
3.8	Built in Self-Test (BIST)	1
3.9	BIST concepts and test pattern generation	1
	Module-4: Library Design	**(9 hrs)**
4.1	Digital libraries, Pad cell Libraries	1
4.2	Analogue libraries, Macro Libraries	1
4.3	ASICs: Design goals for ASICs	1
4.4	Design Styles. Geometric layout: Standard cell Layouts	1
4.5	LEF data format, GDSII format.	1
4.6	Geometric Verification: Introduction	1
4.7	Layer preprocessing, Design Rule check,	1
4.8	Extract, Extraction of parasitic capacitors and resistors	1
4.9	ERC, LVS	1
	Module-5: Assembly & packaging Methods	**(7 hrs)**
5.1	Die Assembly	1
5.2	Electrical connections	1
5.3	Packaging Methods (Lecture 2)	1

5.4	Packaging Methods (Lecture 1)	1
5.5	PCB Design: PCB design flow	1
5.6	Schematic entry for PCB design	1
5.7	PCB layout	1

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
KTU
Estd. 2014

CST 394	NETWORK SECURITY	Category	L	T	P	Credits	Year of Introduction
		VAC	3	1	0	4	2019

Preamble:

The purpose of this course is to create a better understanding of the network security concepts. This course covers network security standards, email security services, web security mechanisms, firewalls and wireless security mechanisms. This course helps the learner to gain insight into the key aspects of secure network communication and enables to apply in real-life scenarios.

Prerequisite: A sound background in Number Theory and Cryptographic Algorithms.

Course Outcomes: After the completion of the course the student will be able to

CO#	Course Outcomes
CO1	Identify the key aspects of security, intrusion detection systems and digital signature schemes **(Cognitive Knowledge Level: Apply)**
CO2	Explain the security standards used in network communication (**Cognitive Knowledge Level:Understand)**
CO3	Identify the mechanisms in email security services (**Cognitive Knowledge Level: Apply)**
CO4	Summarize the protocols used to provide web security (**Cognitive Knowledge Level: Understand)**
CO5	Explain the fundamental concepts of wireless network security and firewalls **(Cognitive Knowledge Level: Understand)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓								✓
CO2	✓	✓	✓	✓								✓
CO3	✓	✓	✓	✓		✓						✓
CO4	✓	✓	✓	✓	✓	✓						✓
CO5	✓	✓	✓	✓								✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Lifelong learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination (%)
	Test 1 (%)	Test 2 (%)	
Remember	30	30	30
Understand	40	40	40
Apply	30	30	30
Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3

Continuous Internal Evaluation Pattern:

Attendance **: 10 marks**

Continuous Assessment Tests **: 25 marks**

Continuous Assessment Assignment **: 15 marks**

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. The first series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

Syllabus

Module – 1 (Network Security Basics)

Introduction to network security - Security requirements, Challenges of security, Network security model. Malicious programs – Worms, Viruses, Trojans, Spyware, Adware. Intrusion Detection Systems (IDS) - Uses, Techniques. Digital signatures - ElGamal, Schnorr, Digital Signature Standard (DSS).

Module – 2 (Network Security Standards)

Kerberos v4 – Configuration, Authentication, Encryption, Message formats. Kerberos v5 – Cryptographic algorithms, Message formats. Public Key Infrastructure (PKI) – Trust models, Revocation. Real-time communication security – Perfect Forward Secrecy (PFS), Denial-of-Service protection, Endpoint identifier hiding, Live partner reassurance. Internet Protocol Security (IPSec) - Authentication Header (AH), Encapsulating Security Payload (ESP), Internet Key Exchange (IKE) phases.

Module – 3 (Email Security)

Introduction to email security - Security services for email, Establishing keys, Privacy, Authentication, Message integrity, Non-repudiation. Privacy Enhanced Mail (PEM) – Encryption, Source authentication and integrity protection, Message formats. Secure/Multipurpose Internet Mail Extensions (S/MIME) – Messages, Differences from PEM. Pretty Good Privacy (PGP) - Encoding, Certificate and key revocation, Anomalies, Object formats.

Module – 4 (Web Security)

Introduction to web security - Web security considerations, Threats. Secure Sockets Layer (SSL) – Architecture, Protocols, Transport Layer Security (TLS) – Differences from SSL. Hypertext Transfer Protocol Secure (HTTPS) – Connection initiation, Closure. Secure Shell (SSH) – Transport layer protocol, User authentication protocol, Connection protocol.

Module – 5 (Wireless Network Security and Firewalls)

IEEE 802.11 Wireless LAN - Network components, Architectural model, Services. IEEE 802.11i wireless LAN security - Services, Phases of operation. Wired Equivalent Privacy (WEP), Wi-Fi Protected Access (WPA), WPA2, Wireless Application Protocol (WAP) – Services, Protocol architecture. Firewalls – Need for firewalls, Packet filters, Circuit-level firewalls, Application layer firewalls.

Text Books

1. C. Kaufman, R. Perlman and M. Speciner, “Network Security: Private Communication in a Public World”, 2/e, PHI.
2. William Stallings, “Cryptography and Network Security Principles and Practice”, 5/e, Pearson

Education Asia.

References

1. Behrouz A. Forouzan, Debdeep Mukhopadhyay, "Cryptography and Network Security", 3/e, Tata McGraw Hill.
2. Tyler Wrightson, "Wireless Network Security A Beginner's Guide", 2012, Tata McGraw Hill.
3. William Stallings, "Network Security Essentials: Applications and Standards", 4/e, Prentice Hall.
4. Schiller J., Mobile Communications, 2/e, Pearson Education.
5. Roberta Bragg et. al., "Network Security: The Complete Reference", Tata McGraw Hill.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Using the Schnorr digital signature scheme, let $q = 83$, $p = 997$ and $d = 23$. Find values for e_1 and e_2.
2. The Digital Signature Algorithm (DSA) specifies that if the signature generation process results in a value of zero, a new value of k should be generated and the signature should be recalculated. Give reason.

Course Outcome 2 (CO2):

1. In Kerberos v4, the authenticator field is not of security benefit when asking the Key Distribution Center (KDC) for a ticket for Bob, but useful when logging in as Bob. Give reasons for your answer.
2. How does the stateless cookie protocol provide clogging protection?

Course Outcome 3 (CO3):

1. If Alice is sending an ENCRYPTED message, she first signs the message digest with her private key and then encrypts the message digest with the pre-message secret key. Why this last encryption was considered necessary for encrypted messages and not for MIC-CLEAR or MIC-ONLY?
2. Which security services are considered desirable in the following cases? (i) Sending a purchase order (ii) Sending a ransom note. (iii) Sending a mission description to security officials.
3. Explain the security mechanism used in Gmail communication.

Course Outcome 4 (CO4):

1. Is it possible in SSL for the receiver to reorder SSL record blocks that arrive out of order? If so, how it can be done? If not, why?
2. Describe any five web security threats, their consequences and countermeasures.

Course Outcome 5 (CO5):

1. Explain the security areas addressed by IEEE 802.11i.
2. Describe the advantages and disadvantages of application layer firewalls.

Model Question Paper

QP CODE:
Reg. No:_____
Name:_____ **PAGES : 3**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH. DEGREE (HONORS) EXAMINATION, MONTH &YEAR
Course Code: CST 394

Course Name: Network Security

Max.Marks:100 **Duration: 3 Hours**

PART A

Answer all Questions. Each question carries 3 Marks

1. Distinguish between signature-based and anomaly-based intrusion detection techniques.

2. A trusted third party is considered as a main component in a network security model. Why?

3. How is endpoint identifier hiding achieved in real-time communication?

4. Show how encryption is used to provide privacy and integrity in Kerberos v5.

5. End-to-end privacy is essential for e-mail security. How is this achieved?

6. List the four steps for preparing an EnvelopedData MIME entity.

7. Show the operation of a Secure Sockets Layer (SSL) Record protocol.

8. For Secure Shell (SSH) packets, what is the advantage of not including the MAC in the scope of packet encryption?

9. List the three security services provided by IEEE 802.11i.

10. Define the terms Access Point, Basic Service Set, Extended Service Set.

(10x3=30)

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11. (a) Using the ElGamal scheme, let p = 881 and d = 700, find values for e1 and e2. Choose r = 17. Find the value of S1 and S2 if M = 400. **(8)**

(b) Explain the requirements and challenges of network security. **(6)**

OR

12. (a) In ElGamal, Schnorr and DSS, what happens if an attacker can find the value of random secret key used by the signer? Also, what happens if a user uses the same value of random secret key to sign two messages? Explain your answer for each scheme separately. **(8)**

(b) Explain the network security model with the help of a neat diagram. **(6)**

13. (a) Alice wishes to log into Bob's workstation remotely. List the steps involved in this communication if Kerberos v4 is used. **(7)**

(b) How does Diffie-Hellman technique provide perfect forward secrecy using signature keys? **(7)**

OR

14. (a) Explain the algorithm for Message Authentication Code (MAC) calculation and verification in Kerberos v5 rsa-md5-des. **(8)**

(b) Compare the aggressive mode and main mode of Phase 1 Internet Key Exchange (IKE). **(6)**

15. (a) Describe the different methods by which authentication of source is performed in email communication. **(7)**

(b) Explain the Signed data and Clear-signed data functions provided by S/MIME. **(7)**

OR

16. (a) Explain the advantages of Pretty Good Privacy (PGP) over Privacy Enhanced Mail (PEM). **(7)**

	(b)	Define non-repudiation. Describe the different ways by which it is implemented in email communication.	**(7)**
17.	(a)	Describe the significance of pseudo-random function of Transport Layer Security.	**(7)**
	(b)	Explain the four different phases of Secure Sockets Layer (SSL) HandshakeProtocol.	**(7)**

OR

18.	(a)	Describe how connection initiation and connection closure is done in Hyper Text Transfer Protocol Secure (HTTPS).	**(7)**
	(b)	Illustrate the sequence of events in Secure Shell (SSH) transport layer protocol packet exchanges.	**(7)**
19.	(a)	Explain the Discovery phase and Authentication phase of IEEE 802.11i operation.	**(7)**
	(b)	Why are firewalls needed? Compare the features of packet filters and circuit level firewalls.	**(7)**

OR

20.	(a)	Explain the two authentication methods used in Wired Equivalent Privacy (WEP).	**(7)**
	(b)	Describe the three transaction classes provided by Wireless Transaction Protocol.	**(7)**

Teaching Plan

No	Contents	No of Lecture Hrs
Module - 1 (Network Security Basics) (7 hrs)		
1.1	Security requirements, Challenges of security	1
1.2	Network security model	1
1.3	Worms, Viruses, Trojans, Spyware, Adware	1
1.4	Intrusion Detection Systems (IDS) uses, Techniques	1
1.5	ElGamal digital signature	1
1.6	Schnorr digital signature	1
1.7	Digital Signature Standard (DSS)	1
Module - 2 (Network Security Standards) (12 hrs)		
2.1	Kerberos v4 configuration, Authentication	1
2.2	Kerberos v4 encryption	1
2.3	Kerberos v4 message formats	1
2.4	Kerberos v5 cryptographic algorithms – rsa-md5-des, des-mac, des-mac-k	1
2.5	Kerberos v5 cryptographic algorithms - rsa-md4-des, rsa-md4-des-k, Encryption for privacy and integrity	1
2.6	Kerberos v5 message formats	1
2.7	Public Key Infrastructure (PKI) trust models	1
2.8	PKI revocation	1
2.9	Perfect Forward Secrecy (PFS), Denial-of-Service protection	1
2.10	Endpoint identifier hiding, Live partner reassurance	1
2.11	Internet Protocol Security (IPSec) Authentication Header (AH), Encapsulating Security Payload (ESP)	1

2.12	Internet Key Exchange (IKE) phases	1
Module - 3 (Email Security) (9 hrs)		
3.1	Security services for email, Establishing keys, Privacy	1
3.2	Authentication, Message integrity, Non-repudiation	1
3.3	Privacy Enhanced Mail (PEM) encryption, Source authentication	1
3.4	PEM integrity protection, Message formats (Lecture 1)	1
3.5	PEM message formats (Lecture 2)	1
3.6	Secure/Multipurpose Internet Mail Extensions (S/MIME) – Messages, Differences from PEM	1
3.7	Pretty Good Privacy (PGP) encoding, Certificate and key revocation, Anomalies	1
3.8	PGP Object formats (Lecture 1)	1
3.9	PGP Object formats (Lecture 2)	1
Module – 4 (Web Security)(9 hrs)		
4.1	Web security considerations, Threats, Secure Sockets Layer (SSL) architecture	1
4.2	SSL protocols (Lecture 1)	1
4.3	SSL protocols (Lecture 2)	1
4.4	Transport Layer Security (TLS) differences from SSL (Lecture 1)	1
4.5	TLS differences from SSL (Lecture 2)	1
4.6	Hypertext Transfer Protocol Secure (HTTPS) connection initiation, Closure	1
4.7	Secure Shell (SSH) transport layer protocol	1
4.8	SSH user authentication protocol	1
4.9	SSH connection protocol	1

Module - 5 (Wireless Security and Firewalls) (8 hrs)		
5.1	IEEE 802.11 Wireless LAN network components, Architectural model, Services	1
5.2	IEEE 802.11i wireless LAN security services, Phases of operation (Lecture 1)	1
5.3	IEEE 802.11i phases of operation (Lecture 2)	1
5.4	Wired Equivalent Privacy (WEP), Wi-Fi Protected Access (WPA), WPA2	1
5.5	Wireless Application Protocol (WAP) services, Protocol architecture (Lecture 1)	1
5.6	WAP protocol architecture (Lecture 2)	1
5.7	Need for firewalls, Packet filters	1
5.8	Circuit-level firewalls, Application layer firewalls	1

CST 396	ADVANCED TOPICS IN MACHINE LEARNING	Category	L	T	P	Credit	Year of Introduction
		VAC	3	1	0	4	2019

Preamble:

This course enables the learners to understand the advanced concepts and algorithms in machine learning. The course covers the standard and most popular supervised learning algorithms such as linear regression, logistic regression, decision trees, Bayesian learning and the naive Bayes algorithm, basic clustering algorithms, auto encoders, sampling methods and PAC learning. This course helps the students to provide machine learning based solutions to real world problems.

Prerequisite: Basic understanding of probability theory, linear algebra, multivariate calculus and multivariate probability theory.

CO1	Illustrate the concepts of regression and classification techniques **(Cognitive Knowledge Level: Apply)**
CO2	Demonstrate various unsupervised learning techniques **(Cognitive Knowledge Level: Apply)**
CO3	Choose suitable model parameters for different machine learning techniques and to evaluate a model performance **(Cognitive Knowledge Level: Apply)**
CO4	Explain the framework of PAC learning, basic concepts of VC dimension and non-uniform learnability **(Cognitive Knowledge Level: Understand)**
CO5	Construct Bayesian models for data and apply computational techniques to draw inferences **(Cognitive Knowledge Level: Apply)**
CO6	Illustrate the concepts of sampling algorithms, auto encoder, generative adversarial networks **(Cognitive Knowledge Level: Apply)**

Mapping of course outcomes with program outcomes

	PO1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO1 2
CO1	✓	✓	✓	✓	✓	✓						✓
CO2	✓	✓	✓	✓	✓	✓						✓
CO3	✓	✓	✓	✓	✓	✓						✓
CO4	✓	✓	✓	✓								✓
CO5	✓	✓	✓	✓	✓							✓
CO6	✓	✓	✓	✓	✓	✓						✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks
	Test1 (Percentage)	Test2 (Percentage)	
Remember	**30**	**30**	**30**
Understand	**30**	**30**	**30**
Apply	**40**	**40**	**40**
Analyse			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	**50**	**100**	**3 hours**

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Tests : 25 marks

Continuous Assessment Assignment : 15 marks

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks

First Internal Examination shall be preferably conducted after completing the first half of the syllabus and the Second Internal Examination shall be preferably conducted after completing remaining part of the syllabus.

There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly covered module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly covered module), each with 7 marks. Out of the 7 questions in Part B, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have a maximum 2 sub-divisions and carry 14 marks.

Syllabus

Module -1 (Supervised Learning)

Overview of machine learning - supervised, semi-supervised, unsupervised learning, reinforcement learning Regression algorithms: least squares linear regression, gradient descent, closed form, normal equations, regularization techniques (LASSO, RIDGE), polynomial regression. Discriminative Methods - Logistic Regression, Decision Tree Learning. Generative Methods - Naive Bayes Classifier, Gaussian Discriminant Analysis (GDA).

Module -2 (Unsupervised Learning)

Clustering - Similarity measures, Hierarchical Agglomerative Clustering, K-means partitional clustering, K-medoids clustering, Gaussian mixture models: Expectation Maximization (EM) algorithm for Gaussian mixture model.

Module -3 (Practical aspects in machine learning)

Classification Performance measures - Precision, Recall, Accuracy, F-Measure, ROC, AUC, generalisation and overfitting, cross-validation, bias-variance tradeoff, error estimation, parameter and model selection. Ensemble Methods - Bagging, Boosting, Adaboost, Random Forests.

Module -4 (Statistical Learning Theory)

Models of learnability- learning in the limit, probably approximately correct (PAC) learning. Sample complexity- quantifying the number of examples needed to PAC learn, Computational complexity of training, Sample complexity for finite hypothesis spaces, PAC results for learning conjunctions, Sample complexity for infinite hypothesis spaces, Vapnik-Chervonenkis(VC) dimension.

Module -5 (Advanced Machine Learning Topics)

Graphical models - Bayesian belief networks, Markov random fields(MRFs), Inference on chains and factor graphs, inference on clique trees. Monte Carlo methods – Basic sampling algorithms, rejection sampling, importance sampling, Markov chain Monte Carlo(MCMC), Gibbs sampling. Variational methods. Auto Encoder, Variational AutoEncoder, Generative Adversarial Networks

Textbook

1. Christopher M. Bishop. Pattern recognition and machine learning. Springer 2006.
2. Ethem Alpaydin, Introduction to Machine Learning, 2nd edition, MIT Press 2010.
3. Mohammed J. Zaki and Wagner Meira, Data Mining and Analysis: Fundamental Concepts and Algorithms, Cambridge University Press, First South Asia edition, 2016.
4. Ian Goodfellow, Yoshua Bengio and Aaron Courville. Deep Learning. MIT Press 2016.
5. Mehryar Mohri, Afshin Rostamizadeh and Ameet Talwalkar. Foundations of Machine Learning. Second edition. MIT Press 2018.
6. Tom Mitchell. Machine Learning. McGraw Hill 1997.
7. Richard O. Duda, Peter E . Hart, David G. Stork. Pattern classification, Second Edition. Wiley.
8. Jiawei Han, Micheline Kamber, Jian Pei. Data Mining Concepts and Techniques, Third Edition. Morgan Kaufmann.
9. David Foster. Generative Deep Learning - Teaching Machines to Paint, Write, Compose, and Play. O'Reilly Media, Inc., June 2019.

Reference Books

1. Kevin P. Murphy. Machine Learning: A Probabilistic Perspective. MIT Press 2012
2. Carl Edward Rasmussen and Christopher K. I. Williams. Gaussian Processes for Machine Learning. MIT Press 2005.

Sample Course Level Assessment Questions

Course Outcome1 (CO1):

1. Consider a naive Bayes classifier with 3 boolean input variables, $\mathbf{X_1}$, $\mathbf{X_2}$ and $\mathbf{X_3}$, and one boolean output, **Y**. How many parameters must be estimated to train such a naive Bayes classifier? How many parameters would have to be estimated to learn the above classifier if we do not make the naive Bayes conditional independence assumption?
2. Describe the ID3 algorithm. Is the order of attributes identical in all branches of the decision tree?
3. Explain the difference between (batch) gradient descent and stochastic gradient descent. Give an example of when you might prefer one over the other.
4. Suppose that you are asked to perform linear regression to learn the function that outputs y, given the D-dimensional input x. You are given N independent data points, and that all the D attributes are linearly independent. Assuming that D is around 100, would you prefer the closed form solution or gradient descent to estimate the regressor?
5. Suppose you have a three class problem where class label $y \in 0, 1, 2$ and each training example $\boldsymbol{X}$ has 3 binary attributes $\boldsymbol{X_1, X_2, X_3} \in \mathbf{0, 1}$. How many parameters (probability distribution) do you need to know to classify an example using the Naive Bayes classifier?

Course Outcome 2(CO2):

1. Which similarity measure could be used to compare feature vectors of two images? Justify your answer.
2. Illustrate the strength and weakness of k-means algorithm.
3. Suppose you want to cluster the eight points shown below using **k**-means

	A_1	A_2
x_1	2	10
x_2	2	5
x_3	8	4
x_4	5	8
x_5	7	5
x_6	6	4
x_7	1	2
x_8	4	9

Assume that **k = 3** and that initially the points are assigned to clusters as follows:

$C_1 = \{x_1, x_2, x_3\}$, $C_2 = \{x_4, x_5, x_6\}$, $C_3 = \{x_7, x_8\}$. Apply the **k**-means algorithm until convergence, using the Manhattan distance.

4. Cluster the following eight points representing locations into three clusters: $A_1(2, 10)$, $A_2(2, 5)$, $A_3(8, 4)$, $A_4(5, 8)$, $A_5(7, 5)$, $A_6(6, 4)$, $A_7(1, 2)$, $A_8(4, 9)$.

   Initial cluster centers are: $A_1(2, 10)$, $A_4(5, 8)$ and $A_7(1, 2)$.

   The distance function between two points $a = (x_1, y_1)$ and $b = (x_2, y_2)$ is defined as $D(a, b) = |x_2 - x_1| + |y_2 - y_1|$

   Use **k**-Means Algorithm to find the three cluster centers after the second iteration.

Course Outcome 3(CO3):

1. What is ensemble learning? Can ensemble learning using linear classifiers learn classification of linearly non-separable sets?
2. Describe boosting. What is the relation between boosting and ensemble learning?
3. Classifier A attains 100% accuracy on the training set and 70% accuracy on the test set. Classifier B attains 70% accuracy on the training set and 75% accuracy on the test set. Which one is a better classifier. Justify your answer.
4. What are ROC space and ROC curve in machine learning? In ROC space, which points correspond to perfect prediction, always positive prediction and always negative prediction? Why?
5. Suppose there are three classifiers A,B and C. The (FPR, TPR) measures of the three classifiers are as follows – A (0, 1), B (1, 1) , C (1,0.5). Which can be considered as a perfect classifier? Justify your answer.

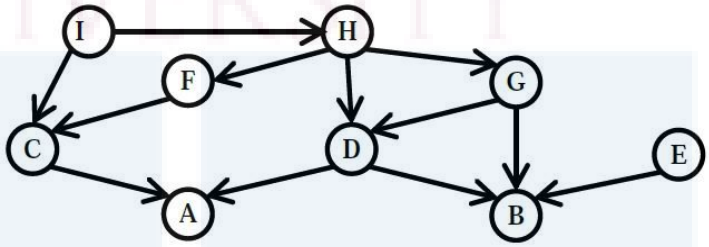
Course Outcome 4(CO4): .

1. A monotone conjunction is a conjunction of the variables such that no variable is negated. Show that the concept class of monotone conjunction is probably approximately correct (PAC)-learnable.
2. Consider a Boolean classification problem with n binary variables and a hypothesis space H, where each hypothesis is a decision tree of depth 2, using only two variables. How many training examples, m suffice to assure that with probability at least 0.99, any consistent learner using H will output a hypothesis with true error at most 0.05
3. Show that the concept class C containing the set of all boolean functions on n variable is not PAC-learnable.

4. What is the Vapnik-Chervonenkis(VC)-dimension of a circle centered at the origin.
5. A hypothesis space that has a high VC dimension is good, bad, or neither? Explain in terms of both (a) richness or expressive power of the hypotheses, and (b) sample complexity.

Course Outcome 5(CO5):

1. Write down the factored conditional probability expression that corresponds to the graphical Bayesian Network shown below.



2. How do we learn the conditional probability tables(CPT) in Bayesian networks if information about some variables is missing? How are these variables called?

Course Outcome 6 (CO6):

1. Derive an algorithm using the inverse transform method to generate a random sample from the exponential distribution.
2. Explain the pros and cons of importance sampling versus rejection sampling.
3. Sketch the core idea of the Monte Carlo method. What is a sample? What is a direct sampling method? Why can't it be used directly to do any inference? What is rejection sampling? What is its major disadvantage?
4. Generative Adversarial Networks(GANs) include a generator and a discriminator. Sketch a basic GAN using those elements, a source of real images, and a source of randomness.
5. The word “adversarial” in the acronym for GANs suggests a two-player game. What are the two players, and what are their respective goals?

Model Question Paper

QP CODE:

Reg No: _____

Name: _____ **PAGES : 5**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH DEGREE EXAMINATION (HONORS), MONTH & YEAR

Course Code: CST 396

Course Name: Advanced Topics in Machine Learning

Max.Marks:100 **Duration: 3 Hours**

PART A

Answer All Questions. Each Question Carries 3 Marks

1.	Suppose you have a dataset with m = 1000000 examples and n = 200000 features for each example. You want to use multivariate linear regression to fit the parameters to our data. Should you prefer gradient descent or the normal equation? Justify your answer.	
2.	Define Information gain? How is that different from Gain ratio? Give the advantage of using Gain ratio measure?	
3.	What is cluster analysis? Identify two applications where cluster analysis can be applied to multimedia data?	
4.	Given two objects represented by the tuples (22, 1, 42, 10) and (20, 0, 36, 8): (i) Compute the Euclidean distance between the two objects. (ii) Compute the Manhattan distance between the two objects.	
5.	Suppose there are three classifiers A,B and C. The (FPR, TPR) measures of the three classifiers are as follows – A (0, 1), B (1, 1) , C (1,0.5). Which can be considered as a perfect classifier? Justify your answer.	
6.	How Bias-Variance Tradeoff affects machine learning algorithms?	
7.	For a particular learning task, if the requirement of error parameter ε changes from 0.1 to 0.01. How many more samples will be required for probably approximately correct(PAC) learning?	

8.	Suppose we have a hypothesis set that labels all points inside an interval ***[a, b]*** as class 1. Find its Vapnik-Chervonenkis(VC)- dimension?		
9.	Given a density function ***f(x)***, the rejection sampling is a method that can generate data points from the density function ***f***. List the three steps to generate a random sample from f using rejection sampling.		
10.	How does the variational auto-encoder(VAE) architecture allow it to generate new data points, compared to auto-encoder, which cannot generate new data points?		**(10x3=30)**
	Part B **(Answer any one question from each module. Each question carries 14 Marks)**		
11.	(a)	. Consider the hypothesis for the linear regression $h_\theta(x) = \theta_0 + \theta_1 x$, and the cost function $J(\theta_0, \theta_1) = 1/2m \sum_{i=1}^{m} (h_\theta(x^{(i)}) - y^{(i)})^2$ where m is the number of training examples. Given the following set of training examples. x | y 3 | 2 1 | 2 0 | 1 4 | 3 . Answer the following questions : . 1) Find the value of $h_\theta(2)$ if $\theta_0 = 0$ and $\theta_1 = 1.5$. 2) Find the value of J(0,1) 3) Suppose the value of $J(\theta_0, \theta_1) = 0$. What can be inferred from this.	**(5)**
	(b)	. Write a gradient descent algorithm for multivariate regression? Compare the gradient and analytical solution to the multivariate regression?	**(9)**
	OR		
12.	(a)	Consider the collection of training samples (S) in the Figure given below. Drug is the target attribute which describes the Drug suggested for each patient. Find the value of the following . i) Gain(S, Sex) ii) Gain (S, Cholesterol)	**(9)**

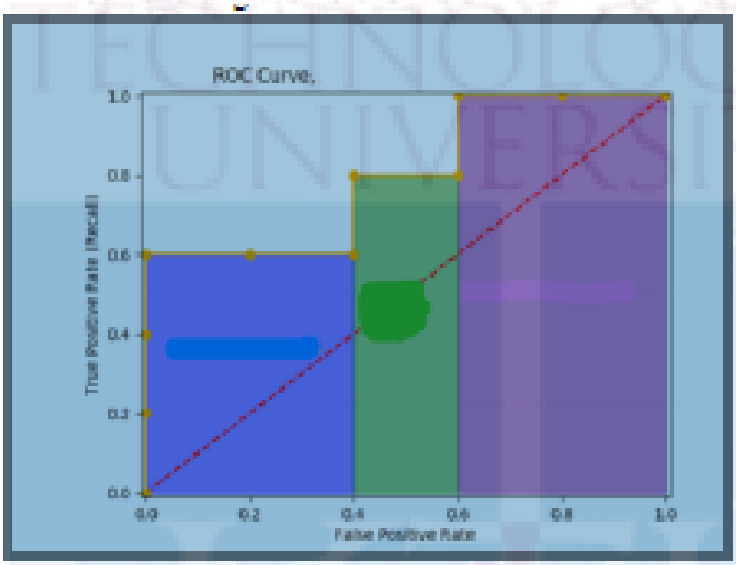
		<table><tr><th>Patient ID</th><th>Age</th><th>Sex</th><th>BP</th><th>Cholesterol</th><th>Drug</th></tr><tr><td>p1</td><td>Young</td><td>F</td><td>High</td><td>Normal</td><td>Drug A</td></tr><tr><td>p2</td><td>Young</td><td>F</td><td>High</td><td>High</td><td>Drug A</td></tr><tr><td>p3</td><td>Middle-age</td><td>F</td><td>Hiigh</td><td>Normal</td><td>Drug B</td></tr><tr><td>p4</td><td>Senior</td><td>F</td><td>Normal</td><td>Normal</td><td>Drug B</td></tr><tr><td>p5</td><td>Senior</td><td>M</td><td>Low</td><td>Normal</td><td>Drug B</td></tr><tr><td>p6</td><td>Senior</td><td>M</td><td>Low</td><td>High</td><td>Drug A</td></tr><tr><td>p7</td><td>Middle-age</td><td>M</td><td>Low</td><td>High</td><td>Drug B</td></tr><tr><td>p8</td><td>Young</td><td>F</td><td>Normal</td><td>Normal</td><td>Drug A</td></tr><tr><td>p9</td><td>Young</td><td>M</td><td>Low</td><td>Normal</td><td>Drug B</td></tr><tr><td>p10</td><td>Senior</td><td>M</td><td>Normal</td><td>Normal</td><td>Drug B</td></tr><tr><td>p11</td><td>Young</td><td>M</td><td>Normal</td><td>High</td><td>Drug B</td></tr><tr><td>p12</td><td>Middle-age</td><td>F</td><td>Normal</td><td>High</td><td>Drug B</td></tr><tr><td>p13</td><td>Middle-age</td><td>M</td><td>High</td><td>Normal</td><td>Drug B</td></tr><tr><td>p14</td><td>Senior</td><td>F</td><td>Normal</td><td>High</td><td>Drug A</td></tr></table>	
	(b)	Explain how LASSO regression helps to reduce the overfitting problem?	**(5)**
13.	(a)	Suppose that we have the following data: <table><tr><th>a</th><th>b</th><th>c</th><th>d</th><th>e</th><th>f</th><th>g</th><th>h</th><th>i</th><th>j</th></tr><tr><td>(2,0)</td><td>(1,2)</td><td>(2,2)</td><td>(3,2)</td><td>(2,3)</td><td>(3,3)</td><td>(2,4)</td><td>(3,4)</td><td>(4,4)</td><td>(3,5)</td></tr></table> Identify the cluster by applying the k-means algorithm, with k = 2. Try using initial cluster centers as far apart as possible.	**(9)**
	(b)	Describe EM algorithm for Gaussian mixtures.	**(5)**
		OR	
14.	(a)	Illustrate the strength and weakness of k-means in comparison with the k-medoids algorithm.	**(4)**
	(b)	Suppose that we have the following data . Use single linkage Agglomerative clustering to identify the clusters. Draw the Dendogram. Use Euclidean distance measure	**(10)**

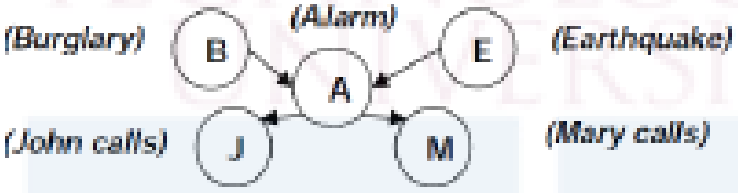
	X	Y
P1	0.4	0.53
P2	0.22	0.38
P3	0.35	0.32
P4	0.26	0.19
P5	0.08	0.41
P6	0.45	0.30

15.	(a)	Define Precision, Recall, Accuracy and F-measure?	**(4)**
	(b)	What does it mean for a classifier to have a high precision but low recall?	**(3)**
	(c)	Fill in the missing values in the accompanying three class confusion matrix. Given that model accuracy is 72% and classification error for class 2 is 20%. Find also the precision and recall for class1	**(7)**

		Predicted		
		Class 1	**Class 2**	**Class 3**
Actual	**Class 1**	14	2	5
	Class 2	?(X)	40	2
	Class 3	1	?(Y)	18

OR

16.	(a)	What are ROC space and ROC curve in machine learning? In ROC space, which points correspond to perfect prediction, always positive prediction and always negative prediction? Why?	**(4)**
	(b)	Given the following ROC Curve? Find the AUC?  	**(3)**
	(c)	How does random forest classifier work? Why is a random forest better than a decision tree?	**(7)**
17.	(a)	Show that the concept class Cn of the conjunction of boolean literals up to n variables is probably approximately correct(PAC)-learnable.	**(8)**
	(b)	Explain the concept of Vapnik-Chervonenkis (VC) dimension using shattering. How the number of training examples required to train the model is related to the VC dimension and what is its relation with training and test errors.	**(6)**
		OR	
18.	(a)	Consider a Boolean classification problem with ***n*** binary variables and a hypothesis space ***H***, where each hypothesis is a decision tree of depth 1. How many training examples, ***m*** suffice to assure that with probability at least 0.99, any consistent learner using ***H*** will output a hypothesis with true error at most 0.05?	**(7)**
	(b)	Prove that VC(H) ≤ log2 |H|, where H is a hypothesis space. (|H| denotes the	**(7)**

		cardinality of the hypothesis space)	
19.	(a)	Shown below is the Bayesian network corresponding to the Burglar Alarm problem, P(J | A) P(M | A) P(A | B, E) P(B) P(E). The probability tables show the probability that variable is True, e.g., P(M) means P(M = t). Find P(J = t ∧ M = f ∧ A = f ∧ B = f ∧ E = t).  P(E) .002 A P(M): t .70; f .01 B E P(A): t t .95; t f .94; f t .29; f f .001 P(B) .001 A P(J): t .90; f .05	**(7)**
	(b)	Derive an algorithm using the inverse transform method to generate a random sample from the distribution with density $f_X(x) = 3x^2, 0 < x < 1$.	**(7)**
		OR	
20.	(a)	Draw the Bayesian Network that corresponds to this conditional probability: ***P(A | B,C,E) P(B | D,E) P(C | F,H) P(D | G) P(E| G,H) P(F | H) P(G) P(H)***	**(6)**
	(b)	What is effective sample size (ESS)? Why is a large ESS necessary but not sufficient for good MCMC mixing?	**(3)**
	(c)	Describe the overall Gibbs sampling algorithm briefly	**(5)**

Teaching Plan

Module 1 : (Supervised Learning)(10 hours)		
1.1	Supervised, semi-supervised, unsupervised learning, reinforcement learning (TB 2: Ch 1)	1 hour
1.2	Least squares linear regression (TB 2: Section 2.6)	1 hour
1.3	Gradient descent, closed form, normal equations (TB 2: Section 5.8)	1 hour
1.4	Regularization techniques (LASSO, RIDGE) (TB 4: Section 7.1)	1 hour
1.5	Polynomial regression (TB 2: Section 2.6)	1 hour
1.6	Logistic Regression (TB 6: Section 3.3)	1 hour
1.7	Decision Tree Learning (ID3) (TB 8: Section 8.2)	1 hour
1.8	Decision Tree Learning (C4.5) (TB 8: Section 8.2)	1 hour
1.9	Naive Bayes Classifier (TB 8: Section 8.3)	1 hour
1.10	Gaussian Discriminant Analysis (GDA) (TB 7: Section 5.2,5.3)	1 hour
Module 2 : (Unsupervised Learning)(8 hours)		
2.1	Similarity measures (TB 8: Section 2.4)	1 hour
2.2	Hierarchical Agglomerative Clustering (TB 3: Chapter 14)	1 hour
2.3	Hierarchical Agglomerative Clustering (TB 3: Chapter 14)	
2.4	K-means partitional clustering (TB 3: Chapter 13)	1 hour
2.5	K-medoids partitional clustering	
2.6	Gaussian mixture models (TB 3: Chapter 13)	1 hour
2.7	Expectation Maximization (EM) algorithm for Gaussian mixture model Lecture-1 (TB 3: Chapter 13)	1 hour
2.8	Expectation Maximization (EM) algorithm for Gaussian mixture model Lecture-2 (TB 3: Chapter 13)	1 hour
Module 3 : (Practical aspects in machine learning) (6 hours)		

3.1	Precision, Recall, Accuracy, F-Measure, ROC, AUC (TB8.5/TB 3: Chapter 22.1)	1 hour
3.2	Generalisation and overfitting, cross-validation (TB 2: Section 2.7,4.8)	1 hour
3.3	Bias-variance tradeoff (TB 2: Chapter 22.3)	1 hour
3.4	Error estimation, parameter and model selection (TB 3: Chapter 8.5)	1 hour
3.5	Bagging, Boosting (TB 8: Chapter 8.6)	1 hour
3.6	Adaboost, Random Forests (TB 8: Chapter 8.6)	1 hour
Module 4 : (Statistical Learning Theory) (TB 5 – Chapter 2, 3.3)(7 hours)		
4.1	Learning in the limit, probably approximately correct (PAC) learning	1 hour
4.2	Quantifying the number of examples needed to PAC learn	1 hour
4.3	Computational complexity of training	1 hour
4.4	Sample complexity for finite hypothesis spaces	1 hour
4.5	PAC results for learning conjunctions	1 hour
4.6	Sample complexity for infinite hypothesis spaces	1 hour
4.7	Vapnik-Chervonenkis(VC) dimension	1 hour
Module 5 : (Advanced Machine Learning Topics) (13 hours)		
5.1	Bayesian belief networks (TB 1 – Chapter 8)	1 hour
5.2	Markov random fields (TB 1 – Chapter 8)	1 hour
5.3	Inference on chains and factor graphs (TB 1 – Chapter 8)	1 hour
5.4	Inference on clique trees (TB 1 – Chapter 8)	1 hour
5.5	Basic sampling algorithms (TB 1 – Chapter 11)	1 hour
5.6	Rejection sampling (TB 1 – Chapter 11)	1 hour
5.7	Importance sampling (TB 1 – Chapter 11)	1 hour
5.8	Markov chain Monte Carlo(MCMC) (TB 1 – Chapter 11)	1 hour
5.9	Gibbs sampling (TB 1 – Chapter 11)	1 hour

5.10	Variational method (TB 1 – Chapter 10)	1 hour
5.11	Auto Encoder (TB 4 – Chapter 14)	1 hour
5.12	Variational AutoEncoder (TB 9 – Chapter 3)	1 hour
5.13	Generative Adversarial Networks (TB 9 – Chapter 4)	1 hour

B.TECH IN ELECTRONICS AND COMPUTER ENGINEERING

Preamble: The advancement of Smart electronic devices into all areas of human life has resulted in the need for electronics engineers with the right blend of Hardware and System Software knowledge, especially embedded systems. In the current scenario ECE Graduates get a good base of Electronics Hardware system, but lack knowledge in (embedded) system software concepts as well as state of the art processor architecture. CSE Graduates gain good knowledge in software associated domains. Since all electronic products today have processors with embedded software (which include Platform management software, Communication software and embedded application software, a right combination of Electronics Engineering and Computer software Engineering is an apt blend for engineers to build a career in the electronics product industry.

Electronics and Computer engineering aims to integrate two separate engineering fields to meet the joint demands of electronics and computer industries in today's world. The job of an electronics and computer engineer is to identify and recommend system improvements to advance technical performance, conduct system evaluations and make appropriate recommendations to modify designs or repair equipment, define and execute testing and maintenance procedures for electronic software and components, design electronic software and components for commercial applications and inspect electronics to ensure compliance with all applicable regulations and safety standard.

Objectives of Electronics and Computer Engineering

The objective of the Electronics and Computer Engineering program is to create engineers capable of solving real-world problems which require computation, communication or control by utilizing the most efficient combination of hardware and software. Students will learn how to build optimal machines using knowledge gained in both computing and electronics domains.

The highlights of the program are as follows:

Intensive courses on Programming and Algorithms:

Problem Solving methods, Data Structures, OOPs, Software Application Design etc.

Fundamental courses to establish electronics fundamentals:

Electronic Circuits, Digital Electronics, Embedded Systems, Signal Processing etc.

Crossover courses covering both software and hardware aspects:

Computing Infrastructure, Programmable Devices, Computing Systems Architecture, Machine Learning, Computer and Communication Networks.

An intensive humanities track along with electives, and design thinking are also included in the curriculum.

CURRICULUM I TO VIII: B. TECH ELECTRONICS AND COMPUTER ENGINEERING

Every course of B. Tech. Programs shall be placed in one of the nine categories as listed in the table below.

Sl. No	Category	Code	Credits
1	Humanities and Social Sciences including Management courses	HMC	8
2	Basic Science courses	BSC	26
3	Engineering Science Courses	ESC	22
4	Program Core Courses	PCC	76
5	Program Elective Courses	PEC	15
6	Open Elective Courses	OEC	3
7	Project work and Seminar	PWS	10
8	Mandatory Non-credit Courses (P/F) with grade	MNC	-----
9	Mandatory Student Activities (P/F)	MSA	2
	Total Mandatory Credits	**162**	
10	Value Added Course (Optional)	VAC	20

No semester shall have more than six lecture-based courses and two laboratory and/or drawing/seminar/project courses in the curriculum. Semester-wise credit distribution shall be as below:

Sem	1	2	3	4	5	6	7	8	Total
Credits	17	21	22	22	23	23	15	17	160
Activity Points	50				50				---
Credits for Activity	2								2
G.Total									**162**

Basic Science Courses: Maths, Physics, Chemistry, Biology for Engineers, Life Science etc

Engineering science courses: Basic Electrical, Engineering Graphics, Programming, Workshop, Basic Electronics, Basic Civil, Engineering Mechanics, Mechanical Engineering, Thermodynamics, Design Engineering, Materials Engineering etc.

Humanities and Social Sciences including Management courses: English, Humanities, Professional Ethics, Management, Finance & Accounting, Life Skills, Professional Communication, Economics etc

Mandatory non-credit courses: Sustainable Engineering, Constitution of India/Essence of Indian Knowledge Tradition, Industrial Safety Engineering, disaster management etc.

Course Code and Course Number

Each course is denoted by a unique code consisting of three alphabets followed by three numerals like **E C L 2 0 1.** The first two letter code refers to the department offering the course. EC stands for course in Electronics & Communication, course code MA refers to a course in Mathematics, course code ES refers to a course in Engineering Science etc. Third letter stands for the nature of the course as indicated in Table 1.

Table 1: Code for the courses

Code	Description
T	Theory based courses (other than the lecture hours, these courses can have tutorial and practical hours, e.g., L-T-P structures 3-0-0, 3-1-2, 3-0-2 etc.)
L	Laboratory based courses (where performance is evaluated primarily on the basis of practical or laboratory work with LTP structures like 0-0-3, 1-0-3, 0-1-3 etc.)
N	Non-credit courses
D	Project based courses (Major, Mini Projects)
Q	Seminar Courses

Course Number is a three digit number and the first digit refers to the Academic year in which the course is normally offered, i.e. 1, 2, 3, or 4 for the B. Tech. Programme of four year duration. Of the other two digits, the last digit identifies whether the course is offered normally in the odd (odd number), even (even number) or in both the semesters (zero). The middle number could be any digit. ECL 201 is a laboratory course offered in EC department for third semester, MAT 101 is a course in Mathematics offered in the first semester, EET 344 is a course in Electrical Engineering offered in the sixth semester, PHT 110 is a course in Physics offered both the first and second semesters, EST 102 is a course in Basic Engineering offered by one or many departments. These course numbers are to be given in the curriculum and syllabi.

Departments

Each course is offered by a Department and their two-letter course prefix is given in Table 2.

Table 2: Departments and their codes

SL No	Department	Course Prefix	SL No	Department	Course Prefix
1	Aeronautical Engineering	AO	23	Electronics and Communication Engineering	EC
2	Agriculture Engineering	AG	24	Electronics and Computer Engineering	ER
3	Applied Electronics and Instrumentation	AE	25	Electrical and Computer Engineering	EO
4	Artificial Intelligence	AI	26	Electrical and Electronics Engineering	EE
5	Artificial Intelligence and Data Science	AD	27	Food Technology	FT
6	Artificial Engineering and Machine Learning	AM	28	Humanities	HU
7	Automobile Engineering	AU	29	Industrial Engineering	IE
8	Biomedical Engineering	BM	30	Information Technology	IT
9	Biotechnology	BT	31	Instrumentation & Control	IC
10	Chemical Engineering	CH	32	Mandatory Courses	MC
11	Chemistry	CY	33	Mathematics	MA
12	Civil Engineering	CE	34	Mechanical Engineering	ME
13	Civil and Environmental Engineering	CN	35	Mechatronics	MR
14	Computer Science and Business Systems	CB	36	Metallurgy	MT
15	Computer Science and Design	CX	37	Mechanical (Auto)	MU
16	Computer Science and Engineering	CS	38	Mechanical (Prod)	MP
17	Computer Science and Engineering (Artificial Intelligence)	CA	39	Naval & Ship Building	SB
18	Computer Science and Engineering (Artificial Intelligence and Machine Learning)	CM	40	Physics	PH
19	Computer Science and Engineering (Data Science)	CD	41	Polymer Engineering	PO
20	Computer Science and Engineering (Cyber Security)	CC	42	Production Engineering	PE
21	Cyber Physical Systems	CP	43	Robotics and Automation	RA
22	Electronics & Biomedical	EB	44	Safety & Fire Engineering	FS

SEMESTER I

SLOT	COURSE NO.	COURSES	L-T-P	HOURS	CREDIT
A	MAT 101	LINEAR ALGEBRA AND CALCULUS	3-1-0	4	4
B 1/2	PHT 100	ENGINEERING PHYSICS	3-1-0	4	4
	CYT 100	ENGINEERING CHEMISTRY	3-1-0	4	4
C 1/2	EST 100	ENGINEERING MECHANICS	2-1-0	3	3
	EST 110	ENGINEERING GRAPHICS	2-0-2	4	3
D 1/2	EST 120	BASICS OF CIVIL & MECHANICAL ENGINEERING	4-0-0	4	4
	EST 130	BASICS OF ELECTRICAL & ELECTRONICS ENGINEERING	4-0-0	4	4
E	HUN 101	LIFE SKILLS	2-0-2	4	--
S 1/2	PHL 120	ENGINEERING PHYSICS LAB	0-0-2	2	1
	CYL 120	ENGINEERING CHEMISTRY LAB	0-0-2	2	1
T 1/2	ESL 120	CIVIL & MECHANICAL WORKSHOP	0-0-2	2	1
	ESL 130	ELECTRICAL & ELECTRONICS WORKSHOP	0-0-2	2	1
TOTAL				**23/24 ***	**17**

*Minimum hours per week

NOTE: To make up for the hours lost due to the induction program, one extra hour may be allotted to each course

SEMESTER II

SLOT	COURSE NO.	COURSES	L-T-P	HOURS	CREDIT
A	MAT 102	VECTOR CALCULUS, DIFFERENTIAL EQUATIONS AND TRANSFORMS	3-1-0	4	4
B 1/2	PHT 100	ENGINEERING PHYSICS A	3-1-0	4	4
	CYT 100	ENGINEERING CHEMISTRY	3-1-0	4	4
C 1/2	EST 100	ENGINEERING MECHANICS	2-1-0	3	3
	EST 110	ENGINEERING GRAPHICS	2-0-2	4	3
D 1/2	EST 120	BASICS OF CIVIL & MECHANICAL ENGINEERING	4-0-0	4	4
	EST 130	BASICS OF ELECTRICAL & ELECTRONICS ENGINEERING	4-0-0	4	4
E	HUN 102	PROFESSIONAL COMMUNICATION	2-0-2	4	--
F	EST 102	PROGRAMMING IN C	2-1-2	5	4
S 1/2	PHL 120	ENGINEERING PHYSICS LAB	0-0-2	2	1
	CYL 120	ENGINEERING CHEMISTRY LAB	0-0-2	2	1
T 1/2	ESL 120	CIVIL & MECHANICAL WORKSHOP	0-0-2	2	1
	ESL 130	ELECTRICAL & ELECTRONICS WORKSHOP	0-0-2	2	1
TOTAL				**28/29**	**21**

NOTE:

1. Engineering Physics A and Engineering Chemistry shall be offered in both semesters. Institutions can advise students belonging to about 50% of the number of branches in the Institution to opt for Engineering Physics A in SI and Engineering Chemistry in S2 & vice versa. Students opting for Engineering Physics A in a semester should attend Physics Lab in the same semester and students opting for Engineering Chemistry in one semester should attend Engineering Chemistry Lab in the same semester.

2. Engineering Mechanics and Engineering Graphics shall be offered in both semesters. Institutions can advise students belonging to about 50% of the number of branches in the Institution to opt for Engineering Mechanics in SI and Engineering Graphics in S2 & vice versa.
3. Basics of Civil & Mechanical Engineering and Basics of Electrical & Electronics Engineering shall be offered in both semesters. Basics of Civil & Mechanical Engineering contain equal weightage for Civil Engineering and Mechanical Engineering. Slot for the course is D with CIE marks of 25 each and ESE marks of 50 each. Students belonging to branches of AEI, EI, BME, ECE, EEE, ICE, CSE, IT, RA can choose this course in S1.

   Basics of Electrical & Electronics Engineering contain equal weightage for Electrical Engineering and Electronics Engineering. Slot for the course is D with CIE marks of 25 each and ESE marks of 50 each. Students belonging to AERO, AUTO, CE, FSE, IE, ME, MECHATRONICS, PE, METALLURGY, BT, BCE, CHEM, FT, POLY can choose this course in S1. Students having Basics of Civil & Mechanical Engineering in one semester should attend Civil & Mechanical Workshop in the same semester and students having Basics of Electrical & Electronics Engineering in a semester should attend Electrical & Electronics Workshop in the same semester.

4. LIFE SKILLS

   Life skills are those competencies that provide the means for an individual to be resourceful and positive while taking on life's vicissitudes. Development of one's personality by being aware of the self, connecting with others, reflecting on the abstract and the concrete, leading and generating change, and staying rooted in time-tested values and principles is being aimed at. This course is designed to enhance the employability and maximize the potential of the students by introducing them to the principles that underlie personal and professional success, and help them acquire the skills needed to apply these principles in their lives and careers.

5. PROFESSIONAL COMMUNICATION

   Objective is to develop in the under-graduate students of engineering a level of competence in English required for independent and effective communication for their professional needs. Coverage: Listening, Barriers to listening, steps to overcome them, Purposive listening practice, Use of technology in the professional world. Speaking, Fluency & accuracy in speech, Positive thinking, improving self-expression, Tonal variations, Group discussion practice, Reading, Speed reading practice, Use of extensive readers, Analytical and critical reading practice, Writing Professional Correspondence, Formal and informal letters, Tone in formal writing, Introduction to reports. Study Skills, Use of dictionary, thesaurus etc., Importance of contents page, cover & back pages, Bibliography, Language Lab.

SEMESTER III

SLOT	COURSE NO.	COURSES	L-T-P	HOURS	CREDIT
A	MAT 203	DISCRETE MATHEMATICAL STRUCTURES	3-1-0	4	4
B	CST 201	DATA STRUCTURES	3-1-0	4	4
C	ERT 203	DIGITAL SYSTEMS AND VLSI DESIGN	3-1-0	4	4
D	ERT 205	ELECTRONIC DEVICES AND CIRCUITS	3-1-0	4	4
E 1/2	EST 200	DESIGN AND ENGINEERING	2-0-0	2	2
	HUT 200	PROFESSIONAL ETHICS	2-0-0	2	2
F	MCN 201	SUSTAINABLE ENGINEERING	2-0-0	2	--
S	CSL 201	DATA STRUCTURES LAB	0-0-3	3	2
T	ERL 201	DIGITAL SYSTEMS AND VLSI DESIGN LAB	0-0-3	3	2
R/M	VAC	REMEDIAL/MINOR COURSE	3-1-0	4**	4
TOTAL				**26/30**	**22/26**

NOTE:

1. Design & Engineering and Professional Ethics shall be offered in both S3 and S4. Institutions can advise students belonging to about 50% of the number of branches in the Institution to opt for Design & Engineering in S3 and Professional Ethics in S4 & vice versa.

2. **All Institutions shall keep 4 hours exclusively for the Remedial class/Minor course (Thursdays from 3 to 5 PM and Fridays from 2 to 4 PM). If a student does not opt for a minor programme, he/she can be given remedial classes.

SEMESTER IV

SLOT	COURSE NO.	COURSES	L-T-P	HOURS	CREDIT
A	MAT 204	PROBABILITY, RANDOM PROCESS AND NUMERICAL METHODS	3-1-0	4	4
B	CST202	COMPUTER ORGANIZATION AND ARCHITECTURE	3-1-0	4	4
C	ERT204	OBJECT ORIENTED PROGRAMMING USING JAVA	3-1-0	4	4
D	ERT206	INTEGRATED CIRCUITS	3-1-0	4	4
E 1/2	EST200	DESIGN AND ENGINEERING	2-0-0	2	2
	HUT200	PROFESSIONAL ETHICS	2-0-0	2	2
F	MCN202	CONSTITUTION OF INDIA	2-0-0	2	--
S	ERL202	INTEGRATED CIRCUITS LAB	0-0-3	3	2
T	ERL204	OBJECT ORIENTED PROGRAMMING LAB	0-0-3	3	2
R/M/H	VAC	REMEDIAL/MINOR/HONOURS COURSE	3-1-0	4**	4
TOTAL				**26/30**	**22/26**

NOTE:

1. Design & Engineering and Professional Ethics shall be offered in both S3 and S4. Institutions can advise students belonging to about 50% of the number of branches in the Institution to opt for Design & Engineering in S3 and Professional Ethics in S4 & vice versa.

2. **All Institutions should keep 4 hours exclusively for the Remedial class/Minor course (Thursdays from 3 to 5 PM and Fridays from 2 to 4 PM). If a student does not opt for minor programme, he/she can be given remedial class.

SEMESTER V

SLOT	COURSE NO.	COURSES	L-T-P	HOURS	CREDIT
A	ERT301	DIGITAL SIGNAL PROCESSING	3-1-0	4	4
B	CST303	COMPUTER NETWORKS	3-1-0	4	4
C	ERT305	DATABASE MANAGEMENT SYSTEMS	3-1-0	4	4
D	ERT307	MICROPROCESSORS AND ADVANCED MICROCONTROLLERS	3-1-0	4	4
E	CST 309	MANAGEMENT OF SOFTWARE SYSTEMS	3-0-0	3	3
F	MCN301	DISASTER MANAGEMENT	2-0-0	2	--
S	ERL331	COMPUTER NETWORKING LAB	0-0-3	3	2
T	CSL333	DATABASE MANAGEMENT SYSTEMS LAB	0-0-3	3	2
R/M/H	VAC	REMEDIAL/MINOR/HONOURS COURSE	3-1-0	4**	4
TOTAL				**27/31**	**23/27**

NOTE:

1. Industrial Economics & Foreign Trade and Management for Engineers shall be offered in both S5 and S6. Institutions can advise students belonging to about 50% of the number of branches in the Institution to opt for Industrial Economics & Foreign Trade in S5 and Management for Engineers in S6 and vice versa.

2. *All Institutions should keep 4 hours exclusively for the Remedial class/Minor/Honours course (Tuesdays from 3 to 5 PM and Wednesdays from 3 to 5 PM). If a student does not opt for a minor/honours programme, he/she can be given remedial classes.

SEMESTER VI

SLOT	COURSE NO.	COURSES	L-T-P	HOURS	CREDIT
A	ERT302	OPERATING SYSTEMS	3-1-0	4	4
B	ERT304	EMBEDDED SYSTEMS & IoT	3-1-0	4	4
C	ERT306	DATA COMMUNICATION AND NETWORKING	3-1-0	4	4
D	ERT–	PROGRAM ELECTIVE I	2-1-0	3	3
E	HUT300	INDUSTRIAL ECONOMICS AND FOREIGN TRADE	3-0-0	3	3
F	ERT308	COMPREHENSIVE COURSE WORK	1-0-0	1	1
S	ERL332	SIGNAL PROCESSING LAB	0-0-3	3	2
T	ERD334	MINI PROJECT	0-0-3	3	2
R/M/H	VAC	REMEDIAL/MINOR/HONOURS COURSE	3-1-0	4**	4
TOTAL				**25/29**	**23/27**

Different Specializations Introduced Through Various Elective Buckets

Bucket	Specialization	Semester			
		S6	S7	S8	
		PE I	PE II	PE III	PE IV
1	COMPUTER SCIENCE SPECIALIZATION	GRAPH THEORY	FORMAL LANGUAGES & AUTOMATA THEORY	COMPILER DESIGN	SYSTEM SOFTWARE
2	MACHINE LEARNING	FOUNDATIONS OF MACHINE LEARNING	MACHINE LEARNING	DEEP LEARNING	PYTHON BASICS FOR MACHINE LEARNING
3	ROBOTICS AND AUTOMATION	SENSORS AND ACTUATORS	NETWORK & LINEAR CONTROL	ROBOTICS & AUTOMATION	MICRO-ELECTRO-MECHANICAL

			SYSTEMS		SYSTEMS
4	SIGNAL PROCESSING & APPLICATIONS	BIOMEDICAL SIGNALS & TRANSDUCERS	INTRODUCTION TO BIOMEDICAL SIGNAL PROCESSING	MEDICAL IMAGE PROCESSING	SPEECH AND AUDIO PROCESSING

PROGRAM ELECTIVE I

SLOT	COURSE NO.	COURSES	L-T-P	HOURS	CREDIT
D	ERT312	SENSORS & ACTUATORS	2-1-0	3	3
	ERT 322	BIOMEDICAL SIGNAL & TRANSDUCERS	2-1-0		
	ERT332	ELECTRONIC PRODUCT DESIGN	2-1-0		
	ERT342	GRAPH THEORY	2-1-0		
	ERT352	CLOUD COMPUTING	2-1-0		
	CST312	FOUNDATIONS OF MACHINE LEARNING	2-1-0		

NOTE:

1. Industrial Economics & Foreign Trade and Management for Engineers shall be offered in both S5 and S6. Institutions can advise students belonging to about 50% of the number of branches in the Institution to opt for Industrial Economics & Foreign Trade in S5 and Management for Engineers in S6 and vice versa.
2. *All Institutions should keep 4 hours exclusively for the Remedial class/Minor/Honours course (Tuesdays from 2 to 4 PM and Wednesdays from 2 to 4 PM). If a student does not opt for a minor/honours programme, he/she can be given remedial classes.
3. Comprehensive Course Work: The comprehensive course work in the sixth semester of study shall have a written test of 50 marks. The written examination will be of objective type similar to the GATE examination and will be conducted online by the University. **Syllabus for the comprehensive examination shall be prepared by the respective BoS choosing any 5 core courses studied from semester 3 to 5**. The pass minimum for this course is 25. The course should be mapped with a faculty and classes shall be arranged for practicing questions based on the core courses listed in the curriculum.

COURSES TO BE CONSIDERED FOR COMPREHENSIVE COURSE WORK

1.DATA STRUCTURES.
2. OBJECT ORIENTED PROGRAMMING USING JAVA.
3. DATABASE MANAGEMENT SYSTEMS.
4. DIGITAL SYSTEMS AND VLSI DESIGN.
5. INTEGRATED CIRCUITS.

4. Mini project: It is introduced in sixth semester with a specific objective to strengthen the understanding of student's fundamentals through application of theoretical concepts. Mini project can help to boost their skills and widen the horizon of their thinking. The ultimate aim of an engineering student is to resolve a problem by applying theoretical knowledge. Doing more projects increases problem-solving skills. Students should identify a topic of interest in consultation with Faculty/Advisor. Review the literature and gather information pertaining to the chosen topic. State the objectives and develop a methodology to achieve the objectives. Carryout the design/fabrication or develop codes/programs to achieve the objectives. Demonstrate the novelty of the project through the results and outputs. The progress of the mini project is evaluated based on a minimum of two reviews. The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The product has to be demonstrated for its full design specifications. Innovative design concepts, reliability considerations, aesthetics/ergonomic aspects taken care of in the project shall be given due weight. The internal evaluation will be made based on the product, the report and a viva- voce examination, conducted by a 3 member committee appointed by Head of the Department comprising HoD or a senior faculty member, Academic coordinator for that program, project guide/coordinator.

Total marks: 150, CIE 75 marks and ESE 75 marks
Split up for CIE
Attendance : 10
Guide : 15
Project Report : 10

Evaluation by the Committee (will be evaluating the level of completion and demonstration of functionality/specifications, presentation, oral examination, work knowledge and involvement) : 40

SEMESTER VII

SLOT	COURSE NO.	COURSES	L-T-P	HOURS	CREDIT
A	ERT401	CMOS VLSI DESIGN	2-1-0	3	3
B	ERTXXX	PROGRAM ELECTIVE II	2-1-0	3	3
C	ERTXXX	OPEN ELECTIVE	2-1-0	3	3
D	MCN401	INDUSTRIAL SAFETY ENGINEERING	2-1-0	3	---
S	ERL411	EMBEDDED SYSTEMS AND IoT LAB	0-0-3	3	2
T	ERQ413	SEMINAR	0-0-3	3	2
U	ERD415	PROJECT PHASE I	0-0-6	6	2
R/M/H	VAC	REMEDIAL/MINOR/HONOURS COURSE	3-1-0	4*	4
TOTAL				**24/28**	**15/19**

PROGRAM ELECTIVE II

SLOT	COURSE NO.	COURSES	L-T-P	HOURS	CREDIT
B	ERT413	NETWORK AND LINEAR CONTROL SYSTEMS	2-1-0	3	3
	ERT423	INTRODUCTION TO BIOMEDICAL SIGNAL PROCESSING	2-1-0		
	ERT433	HYBRID AND ELECTRIC VEHICLES	2-1-0		
	ERT443	FORMAL LANGUAGES & AUTOMATA THEORY	2-1-0		
	CST413	MACHINE LEARNING	2-1-0		
	CST463	WEB PROGRAMMING	2-1-0		

OPEN ELECTIVE

The open elective is offered in semester 7. Each program should specify the courses (maximum 5) they would like to offer as electives for other programs. The courses listed below are offered by **the Department of ELECTRONICS & COMPUTER ENGINEERING for students of all undergraduate branches offered in the college under KTU**

SLOT	COURSE NO.	COURSES	L-T-P	HOURS	CREDIT
C	ERT435	COMPUTER HARDWARE ENGINEERING	2-1-0	3	3
	ERT425	COMPUTER BASED CONTROL SYSTEM	2-1-0		
	ERT427	ROBOTICS AND AUTOMATION	2-1-0		
	ERT445	OBJECT ORIENTED CONCEPTS	2-1-0		
	ERT455	CONCEPTS IN MACHINE LEARNING	2-1-0		
	ERT465	INTERNET OF THINGS	2-1-0		

NOTE :

1. *All Institutions should keep 4 hours exclusively for Remedial class/Minor/Honours course (Mondays from 10 to 12 and Wednesdays from 10 to 12 Noon). If a student does not opt for minor/honours programme, he/she can be given remedial class.
2. Seminar: To encourage and motivate the students to read and collect recent and reliable information from their area of interest confined to the relevant discipline from technical publications including peer reviewed journals, conference, books, project reports etc., prepare a report based on a central theme and present it before a peer audience. Each student shall present the seminar for about 20 minutes duration on the selected topic. The report and the presentation shall be evaluated by a team of faculty members comprising Academic coordinator for that program, seminar coordinator and seminar guide based on style of presentation, technical content, adequacy of references, depth of knowledge and overall quality of the report.

Total marks: 100, only CIE, minimum required to pass 50

Attendance	10
Seminar Diary	10
Guide	20
Report	20
Presentation	40

3. Project Phase I: The course 'Project Work' is mainly intended to evoke the innovation and invention skills in a student. The course will provide an opportunity to synthesize and apply the knowledge and analytical skills learned, to be developed as a prototype or simulation. The project extends to 2 semesters and will be evaluated in the 7th and 8th semester separately, based on the achieved objectives. One third of the project credits shall be completed in 7th semester and two third in 8th semester. It is recommended that the projects may be finalized in the thrust areas of the respective engineering stream or as interdisciplinary projects. Importance should be given to address societal problems and developing indigenous technologies. The assignment to normally include:
   - Literature study/survey of published literature on the assigned topic
   - Formulation of objectives
   - Formulation of hypothesis/ design/ methodology
   - Formulation of work plan and task allocation.
   - Block level design documentation
   - Seeking project funds from various agencies
   - Preliminary Analysis/Modeling/Simulation/Experiment/ Design/Feasibility study
   - Preparation of Phase 1 report

Total marks: 100, only CIE, minimum required to pass	50
Guide	30
Interim evaluation by the Evaluation committee	20
Final evaluation by the Evaluation committee	30
Phase – I Report (By Evaluation committee)	20

The evaluation committee comprises HoD or a senior faculty member, Project coordinator and project supervisor.

SEMESTER VIII

SLOT	COURSE NO.	COURSES	L-T-P	HOURS	CREDIT
A	ERT402	ALGORITHM ANALYSIS AND DESIGN	2-1-0	3	3
B	XXX	PROGRAM ELECTIVE III	2-1-0	3	3
C	XXX	PROGRAM ELECTIVE IV	2-1-0	3	3
D	XXX	PROGRAM ELECTIVE V	2-1-0	3	3
E	ERT404	COMPREHENSIVE VIVA VOCE	1-0-0	1	1
U	ERD416	PROJECT PHASE II	0-0-12	12	4
R/M/H	VAC	REMEDIAL/MINOR/HONOURS COURSE	3-1-0	4*	4
TOTAL				**25/28**	**17/21**

PROGRAM ELECTIVE III

SLOT	COURSE NO.	COURSES	L-T-P	HOURS	CREDIT
B	ERT414	ROBOTICS AND AUTOMATION	2-1-0	3	3
	ERT424	MEDICAL IMAGE PROCESSING	2-1-0		
	ERT434	HYBRID AND ELECTRIC VEHICLES	2-1-0		
	ERT444	COMPILER DESIGN	2-1-0		
	CST414	DEEP LEARNING	2-1-0		
	ERT454	CRYPTOGRAPHY AND NETWORK SECURITY	2-1-0		

PROGRAM ELECTIVE IV

SLOT	COURSE NO.	COURSES	L-T-P	HOURS	CREDIT
C	ERT416	MICRO-ELECTRO-MECHANICAL SYSTEMS	2-1-0	3	3
	ERT426	SPEECH AND AUDIO PROCESSING	2-1-0		
	ERT436	COMMUNICATION ENGINEERING	2-1-0		
	ERT446	PYTHON BASICS FOR MACHINE LEARNING	2-1-0		
	ERT456	SYSTEM SOFTWARE	2-1-0		
	CST426	CLIENT SERVER ARCHITECTURE	2-1-0		

PROGRAM ELECTIVE V

SLOT	COURSE NO.	COURSES	L-T-P	HOURS	CREDIT
D	ERT418	PLC AND DATA ACQUISITION SYSTEMS	2-1-0	3	3
	ERT428	POWER ELECTRONICS	2-1-0		
	ERT438	LOW POWER VLSI	2-1-0		
	CST428	BLOCK CHAINTECHNOLOGIES	2-1-0		
	ERT458	WIRELESS SENSOR NETWORKS	2-1-0		
	ERT468	REAL TIME OPERATING SYSTEMS	2-1-0		

NOTE

1. *All Institutions should keep 4 hours exclusively for the Remedial class/Minor/Honours course (Mondays from 10 to 12 and Wednesdays from 10 to 12). If a student does not opt for a minor/honours programme, he/she can be given remedial classes.
2. Comprehensive Course Viva: The comprehensive course viva in the eighth semester of study shall have a viva voce for 50 marks. The viva voce shall be conducted based on the syllabus mentioned for comprehensive course work in the sixth semester. The viva voce will be conducted by the same three member committee assigned for final project phase II evaluation towards the end of the semester. The pass minimum for this course is 25. The course should be mapped with a faculty and classes shall be arranged for practicing questions based on the core courses listed in the curriculum. The mark will be treated as internal and should be uploaded along with internal marks of other courses.
3. **Project Phase II:** The object of Project Work II & Dissertation is to enable the student to extend further the investigative study taken up in Project 1, either fully theoretical/practical or involving both theoretical and practical work, under the guidance of a Supervisor from the Department alone or jointly with a Supervisor drawn from R&D laboratory/Industry. This is expected to provide good training for the student(s) in R&D work and technical leadership. The assignment to normally include:
    - In depth study of the topic assigned in the light of the Report prepared under Phase I;
    - Review and finalization of the Approach to the Problem relating to the assigned topic;
    - Detailed Analysis/ Modeling/ Simulation/ Design/ Problem Solving/ Experiment as needed;
    - Final development of product/process, testing, results, conclusions and future directions;
    - Preparing a paper for Conference presentation/Publication in Journals, if possible;

- Preparing a Dissertation in the standard format for being evaluated by the Department;
- Final Presentation before a Committee

Total marks: 150, only CIE, minimum required to pass 75

Guide : 30

Interim evaluation, 2 times in the semester by a committee : 50

Quality of the report evaluated by the above committee : 30

(The evaluation committee comprises HoD or a senior faculty member, Project coordinator and project supervisor).

Final evaluation by the final evaluation committee : 40

(The final evaluation committee comprises Project coordinator, expert from Industry/research Institute and a senior faculty from a sister department. The same committee will conduct Comprehensive for 50 marks).

MINOR

Minor is an additional credential a student may earn if s/he does 20 credits worth of additional learning in a discipline other than her/his major discipline of B.Tech. degree. The objective is to permit a student to customize their Engineering degree to suit their specific interests. Upon completion of an Engineering Minor, a student will be better equipped to perform interdisciplinary research and will be better employable. Engineering Minors allow a student to gain interdisciplinary experience and exposure to concepts and perspectives that may not be a part of their major degree programs.

The academic units offering minors in their discipline will prescribe the set of courses and/or other activities like projects necessary for earning a minor in that discipline. A specialist basket of 3-6 courses is identified for each Minor. Each basket may rest on one or more foundation courses. A basket may have sequences within it, i.e., advanced courses may rest on basic courses in the basket. S/he accumulates credits by registering for the required courses, and if the requirements for a particular minor are met within the time limit for the course, the minor will be awarded. This will be mentioned in the Degree Certificate as “Bachelor of Technology in xxx with Minor in yyy”. The fact will also be reflected in the consolidated grade card, along with the list of courses taken. If one specified course cannot be earned during the course of the programme, that minor will not be awarded. The individual course credits earned, however, will be reflected in the consolidated grade card.
(i) The curriculum/syllabus committee/BoS shall prepare syllabus for courses to be included in the curriculum from third to eight semesters for all branches. The minor courses shall be identified by **M-slot courses.**

(ii) Registration is permitted for minors at the beginning of third semester. Total credits required is 182 (162 + 20 credits from value added courses)

(iii) Out of the 20 Credits, 12 credits shall be earned by undergoing a minimum of three courses listed in the curriculum for minor, of which one course shall be a mini project based on the chosen area. They can do mini projects either in S7 or in S8. The remaining 8 credits could be acquired by undergoing 2 MOOCs recommended by the Board of studies and approved by the Academic Council or through courses listed in the curriculum. The classes for Minor shall be conducted along with regular classes and no extra time shall be required for conducting the courses.

(iv) There won't be any supplementary examination for the courses chosen for Minor.

(v) On completion of the program, "Bachelor of Technology in xxx with Minor in yyy" will be awarded.

(vi) The registration for the minor program will commence from semester 3 and all academic units offering minors in their discipline should prescribe a set of such courses. The courses shall be grouped into a maximum of 3 baskets. The basket of courses may have sequences within it, i.e., advanced courses may rest on basic courses in the basket. Reshuffling of courses between various baskets will not be allowed. There is an option to skip any two courses listed here and to opt for equivalent MOOC courses approved by the Academic Council. In any case, they should carry out a mini project based on the chosen area in S7 or S8. Students who have registered **for B.Tech Minor in the ELECTRONICS & COMPUTER ENGINEERING Branch** can opt to study the courses listed below.

SEMESTER	GROUP I				GROUP II				GROUP III			
	Course No.	Course Name	HOURS	CREDIT	Course No.	Course Name	HOURS	CREDIT	Course No.	Course Name	Hours	Credit
S3	ERT281	LOGIC CIRCUIT DESIGN	4	4	CST285	DATA COMMUNICATION	4	4	CST283	PYTHON FOR MACHINE LEARNING	4	4
S4	ERT282	MICROPROCESSORS AND MICROCONTROLLERS	4	4	CST286	INTRODUCTION TO COMPUTER NETWORKS	4	4	CST284	MATHEMATICS FOR MACHINE LEARNING	4	4
S5	ERT381	EMBEDDED SYSTEMS	4	4	CST385	CLIENT SERVER SYSTEMS	4	4	CST383	CONCEPTS IN MACHINE LEARNING	4	4
S6	ERT382	INTERNET OF THINGS	4	4	CST386	WIRELESS NETWORKS AND IOT APPLICATIONS	4	4	CST384	CONCEPTS IN DEEP LEARNING	4	4
S7	ERD481	MINIPROJECT	4	4	ERD481	MINIPROJECT	4	4	ERD481	MINIPROJECT	4	4
S8	ERD482	MINIPROJECT	4	4	ERD482	MINIPROJECT	4	4	ERD482	MINIPROJECT	4	4

HONOURS

Honours is an additional credential a student may earn if s/he opts for the extra 20 credits needed for this in her/his own discipline. Honours is not indicative of class. KTU is providing this option for academically extra brilliant students to acquire Honours. Honours is intended for a student to gain expertise/specialize in an area inside his/her major B.Tech discipline and to enrich knowledge in emerging/advanced areas in the branch of engineering concerned. It is particularly suited for students aiming to pursue higher studies. Upon completion of Honours, a student will be better equipped to perform research in her/his branch of engineering. On successful accumulation of credits at the end of the programme, this will be mentioned in the Degree Certificate as "Bachelor of Technology in xxx, with Honours." The fact will also be reflected in the consolidated grade card, along with the list of courses taken. If one specified course cannot be earned during the course of the programme, Honours will not be awarded. The individual course credits earned, however, will be reflected in the consolidated grade card.

The courses shall be grouped into a maximum of 3 groups, each group representing a particular specialization in the branch. The students shall select only the courses from the same group in all semesters. It means that the specialization is to be fixed by the student and cannot be changed subsequently. The internal evaluation, examination and grading shall be exactly as for other mandatory courses. The Honours courses shall be identified by H slot courses.

(i) The curriculum/syllabus committee/BoS shall prepare syllabus for courses to be included in the curriculum from fourth to eight semesters for all branches. The honours courses shall be identified by H slot courses.

(ii) Registration is permitted for Honours at the beginning of fourth semester. Total credits required is 182 (162 + 20 credits from value added courses).

(iii) Out of the 20 Credits, 12 credits shall be earned by undergoing a minimum of three courses listed in the curriculum for honours, of which one course shall be a mini project based on the chosen area. The remaining 8 credits could be acquired by undergoing 2 MOOCs recommended by the Board of Studies and approved by the Academic Council or through courses listed in the curriculum. The classes for Honours shall be conducted along with regular classes and no extra time shall be required for conducting the courses. The students should earn a grade of 'C' or better for all courses under honours.

(iv) There won't be any supplementary examination for the courses chosen for honours.

(v) On successful accumulation of credits at the end of the programme, "Bachelor of Technology in xxx, with Honours" will be awarded if overall CGPA is greater than

or equal to 8.5, earned a grade of 'C' or better for all courses chosen for honours and without any history of 'F' Grade.

(vi) The registration for honours program will commence from semester 4 and all academic units offering honours in their discipline should prescribe a set of such courses. The courses shall be grouped into a maximum of 3 groups, each group representing a particular specialization in the branch. The students shall select only the courses from the same group in all semesters. It means that the specialization is to be fixed by the student and cannot be changed subsequently. There is an option to skip any two courses listed here and to opt for equivalent MOOC courses approved by the Academic Council. In any case, they should carry out a mini project based on the chosen area in S8. Students who have registered for **B.Tech HONOURS in ELECTRONICS & COMPUTER ENGINEERING** can opt to study the courses listed below.

SEMESTER	GROUP I				GROUP II				GROUP III			
	Course No.	Course Name	HOURS	CREDIT	Course No.	Course Name	HOURS	CREDIT	Course No.	Course Name	HOURS	CREDIT
S4	ERT292	DIGITAL SYSTEM DESIGN	4	4	CST 294	COMPUTATIONAL FUNDAMENTALS FOR MACHINE LEARNING	4	4	CST292	NUMBER THEORY	4	4
S5	ERT393	FPGA BASED SYSTEM DESIGN	4	4	CST 395	NEURAL NETWORKS AND DEEP LEARNING	4	4	CST393	CRYPTOGRAPHIC ALGORITHMS	4	4
S6	ERT394	ELECTRONIC DESIGN AND AUTOMATION TOOLS	4	4	CST 396	ADVANCED TOPICS IN MACHINE LEARNING	4	4	CST394	NETWORK SECURITY	4	4
S7	ERT495	MEMS DESIGN	4	4	CST 497	ADVANCED TOPICS IN ARTIFICIAL INTELLIGENCE	4	4	CST495	CYBER FORENSICS	4	4
S8	ERD496	MINIPROJECT	4	4	ERD 496	MINIPROJECT	4	4	ERD 496	MINIPROJECT	4	4

INDUCTION PROGRAM

There will be a three weeks induction program for first semester students. It is a unique three-week immersion Foundation Programme designed especially for the fresher's which includes a wide range of activities right from workshops, lectures and seminars to sports tournaments, social work and much more. The programme is designed to mold students into well-rounded individuals, aware and sensitized to local and global conditions and foster their creativity, inculcate values and ethics, and help students to discover their passion. Foundation Programme also serves as a platform for the fresher's to interact with their batch mates and seniors and start working as a team with them. The program is structured around the following five themes:

The programme is designed keeping in mind the following objectives:

- **Values and Ethics**: Focus on fostering a strong sense of ethical judgment and moral fortitude.
- **Creativity**: Provide channels to exhibit and develop individual creativity by expressing themselves through art, craft, music, singing, media, dramatics, and other creative activities.
- **Leadership, Communication and Teamwork**: Develop a culture of teamwork and group communication.
- **Social Awareness**: Nurture a deeper understanding of the local and global world and our place as concerned citizens of the world.
- **Physical Activities & Sports**: Engage students in sports and physical activity to ensure healthy physical and mental growth.

SEMESTER VII

ERT401	CMOS VLSI DESIGN	Category	L	T	P	Credit
		PCC	2	1	0	3

Prerequisite: ERT203 Digital Systems and VLSI Design

Course Outcomes: After the completion of the course the student will be able to

CO#	Course Outcomes
CO1	Design and analyze CMOS Inverters and design Basic CMOS Digital Circuits. **(Cognitive knowledge: Apply)**
CO2	Explain CMOS fabrication process and prepare physical layout for various MOS Circuits. **(Cognitive Knowledge Level: Apply**)
CO3	Design and analyze various Combinational Logic Circuits and Data Path Subsystems. **(Cognitive KnowledgeLevel: Apply**)
CO4	Design various Sequential Logic Circuits**. (CognitiveKnowledge Level: Apply)**
CO5	Design CMOS Memory Arrays. **(CognitiveKnowledge Level: Apply)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓		✓							✓
CO2	✓	✓	✓		✓							✓
CO3	✓	✓	✓		✓							✓
CO4	✓	✓	✓		✓							✓
CO5	✓	✓	✓		✓							✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Lifelong learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester ExaminationMarks (%)
	Test1	Test2	
Remember	**10**	**10**	**10**
Understand	**20**	**20**	**50**
Apply	**20**	**20**	**40**
Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	**50**	**100**	**3 hours**

Continuous Internal Evaluation Pattern:

Attendance	:	**10 marks**
Continuous Assessment Tests (2 Nos)	:	**25 marks**
Assignment/Quiz/Course project	:	**15 marks**

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. First Internal Examination shall be preferably conducted after completing the first two modules and the Second Internal Examination shall be preferably conducted after completing the next two modules.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

Syllabus

Module-1: Introduction to CMOS technology and basic VLSI circuits

MOS Transistor operations (Enhancement and depletion type), Complementary Metal Oxide Semiconductors (CMOS)-Static CMOS Inverter: DC Characteristics, Switching Threshold, Noise Margin- Basics, Dynamic behavior: Device Capacitances, Propagation Delay, Types of Power Dissipation. Implementation of CMOS logic gates.

Module-2: CMOS fabrication process and physical layout for various MOS Circuits

CMOS fabrication Processes: -N-well, P-well and Twin well. MOS Circuit Layout – Stick diagrams, Layout design rules, Transistor layout - PMOS and NMOS, Gate Layout - Inverter, NAND, NOR and XOR.

Module- 3: Designing Combinational Logic Gates in CMOS

Combinational logic Circuits: Static MOS - Complementary MOS - Ratioed logic - Pass Transistor logic - Differential Pass Transistor Logic - Transmission gate logic, Dynamic MOS- Dynamic Logic Design-Pre-charge- Evaluate logic, Domino Logic, NP domino logic, Speed and power Dissipation, Signal Integrity issues.

Module- 4: Designing of Sequential Logic Circuits and Datapath Subsystems

Sequential Logic Circuits: Introduction -Timing Metrics for sequential circuits, Static Latches and Registers, Dynamic Latches and Registers, alternative register styles. Datapath Subsystems: - Adder - Ripple carry Adder - Full adder - Carry-Bypass Adder - Carry Select Adder - Carry Look Ahead Adder, Multiplier - Array Multiplier - Carry Save Multiplier, Shifter - Barrel Shifter.

Module- 5: Designing Memory and array structures

Design of the Memory: Read Only Memory-4x4 MOS ROM Cell Arrays (NOR), Random Access Memory –SRAM-Six transistor CMOS SRAM cell, DRAM –Three transistor and One transistor Dynamic Memory Cell.

Text Books

1. J.M. Rabaey, A. Chandrakasan and B. Nikolic, Digital Integrated Circuits- A Design Perspective, 2nd ed., PHI.
2. Douglas A. Pucknell & Kamran Eshraghian, Basic VLSI Design, PHI.
3. CMOS digital integrated circuits: Analysis and design, Sung-Mo Kang, Yusuf Lablebici, TATA McGraw-Hill.
4. CMOS VLSI Design, a Circuits and Systems Perspective, Neil H. E. Weste, David Money Harris, Addison-Wesley.

Reference Books

1. CMOS Logic Circuit Design byJohn P. Uyemura, Springer India Pvt. Ltd. New Delhi.
2. Analysis &Design of Digital Integrated Circuits by David A. Hodges, Horace G. Jackson, R. Saleh, McGraw Hill.
3. VLSI Circuit Layout: theory and design, Edited by T.C Hu, Ernest S. Kuh, IEEE Press
4. Relevant IEEE Journals on VLSI Circuits and Systems.

Course Level Assessment Questions

Course Outcome 1 (CO1): Design and analyze CMOS Inverters and design Basic CMOS Digital Circuits.

1. Draw the stricture of a N-channel MOS and describe it’s working.
2. Design a CMOS inverter with proper Transistor sizing.
3. Draw and explain the voltage transfer characteristics (VTC) of a CMOS Inverter and obtain its threshold voltage.
4. Analyze the static and dynamic behavior of CMOS Inverter.

Course Outcome 2 (CO2): Explain CMOS fabrication processes and prepare physical layout for various MOS Circuits

1. Explain the concept and importance of stick diagrams in generating the physical layout of an integrated circuit.
2. Explain the lambda(λ) based layout rules in translating stick diagrams into actual geometry in silicon (the physical layout) and its dependency on the process technology.
3. Draw basic MOS transistor layout employing the concept of stick diagrams.
4. Draw the physical layout of a CMOS Inverter, NAND and NOR gates.

Course Outcome 3 (CO3): Design various Combinational Logic Circuits

1. Design Pseudo NMOS inverter and Pass Transistor gate and study the VTCs.
2. Explain the use of Transmission gates in the efficient implementation of complex gates.
3. Describe the basic principles of dynamic logic with necessary diagrams.
4. Explain how the dynamic logic implementation of gates reduce Power dissipation and improve speed of operation.

Course Outcome 4 (CO4): Design Sequential Logic Circuits and Datapath Subsystems

1. Define and explain the three important timing parameters associated with a register.
2. Explain the implementation of latches and registers in the static style.
3. Explain the implementation of latches and registers in the dynamic style.
4. Explain the implementation of various Datapath subsystems.

Course Outcome 5 (CO5): Design and analyze various types of Memories

1. Explain the design of ROM arrays using NAND and NOR gates.
2. Explain the implementation of various types of Non-Volatile Read Write memories.
3. Explain the operations (read and write) of a six transistor CMOS SRAM cell.
4. Explain the operations (read and write) of a three transistor DRAM cell.

Model Question Paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B.TECH. DEGREE EXAMINATION, MONTH & YEAR

Course Code: ERT401

Course Name: CMOS VLSI Design

Max.Marks:100 **Duration: 3 Hours**

PART A

Answer All Questions. Each Question Carries 3 Marks

(10x3=30)

1. Draw and explain the Voltage Transfer Characteristics of CMOS inverter.
2. What is Noise margin? Obtain its expression.
3. Explain the λ-based design rules for CMOS circuit layout.

4. Draw the stick diagram for a CMOS Inverter.

5. Explain the basic concept of complementary static CMOS design.

6. List out the merits and drawbacks of np domino over domino logic.

7. Define the following timing parameters associated with a register
i) Setup Time ii) Hold Time iii) Propagation Delay.

8. With the help of truth table explain the implementation of Sum and Carry outputs of a binary full adder.

9. What is Read Only memory? Explain NOR cell array-based ROM.

10. Draw the circuit diagram and explain the operation of a one transistor DRAM Cell.

PART B

(Answer any one question from each module. Each question carries 14 Marks)

Module I

11.	a)	Derive the expression for the switching threshold of a CMOS inverter. Hence derive transistor sizing.	14	K2

OR

12.		Derive the expression for the propagation delay of the CMOS inverter	14	K3

Module II

13.		Explain the Twin-well process of CMOS fabrication.	14	K2

OR

14.		Sketch the logic diagram and the stick diagram of a CMOS NOR gate.	14	K2

Module III

15.	a)	Draw and explain the Precharge- Evaluate phase in the dynamic logic.	8	K2
	b)	Draw and explain the working of a NP domino logic with neat diagram.	6	K2

OR

16.	a)	Explain the pass transistor implementation of an AND gate.	9	K3

	b)	Show that the Transmission gate logic style is best suited to enable rial-to-rail switching.	5	K3

Module IV

17	a)	Explain the carry look ahead principle for the implementation of fast adders.	8	K2
	b)	With the help of a transistor level circuit diagram explain the implementation of a 4-bit carry look ahead adder.	6	K2

OR

18		Discuss the architecture and operation of an array multiplier. Explain how it performs multiplication of two binary numbers and analyze its time complexity.	14	K3

Module V

19		Explain the Read/Write operation of a 6T CMOS SRAM cell.	14	K2

OR

20		Explain the operation of a 3T DRAM cell.	14	K2

Teaching Plan

No	Contents	Hours (35)
Module 1: Introduction to CMOS technology and basic VLSI circuits (8 hours)		
1.1	MOS Transistor operations (Enhancement and depletion type)	1
1.2	Complementary Metal Oxide Semiconductors (CMOS)-Static CMOS Inverter: DC Characteristics (Lecture 1)	1
1.3	Complementary Metal Oxide Semiconductors (CMOS)-Static CMOS Inverter: DC Characteristics (Lecture 2)	1
1.4	Switching Threshold, Noise Margin - Basics	1
1.5	Dynamic behavior: Device Capacitances, Propagation Delay	1

1.6	Types of Power Dissipation.	1
1.7	Implementation of CMOS logic gates. (Lecture 1)	1
1.8	Implementation of CMOS logic gates. (Lecture 2)	1
Module 2: CMOS fabrication process and physical layout for MOS (7 hours)		
2.1	CMOS fabrication Processes: N-well	1
2.2	CMOS fabrication Processes: P-well	1
2.3	CMOS fabrication Processes: Twin well	1
2.4	Introduction to stick diagram and Stick diagrams (Lecture 1)	1
2.4	Stick diagrams (Lecture 2)	1
2.5	Layout design rules λ– based and micron	1
2.6	Transistor layout - PMOS and NMOS,	1
2.7	Gate Layout - Inverter, NAND, NOR and XOR	1
Module 3: Design Combinational Logic Circuits (7 hours)		
3.1	Static Complementary MOS	1
3.2	Ratioed logic, Pass Transistor logic, Differential Pass Transistor Logic	1
3.3	Transmission gate logic	1
3.4	Dynamic MOS- Basic Principles, Pre-charge- Evaluate logic	1
3.5	NP domino logic.	1
3.6	Speed and power Dissipation	1
3.7	Signal Integrity issues	1
Module 4: Designing of Sequential Logic Circuits and Datapath Subsystems (7 hours)		
4.1	Introduction, Timing Metrics for sequential circuits	1

4.2	Static Latches and Registers	1
4.3	Dynamic Latches and Registers, alternative register styles.	1
4.4	Datapath Subsystems: Adder - Ripple carry Adder	1
4.5	Full adder - Carry-Bypass Adder - Carry Select Adder, Carry Look Ahead Adder	1
4.6	Multiplier-Array Multiplier-Carry Save Multiplier.	1
4.7	Shifter-Barrel Shifter	1
Module 5: Designing Memory and array structures (6 hours)		
5.1	Design of the Memory: Read Only Memory	1
5.2	4x4 MOS ROM Cell Arrays (NOR)	1
5.3	4x4 MOS ROM Cell Arrays (OR)	1
5.4	Random Access Memory –SRAM-Six transistor CMOS SRAM cell,	1
5.5	SRAM- Read and Write operations	1
5.6	DRAM –Three transistor and One transistor Dynamic Memory Cell.	1

PROGRAM ELECTIVE II

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
ERT 413	NETWORK AND LINEAR CONTROL SYSTEMS	PEC	2	1	0	3

Preamble: This course aims to develop the skills for mathematical modelling and analysis of linear control systems.

Prerequisite: Mathematics course in differential equations and Laplace transform

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understanding and application of the fundamentals of electrical circuits, their elements and network reduction techniques. **(Cognitive Knowledge Level: Understand)**
CO 2	Analysis and modelling of mechanical systems using translational and rotational systems, along with the understanding of force voltage & force-current analogy. **(Cognitive Knowledge Level: Apply)**
CO 3	Implementing techniques to ensure the stability of linear control systems; using the Routh's Hurwitz criterion, Root locus method and frequency response analysis. **(Cognitive Knowledge Level: Apply)**
CO 4	Understand and model control systems using Laplace Transforms and transfer functions to analyze electrical networks and control systems structures. **(Cognitive Knowledge Level: Apply)**
CO 5	Apply poles and zeros concept, analyze first and second order systems, and compute static and dynamic error coefficients within time domain analysis of feedback control systems. **(Cognitive Knowledge Level: Apply)**

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	✓	✓	✓									
CO 2	✓	✓	✓									
CO 3	✓	✓	✓	✓								
CO 4	✓	✓	✓									

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	10
Understand	20	20	30
Apply	20	20	60
Analyse	-	-	-
Evaluate	-	-	-
Create	-	-	-

Mark Distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance: 10 marks

Continuous Assessment Test (2 Numbers): 25 marks

Assignment/Quiz/Course project: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub- divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Apply the source transformation technique to the given electrical circuit and determine the resulting equivalent voltage source.
2. For the given electrical circuit with passive elements, derive the voltage-current relationship for each element based on passive sign convention.
3. Explain the concept of network analysis in the frequency domain and discuss the significance of using Laplace transforms for analyzing RLC circuits.

Course Outcome 2 (CO2):

1. Explain the effect of feedback.

2. Using block diagram reduction techniques find the transfer function of the given system.
3. Find the overall gain for the given signal flow graph using Mason's gain equation.

Course Outcome 3 (CO3):

1. Obtain the transfer function of mechanical and electrical systems.
2. Obtain the transfer function of analogous circuits.
3. Obtain the impulse response of a system.

Course Outcome 4 (CO4):

1. Obtain the response of first/second order system.
2. Obtain the steady state error.
3. Obtain the time domain specifications of a second order system.

Course Outcome 5 (CO5):

1. Explain the effect of addition of poles and zeros on root locus.
2. Define the frequency domain specifications.
3. Check the stability of a system using Bode plot.

Module 1 (6 Hours)

Introduction to Electrical Circuits

Circuit concept – Types of elements - source transformation-voltage - current relationship for passive elements. Network reduction techniques: series, parallel, series parallel, examples, time and frequency domain analysis of RLC circuits.

Module 2 (7 Hours)

Introduction to control systems

Basic components of a control system, types of control systems, examples of control systems, effect of feedback systems, Laplace Transforms, transfer function, modelling of electrical networks, block diagram reduction, signal flow graphs.

Module 3 (6 Hours)

Modelling of mechanical systems

Translational and rotational systems, transfer function for typical mechanical systems, analogous systems–force voltage & force-current analogy, impulse response and its relation with transfer function

Module 4 (6 Hours)

Time domain analysis of feedback control systems

Transient and steady-state response, standard test signals, type and order of systems, concept of poles and zeros, time response of first and second order systems to unit impulse and step input, time domain specifications, Steady-state response, steady state error, static and dynamic error coefficients.

Module 5 (10 Hours)

Stability of linear control systems

Concept of stability, methods of determining stability, Routh's Hurwitz criterion, Root locus - construction of root locus, effect of addition of poles and zeros on root locus.

Frequency response analysis: Frequency domain specifications, stability from Bode plots, relative stability, gain margin and phase margin, introduction to lead, lag and lead-lag compensating networks (excluding design).

Text Books

1. Ravish R. Singh: Network Analysis and Synthesis, 2/e, McGraw Hill Education, 2019
2. Farid Golnaraghi, Benjamin C. Kuo, Automatic Control Systems, 9/e, Wiley India.
3. M. Gopal, Control Systems, 4/e, McGraw Hill Education India Education,

References

1. Norman S. Nise, Control System Engineering, 5/e, Wiley India
2. Richard C Dorf and Robert H. Bishop, Modern Control Systems, 9/e, Pearson Education,2001.

Model Question Paper

Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B. TECH. DEGREE EXAMINATION,

MONTH AND YEAR

Course Code: ERT 413

Course Name: NETWORK & LINEAR CONTROL SYSTEMS

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all questions, each carries 3 marks

1. Explain the concept of network analysis in the frequency domain
2. Discuss the significance of using Laplace transforms for analyzing RLC circuits.
3. Compare open loop and closed loop control systems.
4. Draw signal flow graph for the following equations

$$x_2 = 4x_1 + 2x_3 + 2x_2, \quad x_3 = 6x_1 + 5x_2 + 2x_3, \quad x_4 = 2x_2 + 2x_3$$

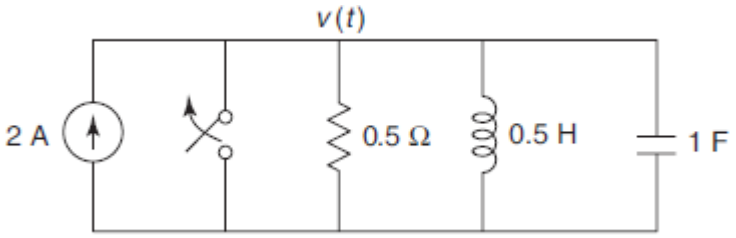
5. Write the Force – Voltage analogies for Mass, spring constant and Damping coefficient of a mechanical system.
6. Distinguish between mechanical translational and rotational systems.
7. How a control system is classified depending on the value of damping?
8. What do you understand by steady state response and transient response of a system?
9. State advantages of Routh-Hurwitz criterion.
10. How locations of roots of the characteristic equation are related to stability?

PART B

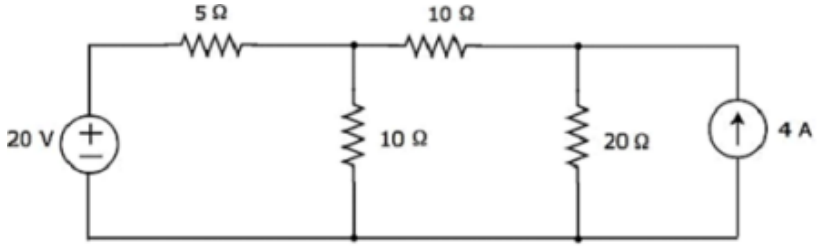
Answer any one full question from each module. Each question carries 14 Marks

Module 1

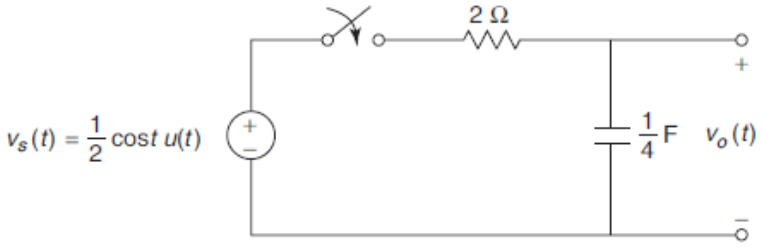
11. (a) In the network of Figure, the switch is opened at t = 0 obtain the expression for v(t). Assume zero initial conditions. (10)



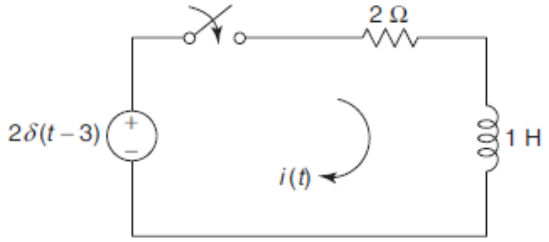
(b) Calculate the current through 20Ω using node analysis (4)



12. For the network shown in Figure, find the response $v_0(t)$. (10)

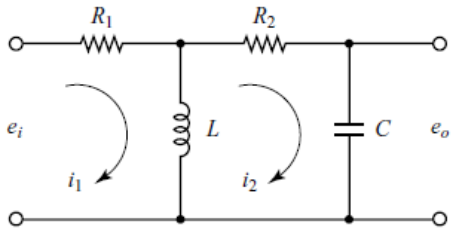


(b) For the network shown in Figure, determine the current i (t) when the switch is closed at t = 0. Assume that initial current in the inductor is zero. (4)

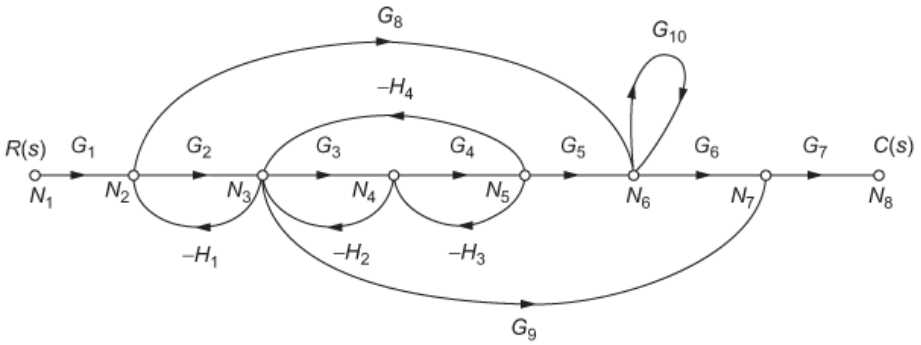


Module 2

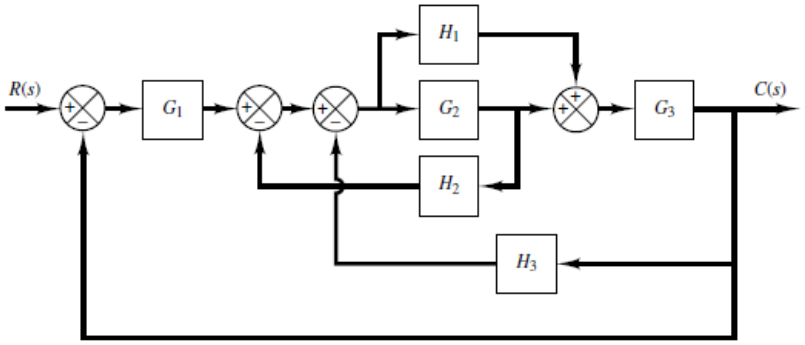
13. (a) Obtain the transfer function $E_o(s)/E_i(s)$ of the electrical circuit shown in figure. (4)



(b) Find the overall gain C(s)/R(s) of the signal flow graph shown in figure. (10)



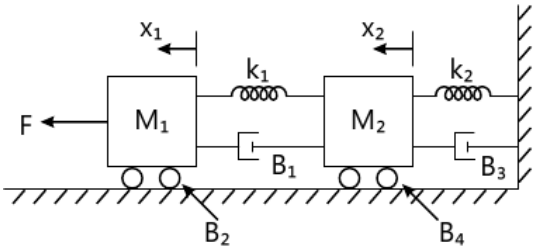
14. a) Simplify the block diagram shown in figure and obtain the closed loop transfer function C(s)/R(s). (10)



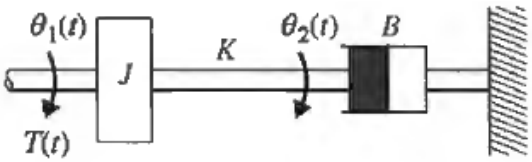
b) Explain the effect of feedback on control system. (4)

Module 3

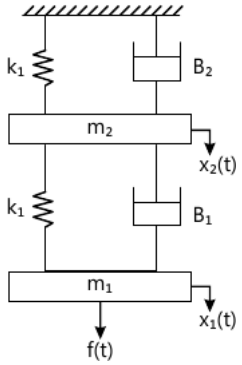
15. a) Determine the transfer function of the mechanical system shown below. (10)



b) Find the transfer function of the rotational system shown in figure. (4)



16. a) Obtain the differential equation for the mechanical system shown in figure and draw the analogous electrical network based on i) Force - voltage analogy ii) Force - current analogy. (8)



b) Derive the relationship between impulse response and transfer function. (6)

Module 4

17. a) Obtain the unit step response of under damped second order system. (8)

b) Consider the unit step response of a unity feedback control system whose overall loop transfer function is $G(s)=\frac{1}{s(s+1)}$. Obtain t_r, t_p, M_p and t_s (2%). (6)

18. a) For a unity feedback control system the open loop transfer function, $G(s)=\frac{10(s+2)}{s^2(s+1)}$. Find (i) the position, velocity, and acceleration error constants, (ii) the steady state error when the input is R(s) where $R(s)=\frac{3}{s}-\frac{2}{s^2}+\frac{1}{3s^3}$. (10)

b) Derive expression for the percentage maximum overshoot of an under damped second order system for unit step input. (4)

Module 5

19. a) The open loop transfer function of a unity feedback control system is $G(s)=\frac{50}{s(1+0.05s)(1+0.25s)}$. Draw the Bode plot and evaluate the gain and phase margin. (10)

b) State the frequency domain specifications of a system. (4)

20. a) Determine the range of K for stability of unity feedback system whose open loop transfer function is $G(s)=\frac{K}{s(s+1)(s+2)}$. (9)

b) Write a short note on effects of adding pole and zero on the root locus. (5)

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Introduction to Electrical Circuits**	**6**
1.1	Circuit concept – Types of elements	1
1.2	source transformation-voltage - current relationship for passive elements	1
1.3	Network reduction techniques: series, parallel, series parallel	1
1.4	examples	1
1.5	time and frequency domain analysis of RLC circuits.	2
2	**Introduction to control systems**	**7**
2.1	Basic components of a control system, types of control system	1

2.2	Examples of control systems, effect of feedback systems	1
2.3	Laplace Transforms	1
2.4	Transfer function, modelling of electrical networks	1
2.5	Block diagram reduction	2
2.6	Signal flow graphs	1
3	**Modelling of mechanical systems**	**6**
3.1	Translational systems, transfer function for typical mechanical systems	2
3.2	Rotational systems, transfer function for typical mechanical systems	1
3.3	Analogous systems–force voltage analogy	1
3.4	force-current analogy	1
3.5	Impulse response and its relation with transfer function	1
4	**Time domain analysis of feedback control systems**	**6**
4.1	Transient and steady-state response, standard test signals	1
4.2	Type and order of systems, concept of poles and zeros	1
4.3	Time response of first and second order systems to unit impulse and step input	2
4.4	Time domain specifications, Steady-state response, steady state error	1
4.5	Static and dynamic error coefficients	1
5	**Stability of linear control systems**	**10**
5.1	Concept of stability, methods of determining stability	1
5.2	Routh's Hurwitz criterion	1
5.3	Root locus - construction of root locus	3
5.2	Effect of addition of poles and zeros on root locus	1
5.3	Frequency domain specifications	1
5.4	Stability from Bode plots, relative stability, gain margin and phase margin	3

ERT423	INTRODUCTION TO BIOMEDICAL SIGNAL PROCESSING	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Course Outcomes: After the completion of the course the student will be able to

CO 1	**Explain** the fundamental characteristics of various biomedical signals (ECG, EEG) and identify **their** role in computer-aided medical diagnosis. (**Cognitive Knowledge level: Understand**)
CO 2	**Analyze** and **interpret** electrocardiographic data for the assessment of cardiac health, including the identification and **classification** of arrhythmias. (**Cognitive Knowledge level: Apply**)
CO 3	**Apply** their understanding of the electrophysiological basis of brain activity to **analyze** EEG signals in various neurological applications (**Cognitive Knowledge level: Apply**)
CO 4	Students will be able to **critically evaluate** and **select** appropriate signal conversion and noise cancellation techniques to **improve** the quality of biomedical signals for accurate processing. (**Cognitive Knowledge level: Understand**)
CO 5	**Design** and **implement** a basic ECG analysis system using their knowledge of advanced processing techniques and the potential of VLSI technology in medical devices. (**Cognitive Knowledge level: Apply**)

MAPPING OF COURSE OUTCOMES WITH PROGRAM OUTCOMES

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	✓	✓	✓	✓		✓						✓
CO 2	✓	✓	✓	✓		✓						✓
CO 3	✓	✓	✓	✓		✓						✓
CO 4	✓	✓	✓	✓		✓						✓
CO 5	✓	✓	✓	✓		✓						✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

ASSESSMENT PATTERN:

Bloom's Category	Test 1 (%)	Test 2 (%)	End Semester Examination Marks (%)
Remember	20	20	20
Understand	35	35	35
Apply	45	45	45
Analyse			
Evaluate			
Create			

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	**50**	**100**	**3**

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Test	: 25 marks
Continuous Assessment Assignment	: 15 marks

INTERNAL EXAMINATION PATTERN:

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first two modules of the syllabus and the second series test shall be preferably conducted after completing the next two modules.

END SEMESTER EXAMINATION PATTERN:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

SYLLABUS

MODULE I : INTRODUCTION TO BIOMEDICAL SIGNALS

The nature of Biomedical Signals, Examples of Biomedical Signals - Biomedical Signals Like: Electrocardiogram (ECG), Electroencephalogram (EEG). Introduction to computers in medicine – characteristics of medical data, medical instrument, iterative definition of medicine, evolution of microprocessor-based systems, microprocessor-based medical instruments, software design of digital filters.

Module II : Cardiological signal processing

Basic electrocardiography, ECG data acquisition, ECG lead system, ECG parameters & their estimation – ECG QRS detection techniques, estimation of ST segment inclination. The use of multi-scale analysis for parameters estimation of ECG waveforms, arrhythmia analysis monitoring, long-term continuous ECG recording.

Module III : Neurological signal processing

The brain & its potentials, electrophysiological origin of brain waves, The EEG signal & its characteristics, EEG analysis, Linear prediction theory. Sleep EEG – data acquisition & classification of sleep stages, dynamics of sleep-wake transitions.

Module IV : Signal Conversion & Noise Cancellation Techniques

Signal conversion - Simple signal conversion systems, conversion requirements for biomedical signals, signal conversion circuits. Adaptive noise canceller – Cancellation of 60 Hz interference in electrocardiography, cancelling donor-heart interference in heart transplant ECG, cancellation of ECG signal from electrical activity of the chest muscles, cancelling maternal ECG in fetal ECG, cancellation of high frequency noise in electro-surgery.

Module V : ECG Analysis Systems & VLSI in Digital Signal Processing

ECG analysis systems – ECG interpretation, ST-segment analyzer, portable arrhythmia monitor. Digital signal processors, high-performance VLSI signal processing, VLSI applications in medicine, VLSI sensors for biomedical signals, VLSI tools, choice of custom ASIC or off-the-shelf components.

Textbooks:

1. Willis J. Tompkins, “Biomedical Digital Signal Processing”, PHI 2001
2. D C Reddy, “Biomedical Signal Processing Principles and Techniques”, McGrawHill publications 2005

Reference Books:

1. Rangaraj M. Rangayyan, “Biomedical Signal Analysis”, John Wiley & Sons 2002
2. Andrewg Webb, Principle of biomedical Instrumentation, Cambridge University Press, 2018.
3. Sörnmo, L. and Laguna, P Bioelectrical signal processing in cardiac and neurological applications (Vol. 8). Academic Press., 2005.

Course Contents and Lecture Schedule

No.	Topic	Hours (37)
1	**Module-1**	**7**
1.1	The nature of Biomedical Signals	1
1.2	Examples of Biomedical Signals - Biomedical Signals Like: Electrocardiogram (ECG)	1
1.3	Electroencephalogram (EEG).	1

1.4	Introduction to computers in medicine – characteristics of medical data, medical instrument	1
1.5	Iterative definition of medicine, evolution of microprocessor-based systems	1
1.6	microprocessor-based medical instruments	1
1.7	software design of digital filters.	1
2	**Module-2**	**8**
2.1	BASIC ELECTROCARDIOGRAPHY, ECG DATA ACQUISITION	1
2.2	ECG lead system	1
2.3	ECG parameters & their estimation	1
2.4	ECG QRS detection techniques	1
2.5	estimation of ST segment inclination.	1
2.6	The use of multi-scale analysis for parameters estimation of ECG waveforms	1
2.7	Arrhythmia analysis monitoring	1
2.8	long-term continuous ECG recording.	1
3	**Module-3**	**7**
3.1	THE BRAIN & ITS POTENTIALS	1
3.2	electrophysiological origin of brain waves	1
3.3	The EEG signal & its characteristics	1
3.4	EEG analysis	1
3.5	Linear prediction theory.	1
3.6	Sleep EEG – data acquisition & classification of sleep stages	1
3.7	dynamics of sleep-wake transitions.	1
4	**Module-4**	**8**
4.1	SIGNAL CONVERSION - SIMPLE SIGNAL CONVERSION SYSTEMS	1
4.2	conversion requirements for biomedical signals	1

4.3	signal conversion circuits	1
4.4	Adaptive noise canceller – Cancellation of 60 Hz interference in electrocardiography	1
4.5	cancelling donor-heart interference in heart transplant ECG	1
4.6	cancellation of ECG signal from electrical activity of the chest muscles	1
4.7	cancelling maternal ECG in fetal ECG	1
4.8	cancellation of high frequency noise in electro-surgery.	1
5	**Module-5**	**7**
5.1	ECG ANALYSIS SYSTEMS – ECG INTERPRETATION	1
5.2	ST-segment analyzer	1
5.3	portable arrhythmia monitor	1
5.4	Digital signal processors, high-performance VLSI signal processing	1
5.5	VLSI applications in medicine	1
5.6	VLSI sensors for biomedical signals	1
5.7	VLSI tools, choice of custom ASIC or off-the-shelf components.	1

SAMPLE COURSE LEVEL ASSESSMENT QUESTIONS:

Course Outcome 1 (CO1): Compare and contrast the electrical characteristics of Electrocardiogram (ECG) and Electroencephalogram (EEG) signals.

Course Outcome 2 (CO2): Analyze a sample ECG recording and identify the P, QRS, and T waves. Explain the physiological events underlying each waveform and their significance in cardiac function assessment.

Course Outcome 3 (CO3): What functional states of brain does EEG reflect?

Course Outcome 4 (CO4): Evaluate the advantages and limitations of two common noise cancellation techniques.

Course Outcome 5 (CO5): Specify the key components and functionalities required for portable ECG arrhythmia detection system.

MODEL QUESTION PAPER

Reg No:_____

Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY SEVETH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: ERT 423

Course name : INTRODUCTION TO BIOMEDICAL SIGNAL PROCESSING

Max Marks: 100 **Duration: 3 Hours**

PART-A

(ANSWER ALL QUESTIONS. EACH QUESTION CARRIES 3 MARKS)

1. Briefly describe the two main categories of biomedical signals based on their origin
2. What are the characteristics of medical data?
3. Distinguish between precordial leads and limb leads.
4. What is the role of secondary lead in ambulatory ECG?
5. What functional states of the brain? What does EEG reflect? Enumerate them.
6. Explain the electrophysiological origin of brain waves.
7. What is the purpose of using a low-pass filter prior to sampling an analog signal?
8. In Heart transplant procedure what are the primary and reference signals? specify.
9. What are the various steps in ECG interpretation?
10. Draw the diagram of a typical digital signal processor.

PART-B
(Answer any one full question from each module)

11. Draw the waveform corresponding to two cycles of a typical ECG signal and indicate the following waves and periods: (a) the P, QRS, and T waves; (b) the RR interval; (c) atrial contraction; (d) atrial relaxation; (e) ventricular contraction; and (f) ventricular relaxation.

OR

12. Explain in detail about the bioelectric signal which is responsible for the electrical activity of Brain.

13. What are ECG parameters and how can they be estimated?

OR

14. What is long-term continuous ECG recording? Explain the 3 methods for long-term continuous ECG recording.

15. What is Linear Prediction Theory? Explain the realization of correlation canceller.

OR

16. What is EEG analysis? Explain the following methods in EEG analysis

(i) Time and frequency domain methods (3 marks)

(ii) Parametric Model (6 marks)

(iii) Phenomenological Model (5 marks)

17. Explain various signal conversion circuits with neat diagrams

OR

18. With the adequate diagram, explain the cancellation of high frequency noise in electrosurgery.

19. Explain in detail about portable arrhythmia monitoring.

OR

20. (a) What are the VLSI applications in medicine. (7 marks)

(b) How are VLSI sensors used for biomedical signals? (7 marks)

CODE	COURSE NAME	CATEGORY	L	T	P	CREDITS
ERT433	HYBRID & ELECTRIC VEHICLE	PE	3	0	0	3

Preamble : **Electric and Hybrid vehicles are gaining popularity globally. This course introduces the fundamental concepts of electric and hybrid and vehicles, drive trains, electrical machines used, energy storage devices and charging systems**

Prerequisite : **Nil**

Course Outcomes : After the completion of the course the student will be able to:

CO 1	Explain the fundamentals of Conventional, Electric and Hybrid EV
CO 2	Describe different configurations of electric and hybrid electric drive trains
CO 3	Discuss the propulsion unit, DC and PMSM drives used for electric and hybrid vehicles
CO 4	Compare various energy storage and EV charging systems
CO 5	Selection and sizing of drive systems for EV

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	1					2					2
CO 2	3	2										
CO 3	3	2										
CO 4	3	3	1									
CO 5	3	1	2									

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember (K1)	20	20	40
Understand (K2)	20	20	40
Apply (K3)	10	10	20
Analyse (K4)	-	-	-
Evaluate (K5)	-	-	-
Create (K6)	-	-	-

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Mark distribution

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Test (2 numbers) : 25 marks

Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern : There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Which are the resistive forces that retard the motion of a four-wheel vehicle? (K1)
2. Explain briefly the performance parameters of the vehicle. (K1)
3. What are the disadvantages of a heat engine (ICE) when compared to an electric Engine? (K1)

Course Outcome 2 (CO2):

1. Draw and explain architecture and power flow control of a series parallel hybrid electric vehicle. (K2)
2. Differentiate between parallel hybrid and series hybrid configurations. (K2)
3. With the help of a block diagram explain the major subsystems of an electric vehicle. (K1)

Course Outcome 3 (CO3):

1. Draw the block diagram of the Electric Propulsion unit of an electric vehicle and mention the relevance of each block. (K1)
2. Derive the speed torque equation of a separately excited DC motor. (K2)
3. With a neat circuit diagram explain the independent control of orthogonal flux and torque in a separately excited DC motor (K2)

Course Outcome 4 (CO4):

1. With the help of block diagram explain the battery management supporting system of hybrid vehicle. (K2)
2. Describe the terms State-of-Charge and Depth-of-Discharge as applied to batteries. (K1)
3. What are the advantages of using super capacitors along with battery in EV (K1)

Course Outcome 5 (CO5):

1. Draw the typical torque - speed envelope curves of drive train motors with the continuous, intermittent and peak overload ratings. (K1)

2. With the help of neat figure explain the epicyclic gear transmission system used in electric vehicles. (K2)

Model Question Paper

QP CODE: **Pages:**

Reg No.:_____

Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY FIRST SEMESTER B.TECH DEGREE EXAMINATION,

MONTH & YEAR

Course Code: EET 418

Course Name: ELECTRIC AND HYBRID VEHICLES

Max. Marks: 100 **Duration: 3 hours**

PART A

Answer all questions; each question carries 3 marks.

1.	Explain rolling resistance and aerodynamic drag in vehicles.	(3)
2.	Write short notes on gradeability of the automobile system	(3)
3.	With the help of a block diagram, explain the major components of an electric vehicle.	(3)
4.	What is axial balancing ?	(3)
5.	What are the electric components used in the propulsion unit of EV/HEV?	(3)
6.	List the advantages of PMSM motors over DC and induction motors.	(3)
7.	Explain the terms specific energy and energy density as applied to the batteries.	(3)
8.	Explain the V2G concept.	(3)

9. What is meant by Constant Power Speed Ratio as applied to an electric motor? (3)

10. What is the significance of a communication network in electric/hybrid vehicles? (3)

PART B

Answer any one complete question from each section; Each question carries 14 mark

11 (a) Draw and explain ideal traction power plant characteristics of various power plants and various power source characteristics used in electric and hybrid electric vehicles. (8)

(b) Why is a gear system needed for an ICE? Explain with relevant characteristic curves. (6)

OR

12 (a) Explain the levels of automation and its significance in autonomous vehicles (5)

(b) What are the resistive forces acting on the vehicle movement? Obtain the dynamic equation of the vehicle movement. (9)

13 (a) Draw and explain different classification of electric vehicles based on power source configurations. (7)

(b) Explain the different power flow control modes of a typical parallel hybrid system with the help of block diagrams. (7)

OR

14 (a) Explain in detail the EV drivetrain alternatives based on drivetrain configurations (6)

(b) Explain the different power flow control modes of a typical ICE dominated series-parallel hybrid system with the help of block diagrams (8)

15 (a) With the help of a block diagram, explain the Field Oriented Control scheme in the Permanent Magnet Synchronous Motor. (10)

(b) Compare sensored & sensorless FOC control in Permanent Magnet Synchronous Motor (4)

OR

16 (a) Explain the closed loop operation of DC Motor for speed control in electric vehicles. (10)

(b) Explain how independent control of flux and torque is obtained in DC Motor (4)

17 (a) A hybrid electric vehicle has two sources- an ICE with output power of 80kW and battery storage. The battery storage is a 150 Ah, C10 battery at 120V. (i). Calculate the battery energy capacity (ii). Without de-rating the Ahr capacity, what is the maximum power that can be supported by the battery (4)

(b) Explain the operation, advantages and disadvantages of Supercapacitor and Fuel cell (10)

OR

18 (a) Explain the working of Li-ion cell (8)

(b) What do you mean by hybridization of energy storage system Explain (6)

19 (a) Explain briefly the factors to be considered for the determination of power electronics components for EV (8)

(b) Explain briefly the factors to be considered while sizing the electric motor for EV. (6)

OR

20 (a) Explain the Electronic Control Unit of Electric vehicle (10)

(b) List the different energy management strategies (4)

Syllabus

Module 1

Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies.

Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, mathematical models to describe vehicle performance.

Module 2

Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.

Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis

Module 3

Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles

DC Drives: Review of Separately excited DC Motor control – Speed and torque equations - Independent control of orthogonal flux and torque - Closed loop control of speed and torque (block diagram only)

PMSM Drives: PMSM motor basics – Independent control of orthogonal flux and torque (concept only)- Field Oriented Control (FOC) – Sensored and sensorless control (block diagram only)

Module 4

Energy Storage: Introduction to energy storage requirements in Hybrid and Electric Vehicles- Battery based energy storage systems, Battery Management System, Types of battery- Fuel Cell based energy storage systems- Supercapacitors-Hybridization of different energy storage devices

Module 5

Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics

Vehicle Communication: Need & requirements, Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies

Text Book

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003

References:

1. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.
2. Mehrdad Ehsani, YimiGao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.

3. Chris Mi, M A Masrur, D W Gao, "Hybrid Electric Vehicles – Principles and applications with practical perspectives," Wiley, 2011
4. Anderson JM, Nidhi K, Stanley KD, Sorensen P, Samaras C, Oluwatola OA, Autonomous vehicle technology: A guide for policymakers, Rand Corporation,2014

Course Contents and Lecture Schedule:

No.	Topic	No. of Lectures
1	**Introduction to hybrid/electric, conventional & autonomous vehicles**	**(8 hours)**
1.1	Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles	1
1.2	Impact of modern drive-trains on energy supplies	1
1.3	Conventional Vehicles: Basics of vehicle performance	1
1.4	Vehicle power source characterization, transmission characteristics	2
1.6	Mathematical models to describe vehicle performance	2
1.7	Autonomous Vehicles: Levels of automation, significance & effects of automation in vehicles	1
2	**Hybrid & Electric drive-trains**	**(7 hours)**
2.1	Hybrid Electric Drive-trains: Basic concept of hybrid traction	1
2.2	Introduction to various hybrid drive-train topologies	1
2.3	Power flow control in hybrid drive-train topologies, fuel efficiency analysis.	2
2.4	Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies	1
2.5	Power flow control in electric drive-train topologies, hub motors, fuel efficiency analysis.	2
3	**Electric Propulsion System**	**(7 Hours)**
3.1	Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles	2
3.2	DC Drives: Review of Separately excited DC Motor control – Speed and torque equations - Independent control of orthogonal flux and torque – Closed loop control of speed and torque (block diagram only)	2
3.3	PMSM Drives: PMSM motor basics – Independent control of orthogonal flux and torque (concept only)	2

3.4	Field Oriented Control (FOC) of Permanent Magnet Synchronous Motor – Sensored and sensorless control (block diagram only)	1
4	**Energy Storage**	**(6 Hours)**
4.1	Energy Storage: Introduction to energy storage requirements in Hybrid and Electric Vehicles- Battery based energy storage systems, Battery Management System	2
4.2	Types of battery-Lithium ion, Lead acid	2
4.3	Fuel Cell based energy storage systems- Supercapacitors-Hybridization of different energy storage devices	2
5	**Sizing the drive System**	**(6 Hours)**
5.1	Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE)	1
5.2	Sizing the propulsion motor	1
5.3	Sizing the power electronics	1
5.4	Introduction to energy management strategies used in hybrid and electric vehicles,	1
5.5	classification of different energy management strategies	1
5.6	comparison of different energy management strategies	1

ERT 443	FORMAL LANGUAGES AND AUTOMATA THEORY	Category	L	T	P	Credit
		PEC	2	1	0	3

Prerequisite: Basic knowledge about the following topic is assumed: sets, relations - equivalence relations, functions, proof by Principle of Mathematical Induction.

Course Outcomes: After the completion of the course the student will be able to

CO1	Understand the fundamental concepts of formal language theory, deterministic and nondeterministic finite state automata, equivalence between DFA and NFA, regular grammars, and their equivalence with DFA. **[Cognitive knowledge level: Understand]**
CO2	Understand the concepts of Regular Expressions, Equivalence between REs and DFA, Pumping Lemma for regular languages, Closure Properties of Regular Languages, and DFA state minimization.. [**Cognitive knowledge level: Understand**]
CO3	Implement Context-Free Grammars (CFG) for representing Context-Free Languages with correctness proofs, derivation trees, ambiguity resolution, and transformation into Chomsky Normal Form and Greibach Normal Form. **[Cognitive knowledge level : Apply]**
CO4	Design a Pushdown Automaton and a Context-Free Grammar for a given context-free language. [**Cognitive knowledge level** : **Apply**]
CO5	Design Turing machines as language acceptors or transducers. [**Cognitive knowledge level: Apply]**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO1 2
CO1	✓	✓	✓									✓
CO2	✓	✓	✓	✓								✓
CO3	✓	✓	✓	✓								✓
CO4	✓	✓	✓	✓								✓
CO5	✓	✓	✓	✓								✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	PO7	Environment and Sustainability
PO2	Problem Analysis	PO8	Ethics
PO3	Design/Development of solutions	PO9	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination Marks**
	Test 1 (Marks)	**Test 2 (Marks)**	
Remember	**30**	**30**	**30**
Understand	**30**	**30**	**30**
Apply	**40**	**40**	**40**
Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	**CIE Marks**	**ESE Marks**	**ESE Duration**
150	**50**	**100**	**3 hours**

Continuous Internal Evaluation Pattern:

Attendance : **10 marks**

Continuous Assessment - Test : **25 marks**

Continuous Assessment - Assignment : **15 marks**

Internal Examination Pattern:

Each of the two internal examinations have to be conducted out of 50 marks. The first series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing the remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

Syllabus

ERT 443 Formal Languages and Automata Theory Module - 1

(Introduction to Formal Language Theory and Regular Languages)

Introduction to formal language theory– Alphabets, Strings, Concatenation of strings, Languages.

Regular Languages - Deterministic Finite State Automata (DFA) (Proof of correctness of construction not required), Nondeterministic Finite State Automata (NFA), Equivalence of DFA and NFA**,** Regular Grammar (RG), Equivalence of RGs and DFA(Proof not required).

Module - 2 (More on Regular Languages)

Regular Expression (RE), Equivalence of REs and DFA (proof not required), Necessary conditions for regular languages, Pumping Lemma for regular languages. Closure Properties of Regular Languages, DFA state minimization.

Module - 3 (Myhill-Nerode Theorem and Context-Free Grammars)

Myhill-Nerode Theorem (MNT) (No proof required), Applications of MNT.

Context Free Grammar (CFG)- CFG representation of Context-Free Languages (proof of correctness is required), derivation trees and ambiguity, Chomsky Normal Form, Greibach normal form.

Module - 4 (More on Context-Free Languages)

Nondeterministic Pushdown Automata (PDA), Deterministic Pushdown Automata (DPDA), Equivalence of PDAs and CFGs (Proof not required), Pumping Lemma for Context-Free Languages (Proof not required), Closure Properties of Context Free Languages.

Module - 5 (Context Sensitive Languages, Turing Machines)

Context Sensitive Languages - Context Sensitive Grammar (CSG), Linear Bounded Automata.

Turing Machines - Standard Turing Machine, Robustness of Turing Machine, Halting Problem, Recursive and Recursively Enumerable Languages.

Chomsky classification of formal languages.

Text Book

1. Dexter C. Kozen, Automata and Computability, Springer (1999)

Reference Materials

1. John E Hopcroft, Rajeev Motwani and Jeffrey D Ullman, Introduction to Automata Theory, Languages, and Computation, 3/e, Pearson Education, 2007
2. Michael Sipser, Introduction To Theory of Computation, Cengage Publishers, 2013.

Sample Course Level Assessment Questions

Course Outcome 1 (CO1): Design a DFA for strings in which number of a's is multiple of 3 and number of b's is multiple of 2. Σ = {a, b}.

Course Outcome 2 (CO2):

(i) Write a Regular Expression for the language:$L = \{x \in \{a, b\}^* | third\ last\ symbol\ in\ x\ is\ b\}$

(ii) State the closure properties of regular language.

Course Outcome 3 (CO3):

(i) Write a Context-Free Grammar for the language $L = \{a^n b^{2n} | n \geq 0\}$.

(ii) Convert the Context-Free Grammar with productions: {S→ aSb|ε} into Greibach Normal form.

Course Outcome 4 (CO4):

(i) Design a PDA for the language L= { WW^r | W ∈{a,b}* }. Also illustrate the computation of the PDA on the string 'aabbaa'.

(ii) State Equivalence theorem between empty stack PDA and Final State PDA.

Course Outcome 5 (CO5):

(i) Design a Turing Machine for the language $L = \{a^n b^n c^n | n \geq 0\}$

(ii) Design a Turing Machine to compute the square of a natural number. Assume that the input is provided in unary representation.

Model Question paper

QP CODE: PAGES:3

Reg No:_____ Name :_____ APJ

ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: ERT 443

Course Name: Formal Languages and Automata Theory

Max.Marks:100 Duration: 3 Hours

PART A

Answer all Questions. Each question carries 3 Marks

1. Design a DFA for the language $L = \{x \in \{a, b\}^* | aba \text{ is not a substring in } x\}$.
2. Write a Regular Grammar for the language: $L = \{axb | x \in \{a, b\}^*\}$
3. Write a Regular Expression for the language: $L = \{x \in \{0,1\}^* | \text{there are no consecutive } 1's \text{ in } x\}$
4. Prove that the language $L_1 = \{a^{n!} | n \in N\}$ is not regular.
5. List out the applications of Myhill-Nerode Theorem.
6. Write a Context-Free Grammar for the language: $L = \{x \in \{a, b\}^* | \ \#_a(x) = \#_b(x)\}$. Here, the notation $\#_1(w)$ represents the number of occurrences of the symbol 1 in the string w.
7. Design a PDA for the language of odd length binary palindromes (no explanation is required, just list the transitions in the PDA).
8. Prove that Context Free Languages are closed under set union.
9. Write a Context Sensitive Grammar for the language $L = \{a^n b^n c^n | n \geq 0\}$ (no explanation is required, just write the set of productions in the grammar).
10. Differentiate between Recursive and Recursively Enumerable Languages.

(10x3=30)

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11 (a) Draw the state-transition diagram showing an NFA N for the following language L. Obtain the DFA D equivalent to N by applying the subset construction algorithm. $L = \{x \in \{a, b\}^* | \textit{ the second last symbol in } x \textit{ is } b\}$ — 7

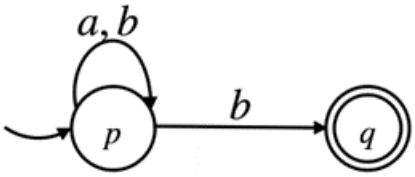
(b) Draw the state-transition diagram showing a DFA for recognizing the following language: $L = \{x \in \{0,1\}^* | x \textit{ is a binary representation of a natural number which is a}$ multiple of 5$\}$ — 7

OR

12 (a) Write a Regular grammar G for the following language Ldefined as: $L = \{x \in \{a, b\}^* | x \textit{does not contain consecutive} b's\}$. — 7

(b) Obtain the DFA A_G over the alphabet set Z = $\{a, b\}$, equivalent to the regular grammar G with start symbol S and productions: $S \rightarrow aA$ and $A \rightarrow aA|bA|b$. — 7

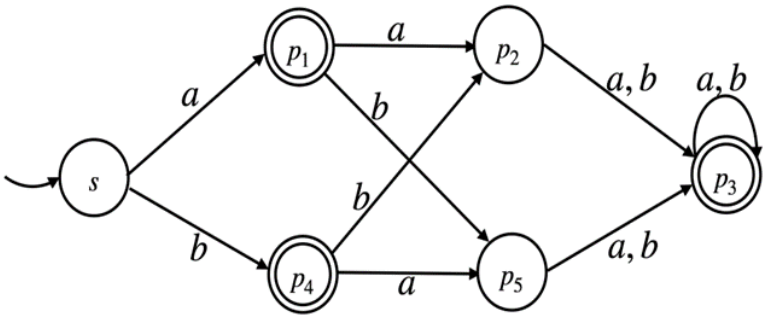
13 (a) Using Kleen's construction, obtain the regular expression for the language represented by the following NFA — 7



(b) Using pumping lemma for regular languages, prove that the language $L = \{a^n b^n | n \geq 0\}$ is not regular. — 7

OR

14 (a) Obtain the minimum-state DFA from the following DFA. — 8



(b) List the closure properties of regular languages — 6

15 (a) Construct the CFG for the language having any number of a's over the set ∑= {a}. — 7

(b) With an example, explain ambiguity in Context Free Grammar — 7

OR

16 (a) Convert the Context-Free Grammar with productions: $\{S \rightarrow aSb|\epsilon\}$ into Greibach Normal form. — 8

(b) Convert the Context-Free Grammar with productions: $\{S \rightarrow aSa|bSb|SS|\epsilon\}$ into Chomsky Normal form. — 6

17	(a)	Design a PDA for the language $L = \{a^m b^n c^{m+n} \mid n \geq 0, m \geq 0\}$. Also illustrate the computation of the PDA on a string in the language	7
	(b)	With an example illustrates how a multi-state PDA can be transformed into an equivalent single-state PDA.	7
		OR	
18	(a)	Using pumping lemma for context-free languages, prove that the language: $L = \{ww \mid w \in \{a, b\}^*\}$ is not a context-free language.	7
	(b)	Design a PDA for strings in which number of a's is less than number of b's.	8
19	(a)	Design a Turing machine to obtain the sum of two natural numbers a and b, both represented in unary on the alphabet set $\{1\}$. Assume that initially the tape contains $\vdash 1^a 01^b \text{b}^\omega$. The Turing Machine should halt with $\vdash 1^{a+b} \text{b}^\omega$ as the tape content. Also, illustrate the computation of your Turing Machine on the input a = 3and b = 2.	7
	(b)	With an example illustrate how a CFG can be converted to a single-state PDA.	7
		OR	
20	(a)	Design a Turing machine to obtain the sum of two natural numbers $a$and b, both represented in unary on the alphabet set $\{1\}$. Assume that initially the tape contains $\vdash 1^a 01^b \text{b}^\omega$. The Turing Machine should halt with $\vdash 1^{a+b} \text{b}^\omega$ as the tape content. Also, illustrate the computation of your Turing Machine on the input a = 3and b = 2.	7
		Write a context-sensitive grammar for the language $L = \{a^n b^n c^n \mid n \geq 0\}$.	
	(b)	Also illustrate how the string $a^2b^2c^2$ can be derived from the start symbol of the proposed grammar.	7

Teaching Plan

Sl. No	Topic	No. of Hours (36 hrs)
Module - 1 (Introduction to Formal Language Theory and Regular Languages)		**9 Hours**
1.1	Introduction to formal language theory – Alphabets, strings, concatenation of strings, Languages	1 Hour
1.2	Deterministic Finite State Automata (DFA) – Example DFA (Proof of correctness of construction not required)	1 Hour
1.3	Formal definition of DFA, Language accepted by the class of DFA	1 Hour
1.4	Nondeterministic Finite State Automata (NFA) – Example NFA	1 Hour

1.5	Formal definition of NFA, NFA with ε transitions - examples, formal definition	1 Hour
1.6	Equivalence of DFA and NFA with and without ε transitions - Subset construction	1 Hour
1.7	Regular Grammar (RG) – Example RGs, derivation of sentences	1 Hour
1.8	Formal definition of RG, Language represented by a RG	1 Hour
1.9	Equivalence of RG and DFA	1 Hour
Module - 2 (More on Regular Languages)		**6 Hours**
2.1	Regular Expression (RE) - and formal definition	1 Hour
2.2	Example REs and formal definition	1 Hour
2.3	Necessary conditions for regular languages.	1 Hour
2.4	Pumping Lemma for regular languages	1 Hour
2.5	Closure Properties of Regular Languages (proof not required)	1 Hour
2.6	State Minimization Algorithm - Example	1 Hour
Module - 3 (Myhill-Nerode Relations and Context-Free Grammars)		**7 Hours**
3.1	Myhill-Nerode Theorem (MNT)	1 Hour
3.2	Applications of MNT	1 Hour
3.3	Context Free Grammar (CFG) - Example CFGs and formal definition	1 Hour
3.4	CFG Representation of Context-Free Languages	1 Hour
3.5	Derivation Trees and ambiguity	1 Hour
3.6	Chomsky Normal Form	1 Hour
3.7	Greibach Normal Form	1 Hour
Module - 4 (More on Context-Free Languages)		**7 Hours**
4.1	Nondeterministic Pushdown Automata (PDA) – Example PDAs, formal definition	1 Hour
4.2	Deterministic PDA	1 Hour
4.3	Conversion of CFG to PDA (No proof required)	1 Hour
4.4	Conversion of PDA to CFG - Part I (No proof required)	1 Hour

4.5	Conversion of PDA to CFG - Part II (No proof required)	1 Hour
4.6	Pumping Lemma for context-free languages (No proof required)	1 Hour
4.7	Closure Properties of Context-Free Languages	1 Hour

Module - 5 (Context Sensitive Languages, Turing Machines)		**7 Hours**
5.1	Context Sensitive Grammar (CSG) - Examples, formal definition	1 Hour
5.2	Linear Bounded Automata (LBA) - Example LBA, formal definition	1 Hour
5.3	Turing Machine (TM) - TM as language acceptors - examples, formal definition	1 Hour
5.4	TM as transducers - examples	1 Hour
5.5	Halting Problem of TM	1 Hour
5.6	Recursive and Recursively Enumerable Languages	1 Hour
5.7	Chomsky classification of formal languages	1 Hour

OPEN ELECTIVE

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
ERT435	COMPUTER HARDWARE ENGINEERING	OEC	2	1	0	3

Prerequisite: Nil

Course Outcomes: After the completion of the course, the student will be able to

CO 1	Understand the components in the motherboard and buses
CO 2	Understand memory and different storage media
CO 3	Understand different types of video and audio hardware
CO 4	Understand the different types of I/O interfaces
CO 5	Understand power supply system

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2	2	2									
CO 2	2	2	2									
CO 3	1	2	1									
CO 4	2	2	2									
CO 5		2	1									

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	20	20	40
Understand	30	30	60
Apply	-	-	-
Analyse	-	-	-
Evaluate	-	-	-
Create	-	-	-

Mark Distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance: 10 marks

Continuous Assessment Test (2 Numbers): 25 marks

Assignment/Quiz/Course project: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub- divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Identify different components on motherboard.
2. Discuss connectors and system Bus types

Course Outcome 2 (CO2):

1. Comparison of different recordable devices.
2. Role of removable flash media types.

Course Outcome 3 (CO3):

1. Different audio hardware
2. Different video hardware

Course Outcome 4 (CO4):

1. How to troubleshoot I/O interface devices.
2. Difference between serial and parallel ports

Course Outcome 5 (CO5):

1. Discuss the different voltage signals of SMPS
2. Power use calculations.

SYLLABUS

Module I: Introduction to computer hardware (8 Hours)

Introduction to computer hardware Processors, Mother Boards and buses: Evolution, classification of computers, modern computers and history of PC, system types and system components. PC Processors and architecture, processor specifications, features. Motherboards and Buses: Mother board form Factors, obsolete form factor, ATX and other modern form factors. Processor sockets/slots. Chipsets, evolution, Intel chipsets and models, Traditional north/south bridge architecture, hub architecture, Intel Integrated Graphics, Motherboard connectors and system Bus types, the Processor Bus, Memory bus, I/O Buses, System Resources, Motherboard selection criteria.

Module II: BIOS, memory, Types of Storages (8 Hours)

BIOS: Basics, ROM BIOS, the BIOS upgrading, plug and play BIOS and BIOS Error Messages, Memory: ROM, DRAM, SRAM, types of RAM and upgrades memory. Magnetic storage: How magnetic fields are used to store data, read/write head design. Hard Disk storage: Hard drive advancements and form factors: Hard disk drives components and operation, Hard Disk features; capacity and performance. Optical storage: CD - DVD construction technology, DVD tracks and sectors, handling errors. Optical disk format; CD and DVD formats and copy protection, optical dive performance and trouble shooting. Removable storage: Role of removable Flash media drives; flash memory media, types of flash memory drives.

Module III: Video and Audio hardware (7 Hours)

Video hard ware: Display adapters and monitors, integrated video/motherboard chipsets, video RAM and DAC. Video display interface, digital display interface, Monitors display specifications, LCD, CRT, OLED display technologies. Homogeneous and heterogeneous adapters, video capture devices, bad pixels, Audio hardware: Audio adapter concepts, evaluating the quality, sampling, installation sound cards, Microphone, Speakers and their selection criteria

Module IV: Introduction to I/O interfaces (6 Hours)

I/O interfaces: I/O ports, differences between serial and parallel ports, universal serial bus (USB), IEEE 1394, Hot-plugging and low speed external connections. Input devices: Keyboards (101,104), Keyboard/mouse interface connectors, USB keyboards, VGA, DV, HDMI ports.

Module V: Power supply systems (7 Hours)

Power Functions: Switch Mode Power Supply (SMPS), Voltages and current ratings, Power switches; ATX, PC/XT/AT and LPX, Motherboard power connectors (ATX and ATX 12V), compatibility and ATX design, Additional power connectors and specifications. Power use calculations, power cycling, power management and power-protections.

Text books:

1. Scott Mueller - Upgrading and Repairing PCs-Que Publishing
2. (McGraw Hill professional) Michael Meyers - Mike Meyers' CompTIA A+ guide to managing and troubleshooting PCs-McGraw-Hill (2007)

Model Question Paper

Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY THIRD SEMESTER B. TECH DEGREE EXAMINATION,

MONTH AND YEAR

Course Code: EST 435

Course Name: Computer Hardware Engineering

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all questions, each carries 3 marks

21. Give the signal voltages for following colours of ATX connectors: Red, Black, Orange and Purple
22. What are the uses of Chipsets in a PC?
23. Explain Flash Memory.
24. What is USB
25. Compare the characteristics of CRT and LCD monitors
26. What are the different audio adaptor standards?
27. Write a note on different mouse types available.
28. Explain IEEE 1394.
29. Mention different connectors used to connect monitor with PC.
30. List various SMPS power supply connectors used in PC-AT.

PART B

Answer any one full question from each module.

Each question carries 14 Marks

Module1

31. A) State any eight motherboard selection criterion (8 marks)

B) Explain the Motherboard Chipsets. (6 Marks)

32. A) With necessary examples explain different motherboard form factors. (7 marks)

B) Explain north/south bridge architecture (7 Marks)

Module2

33. A) explain the functions of bios. (7 marks)

B) Briefly explain about optical storage media. (7 Marks)

14 A) Explain the working of hard drives. (7 Marks)

B) Explain about different types of ROM. (7 Marks)

Module3

15. A) Explain three different types of DRAMS. (9 Marks)

B) Explain 3 different display devices. (9 Marks)

16. A) what are the selection criteria of speaker (5 marks)

B) Explain about any 2 video display connectors. (9 Marks)

Module4

17. A) Explain different keyboard connectors. (7 Marks)

B) Explain the working principle of optical mouse (7 marks)

18. A) Explain the connector details of serial port (8 marks)

B) Differences between serial and parallel ports. (6 marks)

Module5

19. A) Explain Characteristics of Power Supplies. (9 marks)

B) Explain any three connectors of Power supplies. (5 marks)

20. A) Explain in detail about Motherboard power connectors (8 marks)

B) Write a note on power management and power-protections (6 marks)

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Introduction to computer hardware**	**8**
1.1	Introduction to computer hardware Processors, Mother Boards and buses: Evolution, classification of computers, modern computers and history of PC, system types and system components.	1
1.2	PC Processors and architecture, processor specifications, features	1
1.3	Motherboards and Buses: Mother board form Factors, obsolete form factor, ATX and other modern form factors	1
1.4	Processor sockets/slots	1
1.5	Chipsets, evolution, Intel chipsets and models	1
1.6	Traditional north/south bridge architecture, hub architecture, Intel Integrated Graphics	1
1.7	Motherboard connectors and system Bus types, the Processor Bus, Memory bus, I/O Buses	1
1.8	System Resources, Motherboard selection criteria.	1
2	**BIOS, memory, Types of Storages**	**8**
2.1	BIOS: Basics, ROM BIOS, the BIOS upgrading, plug and play BIOS and BIOS Error Messages	1
2.2	Memory: ROM, DRAM, SRAM, types of RAM and upgrades memory	1
2.3	Magnetic storage: How magnetic fields are used to store data, read/write head design	1
2.4	Hard Disk storage: Hard drive advancements and form factors: Hard disk drives components and operation, Hard Disk features; capacity and performance	1
2.5	Optical disk format; CD and DVD formats and copy protection, optical dive performance and trouble shooting	1
2.6	handling errors	1

2.7	Removable storage: Role of removable Flash media drives; flash memory media	1
2.8	types of flash memory drives.	1
3	**Video hard ware**	**7**
3.1	Video hard ware: Display adapters and monitors, integrated video/motherboard chipsets, video RAM and DAC	1
3.2	Video display interface, digital display interface	1
3.3	Monitors display specifications, LCD, CRT, OLED display technolog	1
3.4	Homogeneous and heterogeneous adapters, video capture devices, bad pixels	1
3.5	Audio hardware: Audio adapter concepts, evaluating the quality	1
3.6	sampling, installation sound cards,	1
3.7	Microphone, Speakers and their selection criteria	1
4	**Introduction to I/O interfaces**	**6**
4.1	I/O interfaces: I/O ports, differences between serial and parallel ports	1
4.2	universal serial bus (USB), IEEE 1394	1
4.3	Hot-plugging and low speed external connections	1
4.4	Input devices: Keyboards (101,104)	1
4.5	Keyboard/mouse interface connectors, USB keyboards	1
4.6	VGA, DV, HDMI ports	1
5	**Power supply system**	**7**
5.1	Power Functions: Switch Mode Power Supply (SMPS), Voltages and current ratings, Power switches	1
5.2	ATX, PC/XT/AT and LPX	1
5.3	Motherboard power connectors (ATX and ATX 12V)	**1**
5.4	compatibility and ATX design	3
5.5	Additional power connectors and specifications	2
5.6	Power use calculations, power cycling	1
5.7	power management and power-protections.	1

ERT 425	COURSE NAME COMPUTER BASED CONTROL SYSTEM	CATEGORY	L	T	P	CREDIT
		OEC	2	1	0	3

Preamble: The basic objective of this course is to deliver fundamental concepts in computer-based process control. Basic concepts of PLC, microcomputers, direct digital control and distributed digital control are discussed in this course. SCADA, RTU, Intelligent controllers and real time systems are also introduced to students through this course.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand the fundamentals of automatic process control
CO 2	Understand the basic concepts of PLCs and microcomputers
CO 3	Know about direct digital control and distributed digital control
CO 4	Build knowledge on SCADA, RTU and intelligent controllers
CO 5	Familiarize real time systems

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2	2	2	2	1	1	-	-	-	-	-	1
CO 2	2	2	2	2	2	1	-	-	-	-	-	1
CO 3	2	2	2	2	1	1	-	-	-	-	-	1
CO 4	2	2	2	2	2	1	-	-	-	-	-	1
CO 5	2	2	2	2	1	1	-	-	-	-	-	1

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	10
Understand	20	20	20
Apply	20	20	70
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. With block diagram and suitable examples explain open loop and closed loop control (K2)
2. Explain various types of control used in process control (K2)
3. Explain tuning of PID controller? What is the effect of P, I and D parameters? (K2)
4. Explain role and working of PID controller? Draw the step response characteristics of PID controller (K2)

Course Outcome 2 (CO2)

1. Explain the architecture of PLC. (K2)
2. Detail the applications of PLC (K2)
3. Explain interfacing of input and output devices with PLC (K2)
4. With a neat block diagram explain the architecture of microcomputer. (K2)

Course Outcome 3 (CO3):

1. With flowchart explain position and velocity algorithm in DDC (K2)
2. Explain hierarchical levels in distributed control systems (K2)

Course Outcome 4 (CO4):

1. Explain basic functions carried out by SCADA. (K2)
2. Explain in detail I/O modules of RTU (K2)
3. Explain fuzzy controller with suitable block diagram. Also Compare fuzzy controller with ANN based controller. (K2)

Course Outcome 5 (CO5):

1. Explain various modules in real time system. (K2)
2. Explain multitasking. (K2)
3. Explain in detail PC based distributed control system. (K2)

Model Question Paper PAGES: 2
QPCODE:
Reg. No: ----------
Name: ----------

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
SEVENTH SEMESTER B.TECH. DEGREE EXAMINATION
MONTH & YEAR

Course Code**: EST 425**
Course Name: **COMPUTER BASED CONTROL SYSTEM**

Max. Marks: 100 **Duration: 3 Hours**

PART A
Answer all Questions. Each question carries 3 Marks

1. Describe feed forward control with suitable example.
2. With neat sketches, explain various control system responses.
3. Explain the block diagram of microcomputer
4. Using suitable example describe the construction of ladder diagram.
5. Explain the structure of direct digital control.
6. List out the advantages of distributed control systems
7. Define SCADA.
8. Compare PLC with SCADA.
9. Explain about Analog input & output modules in RTU.
10. Explain the Architecture of Linux.

PART B

Answer any one full question from each module. Each question carries 14 Marks

Module-1

11. With neat sketches, explain the effect of P, PI and PID controller in a feedback control system when it is subjected to a step change in load variable.

12. a. With suitable example explain the principle of single controller loop.

    b. Explain (i) Multi-position control (ii) Ratio control

Module-2

13. Explain in detail, the architecture of programmable controllers.

14. Explain the functions and operation of analog input and output modules.

Module-3

15. Explain algorithm structure of cascade control, ratio control and multivariable control.

16. Explain in detail the hierarchical levels of distributed control system.

Module-4

17. Explain the basic functions of SCADA system.

18. With a neat block diagram, explain the basic operation of Fuzzy logic controller.

Module-5

19. Explain in detail PC based distributed control system.

20. With the help of an example, explain inter task communication.

Syllabus

Module 1: Fundamentals of Automatic process control

Introduction- open loop and closed loop control, Two position and multi-position control- PID control- controller operation- control system response- control loop tuning- Multivariable control - feedforward control with example.

Module 2: PLC & Microcomputers

Programmable logic controllers: Introduction – principles of operation – AND, OR, AND-OR – Architecture – Programming languages – ladder diagram instructions – functional Blocks- Applications of PLC.
Microcomputers- Block diagram- Analog and digital I/O modules.

Module 3: Direct digital control & Distributed digital control

Direct digital control -DDC structure-DDC software: position algorithm-velocity algorithm-position vs velocity algorithm-cascade control-ratio control-multivariable control- computer instrumentation-feed forward control.

Distributed digital control - Advantages of distributed control systems—functional requirements of process control system-system architecture-Distributed control systems-hierarchical levels.

Module 4: SCADA, RTU & Intelligent controllers

Supervisory control and data acquisition systems- block diagram- channel scanning- conversion into engineering units- data processing- distributed SCADA system.

Remote Terminal Unit- Analog & Digital I/O Modules – Communication Module – Special software Facilities.

Intelligent controllers-Artificial intelligent based systems-Fuzzy logic system-fuzzy controller-Introduction to Artificial neural networks-Neural controllers-Neuro fuzzy control system.

Module 5: Real time systems

Real time programming- Introduction- Input subsystem, processing subsystem, output subsystem, Interrupts, Information Processing. Multitasking-Task Management-Inter task communication-example- real time Linux.

Interfacing PC to outside world-PC in real time environment-PC based distributed control systems.

Text Books

1. Krishna Kant, Computer-Based Industrial Control, PHI learning Private ltd., Second edition,2013

Reference Books

1. Davis W. Pessen, Industrial Automation: Circuit Design and Components, Wiley, 2011
2. Pierre Belanger, Control Engineering: A Modern Approach, Saunders College Publishing, USA, 2005.
3. Laplante P.A., Real Time Systems: An Engineer.s Handbook, Prentice Hall of India Pvt. Ltd., New Delhi, 2004.
4. Stuart A. Boyer: SCADA-Supervisory Control and Data Acquisition, ISA-Instrumentation, Systems, and Automation Society, 2016
5. Gordon Clarke, Deon Reynders: Practical Modern SCADA Protocols: DNP3, 60870.5 and Related Systems, Newnes Publications, Oxford, UK,2004
6. Efim Rosenwasser, Bernhard P. Lampe, Multivariable computer-controlled systems: a transfer function approach, Springer, 2006

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Fundamentals of Automatic process control**	**7hr**
1.1	Introduction- open loop and closed loop control	2
1.2	Two position and multi-position control- PID control	2
1.3	controller operation- control system response- control loop tuning	2
1.4	Multivariable control -feedforward control with example	1
2	**PLC & Microcomputers**	**7hr**
2.1	**Programmable logic controllers:** Introduction – principles of operation – AND, OR, AND-OR	1
2.2	Architecture	1
2.3	Programming languages – ladder diagram instructions	2
2.4	functional Blocks-Applications of PLC	1
2.5	Microcomputers- Block diagram- Analog and digital I/O modules.	2
3	**Direct digital control & Distributed digital control**	**7hr**
3.1	**Direct digital control** -DDC structure	1

3.2	DDC software: position algorithm-velocity algorithm-position vs velocity algorithm-cascade control-ratio control-multivariable control- computer instrumentation-feed forward control	3
3.3	**Distributed digital control** - Advantages of distributed control systems—functional requirements of process control system-system architecture	2
3.4	Distributed control systems-hierarchical levels	1
4	**SCADA, RTU & Intelligent controllers**	**8hr**
4.1	Supervisory control and data acquisition systems- block diagram-channel scanning- conversion into engineering units- data processing- distributed SCADA system.	2
4.2	Remote Terminal Unit- Analog & Digital I/O Modules - Communication Module – Special software Facilities	2
4.3	Intelligent controllers-Artificial intelligent based systems - Fuzzy logic system-fuzzy controller	2
4.4	Introduction to Artificial neural networks-Neural controllers - Neuro fuzzy control system	2
5	**Real time systems**	**7hr**
5.1	Real time programming-Introduction- Input subsystem, processing subsystem, output subsystem, Interrupts, Information Processing.	2
5.2	Multitasking-Task Management - Inter task communication with example.	2
5.3	Real time Linux – Architectures	1
5.4	Interfacing PC to outside world-PC in real time environment-PC based distributed control systems	2

ERT427	ROBOTICS AND AUTOMATION	CATEGORY	L	T	P	CREDIT
		OEC	2	1	0	3

Prerequisite: Nil

Course Outcome: After the successful completion of the course, the student will be able to

CO1	Attain a thorough understanding of different types of Robots and their applications (**Cognitive Knowledge level: Understand**)
CO2	Select appropriate sensors and actuators based on the robotic applications (**Cognitive Knowledge level: Understand**)
CO3	Perform kinematic and dynamic analyses for robots. (**Cognitive Knowledge level: Apply**)
CO4	Carry out the design and control of a simple robot. (**Cognitive Knowledge level: Apply**)
CO5	Integrate mechanical and electrical hardware for making a robotic device (**Cognitive Knowledge level: Understand**)

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓										✓
CO2	✓	✓										✓
CO3	✓	✓										✓
CO4	✓	✓		✓								✓
CO5	✓	✓		✓								✓

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	20
Understand	30	30	60
Apply	10	10	20
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
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Continuous Internal Evaluation Pattern:

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Continuous Assessment Test (2 numbers) : 25 marks

Assignment/Quiz/Course project : 15 marks

Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer anyone. Each question can have a maximum of two sub-divisions and carry 14marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): Appreciate the classification of robots, fundamental systems and their applications in various domains.

1. Write down the brief history and growth of robotics.
2. Describe the different basic components of a robotic system and their functions.
3. Explain the principle of degree of freedom or connectivity in terms of robotic joints.

Course Outcome 2(CO2): Compare and contrast the working principles and applications of various sensors and actuators used in robotic systems.

1. With neat sketches elucidate the working of any one type of tactile sensor used forcontact and proximity assessment.
2. Describe the imaging, sensing and digitization processes in a basic robotic visionsystem.
3. List and justify any two applications where pneumatic actuators are preferred overhydraulic ones.

Course Outcome 3 (CO3): Apply the principles and techniques of kinematic and dynamic modelling in robotics.

1. Describe the techniques and methods for the representation of position and orientationof objects, their translation and rotation, as well as the coordinate transformation in the workspace of a robot.
2. Explain the Denavit-Hartenberg (D-H) convention for selecting frames ofreference in robotics applications.

3. Apply the D-H convention to represent the different serial kinematic arrangementsfitted with various end effectors.

Course Outcome 4 (CO4): Perform basic programming for the control of robotic devices.

1. Explain the process of control of position and force of manipulators in robots.
2. Illustrate the working of a robotic device using the closed-loop control system with a suitable example.
3. Describe the commonly used methods for robot programming.

Course Outcome 5 (CO5): Design robotic devices by integrating mechanical and electrical hardware.

1. List out the various industrial Applications of Robots with examples.
2. Illustrate the significance of Artificial Intelligence (AI) in Robotics
3. Evaluate the role of robotics and automation in Industry 4.0.

SYLLABUS

MODULE I : Introduction to Robotics

Definition and Origin of Robotics. Robot Anatomy. Robot Specifications. Robot Characteristics – Accuracy, Precision, and Repeatability. Classification of Robots. Advantages and Disadvantages of Robots. Robot Structure - Types of Joints and End Effectors, Mechanisms and Manipulators. Common Kinematic Arrangements. Degree of Freedom. Robot Coordinates. Areas of Application for Robots.

MODULE II : Introduction to Sensors and Actuation Systems for Robots

Actuators: Types of Robotic Drive Systems and Actuators: Hydraulic, Pneumatic and Electric drives. Transmission: Gears, Timing Belts and Bearings. Parameters for selection of actuators. Specification. Areas of Application for: Stepper Motor & Servo Motor. Sensors: Types and Applications of Sensors in Robotics: Position, Displacement and VelocitySensors. Tactile Sensors for Contact and Proximity Assessment.

MODULE III : Introduction to Robot Kinematics and Dynamics

Introduction to Kinematics: Positionand Orientation of Objects. Rotation. Euler Angles. Rigid Motion Representation using Homogenous Transformation Matrix. Kinematic Modelling: Translation and Rotation Representation, Coordinate Transfōrmation, Forward and Inverse Kinematics. *Forward Kinematics*-Link Coordinates, Denavit-Hartenberg Representation, Application of DH Convention to Different Serial Kinematic Arrangements.

MODULE IV : Introduction to Robot Control

Basics of Control: Open Loop- Closed Loop, Transfer Functions, Control Laws: P, PD, PID, Linear and Non-linear Controls; Control Hardware andInterfacing; Embedded Systems: Microcontroller Architecture and Integration with Sensors, Actuators, Components.

MODULE V : Recent Developments in Robotics

Mobile Robots: Mobile Robot Kinematics. Humanoid Robotics: Biped Locomotion, Imitation Learning. Collaborative Robots: Collaborative Robot, Collaborative Operation, Applications. Artificial Intelligence inRobotics: Applications in Unmanned Systems, Defense, Medical, Industries, etc. Industrial Applications of Robots in Material Handling and Assembly. Robotics and Automation for Industry 4.0.

Text Books:

1. S.K. Saha, Introduction to Robotics, Tata McGraw Hill, 2nd Edition, 2014
2. Saeed B. Niku, Introduction to Robotics: Analysis, Systems, Applications, JohnWiley & Sons, 2nd Edition, 2011.
3. Spong and Vidyasagar, Robot Dynamics and Control, John Wiley & Sons, 1990.
4. Mikell P. Groover, et al., Industrial Robotics – Technology, Programming and Applications, McGraw Hill, 2nd Edition, 2012

Reference Books:

1. John. J. Craig, Introduction to Robotics: Mechanics and Control, PHI, 2005.
2. Ashitava Ghosal, Robotics, Fundamental concepts and analysis, OXFORD University Press, 2006
3. Fu, K. S, Gonzalez, R. C, Lee, C. S. G., Robotics, Control, Sensing, Vision and Intelligence, McGraw-Hill, 1987.
4. Asada, H., and J. J. Slotine. *Robot Analysis and Control*. New York, NY: Wiley, 1986.
5. Robert J. Schilling, Fundamentals of Robotics: Analysis & Control, Pearson Education, 2000
6. Klafter, R.D., Chmielewski, T.A, Negin, M, Robotic Engineering An Integrated Approach, PHI, 2007
7. S. R. Deb, Robotics Technology and Flexible Automation, Tata McGraw Hill, New Delhi, 1994.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Module 1: Introduction to Robotics**	**7**
1.1	Definition and Origin of Robotics.	1
1.2	Robot Anatomy. Robot Specifications.	1
1.3	Robot Characteristics – Accuracy, Precision, and Repeatability.	1
1.4	Classification of Robots. Advantages and Disadvantages of Robots.	1
1.5	Robot Structure - Types of Joints and End Effectors, Mechanisms and Manipulators.	1
1.6	Common Kinematic Arrangements. Degree of Freedom.	1
1.7	Robot Coordinates. Areas of Application for Robots.	1
2	**Module 2: Introduction to Robotic Sensors and Actuators**	**7**
2.1	Actuators: Types of Robotic Drive Systems and Actuators	1
2.2	Hydraulic, Pneumatic and Electric drives.	1
2.3	Transmission: Gears, Timing Belts and Bearings.	1
2.4	Parameters for selection of actuators.	1
2.5	Specification. Areas of Application for: Stepper Motor & Servo Motor.	1
2.6	Sensors: Types and Applications of Sensors in Robotics: Position,	1
2.7	Displacement and VelocitySensors. Tactile Sensors for Contact and Proximity Assessment.	1
3	**Module 3: Introduction to Robot Kinematics and Dynamics**	**8**
3.1	Introduction to Kinematics: Positionand Orientation of Objects. Rotation.	1

3.2	Euler Angles. Rigid Motion Representation usingHomogenous Transformation Matrix.	1
3.3	Kinematic Modelling: Translation and Rotation Representation	1
3.4	Coordinate Transformation, Forward and Inverse Kinematics.	1
3.5	Forward Kinematics-Link Coordinates,	1
3.6	Denavit-Hartenberg Representation	2
3.7	Application of DHConvention to Different Serial Kinematic Arrangements.	1
4	**Module 4: Introduction to Robot Control**	**9**
4.1	Basics of Control: Open Loop- Closed Loop Transfer Functions	2
4.2	Control Laws: P, PD, PID	2
4.3	Linear and Non-linear Controls	2
4.4	Control Hardware andInterfacing	1
4.5	Embedded Systems: Microcontroller Architecture and Integration with Sensors, Actuators, Components	2
5	**Module 5: Recent Developments in Robotics.**	**7**
5.1	Mobile Robots: Mobile Robot Kinematics.	1
5.2	Humanoid Robotics: Biped Locomotion	1
5.3	Imitation Learning. Collaborative Robots: Collaborative Robot,	1
5.4	Collaborative Operation, Applications. Artificial Intelligence inRobotics:	2
5.5	Applications in Unmanned Systems, Defense, Medical, Industries, etc.	1
5.6	Industrial Applications of Robots in Material Handling and Assembly. Robotics and Automation for Industry 4.0.	1

Model Question Paper

A P J ABDUL KALAM TECHNOLOGICAL UNIVERSITYEIGHTH SEMESTER B TECH DEGREE EXAMINATIONCOURSE: ECT476 ROBOTICS

TIME: 3 HRS MAX. MARKS: 100PART A

Answer All Questions

1	List out the different criteria based on which robots are classified.	3
2	What are the basic components of a robot?	3
3	Determine the advantages of using electric drive systems in robots.	3
4	Identify the sensors used in robots for sensing position and velocity.	3
5	Recognize the need for Denavit-Hartenberg convention in robotics.	3
6	Describe joint angle, joint distance, link length and link twist.	3
7	How is the speed of an electric motor controlled using a microprocessor?	3
8	Distinguish between linear and rotary hydraulic actuation mechanisms.	3
9	Find any four non-industrial applications of robots	3
10	Substantiate the need for robot ethics.	3

PART B

Answer one question from each module. Each question carries 14 marks.

Module I

11(A)	Describe the commonly used types of joints and end effectors in robots.	*8*
11(B)	Explain the basic structure of anyrobotic system. How each component is different from the others in terms of its functionality?	*6*

OR

12(A)	Discuss the common kinematic arrangements in robots and find out the degree of freedom for each.	*8*
12(B)	Write notes on terms like accuracy, precision, and repeatability in connection with a robotic system.	*6*

Module II

13(A)	Compare among hydraulic, pneumatic and electric types of robotic drives and mention the specific area of application for each.	*8*

13(B) Describe how direction control is carried out on electric motors in robots using H- Bridge. *6*

OR

14(A) Discuss the different characteristics of tactile sensors. Describe with the help of a neat diagram the working of commonly used tactile sensors *8*

14(B) Elaborate on the imaging, sensing and digitization processes in robotic vision systems. *6*

Module III

15(A) A frame 'B' was rotated about the x-axis 90°, then, it was translated about the current a-axis 3 inches before it was rotated about z-axis 90°. Finally, it was translated about the current a-axis 5 inches. *8*

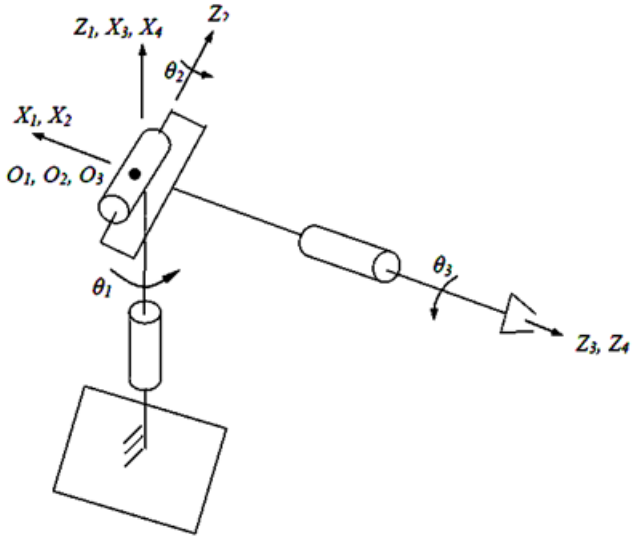
a) Write an equation that describes the motion.

b) Find the final location of a point P $(1, 5, 4)^T$ attached to the frame relative to the reference frame.

15(B) Distinguish between rotation matrix and homogenous transformation matrix. *6*

OR

16(A) Find the Denavit-Hartenberg representation parameters of a spherical arm shown in the figure below: *8*



16(B)	Describe the common kinematic arrangements of robots based on Cartesian-coordinate and Cylindrical-coordinate system	*6*

Module IV

17(A)	Discuss the different control schemes of robots	*8*
17(B)	Describe the basic structure of any robot programming language.	*6*

OR

18(A)	Elaborate the processes involved in robot actuation and the control methods used with block diagrams	*8*
18(B)	Differentiate between textual and lead through programming methods	*6*

Module V

19(A)	What are mobile robots: Describe how kinematics involved in mobile robots are different from others	*8*
19(B)	Enumerate the challenges involved in biped motion of humanoid robots	*6*

OR

20(A)	Discuss the significant roles played by robotics in different areas for realizing Industry 4.0.	*8*
20(B)	Examine the involvement of artificial intelligence in Robotics	*6*

ERT445	OBJECT ORIENTEDPROGRAMMING	CATEGORY	L	T	P	CREDIT
		OEC	2	1	0	3

Prerequisite: Topics covered under the course PROGRAMMING IN C (EST 102) Course Outcomes: After the completion of the course the student will be able to

CO1	Write Java programs using the object-oriented concepts - classes, objects, constructors, inheritance and polymorphism (Cognitive Knowledge Level: **Apply**)
CO2	Utilize datatypes, operators, control statements, built in packages & interfaces, Input/ Output Streams and Files in Java to develop programs (Cognitive Knowledge Level: **Apply**)
CO3	Illustrate how robust programs can be written in Java using exception handling mechanism (Cognitive Knowledge Level: **Understand**)
CO4	Write application programs in Java using multithreading and database connectivity (Cognitive Knowledge Level: **Apply**)
CO5	Write Graphical User Interface based application programs by utilizing event handling features and Swing in Java (Cognitive Knowledge Level: **Apply**)

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✔	✔	✔	✔								✔
CO2	✔	✔	✔	✔								✔
CO3	✔	✔	✔	✔						✔		✔
CO4	✔	✔	✔	✔								✔
CO5	✔	✔	✔	✔								✔

Abstract POs defined by National Board of Accreditation			
PO#	**BroadPO**	**PO#**	**BroadPO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Lifelong learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks (%)
	Test1 (Marks %)	Test2 (Marks %)	
Remember	30	30	30
Understand	30	30	30
Apply	40	40	40
Analyse			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	**50**	**100**	**3 hours**

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Tests : 25 marks

Continuous Assessment Assignment : 15 marks

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks

First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus.

There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly covered module), having 3 marksfor each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly covered module), each with 7 marks. Out of the 7 questions in Part B, a student should answer any 5.

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

SYLLABUS

Syllabus

Module 1 (Introduction):

Basic Object-Oriented concepts -Object Modeling Using Unified Modeling Language (UML) – UML diagrams, Use case model, Class diagram, Activity diagram.

Introduction to Java - Java programming and Runtime Environment, Development Platforms- Java Virtual Machine (JVM), Java compiler, Bytecode, Java Buzzwords, Java program structure, Comments.

Primitive Data types - Integers, Floating Point Types, Characters, Boolean. Literals, Type Conversion and Casting, Variables, Arrays, Strings, Vector class.

Operators - Arithmetic Operators, Bitwise Operators, Relational Operators, Boolean Logical Operators, Assignment Operator, Conditional (Ternary) Operator, Operator Precedence.

Control Statements - Selection Statements, Iteration Statements and Jump Statements.

Module 2 (Core Java Fundamentals):

Object Oriented Programming in Java - Class Fundamentals, Declaring Objects, Introduction to Methods, Constructors, **this** Keyword, Method Overloading, Access Control, Static Members, Final Variables.

Inheritance - Super Class, Sub Class, The Keyword **super**, protected Members, Method Overriding, the Object class, Abstract Classes and Methods.

Module 3 (More features of Java):

Packages and Interfaces - Defining Package, ImportingPackages, Interfaces.

Exception Handling - Checked Exceptions, Unchecked Exceptions, **try** Block and **catch** Clause, Multiple **catch** Clauses, Nested **try** Statements, **throw**, **throws** and **finally**.

Input/output - I/O Basics, Reading Console Input, Writing Console Output, Print Writer Class, Object Streams and Serialization, Working with Files.

Module 4 (Advanced features of Java):

Java Library - String Handling – String Constructors, String Length, Special String Operations - Character Extraction, String Comparison, Searching Strings, Modifying Strings, using value of().

Multithreaded Programming - The Java Thread Model, The Main Thread, Creating Thread, Creating Multiple Threads, Synchronization, Suspending, Resuming and Stopping Threads.

Module 5 (Graphical User Interface and Database support of Java):

Swings fundamentals-Swing Controls, Components and Containers, Swing Packages, EventHandling in Swings, Swing Layout Managers, Exploring Swings –JFrame, JLabel, Swing Buttons,JText Field.

Java Database Connectivity **(**JDBC) - JDBC overview, Creating and Executing Queries – create table, delete, insert, select.

Text Books:

1. Herbert Schildt, Java: The Complete Reference, 8/e, Tata McGraw Hill, 2011.

   Rajib Mall, Fundamentals of Software Engineering, 4th edition, PHI, 2014.

2. Paul Deitel, Harvey Deitel, Java How to Program, Early Objects 11th Edition, Pearson,2018.

Reference Books:

1. Y. Daniel Liang, Introduction to Java Programming, 7/e, Pearson, 2013.
2. Nageswararao R., Core Java: An Integrated Approach, Dreamtech Press, 2008.
3. Flanagan D., Java in A Nutshell, 5/e, O'Reilly, 2005.
4. Barclay K., J. Savage, Object Oriented Design with UML and Java, Elsevier, 2004.
5. Sierra K., Head First Java, 2/e, O'Reilly, 2005.
6. Balagurusamy E., Programming JAVA a Primer, 5/e, McGraw Hill, 2014.

Sample Course Level Assessment Questions

Course Outcome1(CO1): For the following passage develop UML diagrams and then implement it as a Java program in accordance with your UML design.

Passage: College Office collects semester fee and college bus fee for each student. A clerkat the college office collects the fees from each student. The bus fee is calculated depending on the distance of the corresponding bus stop from the college. The semester fee varies depending upon the semester as well as branch of each student. Students are supposed to pay the fees in full. Economically backward students are eligible for 50% discount in semester fee. The consolidated fees receipt is issued to each student by the clerk, which contains the student name, admission number, semester and branch of studentalong with details of fees collected. Students can log in and view the details of fees remitted and dues if any. The system allows students and clerk level login to the system. Clerk is able to view reports of each class showing status of fees payment of each student.

Course Outcome 2(CO2): Write a Java program to evaluate a post fix expression containing two operands and a single operator using stack. Stack should be implementedas a separate entity so as to reflect OOP concepts.

Course Outcome 3(CO3): Write a program to demonstrate exception handling mechanism.

Course Outcome 4(CO4): Write a program to demonstrate the start, run, sleep and join methods in Thread class.

Course Outcome 5(CO5): Using Swing create a JFrame with a JLabel and two JButtons.Set the texts of JButtons as “Yes” and “No” respectively. Set the JLabel’s text to the textof the button currently being pressed. Initially the JLabel’s text is blank.

Model Question Paper

QP CODE: PAGES:3

Reg No:_____

Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B.TECH. DEGREE EXAMINATION, MONTH& YEAR

Course Code: ERT 445

Course Name: Object Oriented Programming

Max.Marks:100 **Duration: 3Hours**

PART A

Answer all Questions. Each question carries 3 Marks

1. Briefly explain the portable, secure and robust features of Java.
2. Describe the concepts of object and class with a suitable Java program.
3. Explain the concept of method overriding with an example.
4. What is the use of the keyword ***final*** in Java?
5. Explain the concept of streams.
6. Explain any two applications of Serialization.
7. Distinguish the usage of "==" and ***equals()*** method when comparing String type?
8. Explain String class constructors.
9. Explain any two properties of Swing components in Java.
10. Explain JLabel component. With suitable examples explain any two of its constructors.

Part B

Answer any one question completely from each module

11.

(a) Describe in detail any three Object Oriented Programming principles. Illustrate with suitable examples. (9)

(b) What is Java Runtime Environment? What is the role of Java Virtual Machine in it? (5)

OR

12. (a) Explain Java buzzwords. (5)

(b) Why is Java considered to be platform independent? What is the role of Bytecode inmaking Java platform independent? (9)

13 (a) Explain in detail the primitive data types in Java. 8

(b) Explain automatic type conversion in Java with an example. What are the two conditions required for it? 6

OR

14 (a) Using a suitable Java program explain the difference between ***private*** and ***public*** members in the context of inheritance. 8

(b) Is it possible to use the keyword ***super*** within a static method? Give justification foryour answer. 6

15	(a)	Explain in detail about byte streams and character streams with suitable code samples.	6
	(b)	Describe in detail about exception handling, ***try*** block and ***catch*** clause with the helpof a suitable Java program.	8
		OR	
16	(a)	Explain object streams in Java. Explain the role of Serializable interface with asuitable code sample.	8
	(b)	Explain ***throw***, ***throws*** and ***finally*** constructs with the help of a Java program.	6
17		Describe in detail the creation of a thread using the Runnable interface and theThread class with suitable examples.	14
		OR	
18	(a)	Explain in detail the Delegation Event model for event handling in Java.	7
	(b)	Write a simple program by extending appropriate class to demonstrate the working ofthreads in java.	8
19	(a)	Write a Java program to demonstrate the use of JLabel and JButton by adding themto JFrame.	7
	(b)	Explain step-by-step procedure of using Java Data Base Connectivity in Java programs.	7
		OR	
20	(a)	Explain the class hierarchy of Java Swing components.	7
	(b)	Write a Java Program to create a student table and to add student details to it usingJDBC.	7

Teaching Plan		
Module 1 : Introduction		**(8 hours)**
1.1	Basic Object-Oriented concepts, Java Buzzwords	1 hour
1.2	Object Modeling Using UML – UML diagrams, Use case model	1 hour
1.3	Class diagram, Activity diagram.	1 hour

1.4	Introduction to Java - Java programming and Runtime Environment, Java Virtual Machine (JVM), Java compiler,Bytecode, Java program structure, Comments	1hour
1.5	Primitive Data types - Integers, Floating Point Types, Characters, Boolean Literals, Type Conversion and Casting, Variables	1hour
1.6	Arrays, Strings, Vector class	1hour
1.7	Operators - Arithmetic Operators, Bitwise Operators, Relational Operators, Boolean Logical Operators, Assignment Operator, Conditional (Ternary) Operator, Operator Precedence.	1hour
1.8	Control Statements - Selection Statements, Iteration Statements and Jump Statements.	1hour
Module 2: Core Java Fundamentals		**(7 hours)**
2.1	Object Oriented Programming in Java - Class Fundamentals, Declaring Objects, Introduction to Methods.	1 hour
2.2	Constructors, ***this*** Keyword, Method Overloading,	1 hour
2.3	Using Objects as Parameters, Returning Objects	1 hour
2.4	Access Control, Static Members, Final Variables	1 hour
2.5	Inheritance - Super Class, Sub Class, The Keyword ***super***,	1 hour
2.6	Method Overriding, Final Variables,	1 hour
2.7	The Object class, Abstract Classes and Methods, using ***final*** with Inheritance.	1 hour
Module 3: More features of Java		**(8 hours)**
3.1	Packages and Interfaces: Defining Package, Importing Packages	1 hour
3.2	Interfaces	1 hour
3.3	Input / Output: I/O Basics, Reading Console Input, Writing ConsoleOutput, Print Writer Class	1 hour
3.4	Object Streams and Serialization	1 hour
3.5	Working with Files	1 hour
3.6	Exception Handling**:** Checked Exceptions, Unchecked Exceptions, ***try*** Block and ***catch*** Clause	1 hour

3.7	Multiple ***catch*** Clauses, Nested ***try*** Statements	1 hour
3.8	***throw***, ***throws*** and ***finally***	1 hour
Module 4: Advanced features of Java		**(8 hours)**
4.1	Java Library: String Handling – String Constructors, String Length, Special String Operations	1hour
4.2	Character Extraction, String Comparison, Searching Strings, Modifying Strings Using value Of()	1hour
4.3	Multithreaded Programming: The Java Thread Model, The Main Thread, Creating Thread	1hour
4.4	Creating Multiple Threads, Synchronization.	1hour
4.5	Suspending, Resuming and Stopping Threads.	1hour
4.6	Event handling - Event Handling Mechanisms, Delegation Event Model	1hour
4.7	Event Classes, Sources of Events	1hour
4.8	Event Listener Interfaces	1 hour
Module 5: Graphical User Interface and Database support of Java		**(7 hours)**
5.1	Swings fundamentals, Swing Controls,	1hour
5.2	Components and Containers, Swing Layout Managers	1hour
5.3	Swing Packages, Event Handling in Swings.	1hour
5.4	Exploring Swings –JFrame, JLabel, The Swing Buttons, JText Field.	1 hour
5.5	JDBC overview, Creating and Executing Queries – create table,delete, insert, select (Basics only, DBMS course is not a prerequisite).	1hour
5.6	Creating and Executing Queries – create table, delete, insert, select.	1hour
5.7	Creating and Executing Queries – create table, delete, insert, select.	1 hour

ERT 455	CONCEPTS INMACHINE LEARNING	Category	L	T	P	Credit
		OEC	2	1	0	3

Prerequisite: Familiarity with basics in linear algebra, probability and Python programming.

	Course Outcomes
CO1	Illustrate Machine Learning concepts and basic parameter estimation methods. **(Cognitive Knowledge Level: Apply)**
CO2	Demonstrate supervised learning concepts (regression, linear classification). **(Cognitive Knowledge Level**: **Apply**)
CO3	Illustrate the concepts of Multilayer neural network and Support Vector Machine **(Cognitive Knowledge Level: Apply**)
CO4	Describe unsupervised learning concepts and dimensionality reduction techniques. (**Cognitive Knowledge Level**: **Apply**)
CO5	Solve real life problems using appropriate machine learning models and evaluate the performance measures (**Cognitive Knowledge Level: Apply**)

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓							✓
CO2	✓	✓	✓	✓	✓							✓
CO3	✓	✓	✓	✓	✓							✓
CO4	✓	✓	✓	✓	✓							✓
CO5	✓	✓	✓	✓	✓	✓						✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Lifelong learning

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination Marks**
	Test1 (Percentage)	**Test2 (Percentage)**	
Remember	**30**	**30**	**30**
Understand	**30**	**30**	**30**
Apply	**40**	**40**	**40**
Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	**CIE Marks**	**ESE Marks**	**ESE Duration**
150	**50**	**100**	**3 hours**

Continuous Internal Evaluation Pattern:

Attendance : **10 marks**

Continuous Assessment Tests : **25 marks**

Continuous Assessment Assignment : **15 marks**

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks

First Internal Examination shall be preferably conducted after completing the first half of the syllabus and the Second Internal Examination shall be preferably conducted after completing remaining part of the syllabus.

There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly covered module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly covered module), each with 7 marks. Out of the 7 questions in Part B, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Syllabus

Module-1 (Overview of machine learning)

Machine learning paradigms-supervised, semi-supervised, unsupervised, reinforcement learning. Basics of parameter estimation - maximum likelihood estimation (MLE) and maximum a posteriori estimation(MAP). Introduction to Bayesian formulation.

Module-2 (Supervised Learning)

Regression - Linear regression with one variable, Linear regression with multiple variables, solution using gradient descent algorithm and matrix method, basic idea of overfitting inregression. Linear Methods for Classification- Logistic regression, Perceptron, Naive Bayes, Decision tree algorithm ID3.

Module-3 (Neural Networks (NN) and Support Vector Machines (SVM))

NN - Multilayer feed forward network, Activation functions (Sigmoid, ReLU, Tanh), Backpropagation algorithm. SVM - Introduction, Maximum Margin Classification, Mathematics behind Maximum Margin Classification, Maximum Margin linear separators, soft margin SVM classifier, non-linear SVM, Kernels for learning non-linear functions, polynomial kernel, Radial Basis Function (RBF).

Module-4 (Unsupervised Learning)

Clustering - Similarity measures, Hierarchical Agglomerative Clustering, K-means partitional clustering, Expectation maximization (EM) for soft clustering. Dimensionality reduction – Principal Component Analysis, factor Analysis, Multidimensional scaling, Linear Discriminant Analysis.

Module-5 (Classification Assessment)

Classification Performance measures - Precision, Recall, Accuracy, F-Measure, Receiver Operating Characteristic Curve (ROC), Area Under Curve (AUC. Bootstrapping, Cross Validation, Ensemble methods, Bias-Variance decomposition. Case Study: Develop a classifier for face detection.

Text Book

1. Ethem Alpaydin, Introduction to Machine Learning, 2nd edition, MIT Press 2010.
2. Mohammed J. Zaki and Wagner Meira, Data Mining and Analysis: Fundamental Concepts and Algorithms, Cambridge University Press, First South Asia edition, 2016.
3. Jake VanderPlas, Python Data Science Handbook, O'Reilly Media, 2016
4. Tom Mitchell, Machine Learning, McGraw-Hill, 1997.

Reference Books

1. Christopher Bishop. Neural Networks for Pattern Recognition, Oxford UniversityPress, 1995.
2. Kevin P. Murphy. Machine Learning: A Probabilistic Perspective, MIT Press2012.
3. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements Of StatisticalLearning, Second edition Springer 2007.
4. P. Langley, Elements of Machine Learning, Morgan Kaufmann, 1995.
5. Richert and Coelho, Building Machine Learning Systems with Python.
6. Davy Cielen, Arno DB Meysman and Mohamed Ali. Introducing Data Science:Big Data, Machine Learning, and More, Using Python Tools, Dreamtech Press 2016.

Sample Course Level Assessment Questions

Course Outcome1 (CO1):

1. A coin is tossed 100 times and lands heads 62 times. What is the maximum likelihood estimate for θ, the probability of heads.
2. Suppose data $x_1, ..., x_n$ are independent and identically distributed drawn from anexponential distribution $exp(\lambda)$. Find the maximum likelihood for λ.

3. Suppose $x_1, ..., x_n$ are independent and identically distributed(iid) samples from adistribution with density

$$f_X(x \mid \theta) = \begin{cases} \frac{\theta x^{\theta-1}}{3^\theta}, & 0 \le x \le 3 \\ 0, & \text{otherwise} \end{cases}$$

Find the maximum likelihood estimate (MLE) for θ.

4. Find the maximum likelihood estimator (MLE) and maximum a posteriori (MAP) estimator for the mean of a univariate normal distribution. Assume that we have N samples, $x_1,..., x_N$ independently drawn from a normal distribution with known variance σ^2 and unknown mean μ and the prior distribution for the mean is itself a normal distribution with mean ν and variance β^2. What happens to the MLE and MAP estimators as the number of samples goes to infinity.

Course Outcome 2 (CO2):

1. Explain the difference between (batch) gradient descent and stochastic gradient descent. Give an example of when you might prefer one over the other.
2. Suppose that you are asked to perform linear regression to learn the function that outputs y, given the D-dimensional input x. You are given N independent data points, and that all the D attributes are linearly independent. Assuming that D is around 100, would you prefer the closed form solution or gradient descent to estimate the regressor?
3. Suppose you have a three-class problem where class label $y \in 0, 1, 2$and each training example X has 3 binary attributes $X_1, X_2, X_3 \in 0, 1$. How many parameters (probability distribution) do you need to know to classify an example using the Naive Bayes classifier?

Course Outcome 3 (CO3):

1. What are support vectors and list any three properties of the support vector classifiersolution?
2. Why do you use kernels to model a projection from attributes into a feature space, insteadof simply projecting the dataset directly?
3. Describe how Support Vector Machines can be extended to make use of kernels. Illustratewith reference to the Gaussian kernel $K(x, y) = e^{-z}$,where $z = (x-y)^2$.
4. Briefly explain one way in which using tanh instead of logistic activations makes optimization easier.
5. ReLU activation functions are most used in neural networks instead of the tanh activation function. Draw both activation functions and give a) an advantage of the ReLU function compared to the tanh function. b) a disadvantage of the ReLU function compared to the tanh function.

Course Outcome 4(CO4):

1. Describe cluster analysis? Identify two applications where cluster analysis can be appliedto multimedia data?
2. Given two objects represented by the tuples (22, 1, 42, 10) and (20, 0, 36, 8):
   (i) Compute the Euclidean distance between the two objects.
   (ii) Compute the Manhattan distance between the two objects.
3. Use PCA to reduce the dimension from 2 to 1 for the design matrix ***X***.

$$X = \begin{bmatrix} 6 & -4 \\ -3 & 5 \\ -2 & 6 \\ 7 & -3 \end{bmatrix}$$

4. What is Principal Component Analysis (PCA)? Which eigen value indicates the direction of largest variance?
5. Suppose that one runs a principal component analysis on a data set and tells that the percentage of variance explained by the first 3 components is 80%. How is this percentage of variance explained?

Course Outcome 5 (CO5):

1. Suppose that you are contacted by a food processing company that wants you to develop a classifier that detects whether a rat is present in an image. You collect a large dataset of images by crawling the web, and have annotators determine which images contain rats. This set of images can then be used as the training set for your classifier.

a. Suggest a machine learning method to use for this classification task and evaluate its performance.

b. After you have delivered your solution to the company, they get back to you and complain that when they evaluate on a new test set, they get precision and recall values that are much lower than what you reported to them. Explain what might have gone wrong and propose remedial measures.

2. A real estate firm would like to build a system that predicts the sale prices of a house. They create a spreadsheet containing information about 1,500 house sales in the Kochi area. In addition to the price, there are 10 features describing the house, such as numberof bedrooms, total indoor area, lot area, a swimming pool, location, etc. Explain how you would implement

a machine learning model that would solve this prediction task. Give allsteps you would carry out when developing it. Explain why the model you built is probably useless in the long run.

3. For a classifier, the confusion matrix is given by:

	+	-
+	9	9
-	1	5

What is the precision, recall and accuracy of that classifier?

Model Question Paper

QP CODE: PAGES: 3

Reg No:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B.TECH. DEGREE EXAMINATION MONTH & YEAR

Course Code: ERT 455

Course Name: CONCEPTS IN MACHINE LEARNING

Max.Marks:100 **Duration: 3**Hours

PART A

Answer all Questions. Each question carries 3 Marks

1	Define supervised learning? Name special cases of supervised learning depending on whetherthe inputs/outputs are categorical, or continuous.
2	Differentiate between Maximum Likelihood estimation (MLE) and Maximum a Posteriori(MAP) estimation?
3	What is overfitting and why is it a problem? Give an example of a method to reduce the riskof overfitting.
4	Specify the basic principle of gradient descent algorithm.
5	Suppose that you have a linear support vector machine (SVM) binary classifier. Consider apoint that is currently classified correctly, and is far away from the decision boundary. If you remove the point from the training set, and re-train the classifier, will the decision boundary change or stay the same? Justify your answer.

6 Mention the primary motivation for using the kernel trick in machine learning algorithms?

7 Expectation maximization (EM) is designed to find a maximum likelihood setting of the parameters of a model when some of the data is missing. Does the algorithm converge? If so, do you obtain a locally or globally optimal set of parameters?

8 Illustrate the strength and weakness of k-means algorithm.

9 Classifier A attains 100% accuracy on the training set and 70% accuracy on the test set. Classifier B attains 70% accuracy on the training set and 75% accuracy on the test set. Which one is a better classifier. Justify your answer.

10 How does bias and variance trade-off affect machine learning algorithms?

(10X3=30)

Part B

Answer any one Question from each module. Each question carries 14 Marks

11 (a) Suppose that ***X*** is a discrete random variable with the following probability mass function: where $\boldsymbol{0 \leq \theta \leq 1}$ is a parameter. The following 10 independent observations

X	0	1	2	3
$P(X)$	$2\theta/3$	$\theta/3$	$2(1-\theta)/3$	$(1-\theta)/3$

6

were taken from such a distribution: ***(3, 0, 2, 1, 3, 2, 1, 0, 2, 1)***. What is the maximum likelihood estimate of $\boldsymbol{\theta}$.

A gamma distribution with parameters $\boldsymbol{\alpha, \beta}$ has the following density function, where $\boldsymbol{\Gamma(t)}$ is the gamma function.

$$p(x) = \frac{\beta^{\alpha}}{\Gamma(\alpha)} x^{\alpha-1} e^{-\beta x}$$

(b) If the posterior distribution is in the same family as the prior distribution, then we say thatthe prior distribution is the conjugate prior for the likelihood function. Using the Gamma distribution as a prior, show that the Exponential distribution is a conjugate prior of the Gamma distribution. Also, find the maximum a posteriori estimator for the parameter of the Exponential distribution as a function of $\boldsymbol{\alpha}$ and $\boldsymbol{\beta}$. 8

OR

12 (a) Traffic between 8AM and 9AM at a certain place was measured by counting the number of vehicles that passed at that time. Suppose the counts follow a Poisson process. A random sample of 9 observations was collected, having observed the following number of vehicles: (95, 100, 80, 70, 110, 98, 97, 90, 70). Derive the maximum likelihood estimator for the average number of vehicles that pass by that place between 8 AM and 9 AM, and computethe corresponding estimate using the given sample. 7

(b) Find the maximum a posteriori (MAP) estimator for the mean of a univariate normal distribution. Assume that we have N samples, $x_1,..., x_N$ independently drawn from a normal distribution with known variance σ^2 and unknown mean μ and the prior distribution for the mean is itself a normal distribution with mean v and variance β^2. 7

13 (a) Derive the gradient descent training rule assuming for the target function $o_d = w_0 + w_1x_1 + ... + w_nx_n$. Define explicitly the squared cost/error function E, assuming that a set of training examples D is provided, where each training example $d \in D$ is associated with the target output t_d. 10

(b) How can we interpret the output of a two-class logistic regression classifier as a probability? 4

OR

14 (a) In a two-class logistic regression model, the weight vector $w = [4, 3, 2, 1, 0]$. We apply itto some object that we would like to classify; the vectorized feature representation of this 6

education	residence	gender	has car?
sec	country	female	yes
univ	country	female	yes
prim	city	male	no
univ	city	male	no
sec	city	female	no
sec	country	male	yes
prim	country	female	yes
univ	country	male	yes
sec	city	male	yes
prim	city	female	no
univ	city	female	no
prim	country	male	yes

object is ***x = [−2, 0,−3, 0.5, 3]***. What is the probability, according to the model, that this instance belongs to the positive class?

(b) The following dataset can be used to train a classifier that determines whether a given personis likely to own a car or not. There are three features: education level (primary, secondary, oruniversity); residence (city or country); gender (female, male). Find the root attribute and justify your answer 8

15 (a) Consider a support vector machine whose input space is 2-D, and the inner products are computed by means of the kernel $K(x, y) = (x.y + 1)^2 - 1$, where $x.y$ denotes the ordinary inner product. Show that the mapping to feature space that is implicitly defined by this kernel is the mapping to 5-D given by 10

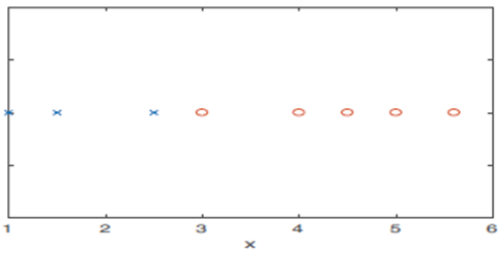
$$\mathbf{x} = \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} \rightarrow \phi(\mathbf{x}) = \begin{bmatrix} x_1^2 \\ x_2^2 \\ \sqrt{2}\, x_1 x_2 \\ \sqrt{2}\, x_1 \\ \sqrt{2}\, x_2 \end{bmatrix}.$$

(b) What is the basic idea of a Support Vector Machine? 4

OR

16 (a) Explain how back propagation can be used to solve XOR problem which is not linearly separable. 8

(b) Consider the following one-dimensional training data set, 'x' denotes negative examples and 'o' positive examples. The exact data points and their labels are given in the table. Supposea SVM is used to classify this data. Indicate which are the support vectors and mark the decision boundary. Find the equation of the hyper plane. 6



x	1	1.5	2.5	3	4	4.5	5	5.6
y	-1	-1	-1	1	1	1	1	1

17 (a) Suppose that we have the following data (one variable). Use single linkage Agglomerative clustering to identify the clusters. 8

Daa: (2, 5, 9, 15, 16, 18, 25, 33, 33, 45).

(b) Given two objects represented by the tuples (22, 1, 42, 10) and (20, 0, 36, 8):

(i) Compute the Euclidean distance between the two objects.

(ii) Compute the Manhattan distance between the two objects. 6

Compute the Minkowski distance between the two objects, using p = 3

OR

18 (a) Suppose that we have the following data:

a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*j*
(2,0)	(1,2)	(2,2)	(3,2)	(2,3)	(3,3)	(2,4)	(3,4)	(4,4)	(3,5)

10

Identify the cluster by applying the k-means algorithm, with k = 2. Try using initial cluster centers as far apart as possible.

(b) List the steps involved in Principal Component Analysis. 4

19 (a) Suppose the dataset had 9700 cancer-free images from 10000 images from cancerpatients. Find precision, recall and accuracy? Is it a good classifier? Justify. 8

Actual Class\ Predicted class	**cancer = yes**	**cancer = no**	**Total**

cancer = yes	90	210	300
cancer = no	140	9560	9700
Total	230	9770	10000

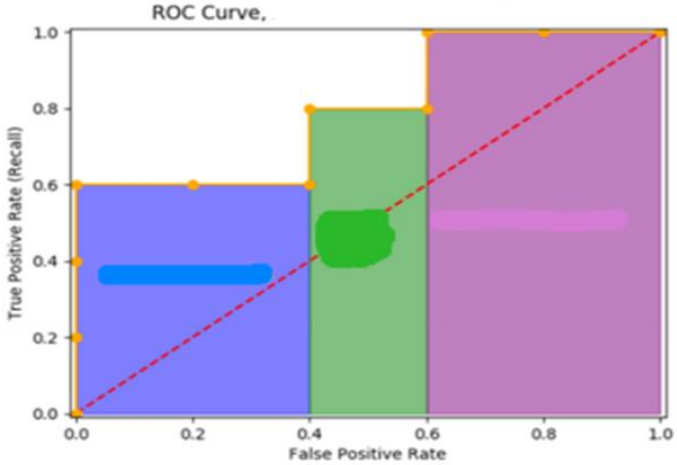
(b) Suppose that you have a classification problem where our feature representation contains about 10,000,000 features. We would like to develop a classifier that can be deployed in a mobile phone, so preferably it should have a small memory footprint. Discuss one solution for how this can be done. 6

OR

20 (a) What are ROC space and ROC curve in machine learning? In ROC space, which points correspond to perfect prediction, always positive prediction and always negative prediction? Why? 6

(b) Suppose there are three classifiers A,B and C. The (FPR, TPR) measures of the threeclassifiers are as follows – A (0, 1), B (1, 1) , C (1,0.5). Which can be considered as aperfect classifier? Justify your answer. 4

(c) Given the following ROC Curve? Find the AUC? 4



Teaching Plan

No	Contents	No of Lecture Hrs
Module 1 : Overview of machine learning (7 hours)		

1.1	Supervised, semi-supervised, unsupervised learning, reinforcement learning (Text Book (TB) 1: Chapter 1)	1hour
1.2	Maximum likelihood estimation (MLE) (TB 1: Section 4.2)	1hour
1.3	Maximum likelihood estimation (MLE)- example (TB 1: Section 4.2)	1hour
1.4	Maximum a posteriori estimation (MAP) (TB 4: Section 6.2)	1hour
1.5	Maximum a posteriori estimation (MAP)-example (TB 4: Section 6.2)	1hour
1.6	Bayesian formulation (TB 1: Section 14.1, 14.2)	1hour
1.7	Bayesian formulation -example (TB 1: Section 14.1, 14.2)	1hour
Module 2 : Supervised Learning (8 hours)		
2.1	Linear regression with one variable (TB 1: Section 2.6)	1hour
2.2	Multiple variables, Solution using gradient descent algorithm and matrix method (No derivation required) (TB 1: Section 5.8)	1hour
2.3	Overfitting in regression, Lasso and Ridge regularization	1hour
2.4	Logistic regression	1hour
2.5	Perceptron	1hour
2.6	Naive Bayes (TB 2: Section 18.2)	1hour
2.7	Decision trees (TB 2: Chapter 19)	1hour
2.8	Decision trees- ID3 algorithm (TB 2: Chapter 19)	1hour
Module 3 : Neural Networks and Support Vector Machines (TB 2: Chapter 21) (11 hours)		
3.1	Multilayer Feed forward Network, Activation Functions (Sigmoid, ReLU, Tanh)	1hour
3.2	Back Propagation Algorithm	1hour
3.3	Illustrative Example for Back Propagation	1hour
3.4	Introduction, Maximum Margin Hyperplane,	1hour
3.5	Mathematics behind Maximum Margin Classification	1hour
3.6	Formulation of maximum margin hyperplane and solution	1hour
3.7	Soft margin SVM	1hour
3.8	Solution of Soft margin SVM	1hour
3.9	Non-linear SVM	1hour

3.10	Kernels for learning non-linear functions and properties of kernel functions.	1hour
3.11	Example Kernels functions- Linear, RBF, Polynomial.	1hour
Module 4 : Unsupervised Learning (10 hours)		
4.1	Similarity measures- Minkowski distance measures (Manhattan, Euclidean), Cosine Similarity	1hour
4.2	Clustering - Hierarchical Clustering (TB 2: Chapter 14)	1hour
4.3	K-means partitional clustering (TB 2: Chapter 13)	1hour
4.4	Expectation maximization (EM) for soft clustering (TB 2: Chapter 13)	1hour
4.5	Expectation maximization (EM) for soft clustering (TB 2: Chapter 13)	1hour
4.6	Dimensionality reduction – Principal Component Analysis (TB 1: Section 6.3)	1hour
4.7	Dimensionality reduction – Principal Component Analysis (TB 1: Section 6.3)	1hour
4.8	Factor Analysis (TB 1: Section 6.4)	1hour
4.9	Multidimensional scaling (TB 1: Section 6.5)	1hour
4.10	Linear Discriminant Analysis (TB 1: Section 6.6)	1hour
Module 5 : Classification Assessment (8 hours)		
5.1	Performance measures - Precision, Recall, Accuracy, F-Measure, ROC, AUC. (TB 2: Chapter 22.1)	1hour
5.2	Boot strapping, Cross validation	1hour
5.3	Ensemble methods- bagging	1hour
5.4	Ensemble methods- boosting	1hour
5.5	Bias-Variance decomposition (TB 2: Chapter 22.3)	1hour
5.6	Bias-Variance decomposition (TB 2: Chapter 22.3)	1hour
5.7	Face detection (TB 3: Chapter 5 Section Application: A Face Detection Pipeline)	1hour
5.8	Face detection (TB 3: Chapter 5 Section Application: A Face Detection Pipeline)	1hour

ERT465	INTERNET OF THINGS	CATEGORY	L	T	P	CREDIT
		OEC	2	1	0	3

Prerequisite: Basic knowledge in Data Communication, Computer Networks and Programming in Python

Course Outcomes: After the completion of the course the students will be able to

CO1	Outline the fundamentals of IoT and its underlying physical and logical architecture **(CognitiveKnowledge Level: Understand)**
CO2	Explain the hardware architectures for IoT (**Cognitive Knowledge Level: Understand)**
CO3	Outline the Network architectures for IoT**(Cognitive Knowledge Level : Understand)**
CO4	Implement data analytics on the IoT platforms **(Cognitive Knowledge Level : Apply)**
CO5	Appreciate the security considerations in IoT **(Cognitive Knowledge Level : Understand)**
CO6	Implement IoT applications using the available hardware and software. **(Cognitive Knowledge Level : Apply)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓									✓
CO2	✓	✓	✓									✓
CO3	✓	✓	✓									✓
CO4	✓	✓	✓	✓	✓							✓
CO5	✓	✓	✓		✓							✓
CO6	✓	✓	✓	✓	✓	✓						✓

Abstract POs Defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and teamwork
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Lifelong learning

Assessment Pattern

Blooms Category	**Continuous Assessment Tests**		**End Semester Examination Marks**
	Test 1 (Percentage)	**Test 2 (Percentage)**	
Remember	30	20	30
Understand	60	50	40
Apply	10	30	30
Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	**CIE Marks**	**ESE Marks**	**ESE Duration**
150	**50**	**100**	**3 Hours**

Continuous Internal Evaluation Pattern:

Attendance	**10 marks**
Continuous Assessment Tests	**25 marks**
Continuous Assessment Assignment	**15 marks**

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. First InternalExamination shall be preferably conducted after completing the first half of the syllabus, and the Second Internal Examination shall be preferably conducted after completing the remaining part ofthe syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2questions each from the completed modules and 1 question from the partly covered module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from thecompleted modules and 1 question from the partly covered module), each with 7 marks. Out of the 7 questions in Part B, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer anyone. Each question can have a maximum 2 subdivisions and carries 14 marks.

Syllabus

Module- 1 (IoT Architecture)

What is IoT, Genesis of IoT, IoT and Digitization, IoT Impact, Convergence of IT and IoT, IoT Challenges, IoT Network Architecture and Design, Drivers Behind New Network Architectures, Comparing IoT Architectures, A Simplified IoT Architecture, The Core IoT Functional Stack, IoT Data Management and Compute Stack.

Module- 2 (Engineering IoT Networks)

Smart Objects: The “Things” in IoT, Sensors, Actuators, and Smart Objects, Sensor Networks, Connecting Smart Objects, Communications Criteria, IoT Access Technologies

Module- 3 (IoT Network Layer)

IP as the IoT Network Layer, The Business Case for IP, the need for Optimization, OptimizingIP for IoT, Profiles and Compliances, Application Protocols for IoT, The Transport Layer, IoT Application Transport Methods

Module 4 (Data Analytics for IoT)

Data and Analytics for IoT, An Introduction to Data Analytics for IoT, Machine Learning, Big Data Analytics Tools and Technology, Edge Streaming Analytics, Network Analytics, Securing IoT, A Brief History of OT Security, Common Challenges in OT Security, Differences between IT and OT Security Practices and Systems, Formal Risk Analysis Structures: OCTAVE and FAIR.

Module 5 (Developing IoT Systems)

IoT Logical Design using Python, IoT Physical Devices and Endpoints - Raspberry Pi interfaces, Programming Raspberry Pi using Python, Other IoT devices, IoT Physical devices and Cloud offerings, Cloud Storage Models, WAMP - Autobahn for IoT, Django, Designing RESTful Web API, Cloud Web Services for IoT.

Textbooks

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", 1st Edition, Pearson Education (Cisco Press Indian Reprint)
2. Arshadeep Bahga, Vijay Madisetti, "Internet of Things: A hands-on approach", University Press, 2015 (First edition)

References

1. Rajkamal, "Internet of Things: Architecture and Design Principles", McGraw Hill (India)Private Limited
2. Dieter Uckelmann, Mark Harrison, Michahelles Florian (Ed.), Architecting the internet ofthings, Springer, 2011
3. Dr. Ovidiu Vermesan, Dr. Peter Friess, Internet of Things: Converging Technologies forSmart Environments and Integrated Ecosystems, River Publishers, 2013

Sample Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Write a short note on the impact of IoT in the real world
2. Explain the challenges of IoT.
3. Compare OT and IT Technology.

4. Describe the elements of one M2M architecture of IoT

Course Outcome 2 (CO2):

1. Mention any four wireless technologies and its architectural characteristics
2. Comment things in IoT
3. Compare biosensors and biodegradable sensors used in IoT
4. Explain the term NB IoT (Narrow Band IoT)

Course Outcome 3 (CO3):

1. Discuss the need for optimization
2. Compare MQTT and COAP
3. Explain different schedule management and packet forwarding models of 6TiSCH

Course Outcome 4(CO4):

1. Compare Bigdata and edge analytics
2. Compare structured and unstructured data
3. Describe the components of FNF

Course Outcome 5(CO5):

1. What are the major challenges in IoT security?
2. Explain the impact of OT Network Characteristics on IoT Security.

Course Outcome 6(CO6):

1. Implement LDR interfacing with Raspberry Pi
2. Explain the development of a RESTful web API.

Model Question Paper

QP CODE: PAGES :3

Reg No: _____ Name: _____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B.TECH. DEGREE EXAMINATION, MONTH & YEAR

Course Code: ERT465 Course Name: Internet of Things

Max.Marks : 100 **Duration: 3 Hours**

PART A

Answer All Questions. Each Question Carries 3 Marks

1. Explain the role of IoT in connected roadways,

2. Describe the functions of the various layers of simplified IoT Architecture Model.

3. Explain the communication protocols employed in Wireless Sensor Networks
4. What are the essential performance considerations of constrained-node networks?
5. Explain the parameters to be considered while choosing between IP adaptation /adoption for last mile communication.
6. With neat diagrams compare the IoT protocol stacks using 6LoWPAN and IP.
7. Differentiate the types of IoT data analytics results.
8. How can the insecure operational protocols be characterized?
9. Write a program to interface an LED and a switch with Raspberry Pi
10. List down the Raspberry Pi interfaces and explain.

(10x3=30)

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11	(a)	Illustrate the impact of IoT in at least 2 domains of normal human life.	8
	(b)	Describe the Application and Analytics sublayer of IoT Architecture	6
		OR	
12	(a)	Describe the Standardized IoT architectures.	8
	(b)	Explain the functions of Access Network Sublayer of IoT Architecture	6
13	(a)	Describe the LoRaWAN technology as an IoT communication paradigm.	10
	(b)	Describe various types of sensors.	4
		OR	
14	(a)	Define actuators. Describe the roles of actuators in IoT systems.	6
	(b)	Explain the IEEE 802.15.4 standard for wireless communication.	8
15	(a)	Explain Message Queuing Telemetry Transport framework and messageformat.	8
	(b)	Explain tunneling of legacy SCADA over IP Networks with a neat diagram.	6
		OR	
16	(a)	Explain SCADA Transport over LLNs with MAP-T.	7
	(b)	Explain RPL encryption and authentication on constrained nodes.	7
17	(a)	Explain the Hadoop ecosystem with a neat diagram.	7
	(b)	Explain the Flexible NetFlow Architecture.	7
		OR	

18	(a)	Explain the "The Purdue Model for Control Hierarchy" and OT network characteristics.	8
	(b)	Explain any twp formal risk analysis structures	6
19	(a)	Explain the working of WAMP protocol.	8
	(b)	Describe how AWS supports IoT development	6
		OR	
20	(a)	Demonstrate an example of Raspberry Pi applications for Industrial IoT.	8
	(b)	Explain the Django Architecture	6

TEACHING PLAN

Sl. No	Contents	No of Lecture Hrs
Module – 1 (IoT Architecture) (6 hrs) (TB-1, Chapter 1,2)		
1.1	What is IoT, Genesis of IoT, IoT and Digitization,	1
1.2	IoT Impact, Convergence of IT and IoT, IoT Challenges	1
1.3	IoT Network Architecture and Design	1
1.4	Drivers Behind New Network Architectures, Comparing IoT Architectures	1
1.5	A Simplified IoT Architecture,	1
1.6	The Core IoT Functional Stack, IoT Data Management and Compute Stack.	1
Module- 2 (Engineering IoT Networks) (7hrs) (TB-1, Chapter 3,4)		
2.1	Smart Objects: The "Things" in IoT,	1
2.2	Sensors, Actuators, and Smart Objects	1
2.3	Sensor Networks	1
2.4	Connecting Smart Objects	1
2.5	IoT Access Technologies –IEEE 802.15.4 (g/e), 1901.2a	1
2.6	IoT Access Technologies - 802.11ah, LoRaWAN	1

2.7	IoT Access Technologies – LoRaWAN, NB IoT, LTE	1
Module- 3 (IoT Network Layer) (7 hrs) (TB-1, Chapter 5,6)		
3.1	IP as the IoT Network Layer, The Business Case for IP	1
3.2	The need for Optimizing IP for IoT	1
3.3	Optimizing IP for IoT, Profiles, and Compliance	1
3.4	Application Protocols for IoT - CoAP	1
3.5	Application Protocols for IoT - MQTT	1
3.6	The Transport Layer, IoT Application Transport Methods	1
3.7	The Transport Layer, IoT Application Transport Methods	1
Module 4 (Data Analytics for IoT) (6hrs)(TB-1, Chapter 7,8)		
4.1	An Introduction to Data Analytics for IoT, Machine Learning	1
4.2	Big Data Analytics Tools and Technology	1
4.3	Edge Streaming Analytics, Network Analytics	1
4.4	A Brief History of OT Security, Common Challenges in OT Security	1
4.5	Differences between IT and OT Security Practices and Systems	1
4.6	Formal Risk Analysis Structures: OCTAVE and FAIR	1
Module 5 (Developing IoT Systems) (9 hrs) (TB-2, Chapter 6,7,8)		
5.1	IoT Logical Design using Python,	1
5.2	IoT Physical Devices and Endpoints	1
5.3	Raspberry Pi interfaces, Programming Raspberry Pi using Python	1
5.4	Other IoT devices	1
5.5	Cloud Storage Models	1
5.6	WAMP-Autobahn for IoT	1
5.7	Django	1
5.8	Designing RESTful Web API	1
5.9	Cloud Web Services for IoT.	1

ERL 411	EMBEDDED SYSTEMS AND IoT LAB	CATEGORY	L	T	P	CREDIT
		PCC	0	0	3	2

Prerequisite: ERT 304 Embedded Systems & IoT

Course Outcomes: At the end of the course, the student should be able to

CO1	Implement interfacing of various sensors and actuators with Arduino.
CO2	Implement interfacing of various sensors and actuators with Node MCU.
CO3	Design and develop smart systems using Raspberry Pi.

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO 8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓				✓		✓	✓
CO2	✓	✓	✓	✓	✓				✓		✓	✓
CO3	✓	✓	✓	✓	✓				✓		✓	✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Lifelong learning

Assessment Pattern

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	75	75	3 hours

Continuous Internal Evaluation Pattern:

Attendance	Continuous Evaluation including Viva	Internal Test	Total
15	30	30	75

End Semester Examination Pattern:

Attribute	Marks
Preliminary work	15 Marks
Implementing the work / conducting the experiment	10 Marks
Performance, result and inference	25 Marks
Viva voce	20 Marks
Record	5 Marks

Fair Lab Record:

All Students attending the Embedded Systems and IoT Lab should have a Fair Record. The fair record should be produced in the University Lab Examination. Every experiment conducted in the lab should be noted in the fair record. For every experiment in the fair record, the right-hand page should contain Experiment Heading, Experiment Number, Date of Experiment, Aim of Experiment, Schemas/Menu & Form Design, and Query questions. The left-hand page should contain Queries and sample output (relations created, Form, and Menu Output) obtained for a set of input.

SYLLABUS

Part A: Arduino based embedded system

1. Implement an arduino based system to detect when something is moved, tilted, or shaken.
2. Implement temperature control system by controlling a fan, if the temperature exceeds a limit. (Use arduino as control board)
3. Use Arduino to read the key presses on matrix keypad and display the pressed key on an LCD display.
4. Use Arduino to monitor one or more voltages and take some action when the voltage rises or falls below a threshold. For example, you want to flash an LED to indicate a low battery level—perhaps to start flashing when the voltage drops below a warning threshold and increasing in urgency as the voltage drops further.
5. Use Arduino to measure voltages greater than 5 volts. For example, you want to display

the voltage of a 9V battery and trigger an alarm LED when the voltage falls below a certain level.

Part B: NodeMCU based systems

6. Installing the Arduino IDE for the ESP8266 and connecting the module to your Wi-Fi network.
7. Reading data from a digital sensor connected to a digital pin of ESP8266.
8. Configuring the ESP8266 module and controlling an LED connected to it, from anywhere in the world; using MQTT.
9. Controlling the lock from the cloud using Blynk and NodeMCU.
10. Sending an e-mail/SMS notification based on activity at sensor connected to NodeMCU; using IFTTT.

Part C: Raspberry Pi based systems

11. Setting up Raspberry Pi by installing OS and obtaining static IP of Raspberry Pi.
12. Light an LED by reading status of a switch connected to GPIO of the board.
13. Install Arduino IDE on Raspberry Pi and control LED using LDR; in which both are connected to Digital IO pin of Arduino.
14. Realize a datalogger with ThingSpeak Server: capture the real-time data of any sensor by Raspberry Pi and upload to the cloud.
15. Implement a Home Appliance Control system using Raspberry Pi using Blynk App.

**** Any three experiments are mandatory from each part.**

Text Books:

1. Michael Margolis - Arduino Cookbook_ Recipes to Begin, Expand, and Enhance Your Projects-O'Reilly Media (2016)
2. Marco Schwartz - Internet of Things with ESP8266-Packt Publishing (2016)
3. Rajesh Singh, Anita Gehlot, Lovi Raj Gupta, Bhupendra Singh, Mahendra Swain - Internet Of things With Raspberry Pi And Arduino-CRC Press_Taylor & Francis Group (2019)

References:

1. Misra_Mukherjee_ Roy - Introduction to IoT (2021)
2. Manoj R. Thakur - NodeMCU ESP8266 Communication Methods and Protocols _ Programming with Arduino IDE-Amazon Media EU S.à r.l. (2018)
3. Dhairya Parikh - Raspberry Pi and MQTT Essentials-Packt (2022)
4. Neil Cameron - Electronics Projects with the ESP8266 and ESP32_ Building Web Pages, Applications, and WiFi Enabled Devices-Apress (2021)

5. https://docs.blynk.io/en/
6. https://www.mathworks.com/help/thingspeak/getting-started-with-thingspeak.html

General instructions: Practical examination to be conducted immediately after the second series test covering entire syllabus given below. Evaluation is a serious process that is to be conducted under the equal responsibility of both the internal and external examiners. The number of candidates evaluated per day should not exceed 20. Students shall be allowed for the University examination only on submitting the duly certified record. The external examiner shall endorse the record

ERQ413	SEMINAR	CATEGORY	L	T	P	CREDIT
		PWS	0	0	3	2

Preamble: The course 'Seminar' is intended to enable a B.Tech graduate to read, understand,present and prepare report about an academic document. The learner shall search in the literature including peer reviewed journals, conference, books, project reports etc., and identify an appropriate paper/thesis/report in her/his area of interest, in consultation with her/his seminar guide. This course can help the learner to experience how a presentation can be made about a selected academic document and also empower her/him to prepare a technical report.

Course Objectives:

- To do literature survey in a selected area of study.
- To understand an academic document from the literate and to give a presentationabout it.
- To prepare a technical report.

Course Outcomes [COs] : After successful completion of the course, the students will be ableto:

CO1	Identify academic documents from the literature which are related to her/his areas ofinterest (Cognitive knowledge level: **Apply**).
CO2	Read and apprehend an academic document from the literature which is related to her/ his areas of interest (Cognitive knowledge level: **Analyze**).
CO3	Prepare a presentation about an academic document (Cognitive knowledge level: **Create**).
CO4	Give a presentation about an academic document (Cognitive knowledge level: **Apply**).
CO5	Prepare a technical report (Cognitive knowledge level: **Create**).

Mapping of course outcomes with program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1		2	1					3
CO2	3	3	2	3		2	1					3
CO3	3	2			3			1		2		3
CO4	3				2			1		3		3
CO5	3	3	3	3	2	2		2		3		3

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	PO7	Environment and Sustainability
PO2	Problem Analysis	PO8	Ethics
PO3	Design/Development ofsolutions	PO9	Individual and team work
PO4	Conduct investigations of complex problems	PO10	Communication
PO5	Modern tool usage	PO11	Project Management and Finance
PO6	The Engineer and Society	PO12	Lifelong learning

General Guidelines

- The Department shall form an Internal Evaluation Committee (IEC) for the seminar with academic coordinator for that program as the Chairperson/Chairman and seminar coordinator & seminar guide as members. During the seminar presentation of a student, all members of IEC shall be present.
- Formation of IEC and guide allotment shall be completed within a week after the University examination (or last working day) of the previous semester.
- Guide shall provide required input to their students regarding the selection of topic/ paper.
- Choosing a seminar topic: The topic for a UG seminar should be current and broad based rather than a very specific research work. It's advisable to choose a topic for the Seminar to be closely linked to the final year project area. Every member of the projectteam could choose or be assigned Seminar topics that covers various aspects linked to the Project area.
- A topic/paper relevant to the discipline shall be selected by the student during the semester break.
- Topic/Paper shall be finalized in the first week of the semester and shall be submitted to the IEC.
- The IEC shall approve the selected topic/paper by the second week of the semester.
- Accurate references from genuine peer reviewed published material to be given in the report and to be verified.

Evaluation pattern

Total marks: 100, only CIE, minimum required to pass 50

Seminar Guide: 20 marks (Background Knowledge – 10 (The guide shall give deserving marks for a candidate based on the candidate's background knowledge about the topic selected), Relevance of the paper/topic selected – 10).

Seminar Coordinator: 20 marks (Seminar Diary – 10 (Each student shall maintain a seminar diary and the guide shall monitor the progress of the seminar work on a weekly basis and shall approve the entries in the seminar diary during the weekly meeting with the student), Attendance – 10).

Presentation: 40 marks to be awarded by the IEC (Clarity of presentation – 10, Interactions – 10 (to be based on the candidate's ability to answer questions during the interactive session of her/his presentation), Overall participation – 10 (to be given based onher/his involvement during interactive sessions of presentations by other students), Quality of the slides – 10).

Report: 20 marks to be awarded by the IEC (check for technical content, overall quality, templates followed, adequacy of references etc.).

ERD415	PROJECT PHASE I	CATEGORY	L	T	P	CREDIT
		PWS	0	0	6	2

Preamble: The course 'Project Work' is mainly intended to evoke the innovation and invention skills in a student. The course will provide an opportunity to synthesize and apply the knowledge and analytical skills learned, to be developed as a prototype or simulation. The project extends to2 semesters and will be evaluated in the 7th and 8th semester separately, based on the achieved objectives. One third of the project credits shall be completed in 7th semester and two third in 8th semester. It is recommended that the projects may be finalized in the thrust areas of the respective engineering stream or as interdisciplinary projects. Importance should be given to address societal problems and developing indigenous technologies.

Course Objectives

1. To apply engineering knowledge in practical problem solving.
2. To foster innovation in design of products, processes or systems.
3. To develop creative thinking in finding viable solutions to engineering problems.

Course Outcomes [COs] : After successful completion of the course, the students will be able to:

CO1	Model and solve real world problems by applying knowledge across domains (Cognitive knowledge level: **Apply**).
CO2	Develop products, processes or technologies for sustainable and socially relevant applications (Cognitive knowledge level: **Apply**).
CO3	Function effectively as an individual and as a leader in diverse teams and to comprehend and execute designated tasks (Cognitive knowledge level: **Apply**).
CO4	Plan and execute tasks utilizing available resources within timelines, following ethical and professional norms (Cognitive knowledge level: **Apply**).
CO5	Identify technology/research gaps and propose innovative/creative solutions (Cognitive knowledge level: **Analyze**).
CO6	Organize and communicate technical and scientific findings effectively in written and oral forms (Cognitive knowledge level: **Apply**).

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO2	✓	✓	✓		✓	✓	✓	✓	✓		✓	✓
CO3									✓	✓	✓	✓
CO4					✓			✓	✓	✓	✓	✓
CO5	✓	✓	✓	✓	✓							✓
CO6					✓			✓	✓	✓	✓	✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	PO7	Environment and Sustainability
PO2	Problem Analysis	PO8	Ethics
PO3	Design/Development of solutions	PO9	Individual and team work
PO4	Conduct investigations of complex problems	PO10	Communication
PO5	Modern tool usage	PO11	Project Management and Finance
PO6	The Engineer and Society	PO12	Lifelong learning

PROJECT PHASE I

Phase 1 Target

- Literature study/survey of published literature on the assigned topic
- Formulation of objectives
- Formulation of hypothesis/ design/ methodology
- Formulation of work plan and task allocation.
- Block level design documentation
- Seeking project funds from various agencies

- Preliminary Analysis/Modelling/Simulation/Experiment/Design/Feasibility study
- Preparation of Phase 1 report

Evaluation Guidelines & Rubrics

- Total: 100 marks (Minimum required to pass: 50 marks).
- Project progress evaluation by guide: 30 Marks.
- Interim evaluation by the Evaluation Committee: 20 Marks.
- Final Evaluation by the Evaluation Committee: 30 Marks.
- Project Phase - I Report (By Evaluation Committee): 20 Marks.

(The evaluation committee comprises HoD or a senior faculty member, Project coordinatorand project supervisor).

Evaluation by the Guide

The guide/supervisor shall monitor the progress being carried out by the project groups on a regular basis. In case it is found that progress is unsatisfactory it shall be reported to the Department Evaluation Committee for necessary action. The presence of each student in the groupand their involvement in all stages of execution of the project shall be ensured by the guide.Project evaluation by the guide: 30 Marks. This mark shall be awarded to the students in his/her group by considering the following aspects:

Topic Selection: innovativeness, social relevance etc. (2)

Problem definition: Identification of the social, environmental and ethical issues of the project problem. (2)

Purpose and need of the project: Detailed and extensive explanation of the purpose and need of the project. (3)

Project Objectives: All objectives of the proposed work are well defined; Steps to be followed to solve the defined problem are clearly specified. (2)

Project Scheduling & Distribution of Work among Team members: Detailed and extensive Scheduling with timelines provided for each phase of project. Work breakdown structure well defined. (3)

Literature survey: Outstanding investigation in all aspects. (4)

Student's Diary/ Daily Log: The main purpose of writing daily diary is to cultivate the habit of documenting and to encourage the students to search for details. It develops the students' thought process and reasoning abilities. The students should record in the daily/weekly activity diary the day to day account of the observations, impressions, information gathered and suggestions given,

if any. It should contain the sketches & drawings related to the observations made by the students. The daily/weekly activity diary shall be signed after every day/week by the guide. (7)

Individual Contribution: The contribution of each student at various stages. (7)

EVALUATION RUBRICS for PROJECT Phase I: Interim Evaluation

No.	Parameters	Marks	Poor	Fair	Very Good	Outstanding
1-a	Topic identification, selection, formulation of objectives and/or literature survey. (Group assessment) [CO1]	10	The team has failed to come with a relevant topic in time. Needed full assistance to find a topic from the guide. They do not respond to suggestions from the evaluation committee and/or the guide. No literature review was conducted. The team tried to gather easy information without verifying the authenticity. No objectives formed yet.	The team has identified a topic. The originally selected topic lacks substance and needs to be revised. There were suggestions given to improve the relevance and quality of the project topic. Only a few relevant references were consulted/ studied and there is no clear evidence to show the team's understanding on the same. Some objectives identified, but not clear enough.	Good evidence of the group thinking and brainstorming on what they are going to build. The results of the brainstorming are documented and the selection of topic is relevant. The review of related references was good, but there is scope of improvement. Objectives formed with good clarity; however, some objectives are not realistic enough.	The group has brainstormed in an excellent manner on what they were going to build. The topic selected is highly relevant, real-world problem and is potentially innovative. The group shows extreme interest in the topic and has conducted extensive literature survey in connection with the topic. The team has come up with clear objectives which are feasible.
			(0 – 3 Marks)	(4 – 6 Marks)	(7 - 9 Marks)	(10 Marks)
1-b	Project Planning, Scheduling and Resource/ Tasks Identification and allocation. (Group assessment) [CO4]	10	No evidence of planning or scheduling of the project. The students did not plan what they were going to build or plan on what materials / resources to use in the project. The students do not have any idea on the budget required. The team has not yet decided on who does what. No project journal kept.	Some evidence of a primary plan. There were some ideas on the materials /resources required, but not really thought out. The students have some idea on the finances required, but they have not formalized a budget plan. Schedules were not prepared. The project journal has no details. Some evidence on task allocation among the team members.	Good evidence of planning done. Materials were listed and thought out, but the plan wasn't quite complete. Schedules were prepared, but not detailed, and needs improvement. Project journal is presented but it is not complete in all respect / detailed. There is better task allocation and individual members understand about their tasks. There is room for improvement.	Excellent evidence of enterprising and extensive project planning. Gantt charts were used to depict detailed project scheduling. A project management/version control tool is used to track the project, which shows familiarity with modern tools. All materials / resources were identified and listed and anticipation of procuring time is done. Detailed budgeting is done. All tasks were identified and incorporated in the schedule. A well-kept project journal shows evidence for all the above, in addition to the interaction with the project guide. Each member knows well about their individual tasks.
			(0 – 3 Marks)	(4 – 6 Marks)	(7 - 9 Marks)	(10 Marks)
Phase 1 Interim Evaluation Total Marks: 20						

EVALUATION RUBRICS for PROJECT Phase I:

Final Evaluation

Sl. No.	Parameters	Marks	Poor	Fair	Very Good	Outstanding
1-c	Formulation of Design and/or Methodology and Progress. (Group assessment) [CO1]	5	None of the team members show any evidence of knowledge about the design and the methodology adopted till now/ to be adopted in the later stages. The team has not progressed from the previous stage of evaluation.	The students have some knowledge on the design procedure to be adopted, and the methodologies. However, the team has not made much progress in the design, and yet to catch up with the project plan.	the students are comfortable with design methods adopted, and they have made some progress as per the plan. The methodologies are understoodto a large extent.	Shows clear evidence of having a well- defined design methodology and adherence to it. Excellent knowledge in design procedure and its adaptation. Adherence to project plan is commendable.
			(0 – 1 Marks)	(2 – 3 Marks)	(4 Marks)	(5 Marks)
1-d	Individual and Teamwork Leadership (Individual assessment) [CO3]	10	The student does not show any interest in the project activities, and is a passive member.	The student shows some interest and participates in some of the activities. However, the activities are mostly easy and superficial in nature.	The student shows very good interest in project, and takes up tasks and attempts to complete them. Shows excellent responsibility and team skills. Supports the other members well.	The student takes a leadership position and supports the other team members and leads the project. Shows clear evidence of leadership.
			(0 – 3 Marks)	(4 – 6 Marks)	(7 - 9 Marks)	(10 Marks)
1-e	Preliminary Analysis/ Modelling / Simulation/ Experiment / Design/ Feasibility study [CO1]	10	The team has not done any preliminary work with respectto the analysis / modelling / simulation / experiment / design /feasibility study/ algorithm development.	The team has started doing some preliminary work with respect to the project. The students however are not prepared enough for the work and they need to improve a lot.	There is some evidence to show that the team has done good amount of preliminaryinvestigation and design/ analysis/ modelling etc. They can improve further.	Strong evidence for excellent progress in the project. The team has completed the required preliminary work already and arepoised to finish the phase I in an excellent manner. They have shown results to prove their progress.
			(0 – 3 Marks)	(4 – 6 Marks)	(7 - 9 Marks)	(10 Marks)

1-f	Documentation and presentation. (Individual & group assessment). [CO6]	5	The team did not document the work at all. The project journal/diary is not presented. The presentation was shallow in content and dull in appearance. The individual student has no idea on the presentation of his/her part.	Some documentation is done, but not extensive. Interaction with the guide is minimal. Presentation includes some points of interest, but overall quality needs to be improved. Individual performance to be improved.	Most of the project details were documented well enough. There is scope for improvement. The presentation is satisfactory. Individual performance is good.	The project stages are extensively documented in the report. Professional documentation tools like LaTeX were used to document the progress of the project along with the project journal. The documentation structure is well- planned and can easily grow into the project report. The presentation is done professionally and with great clarity. The individual's performance is excellent.
			(0 – 1 Marks)	(2 – 3 Marks)	(4 Marks)	(5 Marks)
Total		**30**	**Phase - I Final Evaluation Marks: 30**			

EVALUATION RUBRICS for PROJECT Phase I: Report Evaluation						
Sl. No.	**Parameters**	**Marks**	**Poor**	**Fair**	**Very Good**	**Outstanding**
1-g	Report [CO6]	20	The prepared report is shallow and not as perstandard format. It does not follow proper organization.Contains mostly Unacknowledged content. Lack of effort in preparation is evident.	Project report follows the standard format to some extent. However, its organization is not very good. Language needs to be improved. All references arenot cited properly in the report.	Project report shows evidence of systematic documentation. Report is following the standard format and there are only a few issues. Organization of the report is good. Most of references are cited properly.	The report is exceptionally good. Neatly organized. All references cited properly. Diagrams/Figures, Tables and equations are properly numbered, and listed and clearly shown. Language is excellent and follows standard styles.
			(0 - 7 Marks)	(8 - 12 Marks)	(13 - 19 Marks)	(20 Marks)
Phase - I Project Report Marks: 20						

SEMESTER VII

MINOR

ERD481	MINI PROJECT	CATEGORY	L	T	P	CREDIT
		PWS	0	0	4	4

Prerequisite:

A sound knowledge in courses studied in respective minor stream.

Course Outcomes: After the completion of the course the student will be able to

CO#	CO
CO1	Identify technically and economically feasible problems **(CognitiveKnowledge Level: Apply)**
CO2	Identify and survey the relevant literature for getting exposed to relatedsolutions. **(Cognitive Knowledge Level: Apply)**
CO3	Perform requirement analysis, identify design methodologies and develop adaptable & reusable solutions of minimal complexity by using modern tools. (**Cognitive Knowledge Level: Apply)**
CO4	Prepare technical report and deliver presentation **(Cognitive Knowledge Level: Apply)**
CO5	Apply engineering and management principles to achieve the goal of theproject **(Cognitive Knowledge Level: Apply)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓
CO3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO4	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓
CO5	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓

Abstract POs defined by National Board of Accreditation			
PO#	**BroadPO**	**PO#**	**BroadPO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development ofsolutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Lifelong learning

Course Plan

Student Groups with 4 or 5 members should identify a topic of interest in consultation with a Faculty Advisor/Project Coordinator/Guide. Review the literature and gather information pertaining to the chosen topic. State the objectives and develop a methodology to achieve the objectives. Carryout the design/fabrication or develop codes/programs to achieve the objectives. Innovative design concepts, performance, scalability, reliability considerations, aesthetics/ergonomic, user experience and security aspects taken care of in the project shall be given due weight.

The progress of the mini project is evaluated based on a minimum of two reviews. The review committee may be constituted by a senior faculty member, Mini Project coordinator and project guide. The internal evaluation shall be made based on the progress/outcome of the project,reports and a viva-voce examination, conducted internally by a 3-member committee. A project report is required at the end of the semester. The project has to be demonstrated for its full designspecifications.

Assessment Pattern

Mark Distribution

Total Marks	CIE Marks	ESE Marks
150	**75**	**75**

Continuous Internal Evaluation Pattern:

Attendance	**10 marks**
Project Guide	**15 marks**
Project Report	**10 marks**

Evaluation by the Committee (will be evaluating the level of

completionand demonstration of functionality/specifications,

presentation, oral examination, work knowledge and involvement) : **40 marks**

End Semester Examination Pattern:

The marks will be distributed as

Presentation : **30 marks**

Demo : **20 marks**

Viva : **25 marks.**

Total : **75 marks**.

Guidelines for the Report preparation

- A bonafide report on the mini project shall be submitted within one week after the final presentation. Minimum number of pages should be 40.
- Use Times New Roman font for the entire report – Chapter/Section Title – Times New Roman18, Bold; Heading 2 – Times New Roman16, Bold; Heading 3 – Times NewRoman14, Bold; Body- Times New Roman 12, Normal.
- Line Spacing – Between Heading 2 – 3 lines, between lines in paragraph 1.5 lines.
- Alignments – Chapter/Section Title – Center, heading 2 & 3 should be Left Aligned. Ensure that all body text is paragraph justified.
- Figures & Tables – Ensure that all Figures and Tables are suitably numbered and given proper names/headings. Write figure title under the figure and table title above the table.

Suggestive order of documentation:

i. Top Cover

ii. Title page

iii. Certification page

iv. Acknowledgement

v. Abstract

vi. Table of Contents

vii. List of Figures and Tables

viii. Chapters

ix. Appendices, if any

x. References/Bibliography

SEMESTER VII

HONOURS

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
ERT495	MEMS DESIGN	VAC	4	0	0	4

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand the basic concepts of MEMS and microsystem products (**Cognitive Knowledge level: Understand**)
CO 2	Understand the working principles of micro sensors and actuators (**Cognitive Knowledge level: Understand**)
CO 3	Identify the typical materials used for fabrication of micro systems (**Cognitive Knowledge level: Understand**)
CO 4	Illustrate the various methods in microsystem fabrication and micro manufacturing (**Cognitive Knowledge level: Understand**)
CO 5	Infer the various bonding techniques for MEMS (**Cognitive Knowledge level: Understand**)

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12
CO 1	✓	✓										✓
CO 2	✓	✓				✓						✓
CO 3	✓	✓										✓
CO 4	✓	✓										✓
CO5	✓	✓				✓						✓

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	20	20	40
Understand	30	30	60
Apply	-	-	-
Analyse	-	-	-
Evaluate	-	-	-
Create	-	-	-

Mark Distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance: 10 marks

Continuous Assessment Test (2 Numbers): 25 marks

Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern : There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have a maximum of 2 sub- divisions and carry 14 marks.

COURSE LEVEL ASSESSMENT QUESTIONS

Course Outcome 1 (CO1):

1. Write short notes on the evolution of microfabrication.
2. State the differences between microelectronics and microsystems.
3. Describe micro actuation with shape memory alloy.

Course Outcome 2 (CO2):

1. Explain the working principle of Thermal bimorphs with figures. State any two applications of thermal sensors.
2. Explain the working principle of piezoelectric sensors and actuators with one example.
3. Explain with figures any two types of forces used in micro actuation.

Course Outcome 3 (CO3):

1. Write short notes on molecular theory
2. Explain doping and diffusion processes with diagrams.
3. What are the different kinds of polymers used in MEMS? Mention its uses in the construction of MEMS.

Course Outcome 4 (CO4):

1. Compare the two kinds of resists used in photolithography.
2. Explain ion beam etching
3. What are the essential technologies that are necessary for packaging microsystem products? Explain each of them with figures.

Course Outcome 5 (CO5):

1. Write short notes on Anodic bonding
2. Is MEMS & NEMS the same? Justify your answer.
3. Write short notes on surface bonding.

SYLLABUS

Module 1: Introduction to Micro Electro Mechanical Systems (MEMS) and Microsystems

MEMS and Microsystems: Typical MEMS and microsystem products – Evolution of Microfabrication - Microsystem and microelectronics - Multidisciplinary nature of MEMS – Applications - Principles and examples of Micro sensors and micro actuators – micro accelerometer, comb drives, Micro grippers, micro motors, micro valves, micro pumps, Shape Memory Alloys.

Module 2: Transducer Fundamentals: Actuation and Sensing Technologies

Actuation and Sensing techniques : Thermal sensors and actuators, Electrostatic sensors and actuators , Piezoelectric sensors and actuators, magnetic actuators ; Microsensors - Acoustic wave sensors, Biomedical sensors and biosensors, chemical sensors, pressure sensors, optical sensors - microfluidics.

Module 3: Foundational Sciences for Microsystem Design

Engineering science for Microsystem design - Atomic structure of Matter - Ions - Molecular Theory - Intermolecular force - Doping of semiconductors - Diffusion process - Electrochemistry - Quantum physics. Materials for MEMS and Microsystems - Substrate and wafer - Silicon as substrate Material - Silicon compounds - Silicon piezo resistors - Gallium Arsenide - Quartz – Peizo electric crystals - Polymers.

Module 4: Fabrication and Packaging of Microsystems

Overview of Microsystem fabrication – Photolithography – Ion implantation- Diffusion – Oxidation – Chemical vapour deposition – Etching. Overview of Micro manufacturing – Bulk micro manufacturing, Surface micro machining, LIGA process – Micro stereo lithography. Micro system Packaging: general considerations in packaging design – Levels of Micro system packaging.

Module 5: Bonding Techniques and Applications for Microsystems

Bonding techniques for MEMS : Surface bonding , Anodic bonding , Silicon - on - Insulator , wire bonding, Sealing – Assembly of micro systems. Overview of MEMS areas: RF MEMS, BioMEMS, MOEMS, NEMS.

Text Books:

1. Chang Liu, "Foundations of MEMS", Pearson 2012
2. Tai-Ran Hsu, "MEMS and Microsystems Design and Manufacture", TMH, 2002

Reference Books:

1. James D Plummer, Michael D Deal, Peter B Griffin, "Silicon VLSI Technology", Pearson Education.

2. Nitaigur Premchand Mahalik, "MEMS", Tata Mc Graw Hill.

Model Question Paper

Reg No: Name:

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY THIRD SEMESTER B. TECH DEGREE EXAMINATION, MONTH AND YEAR

Course Code: EST495

COURSE NAME: MEMS DESIGN

Max. Marks: 100 Duration: 3 Hours

PART A

ANSWER ALL QUESTIONS, EACH CARRIES 3 MARKS

1. What is the need of having MEMS?
2. Write notes on the challenges faced by the MEMS industry.
3. What is the principle of Signal transduction methods for micro pressure sensors?
4. Write notes on magnetic actuators.
5. Why is Silicon used as a substrate material for fabrication?
6. Explain the various Silicon compounds used in MEMS.
7. Differentiate between wet and dry etching process.
8. Define etch rate.
9. Mention the applications of NEMS
10. Write short notes on MOEMS

PART B

Answer any one full question from each module. Each question carries 14 Marks

Module 1

11		Write short notes on the multidisciplinary nature of Microsystem design and manufacture	14
12		Discuss the various types of MEMS products in detail with neat diagrams	14

Module 2

13	(a)	Explain the principle of operation of thermal sensors and actuators with neat diagrams.	7
	(b)	Explain the principle of operation of MEMS based electrostatic sensors and actuators.	7
14		List the types of microsensors available in the market. With a neat sketch explain the working principle of any 2 type of sensors.	14

Module 3

15		Describe the atomic structure of matter in MEMS devices.	14
16		Why are polymers used in the MEMS industry? Mention the characteristics of 3 polymers used.	14

Module 4

17		Discuss the process of photolithography. Mention the types of photolithography suitable for at least 2 MEMS devices with justification.	14
18	(a)	Explain briefly about chemical vapor deposition (CVD)	7
	(b)	Describe the ion implantation process with a neat diagram.	7

Module 5

19	(a)	What is SOI? Explain in detail.	7
	(b)	What is RF MEMS? Explain with principle & applications.	7
20	(a)	Write short notes on BioMEMS. Justify the need.	7
	(b)	Write short notes on wire bonding techniques.	7

COURSE CONTENTS AND LECTURE SCHEDULE

No	Topic	No. of Lectures
1	**MEMS and Microsystems**	**9**
1.1	Typical MEMS and microsystem products	1
1.2	Evolution of Microfabrication - Microsystem and microelectronics	1
1.3	Multidisciplinary nature of MEMS - Applications	1
1.4	Principles and examples of Micro sensors and micro actuators – micro accelerometer	2
1.5	comb drives, Micro grippers	2
1.6	micro motors, micro valves,	1
1.7	micro pumps, Shape Memory Alloys.	1
2	**Actuation and Sensing techniques**	**9**
2.1	Thermal sensors and actuators, Electrostatic sensors and actuators	2
2.2	Piezoelectric sensors and actuators, magnetic actuators	1
2.3	Microsensors - Acoustic wave sensors, Biomedical sensors and biosensors	2

2.4	chemical sensors	2
2.5	pressure sensors, optical sensors - microfluidics.	2
3	**Engineering science for Microsystem design**	**10**
3.1	Atomic structure of Matter - Ions - Molecular Theory	2
3.2	Intermolecular force - Doping of semiconductors - Diffusion process	2
3.3	Electrochemistry - Quantum physics	1
3.4	Materials for MEMS and Microsystems - Substrate and wafer Silicon as substrate Material - Silicon compounds	2
3.5	Silicon piezo resistors - Gallium Arsenide - Quartz	2
3.6	Piezoelectric crystals - Polymers.	1
4	**Overview of Microsystem fabrication**	**9**
4.1	Photolithography – Ion implantation	2
4.2	Diffusion – Oxidation – Chemical vapour deposition – Etching	3
4.3	Overview of Micro manufacturing – Bulk micro manufacturing, Surface micromachining	2
4.4	LIGA process – Micro stereolithography	1
4.5	Micro system Packaging: general considerations in packaging design – Levels of Micro system packaging	1
5	**Bonding techniques for MEMS**	**8**
5.1	Surface bonding , Anodic bonding	1
5.2	Silicon - on - Insulator , wire bonding	2
5.3	Sealing – Assembly of micro systems	2
5.4	Overview of MEMS areas : RF MEMS	1
5.5	BioMEMS, MOEMS, NEMS	2

SEMESTER VIII

ERT402	ALGORITHM ANALYSIS ANDDESIGN	Category	L	T	P	Credit
		PCC	2	1	0	3

Preamble:

The course introduces students to the design of computer algorithms, as well as analysis of algorithms. Algorithm design and analysis provide the theoretical backbone of computer science and are a must in the daily work of the successful programmer. The goal of this course is to provide a solid background in the design and analysis of the major classes of algorithms. At the end of the course students will be able to develop their own versions for a given computational task and to compare and contrast their performance.

Prerequisite:

Strong Foundation in Mathematics, Programming in C, Data Structures and Graph Theory.

Course Outcomes: After the completion of the course the student will be able to

CO#	CO
CO1	Analyze any given algorithm and express its time and space complexities in asymptotic notations. **(Cognitive Level: Apply)**
CO2	Derive recurrence equations and solve it using Iteration, Recurrence Tree, Substitution and Master's Method to compute time complexity of algorithms. **(Cognitive Level: Apply)**
CO3	Illustrate Graph traversal algorithms & applications and Advanced Data structures like AVL trees **(Cognitive Level: Apply)**
CO4	Demonstrate Divide-and-conquer, Greedy Strategy, Dynamic programming, Branch-and Bound and Backtracking algorithm design techniques (**Cognitive Level: Apply)**
CO5	Classify a problem as computationally tractable or intractable, and discuss strategies to address intractability **(Cognitive Level: Understand)**
CO6	Identify the suitable design strategy to solve a given problem. **(Cognitive Level: Analyze)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓								✓
CO2	✓	✓	✓	✓								✓
CO3	✓	✓	✓	✓								✓
CO4	✓	✓	✓	✓								✓
CO5	✓	✓										✓
CO6	✓	✓	✓	✓								✓

Abstract POs defined by National Board of Accreditation

PO#	Broad PO	PO#	Broad PO
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Lifel ong learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester ExaminationMarks (%)
	Test 1 (%)	Test 2 (%)	
Remember	30	30	30
Understand	30	30	30
Apply	40	40	40
Analyze			

Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3

Continuous Internal Evaluation Pattern:

Attendance **10 marks**

Continuous Assessment Tests (Average of SeriesTests1&2) **25 marks**

Continuous Assessment Assignment **15 marks**

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, astudent should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 full questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

Syllabus

Module-1 (Introduction to Algorithm Analysis)

Characteristics of Algorithms, Criteria for Analysing Algorithms, Time and Space Complexity - Best, Worst and Average Case Complexities, Asymptotic Notations - Big-Oh (O), Big- Omega (Ω), Big-Theta (Θ),

Little-oh (o) and Little- Omega (ω) and their properties. Time and Space Complexity Calculation of simple algorithms.

Analysis of Recursive Algorithms: Recurrence Equations, Solving Recurrence Equations – Iteration Method, Recursion Tree Method, Substitution method and Master's Theorem (Proof not required).

Module–2 (Advanced Data Structures and Graph Algorithms)

Self Balancing Tree - AVL Trees (Insertion and deletion operations with all rotations in detail, algorithms not expected);

DFS and BFS traversals - Analysis, Strongly Connected Components of a Directed graph, Topological Sorting.

Module–3 (Divide & Conquer and Greedy Strategy)

The Control Abstraction of Divide and Conquer- 2-way Merge sort, Strassen's Algorithm for Matrix Multiplication-Analysis. The Control Abstraction of Greedy Strategy- Fractional Knapsack Problem, Minimum Cost Spanning Tree Computation- Kruskal's Algorithms - Analysis, Single Source Shortest Path Algorithm - Dijkstra's Algorithm-Analysis.

Module-4 (Dynamic Programming, Back Tracking and Branch & Bound)

The Control Abstraction- The Optimality Principle- Matrix Chain Multiplication-Analysis, All Pairs Shortest Path Algorithm - Floyd-Warshall Algorithm-Analysis. The Control Abstraction of Back Tracking – The N Queen's Problem. Branch and Bound Algorithm for Travelling Salesman Problem.

Module-5 (Introduction to Complexity Theory)

Tractable and Intractable Problems, Complexity Classes – P, NP, NP- Hard and NP-Complete Classes- NP Completeness proof of Clique Problem and Vertex Cover Problem- Approximation algorithms- Bin Packing, Graph Coloring. Randomized Algorithms (Definitions of Monte Carlo and Las Vegas algorithms), Randomized version of Quick Sort algorithm with analysis.

Text Books

1. T.H.Cormen, C.E.Leiserson, R.L.Rivest, C. Stein, Introduction to Algorithms, 2nd Edition,Prentice-Hall India (2001).
2. Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekaran, "Fundamentals of ComputerAlgorithms", 2nd Edition, Orient Longman Universities Press (2008)
3. Sara Baase and Allen Van Gelder ―Computer Algorithms, Introduction to Design and Analysis, 3rd Edition, Pearson Education (2009)

Reference Books

1. Jon Kleinberg, Eva Tardos, "Algorithm Design", First Edition, Pearson (2005)
2. Robert Sedgewick, Kevin Wayne, "Algorithms",4th Edition Pearson (2011)
3. GIlles Brassard, Paul Brately, "Fundamentals of Algorithmics", Pearson (1996)

4. Steven S. Skiena, "The Algorithm Design Manual", 2nd Edition, Springer (2008)

Course Level Assessment Questions

Course Outcome 1 (CO1):

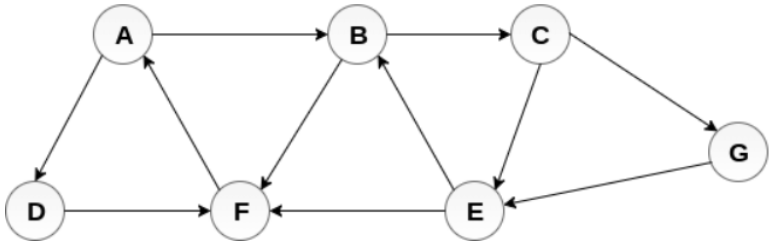
1. Is $2^{n+1} = O(2^n)$? Is $2^{2n} = O(2^n)$? Justify your answer.
2. What is the need of asymptotic analysis in calculating time complexity? What are thenotations used for asymptotic analysis?
3. Calculate the time complexity for addition of two matrices.
4. Define time complexity and space complexity. Write an algorithm for adding n natural numbers and analyse the time and space requirements of the algorithm.

Course Outcome 2 (CO2):

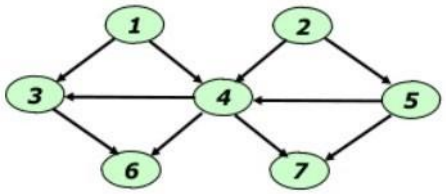
1. State Master's theorem for solving recurrences.
2. Solve the recurrence T(n) = 3T(n-2), using iteration method
3. State the conditions in recurrences where Master Theorem is not applicable.
4. Solve the following recurrence equations using Master's theorem.
   a) $T(n) = 8T(n/2) + 100\ n^2$
   b) $T(n) = 2T(n/2) + 10\ n$
5. Using Recursion Tree method, Solve T(n)= 2T(n/10)+ T(9n/10)+n. Assume constant time for small values of n.

Course Outcome 3 (CO3):

1. Explain the rotations performed for insertion in AVL tree with example.
2. Write down BFS algorithm and analyse the time complexity. Perform BFS traversal on the given graph starting from node A. If multiple node choices are available for next travel, choose the next node in alphabetical order.

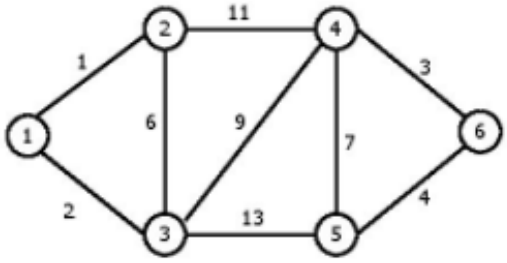


3. Find the minimum and maximum height of any AVL-tree with 7 nodes? Assume that the height of a tree with a single node is 0. (3)
4. Find any three topological orderings of the given graph.

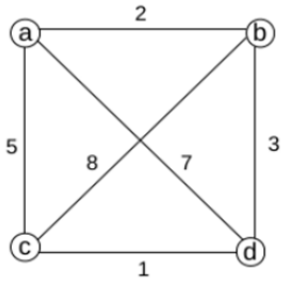


Course Outcome 4 (CO4):

1. Give the control abstraction for Divide and Conquer method.
2. Construct the minimum spanning tree for the given graph using Kruskal's algorithm. Analyse the complexity of the algorithm.



3. Compare Divide and Conquer and Dynamic programming methodologies
4. What is Principle of Optimality?
5. Define Travelling Salesman Problem (TSP). Apply branch and bound algorithm to solve TSP for the following graph, assuming the start city as 'a'. Draw the state space tree.



Course Outcome 5 (CO5):

1. Compare Tractable and Intractable Problems
2. With the help of suitable code sequence convince Vertex Cover Problem is an example of NP-Complete Problem
3. Explain Vertex Cover problem using an example. Suggest an algorithm for finding Vertex Cover of a graph.
4. Write short notes on approximation algorithms.
5. Compare Conventional quick sort algorithm and Randomized quicksort with the help of

asuitable example?

Course Outcome 6 (CO6): (CO attainment through assignment only, not meant forexaminations)

Choosing the best algorithm design strategy for a given problem after applying applicable design strategies – Sample Problems Given.

1. Finding the Smallest and Largest elements in an array of ‘n’ numbers
2. Fibonacci Sequence Generation.
3. Merge Sort
4. Travelling Sales Man Problem
5. 0/1 Knapsack Problem

Model Question Paper

Reg No: ___ Name: _____

PAGES : 4

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B.TECH. DEGREE EXAMINATION, MONTH & YEAR

Course Code: ERT 402

Course Name: Algorithm Analysis and Design

Max. Marks : 100 **Duration: 3 Hours**

PART A

Answer All Questions. Each Question Carries 3 Marks

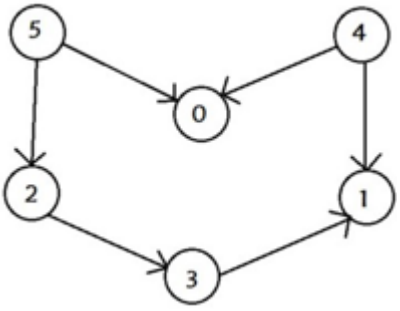
1 Define asymptotic notation? What are the notations used for asymptotic analysis

2 State Master's Theorem. Find the solution to the following recurrence equationsusing Master's theorem.

a) $T(n) = 8T(n/2) + 100\ n^2$

b) $T(n) = 2T(n/2) + 10\ n$

3 Find any two topological ordering of the DAG given below.



4 What is the primary purpose of AVL Trees and how do they ensure balanced binary search trees?

5 Write the control abstraction of greedy strategy to solve a problem.

6 Write an algorithm based on divide-and-conquer strategy to search an element in agiven list. Assume that the elements of list are in sorted order.

7 List the sequence of steps to be followed in Dynamic Programming approach.

8 Illustrate how optimal substructure property could be maintained in Floyd-Warshall algorithm.

9 Differentiate between P and NP problems.

10 Specify the relevance of approximation algorithms.

(10x3=30)

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11 **(a)** Define Big O, Big Ω and Big Θ Notation and illustrate them graphically. **7**

(b) Solve the following recurrence equation using recursion tree method $T(n) = T(n/3) + T(2n/3) + n$, where $n>1$ **7**

$T(n) = 1$, Otherwise

OR

12 **(a)** Explain the iteration method for solving recurrences and solve the following recurrence equation using iteration method. **7**

$T(n) = 3T(n/3) + n; T(1) = 1$

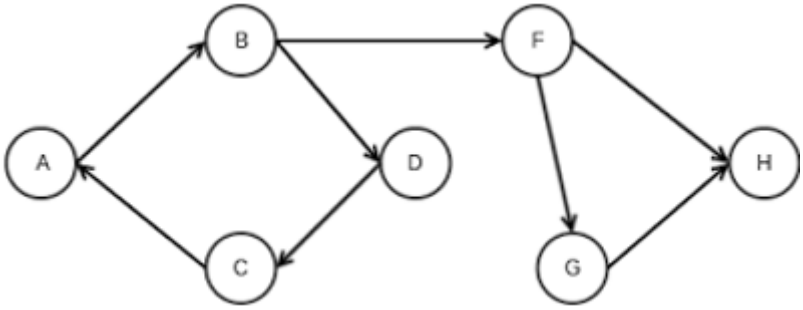
(b) Determine the time complexities of the following two functions fun1( ) and fun2( ). **7**

i)
```
int fun1(int n)
{
if (n <= 1) return n;
return 2*fun1(n-1);
}
```

ii)
```
int fun2 (int n)
{
if (n <= 1) return n;
return fun2 (n-1) + fun2 (n-1)
}
```

13 **(a)** Write DFS algorithm and analyse its time complexity. Illustrate theclassification of edges in DFS traversal. **7**

(b) Find the strongly connected components of the digraph given below: **7**

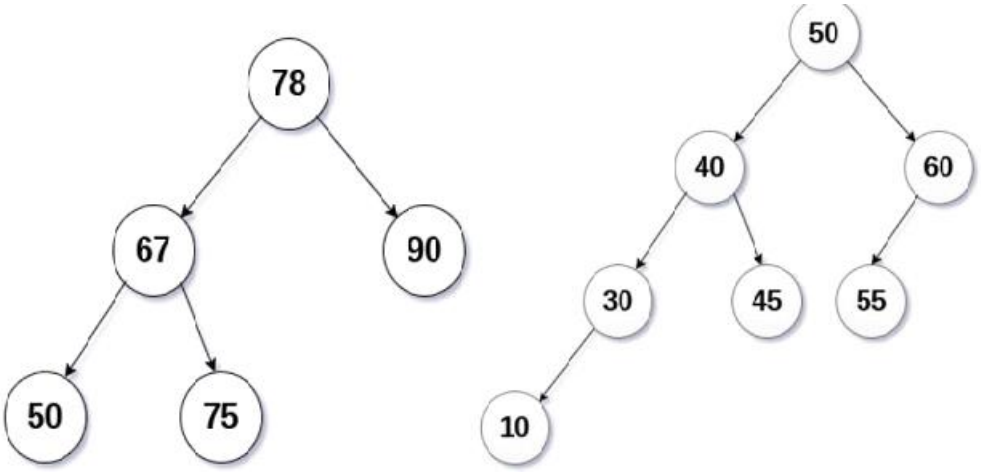


OR

14 **(a)** Illustrate the advantage of height balanced binary search trees over binarysearch trees? Explain various rotations in AVL trees with example. **7**

(b) Perform the following operations in the given AVL trees. **7**

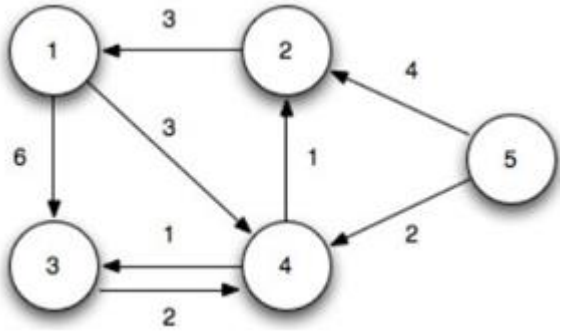
i) Insert 70 ii) Delete 55



15	**(a)**	State Fractional Knapsack Problem and write Greedy Algorithm forFractional Knapsack Problem.	**7**
	(b)	Find the optimal solution for the following Fractional Knapsack problem.Given the number of items(n) = 7, capacity of sack(m) = 15, W={2,3,5,7,1,4,1} and P = {10,5,15,7,6,18,3}	**7**

OR

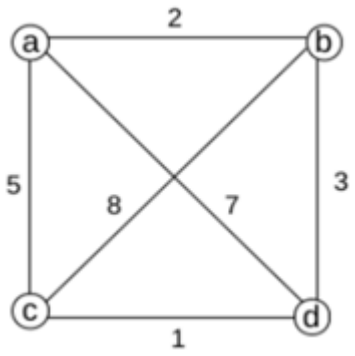
16	**(a)**	Write and explain merge sort algorithm using divide and conquer strategy using the data {30, 19, 35, 3, 9, 46, 10}. Also analyse the time complexity.	**7**
	(b)	Write the pseudo code for Dijkstra's algorithm. Compute the shortest distance from vertex 1 to all other vertices using Dijkstra's algorithm.	**7**



17	**(a)**	Write Floyd-Warshall algorithm and analyse its complexity.	**5**
	(b)	Write and explain the algorithm to find the optimal parenthesization of matrix chain product whose sequence of dimension is 4x10,10x3, 3x12,12x20.	**9**

OR

18	**(a)**	Explain the concept of Backtracking method using 4 Queens problem.	**7**
	(b)	Define Travelling Salesman Problem (TSP). Apply branch and bound algorithm to solve TSP for the following graph, assuming the start city as 'a'.Draw the state space tree.	**7**



19 **(a)** State bin packing problem? Explain the first fit decreasing strategy **7**

(b) Prove that the Clique problem is NP-Complete. **7**

OR

20 **(a)** Explain the need for randomized algorithms. Differentiate Las Vegas andMonte Carlo algorithms. **5**

(b) Explain randomized quicksort and analyse the expected running time of randomized quicksort with the help of a suitable example? **9**

Teaching Plan

No	Topic	No. of Hours (37 hrs)
	Module -1 (Introduction to Algorithm Analysis) 8 hrs.	
1.1	Introduction to Algorithm Analysis: Characteristics of Algorithms, Criteria for Analysing Algorithms.	1 hour
1.2	Time and Space Complexity - Best,Worst and Average Case Complexities.	1 hour
1.3	Asymptotic Notations - Properties of Big-Oh (O), Big- Omega (Ω), Big-Theta (Θ), Little-Oh (o) and Little- Omega (ω).	1 hour
1.4	Illustration of Asymptotic Notations	1 hour

1.5	Time and Space Complexity Calculation of algorithms/code segments.	1 hour
1.6	Analysis of Recursive Algorithms: Recurrence Equations, Solving Recurrence Equations – Iteration Method.	1 hour
1.7	Recursion Tree Method	1 hour
1.8	Substitution method and Master's Theorem and its Illustration.	1 hour
Module-2 (Advanced Data Structures and Graph Algorithms) 7 Hrs.		
2.1	Self Balancing Trees - Properties of AVL Trees, Rotations of AVL Trees	1 hour
2.2	AVL Trees Insertion and Illustration	1 hour
2.3	AVL Trees Deletion and Illustration	1 hour
2.4	Graph Algorithms: BFS traversal, Analysis.	1 hour
2.5	DFS traversal, Analysis.	1 hour
2.6	Strongly Connected Components of a Directed graph, Topological Sorting.	1 hour
2.7	Topological Sorting.	1 hour
Module-3 (Divide & Conquer and Greedy Method) 7 Hrs		
3.1	Divide and Conquer: The Control Abstraction, 2-way Merge Sort, Analysis.	1 hour
3.2	Strassen's Algorithm for Matrix Multiplication, Analysis	1 hour
3.3	Greedy Strategy: The Control Abstraction.	1 hour
3.4	Fractional Knapsack Problem.	1 hour
3.5	Minimum Cost Spanning Tree Computation- Kruskal's Algorithm, Analysis.	1 hour
3.6	Single Source Shortest Path Algorithm - Dijkstra's Algorithm	1 hour
3.7	Illustration of Dijkstra's Algorithm-Analysis.	1 hour

Module-4 (Dynamic Programming, Back Tracking and Branch and Bound) 6 Hrs.		
4.1	Dynamic Programming: The Control Abstraction, The Optimality Principle.	1 hour
4.2	Matrix Chain Multiplication-Analysis, Illustration of Matrix Chain Multiplication-Analysis.	1 hour
4.3	All Pairs Shortest Path Algorithm- Analysis and Illustration of Floyd-Warshall Algorithm.	1 hour
4.4	Back Tracking: The Control Abstraction .	1 hour
4.5	Back Tracking: The Control Abstraction – The N Queen's Problem.	1 hour
4.6	Branch and Bound:- Travelling salesman problem.	1 hour
Module-5 (Introduction to Complexity Theory) 9 Hrs		
5.1	Introduction to Complexity Theory: Tractable and Intractable Problems.	1 hour
5.2	Complexity Classes – P, NP.	1 hour
5.3	NP- Hard and NP-Complete Problems.	1 hour
5.4	NP Completeness Proof of Clique Problem, NP Completeness Proof of Vertex Cover Problem.	1 hour
5.5	Approximation algorithms- Bin Packing Algorithm and Illustration.	1 hour
5.6	Graph Colouring Algorithm and Illustration.	1 hour
5.7	Randomized Algorithms (definitions of Monte Carlo and Las Vegas algorithms).	1 hour
5.8	Randomized Version of Quick Sort Algorithm with Analysis.	1 hour
5.9	Illustration of Randomized Version of Quick Sort Algorithm withAnalysis.	1 hour

ERT414	ROBOTICS AND AUTOMATION	CATEGORY	L	T	P	CREDITS
		PEC	2	1	0	3

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Familiarize with anatomy, specifications and applications of Robots. (**Cognitive Knowledge level: Understand**)
CO 2	Choose the appropriate sensors and actuators for robots. (**Cognitive Knowledge level: Understand**)
CO 3	Choose appropriate Robotic configuration and gripper for a particular application. (**Cognitive Knowledge level: Apply**)
CO 4	Obtain kinematic model of robotic manipulators. (**Cognitive Knowledge level: Understand**)
CO5	Understand the basic concepts in industrial automation. (**Cognitive Knowledge level: Understand**)
CO6	To know about Manufacturing Automation. (**Cognitive Knowledge level: Understand**)

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO 1	✓	✓										✓
CO 2	✓	✓										✓
CO 3	✓	✓										✓
CO 4	✓	✓	✓									✓
CO5	✓	✓	✓									✓
CO6	✓	✓	✓									✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category		Continuous Assessment Tests		End Semester Examination
		1	2	
Remember	K1	10	10	10
Understand	K2	35	35	60
Apply	K3	5	5	30
Analyse				
Evaluate				
Create				

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Test (2 numbers) : 25 marks

Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

COURSE OUTCOME 1 (CO1): FAMILIARIZE WITH ANATOMY, SPECIFICATIONS AND APPLICATIONS OF ROBOTS.

1. Explain the anatomy of a robotic manipulator.
2. Discuss open kinematic vs closed kinematic chain.
3. Define Precision and Accuracy.

COURSE OUTCOME 2 (CO2): CHOOSE THE APPROPRIATE SENSORS AND ACTUATORS FOR ROBOTS

1. Illustrate the working of Internal Sensors.
2. Explain the different classification of sensors.
3. Discuss about various actuators for robots.

COURSE OUTCOME 3 (CO3): CHOOSE APPROPRIATE ROBOTIC CONFIGURATION AND GRIPPER FOR A PARTICULAR APPLICATION

1. Illustrate the working of mechanical grippers and Vacuum grippers.
2. Discuss the about Robot Coordinate Systems.

COURSE OUTCOME 4 (CO4): OBTAIN KINEMATIC MODEL OF ROBOTIC MANIPULATORS

1. Derive forward Kinematic analysis of a typical robots up to 3 DOF.
2. Differentiate Point to point and continuous path planning

COURSE OUTCOME 5 (CO5): TO KNOW ABOUT THE BASIC CONCEPTS IN INDUSTRIAL AUTOMATION

1. Explain laws and principles of Automation
2. Explain benefit and limitations of pneumatics and hydraulics systems

COURSE OUTCOME 6 (CO6): TO KNOW ABOUT MANUFACTURING AUTOMATION.

1. Explain classification and type of automatic transfer machines
2. Discuss programmable Manufacturing Automation CNC machine tools

SYLLABUS

MODULE 1: FUNDAMENTALS OF ROBOTICS AND APPLICATIONS

Definitions- Robots, Robotics - Types of Robots - Anatomy of a robotic manipulator-links, joints, actuators, sensors, controller; Robot considerations for an application- number of axes, work volume, capacity & speed, stroke &reach, Repeatability, Precision and Accuracy, operating environment. Robot Applications- medical, mining, space, defense, security, domestic, entertainment, Industrial Applications-Material handling, welding, Spray painting, Machining.

Module 2: Sensors and Actuators

Sensors and Actuators - touch, force, proximity, vision sensors. Internal Sensors-Position sensors, velocity sensors, acceleration sensors, Force sensors; External sensors-contact type, noncontact type; Vision - Elements of vision sensor, image acquisition, image processing; Selection of sensors. Actuators for robots-Classification-Electric, Hydraulic, Pneumatic actuators.

MODULE 3: ROBOTIC CONFIGURATIONS AND END EFFECTORS, KINEMATICS AND MOTION PLANNING

Robot configurations-PPP, RPP, RRP, RRR; Classification of End effectors - mechanical grippers Vacuum grippers. Selection and design considerations of grippers in robot. Robot Coordinate Systems- D-H representation. The Arm equation – forward Kinematic analysis of a typical robots up to 3 DOF. Motion Planning- Point to point vs continuous path planning.

MODULE 4: AUTOMATION

Automation- Definition, Advantages, goals, types, need, laws and principles of Automation. Elements of Automation. Fluid power and its elements, application of fluid power, Pneumatics vs. Hydraulics, benefit and limitations of pneumatics and hydraulics systems, Role of Robotics in Industrial Automation.

MODULE 5: MANUFACTURING AUTOMATION

Classification and type of automatic transfer machines; Automation in part handling and feeding, Programmable Manufacturing Automation CNC machine tools, Machining centers, Programmable robots, Robot time estimation in manufacturing operations.

TEXT BOOKS

1. Introduction to Robotics by S K Saha, Mc Graw Hill Education
2. Robert. J. Schilling, "Fundamentals of robotics – Analysis and control", Prentice Hall of India 1996.

Reference Books:

1. R K Mittal and I J Nagrath, "Robotics and Control", Tata McGraw Hill, New Delhi,2003.
2. Introduction to Robotics (Mechanics and control), John. J. Craig, Pearson Education Asia 2002.
3. Ashitava Ghosal, "Robotics-Fundamental concepts and analysis", Oxford University press
4. Robotics Technology and Flexible Automation, Second Edition, S. R. Deb "Automation, Production Systems and Computer Integrated Manufacturing"- M.P.Grover, Pearson Education.
5. An Introduction to Automated Process Planning Systems – Tiess Chiu Chang & Richard A. Wysk Anatomy of Automation – Amber G.H & P.S. Amber, Prentice Hall

COURSE CONTENTS AND LECTURE SCHEDULE

No	Topic	No. of Lectures
1	**Fundamentals of Robotics and Applications**	**7**
1.1	Definitions- Robots, Robotics - Types of Robots.	1
1.2	Anatomy of a robotic manipulator-links, joints, actuators, sensors, controller; open kinematic vs closed kinematic chain; degrees of freedom	2
1.3	Robot considerations for an application- number of axes, work volume, capacity & speed, stroke &reach, Repeatability, Precision and Accuracy, operating environment.	2
1.4	Robot Applications- medical, domestic, entertainment, mining, space, defence, security,	1
1.5	Industrial Applications-Material handling, welding, Spray painting, Machining.	1

2	**Sensors and Actuators**	**8**
2.1	Sensor classification- touch, force, proximity, vision sensors.	1
2.2	Internal Sensors-Position sensors, velocity sensors, acceleration sensors, Force sensors;	2
2.3	External sensors-contact type, noncontact type	1
2.4	Vision - Elements of vision sensor, image acquisition, image processing; Selection of sensors.	1
2.5	Actuators for robots- Classification-Electric, Hydraulic	2
2.6	Pneumatic actuators.	1
3	**Robotic configurations and end effectors, Kinematics and Motion Planning**	**7**
3.1	Robot configurations-PPP, RPP, RRP, RRR; Classification of End effectors - mechanical grippers, Vacuum grippers. Selection and design considerations of grippers in robot.	3
3.2	Robot Coordinate Systems- D-H representation. The Arm equation – forward Kinematic analysis of a typical robots up to 3 DOF.	3
3.3	Motion Planning- Point to point vs continuous path planning	1
4	**Automation**	**7**
4.1	Definition, Advantages, goals, types, need, laws and principles of Automation.	2
4.2	Elements of Automation. Fluid power and its elements	2
4.3	application of fluid power, Pneumatics vs. Hydraulics, benefit and limitations of pneumatics and hydraulics systems	2
4.4	Role of Robotics in Industrial Automation	1
5	**Manufacturing Automation**	**7**
5.1	Classification and type of automatic transfer machines	2
5.2	Automation in part handling and feeding,	1
5.3	Programmable Manufacturing Automation CNC machine tools	2
5.4	Machining centers, Programmable robots	1
5.5	Robot time estimation in manufacturing operations.	1

Assignment:

At least two assignments should be given.

MODEL QUESTION PAPER

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B.TECH DEGREE EXAMINATION

COURSE CODE: ERT427

Program: Electronics and Computer Engineering

Course Name: ROBOTICS AND AUTOMATION

Max. Marks: 100 Duration: 3 Hours

PART A

Answer ALL Questions. Each Carries 3 marks.

1.	Define reach and stroke of a robotic manipulator.	(3)
2	What are the characteristics of spot-welding robot?	(3)
3	A strain gauge of gauge factor 2 and resistance of the unreformed wire 100 Ω is used to measure the acceleration of an object of mass 3kg. If the strain is 10-6, cross sectional area=10mm2 and Young's modulus =6.9*10^ -10N/m^2, compute the acceleration of the object.	(3)
4	Compare hydraulic and pneumatic actuators.	(3)
5	What are the advantages and disadvantages of a vacuum gripper?.	(3)
6	Differentiate Point to point vs continuous path planning.	(3)
7	Explain the principles of Automation..	(3)
8	List out the role of Robotics in Industrial Automation.	(3)
9	List out the type of automatic transfer machines.	(3)
10	Define Machining centers	(3)

PART – B

Answer one question from each module. Each question carries 14 marks.

Module – I

11.a)	What is the typical anatomy of a robotic manipulator?	6	CO1	K3
11.b)	Explain in detail the specifications of a robotic manipulator.	8	CO1	K2

OR

12.a)	Explain in detail any three industrial applications of Robots.	9	CO1	K2
12.b)	Define Number of axes, work volume, capacity & speed, stroke &reach of robot.	5	CO1	K2

Module – II

13 a)	How will you choose appropriate sensor for a robotic application?	8	CO2	K2
13 b)	Mention the applications of vision sensor.	6	CO2	K2

OR

14 a)	Outline the method of varying position using servo motor and stepper motor.	9	CO2	K3
14 b)	Explain the working of typical hydraulic actuator	5	CO2	K2

Module – III

15 a)	Explain in detail all robotic configurations.	10	CO3	K2
15 b)	Discuss the D-H representation.	4	CO4	K3

OR

16 a)	Describe the types of end effector & gripper mechanisms with simple sketches	8	CO3	K2
16 b)	Explain the forward Kinematic analysis of a typical robots up to 3 DOF.	6	CO4	K2

Module – IV

17 a)	Explain advantages, goals, types, need, laws and principles of Automation.	9	CO5	K3
17 b)	Explain elements of Automation.	5	CO5	K2

OR

18 a)	Discuss benefit and limitations of pneumatics and hydraulics systems	9	CO5	K2
18 b)	Write short notes on fluid power and its elements	5	CO5	K2

Module – V

19 a)	Explain Automation in part handling and feeding.	8	CO6	K2
19 b)	Explain Programmable Manufacturing Automation.	6	CO6	K2

OR

20 a)	Describe Programmable robots with suitable diagrams	9	CO6	K3
20 b)	Discuss robot time estimation in manufacturing operations.	5	CO6	K2

ERT444	COMPILER DESIGN	Category	L	T	P	Credit
		PEC	2	1	0	3

Prerequisite: Sound knowledge in Data Structures, Formal Languages & Automata Theory.

Course Outcomes: After the completion of the course the student will be able to

CO1	Explain the phases in compilation process(lexical analysis, syntax analysis, semantic analysis, intermediate code generation, code optimization and code generation) and model a lexical analyzer **(Cognitive Knowledge Level: Apply)**
CO2	Model language syntax using Context Free Grammar and develop parse tree representation using leftmost and rightmost derivations (**Cognitive Knowledge Level: Apply)**
CO3	Compare different types of parsers(Bottom-up and Top-down) and construct parser for a given grammar **(Cognitive Knowledge Level: Apply)**
CO4	Build Syntax Directed Translation for a context free grammar, compare variousstorage allocation strategies and classify intermediate representations **(Cognitive Knowledge Level: Apply)**
CO5	Illustrate code optimization and code generation techniques in compilation **(Cognitive Knowledge Level: Apply)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓							✓
CO2	✓	✓	✓	✓	✓							✓
CO3	✓	✓	✓	✓	✓							✓
CO4	✓	✓	✓	✓								✓
CO5	✓	✓	✓	✓								✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination Marks**
	Test 1 (Marks)	**Test 2 (Marks)**	
Remember	**20**	**20**	**20**
Understand	**40**	**40**	**40**
Apply	**40**	**40**	**40**
Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	**CIE Marks**	**ESE Marks**	**ESE Duration**
150	**50**	**100**	**3 hours**

Continuous Internal Evaluation Pattern:

Attendance : **10 marks**

Continuous Assessment - Test : **25 marks**

Continuous Assessment - Assignment : **15 marks**

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing the remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. PartB contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 full questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

Syllabus

Module - 1 (Introduction to compilers and lexical analysis)

Analysis of the source program - Analysis and synthesis phases, Phases of a compiler. Lexical Analysis - Role of Lexical Analyzer, Input Buffering, Specification of Tokens, Recognition of Tokens.

Module - 2 (Introduction to Syntax Analysis)

Role of the Syntax Analyser. Review of Context Free Grammars -Derivation and Parse Trees. Basic parsing approaches - Eliminating left recursion, left factoring. Top-Down Parsing - Recursive Descent parsing, Predictive Parsing,LL(1) Grammars.

Module - 3 (Bottom-Up Parsing)

Handle Pruning. Shift Reduce parsing. LR parsing - Constructing SLR, LALR and canonical LR parsing tables.

Module - 4 (Syntax directed translation and Intermediate code generation)

Syntax directed translation - Syntax directed definitions, S-attributed definitions, L-attributeddefinitions, Storage organization, Storage-allocation strategies. Intermediate Code Generation - Intermediate languages, Graphical representations, Three-Address code, Quadruples, Triples.

Module 5 – (Code Optimization and Generation)

Code Optimization - Principal sources of optimization, Local and global optimizations. Code generation - Issues in the design of a code generator, Target Language, A simple code generator.

Text Books

1. Aho A.V., Ravi Sethi and D. Ullman. Compilers – Principles Techniques and Tools,Addison Wesley, 2006.

Reference Books

1. D.M.Dhamdhere, System Programming and Operating Systems, Tata McGraw Hill & Company, 1996.
2. Kenneth C. Louden, Compiler Construction – Principles and Practice, Cengage Learning Indian Edition, 2006.
3. Tremblay and Sorenson, The Theory and Practice of Compiler Writing, Tata McGraw Hill & Company,1984.

Sample Course Level Assessment Questions

Course Outcome 1 (CO1):

1) Explain the phases of a compiler with a neat diagram.

2) Define a token. Identify the tokens in the expression a := b + 10.

Course Outcome 2 (CO2):

1) Illustrate the process of left recursion and left factoring a grammar.

Course Outcome 3 (CO3):

1. What are the different parsing conflicts in the SLR parsing table?
2. Design a recursive descent parser for the grammar

   $E \rightarrow E + T \mid T$

   $T \rightarrow T*F \mid F$

   $F \rightarrow (E) \mid id$

3. Construct canonical LR(0) collection of items for the grammar below.

   $S \rightarrow L = R$

   $S \rightarrow R$

   $L \rightarrow * R$

   $L \rightarrow id$

   $R \rightarrow L$

Also identify a shift reduce conflict in the LR (0) collection constructed above.

Course Outcome 4 (CO4):

1. Write the quadruple and triple representation of the following intermediate code

   R1 = C * D

   R2 = B + R1

   A = R2

   B[0] = A

2. Differentiate S-attributed Syntax Directed Translation(SDT) and L-attributed SDT. WriteS - attributed SDT for a simple desktop calculator

Course Outcome 5 (CO5):

1. List out the examples of function preserving transformations.
2. What are the actions performed by a simple code generator for a typical three-address statement of the form x: = y op z.

Model Question Paper

QP CODE:

Reg No: _____

Name: _____

PAGES : 4

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B.TECH DEGREE EXAMINATION , MONTH & YEAR

Course Code: ERT 444

Course Name: Compiler Design

Max.Marks:100 Duration: 3

Hours

PART A

Answer All Questions. Each Question Carries 3 Marks

1. Specify the analysis and synthesis parts of compilation.
2. Define the terms token, lexemes and patterns with examples.
3. Is the grammar S --> S | (S) S / Ɛ ambiguous? Justify your answer.
4. What is left recursive grammar? Give an example. What are the steps in removing left recursion?
5. Compare different bottom-up parsing techniques.
6. What are the possible actions of a shift reduce parser.

7. Differentiate synthesized and inherited attributes with examples.

8. Translate a[i] = b * c – b * d, to quadruple.

9. What is the role of peephole optimization in the compilation process.

10. What are the issues in the design of a code generator.

(10x3=30)

Part B

Answer any one question from each module. Each question carries 14 Marks)

11. (a) Explain the different phases of a compiler with a running example. **(9)**

OR

12. (a) What is a regular definition? Give the regular definition of an unsigned integer **(7)**

(b) Express the role of transition diagrams in recognition of tokens. **(7)**

13. (a) What is Recursive Descent parsing? List the challenges in designing such a parser? **(4)**

(b) Consider the following grammar **(10)**

E-→E or T |

TT→ T and

F |F

F→not F | (E) | true | false

(i) Remove left recursion from the grammar.

(ii) Construct a predictive parsing table.

(iii) Justify the statement “The grammar is LL (1)”.

OR

14. (a) What is Recursive Descent parsing? List the problems in designing such a parser **(4)**

(b) Design a recursive descent parser for the grammar S→cAd, A→ab/ b **(5)**

Find the FIRST and FOLLOW of the non-terminals S, A and B in the grammar **(5)**

$S \rightarrow aABe$

$A \rightarrow Abc \mid b$

$B \rightarrow d$

15. (a) Construct the LR(0) set of items and their GOTO function for the grammar **(10)**
$S \rightarrow S\ S + \mid S\ S * \mid a$

(b) Is the grammar SLR? Justify your answer **(4)**

OR

16. (a) Identify LR(1) items for the grammar **(7)**

$S \rightarrow CC$

$C \rightarrow cC \mid d$

(b) Construct LALR table for the above grammar **(7)**

17. (a) Design a Syntax Directed Translator(SDT) for the arithmetic expression (4 * 7 + 19) * 2 and draw an annotated parse tree for the same. **(8)**

(b) Consider the grammar with following translation rules and E as the start symbol **(6)**

$E \rightarrow E1 \# T$ {E.value=E1.value x T.value ;}
| T{E.value=T.value ;}
$T \rightarrow T1 \& F$ { T.value=T1.value + F.value ;}
| F{T.value= F.value ; }
$F \rightarrow num$ { F.value=num. lvalue ;}

Compute E.value for the root of the parse tree for the expression
2#3 & 5# 6 &7

OR

18. (a) Write Syntax Directed Translator (SDT) and parse tree for infix to postfix translation of an expression. **(8)**

    (b) Explain the storage allocation strategies. **(6)**

19. (a) Describe the principal sources of optimization **(7)**

    (b) Illustrate the optimization of basic blocks with examples. **(7)**

OR

20. (a) Write the Code Generation Algorithm and explain the *getreg* function **(6)**

    (b) Generate target code sequence for the following statement **(8)**

d := (a-b)+(a-c)+(a-c).

Teaching Plan

No	Contents	No. of Lecture Hours
Module - 1(Introduction to Compilers and lexical analyzer) (7 hours)		
1.1	Introduction to compilers, Analysis of the source program	1 hour
1.2	Phases of the compiler – Analysis Phases	1 hour
1.3	Phases of the Compiler - Synthesis Phases	1 hour
1.4	Symbol Table Manager and Error Handler	1 hour
1.5	The role of Lexical Analyzer , Input Buffering	1 hour
1.6	Specification of Tokens	1 hour
1.7	Recognition of Tokens	1 hour
Module – 2 (Introduction to Syntax Analysis) (9 hours)		
2.1	Role of the Syntax Analyser	1 hour
2.2	Review of Context Free Grammars	1 hour
2.3	Parse Trees and Derivations	1 hour
2.4	Eliminating left recursion	1 hour

2.5	Left factoring the grammar	1 hour
2.6	Recursive Descent parsing	1 hour
2.7	First and Follow	1 hour
2.8	Predictive Parsing table constructor	1 hour
2.9	LL(1) Grammars	1 hour
Module - 3 (Bottom up parsing) (7 hours)		
3.1	Bottom-up parsing - Handle Pruning	1 hour
3.2	Shift Reduce parsing	1 hour
3.3	LR parsing , SLR Grammar, items	1 hour
3.4	Augmented Grammar, Canonical collection of LR(0) items	1 hour
3.5	SLR Parser Table Construction	1 hour
3.6	Constructing Canonical LR Parsing Tables	1 hour
3.7	Constructing LALR Parsing Tables	1 hour
Module - 4 (Syntax Directed Translation and Intermediate code Generation) (7 hours)		
4.1	Syntax directed definitions	1 hour
4.2	S- attributed definitions, L- attributed definitions	1 hour
4.3	Storage organization	1 hour
4.4	Storage- allocation strategies	1 hour
4.5	Intermediate languages , Graphical representations	1 hour
4.6	Three-Address code	1 hour
4.7	Quadruples, Triples	1 hour
Module - 5 (Code Optimization and Generation) (7 hours)		
5.1	Principal sources of optimization	1 hour
5.2	Local optimizations	1 hour
5.3	Global optimizations	1 hour
5.4	Issues in the design of a code generator – Lecture 1	1 hour
5.5	Issues in the design of a code generator – Lecture 2	1 hour
5.6	Target Language	1 hour
5.7	Design of a simple code generator.	1 hour

ERT 454	CRYPTOGRAPHY AND NETWORK SECURITY	Category	L	T	P	Credit
		PEC	2	1	0	3

Preamble:

The purpose of this course is to provide an understanding of the fundamental principles underlying secure communication and data protection in networked environments. Through exploration of cryptographic techniques and network security protocols, students will gain insights into the intricacies of safeguarding digital assets and ensuring confidentiality, integrity, and authenticity in data transmission.

Prerequisite: A sound knowledge in Cryptography, and Network Security

Course Outcomes: After the completion of the course the student will be able to

CO#	Course Outcomes
CO1	Summarize different classical encryption techniques **(Cognitive Knowledge Level: Understand)**
CO2	Identify mathematical concepts for different cryptographic algorithms (**Cognitive Knowledge Level: Understand)**
CO3	Demonstrate cryptographic algorithms for encryption/key exchange (**Cognitive Knowledge Level: Apply)**
CO4	Summarize different authentication and digital signature schemes (**Cognitive Knowledge Level: Understand)**
CO5	Demonstrate proficiency in understanding electronic mail security, IP Security protocols and Combining Security Associations, and Key Management **(Cognitive Knowledge Level: Understand)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓								✓
CO2	✓	✓	✓	✓								✓
CO3	✓	✓	✓	✓	✓	✓						✓
CO4	✓	✓	✓	✓	✓	✓						✓
CO5	✓	✓	✓	✓	✓	✓						✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development ofsolutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Lifelong learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks(%)
	Test 1 (%)	Test 2 (%)	
Remember	30	30	30
Understand	30	30	30
Apply	40	40	40
Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3

Continuous Internal Evaluation Pattern:

Attendance : **10 marks**

Continuous Assessment Test (Average of series Tests 1&2) : **25 marks**

Continuous Assessment Assignment **: 15 marks**

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Syllabus

Module-1 (Cryptography and Symmetric Cipher Models)

Symmetric Cipher Models- Substitution techniques- Transposition techniques- Rotor Machines- Steganography. Simplified DES- Block Cipher principles- The Data Encryption Standard, Strength of DES- Differential and linear Cryptanalysis. Block Cipher Design principles- Block Cipher modes of operations.

Module-2 (International Data Encryption Algorithm (IDEA) and Advanced Encryption Standard (AES))

IDEA: Primitive operations- Key expansions- One round, Odd round, Even Round- Inverse keys for decryption. AES: Basic Structure- Primitive operation- Inverse Cipher- Key Expansion, Rounds, Inverse Rounds. Stream Cipher –RC4.

Module-3 (Public Key Cryptography and Number Theory)

Public key Cryptography: - Principles of Public key Cryptography Systems, Number theory- Fundamental Theorem of arithmetic, Fermat's Theorem, Euler's Theorem, Euler's Totient Function, Extended Euclid's Algorithm, Modular arithmetic. RSA algorithm- Key Management - Diffie-Hellman Key Exchange, Elliptic curve cryptography.

Module-4 (Authentication)

Authentication requirements- Authentication functions- Message authentication codes- Hash functions- SHA -1, MD5, Security of Hash functions and MACs- Authentication protocols-Digital signatures-Digital signature standards.

Module-5 (Network and IP Security)

Network security: Electronic Mail Security: Pretty good privacy- S/MIME. IP Security: Architecture- authentication Header- Encapsulating Security payload- Combining Security associations- Key management.

Text book

1. Behrouz A. Forouzan, Cryptography and Network Security, Tata McGraw-Hill. 2010
2. William Stallings, Cryptography and Network Security, Pearson Education, 2014

References

1. B. Schneier, Applied Cryptography, Protocols, Algorithms, and Source Code in C, 2 nd Edn, Wiley, 1995.
2. Charlie Kaufman, Radia Perlman, Mike Speciner, Network Security, PHI, 2002

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. What is the necessity of block cipher modes of operation?

Course Outcome 2 (CO2):

1. Explain the mix column operation in AES algorithm.
2. Illustrate RC4 algorithm.

Course Outcome 3 (CO3):

1. Explain the algorithm for generating keys in RSA algorithm.
2. Demonstrate Diffie Hellman Key exchange algorithm.

Course Outcome 4 (CO4):

1. Illustrate the working of SHA-1 with diagrams.
2. Discuss digital signature scheme using RSA.

Course Outcome 5 (CO5):

1. What is PGP? Discuss its working.
2. What are the functionalities provided by Secure MIME?

Model Question Paper

QP CODE:

Reg No: Name:

PAGES: 3

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B.TECH. DEGREE EXAMINATION, MONTH & YEAR

Course Code: ERT 454

Course Name: Cryptography and Network Security

Max.Marks:100 Duration: 3 Hours

PART A

Answer All Questions. Each Question Carries 3 Marks

1. Encrypt the message “this is an exercise” using the additive cipher with key=20.
2. What is the necessity of block cipher modes of operation? List out the advantages and the disadvantages of output feedback mode.
3. What are the primitive operations of IDEA?
4. What are the different types of stream ciphers?
5. Differentiate between Symmetric and Asymmetric Cryptosystem.
6. Generate the key attributes for the values p=11 and q=3. Also encrypt the message m=2 with the generated keys.
7. What are the requirements of a good hash function.
8. How digital signature is implemented using RSA approach.
9. Give the format of Authentication Header in IPSec.
10. Write the general structure of Private key Ring used in PGP.

(10x3=30)

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11. (a) Use Playfair Cipher with key COMPUTER to encrypt the message "CRYPTOHRAPHY". . (6)

    (b) Explain the key generation, Encryption and Decryption of S-DES algorithm in detail. (8)

OR

12. (a) What are the block cipher principles. (6)

    (b) Discuss how to break DES? (8)

    (b) Explain the primitive operations of AES. (8)

OR

14. (a) What are the strengths and limitations of RC4? (4)

    (b) Explain encryption and decryption process in IDEA. (10)

15. (a) Find the GCD (78, 120) using Euclid's Algorithm. (6)

    (b) Explain Diffie-Hellman Key exchange algorithm with suitable example. (8)

OR

16. (a) Give the encryption/decryption procedures using elliptic curve cryptography. (5)

    (b) Explain the algorithm for generating keys in RSA algorithm. Perform encryption and decryption using RSA algorithm for the following P=7;q=11; e=13; m=8. (10)

17. (a) What is a Hash function? What are the requirements of Hash function? (6)

    (b) Illustrate the working of SHA-1 with diagram. (8)

OR

18. (a) Explain the steps of MD5 algorithm and its characteristics. (6)

    (b) Discuss the security of MACs in detail. (8)

19. (a) Explain the sequence of steps involved in the message generation and reception in PGP with block diagrams. (10)

    (b) List out the security association parameters in IPSec. (4)

OR

20. (a) Explain the method of protecting IP datagram from replay attack using IPSec. (6)

    (b) What is S/MIME? Discuss its content types. (8)

Teaching Plan

No	Contents	No: of Lecture Hours (37 hrs)
Module -1 (Cryptography and Symmetric Cipher Models) (6 hours)		
1.1	Symmetric Cipher Models- Substitution techniques	1 hour
1.2	Symmetric Cipher Models- Transposition techniques	1 hour
1.3	Rotor machines, Steganography, Modern Steganography Techniques, Attacks on Steganography	1 hour
1.4	Data Encryption Standard, Strength of DES- Differential and linear Cryptanalysis	1 hour
1.5	Block Cipher, Block Cipher Design principles	1 hour
1.6	Block Cipher modes of operations	1 hour
Module -2 (International Data Encryption Algorithm (IDEA) and Advanced Encryption Standard (AES) (6 hours)		
2.1	IDEA Introduction, Primitive operations, Key generations	1 hour
2.2	Key expansions- One round, Odd round, Even Round, Inverse keys for decryption	1 hour
2.3	AES Introduction, Basic Structure, Primitive operations	1 hour
2.4	Inverse Cipher, Key Expansion	1 hour
2.5	Rounds, Inverse Rounds	1 hour
2.6	Stream Cipher, RC4.	1 Hour
Module-3 (Public Key Cryptography and Number Theory) (7 hours)		
3.1	Public key Cryptography, Principles of Public key Cryptography Systems	1 hour
3.2	Number theory- Fundamental Theorem of arithmetic	1 Hour
3.3	Fermat’s Theorem, Euler’s Theorem, Euler’s Totient Function	1 hour
3.4	Extended Euclid’s Algorithm, Modular arithmetic	1 hour
3.5	RSA algorithm	1 hour
3.6	Key Management - Diffie-Hellman Key Exchange	1 hour
3.7	Elliptic curve cryptography	1 hour

Module-4 (Authentication) (8 hours)		
4.1	Authentication requirements, Authentication functions	1 hour
4.2	Message authentication, Message authentication codes	1 hour
4.3	Hash functions, Requirements of Hash Functions	1 hour
4.4	SHA 1 Secure Hash Function	1 hour
4.5	MD5, Algorithm characteristics	1 hour
4.6	Security of Hash functions and MACs	1 hour
4.7	Digital signatures, Working of Digital signature, Digital signature standards.	1 hour
4.8	Authentication protocols-Digital	1 hour
Module –5 (Network and IP Security) (10 hours)		
5.1	Network security, need of network security, Security services	1 hour
5.2	Electronic Mail Security	1 hour
5.3	Pretty good privacy- Working, PGP Message	1 hour
5.4	S/MIME, S/MIME Functionalities	1 hour
5.5	IP Security, Security problems of IP	1 hour
5.6	IP Security Architecture, Security Association and its parameters	1 hour
5.7	Authentication Header, Encapsulating Security payload	1 hour
5.8	Combining Security associations	1 hour
5.9	Key management- Oakley Key Determination Protocol	1 hour
5.10	Key management- ISAKMP	1 hour

PROGRAM ELECTIVE IV

ERT416	MICRO-ELECTRO-MECHANICAL SYSTEMS	CATEGORY	L	T	P	CREDITS
		OEC	2	1	0	3

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Explain the fundamental concepts of Micro Electro Mechanical Systems (MEMS) design, including materials, mechanical components, working principles, and the impact of scaling laws on miniaturization. (**Cognitive Knowledge level: Understand**)
CO 2	Explain standard micro fabrication techniques. (**Cognitive Knowledge level: Understand**)
CO 3	Apply the principles of electrostatics, thermal expansion, and shape memory alloys to design and evaluate MEMS sensors and actuators for various applications. (**Cognitive Knowledge level: Apply**)
CO 4	Understand and select appropriate bonding techniques for MEMS assembly, and identify potential applications in various fields like RF, BioMEMS, MOEMS, and NEMS. (**Cognitive Knowledge level: Understand**)
CO5	Infer the functionalities of various MEMS devices and their applications in diverse commercial products. (**Cognitive Knowledge level: Understand**)

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO 1	✓	✓										✓
CO 2	✓	✓										✓
CO 3	✓	✓										✓
CO 4	✓	✓	✓									✓
CO5	✓	✓	✓									✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category		**Continuous Assessment Tests**		**End Semester Examination**
		1	**2**	
Remember	K1	10	10	10
Understand	K2	30	30	60
Apply	K3	10	10	30
Analyse				
Evaluate				
Create				

Mark distribution

Total Marks	**CIE**	**ESE**	**ESE Duration**
150	**50**	**100**	**3 hours**

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Test (2 numbers) : 25 marks

Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

COURSE OUTCOME 1 (CO1): Llist three fundamental design considerations for mechanical components in a mems device.

COURSE OUTCOME 2 (CO2): List two advantages and two disadvantages of using wet etching for mems fabrication.

COURSE OUTCOME 3 (CO3): Briefly describe the working principle of a thermal bimorph and provide one example of its application.

COURSE OUTCOME 4 (CO4): Differentiate between rf mems and biomems, providing one application example for each.

COURSE OUTCOME 5 (CO5): Illustrate an example each of a mems device used in inkjet printers and another used in consumer electronics.

SYLLABUS

MODULE 1: Introduction to micro electro mechanical systems (mems) design

Definition of mems. Mems devices. Silicon as a mems material – mechanical properties of silicon. Mechanical components in mems. Design concepts of mechanical components. Working principles of microsystems. Engineering science for microsystems design and fabrication. Scaling laws – scaling in geometry

Module 2: Fabrication Technologies

Surface micromachining: Sacrificial layer processes, Bulk micromachining: micro needles, Etching: dry etching, plasma etching; Wet etching: principle and process architect; High Aspect-Ratio Processes: LIGA process, Deep Reactive Ion Etching (DRIE); Thin film deposition: Chemical Vapor Deposition (CVD), Physical Vapor Deposition (PVD); Evaporation and sputtering

Module 3: Sensors And Actuators

Electrostatic sensors - Parallel plate capacitors, applications. Interdigitated finger capacitor – comb drive devices, micro grippers. Micro motors. Thermal sensing and actuation, thermal expansion, thermal couples, thermal resistors, thermal bimorph, applications. Magnetic actuators,

micromagnetic components. Case studies of mems in magnetic actuators. Actuation using shape memory alloys.

Module 4: Bonding Techniques and Applications for Microsystems

Bonding techniques for MEMS: Surface bonding, Anodic bonding, Silicon - on - Insulator, wire bonding, Sealing – Assembly of micro systems. Overview of MEMS areas: RF MEMS, BioMEMS, MOEMS, NEMS.

Module 5: Case Studies of MEMS

MEMS inertial sensors in automobiles: airbag deployment, automobile navigation; MEMS vibratory gyroscope, MEMS accelerometer. MEMS devices in commercial applications: Inkjet printers, digital micromirror devices (DMD), radio frequency MEMS switches, scanning tunneling microscopes (STM).

Text Books

1. Tai–Ran Hsu – 'Mems & Microsystems Design and Manufacturing' – John Wiley & Sons – 2008 – 2nd Edition
2. Chang Liu, "Foundations of MEMS", Pearson Education Inc., 2006.
3. Stephen D Senturia, "Microsystem Design", Springer Publication, 2000.

Reference Books:

1. James J.Allen, "Micro Electro Mechanical System Design", CRC Press Publisher, 2010
2. Julian w. Gardner, Vijay K. Varadan, Osama O. Awadelkarim, "Micro Sensors MEMS and Smart Devices", John Wiley & Son LTD,2002
3. Mohamed Gad-el-Hak, editor, " The MEMS Handbook", CRC press Baco Raton, 2000
4. Nadim Maluf," An Introduction to Micro Electro Mechanical System Design", Artech House, 2000.
5. Thomas M.Adams and Richard A.Layton, "Introduction MEMS, Fabrication and Application," Springer 2012.
6. Reza Ghodssi, Pinyen, "MEMS Materials and Processes Handbook", Springer Science Business Media, 2011
7. Rai-Choudhury P., "MEMS and MOEMS Technology and Applications", Prentice Hall of India Learning Private Limited, 2009
8. Hans H. Gatzen,Volker Saile, JurgLeuthold, Micro and Nano Fabrication: Tools and Processes, Springer, 2015.
9. Dilip Kumar Bhattacharya, Brajesh Kumar Kaushik, Microelectromechanical Systems (MEMS), Cengage Learning.

COURSE CONTENTS AND LECTURE SCHEDULE

No	Topic	No. of Lectures
1	**Introduction to micro electro mechanical systems (mems) design**	**7**
1.1	Definition of mems. Mems devices. Silicon as a mems material	1
1.2	mechanical properties of silicon. Mechanical components in MEMS.	2
1.3	Design concepts of mechanical components. Working Principles of Microsystems.	2
1.4	Engineering Science for Microsystems design and Fabrication.	1
1.5	Scaling laws – Scaling in geometry	1
2	**Fabrication Technologies**	**8**
2.1	Surface micromachining: Sacrificial layer processes	1
2.2	Bulk micromachining: micro needles; Etching: dry etching, plasma etching	2
2.3	Wet etching: principle and process architect	1
2.4	High Aspect-Ratio Processes: LIGA process, Deep Reactive Ion Etching (DRIE)	1
2.5	Thin film deposition: Chemical Vapor Deposition (CVD), Physical Vapor Deposition (PVD)	2
2.6	Evaporation and sputtering	1
3	**Sensors And Actuators**	**7**
3.1	Electrostatic sensors **-** Parallel plate capacitors**,** Applications**.** Interdigitated Finger capacitor – Comb drive devices**,** Micro Grippers**.** Micro Motors**.**	3
3.2	Thermal Sensing and Actuation, Thermal expansion**,** Thermal couples**,** Thermal resistors**,** Thermal Bimorph**,** Application**s.** Magnetic Actuators**,** Micromagnetic components**.**	3
3.3	Case studies of MEMS in magnetic actuators**.** Actuation using Shape Memory Alloys	1
4	**Bonding Techniques and Applications for Microsystems**	**7**
4.1	Bonding techniques for MEMS: Surface bonding, Anodic bonding	2
4.2	Silicon - on - Insulator, wire bonding, Sealing	2

4.3	Assembly of micro systems. Overview of MEMS areas: RF MEMS	2
4.4	BioMEMS, MOEMS, NEMS.	1
5	**Case Studies of MEMS**	**7**
5.1	MEMS inertial sensors in automobiles: airbag deployment, automobile navigation	2
5.2	MEMS vibratory gyroscope, MEMS accelerometer	1
5.3	MEMS devices in commercial applications: Inkjet printers, digital micromirror devices (DMD	2
5.4	radio frequency MEMS switches	1
5.5	scanning tunneling microscopes (STM).	1

Assignment: At least two assignments should be given.

MODEL QUESTION PAPER

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B.TECH. DEGREE EXAMINATION

COURSE CODE: ERT416

Program: Electronics and Computer Engineering

Course Name: MICRO-ELECTRO-MECHANICAL SYSTEMS

Max. Marks: 100 marks Duration: 3 Hours

PART A

Answer ALL Questions. Each Carries 3 marks.

1. Briefly define Micro Electro Mechanical Systems (MEMS) and provide two key advantages of using MEMS technology
2. State two main reasons why silicon is a widely used material for MEMS devices
3. Differentiate between surface micromachining and bulk micromachining techniques used in MEMS fabrication.
4. Explain the concept of "sacrificial layer" and its role in surface micromachining processes
5. Briefly explain the working principle of a parallel plate capacitor, a fundamental component in many MEMS sensors.
6. Differentiate between interdigitated finger capacitors and comb drive devices used in MEMS. State one application for each type
7. Briefly describe two different techniques used for bonding MEMS devices.

8. Explain the purpose of sealing in MEMS assembly.
9. Briefly describe two applications of MEMS accelerometers in automobiles.
10. What is the basic principle behind the operation of a MEMS vibratory gyroscope

PART – B

Answer one question from each module. Each question carries 14 marks.

Module – I

11.	Describe the working principle of a comb drive actuator. Briefly outline the design considerations for a comb drive actuator intended for high-precision positioning tasks. Include a sketch of the basic structure and labeling of its key components	14
	OR	
12.	Micromachining processes are essential for creating MEMS structures. Compare and contrast two different micromachining techniques (e.g., photolithography and wet etching) based on the following criteria: • Principle of operation • Advantages and limitations • Typical applications	14

Module – II

13	Thin film deposition is a crucial step in MEMS fabrication. Explain the fundamental differences between Chemical Vapor Deposition (CVD) and Physical Vapor Deposition (PVD) techniques. Discuss two specific examples of deposition methods within each category	
	OR	
14	High-aspect-ratio microstructures are crucial for many MEMS devices. Compare and contrast two high-aspect-ratio micromachining processes: LIGA and Deep Reactive Ion Etching (DRIE). Discuss their advantages, limitations, and typical applications.	14

Module – III

15	MEMS technology offers a variety of actuation mechanisms. Compare and contrast two actuation principles: electrostatic and thermal actuation. • Discuss the advantages and limitations of each method. • Provide examples of MEMS devices that utilize each actuation principle	14
	OR	

16	Micro grippers are crucial tools in micro manipulation tasks. Discuss the design considerations and working principles of electrostatic comb drive micro grippers. Analyze the advantages and limitations of this actuation mechanism compared to thermal actuation for micro grippers.	14

Module – IV

17	Selecting the appropriate bonding technique is crucial for successful MEMS device assembly. Compare and contrast three common MEMS bonding techniques: surface bonding, anodic bonding, and wire bonding. Discuss their working principles, advantages, and limitations for different MEMS applications.	14
	OR	
18	Discuss the functionalities and key applications of two emerging MEMS areas: BioMEMS and NEMS. Analyze the specific challenges and considerations for designing MEMS devices in these areas compared to traditional MEMS applications.	14

Module – V

19	Discuss the working principles of MEMS accelerometers and MEMS vibratory gyroscopes. Analyze how these sensors contribute to the functionality of airbag deployment and automobile navigation systems.	14
20	Compare and contrast two MEMS devices from different application areas: digital micromirror devices (DMDs) used in projectors and radio frequency (RF) MEMS switches. Discuss their functionalities and how they operate based on different actuation principles. Evaluate the advantages and limitations of each device in their respective applications	14

ERT426	SPEECH AND AUDIO ROCESSING	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Perequisite: ERT301 Digital Signal processing

Course Outcomes: After the completion of the course the student will be able to

CO1	Understand basic concepts of speech production, speech analysis, speech coding and parametric representation of speech and apply it in practical Applications. **(Cognitive Knowledge level: Understand)**
CO2	Develop systems for various applications of speech processing. **(Cognitive Knowledge level: Apply)**
CO3	Learn Signal processing models of sound perception and application of perception models in audio signal processing. **(Cognitive Knowledge level: Apply)**
CO4	Implement audio compression algorithms and standards. **(Cognitive Knowledge level: Apply)**
CO5	Perform audio quality analysis. **(Cognitive Knowledge level: Understand)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	✓	✓										✓
CO 2	✓	✓	✓									✓
CO 3	✓	✓	✓	✓	✓							✓
CO 4	✓	✓			✓							✓
CO 5	✓	✓	✓									✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Lifelong learning

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1	**2**	
Remember K1	10	10	20
Understand K2	30	30	60
Apply K3	10	10	20
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	**CIE**	**ESE**	**ESE Duration**
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Test (2 numbers) : 25 marks

Assignment/Quiz/Course project :15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Mark patterns are as per the syllabus with 80 % for theory and 20% for logical/numerical problems, derivation and proof.

Course Level Assessment Questions

Course Outcome 1 (CO1): Speech Processing, Parametric representation of speech, LPC analysis

1. Describe algorithm for computing LPC coefficients using autocorrelation method
2. Define short time energy and short time zero crossing rate

Course Outcome 2 (CO2): Frequency domain analysis, Speech coding, Speech enhancement

1. Describe the steps involved in obtaining MFCC coefficients of a speech signal
2. Compare broad categories of speech coding techniques in terms of bitrate and speech quality

Course Outcome 3 (CO3): Models of Audio perception, Psychoacoustic analysis

1. Explain MPEG psycho-acoustic model of audio perception
2. Differentiate between simultaneous masking and temporal masking

Course Outcome 4 (CO4): Audio compression methods, Transform coding of Audio signals

1. Describe various redundancy removal and perceptual irrelevancy removal in audio compression
2. Explain the concept of MDCT and its properties

Course Outcome 5 (CO5): Audio Perception and rendering

1. Explain subjective and objective analysis methods to measure the audio quality
2. What are the physical and psycho-acoustical basis of sound localization and space perception Describe spatial audio standards

Syllabus

Module	Course contents	Hours
I	Speech Production: Acoustic theory of speech production. Speech Analysis: Speech signal, Short-Time Speech Analysis, Time domain analysis (Short time energy, short time zero crossing Rate, ACF). LPC Analysis (LPC model, Auto correlation method).	7
II	Frequency domain analysis (Filter Banks, STFT, Spectrogram), Cepstral Analysis**,** MFCC. Probabilistic formulation of speech recognition, Speech coding: fundamentals, Comparison of waveform coding, vocoding and hybrid coding, Speech enhancement: fundamentals, basic types,	7

	Speaker verification (block diagram), Language Identification (block diagram)	
III	Signal Processing Models of Audio Perception: Basic anatomy of hearing System. Auditory Filter Banks, Psycho-acoustic analysis: Critical Band Structure, Absolute Threshold of Hearing, Simultaneous Masking, Temporal Masking, MPEG psycho-acoustic model.	7
IV	Audio compression methods: Sampling rate and bandwidth requirement for digital audio, Redundancy removal andperceptual irrelevancy removal, Transform coding of digitalaudio: MPEG2-AAC coding standard, MDCT and its properties,Pre-echo and pre-echo suppression, Loss less coding methods.	7
V	Spatial Audio Perception and rendering: The physical and psycho-acoustical basis of sound localization and space perception. Spatial audio standards. Audio quality analysis: Objective analysis methods- PEAQ, Subjective analysis methods - MOS score, MUSHRA score	7

Text Books:

1. Douglas O'Shaughnessy, Speech Communications: Human & Machine, IEEE Press, Hardcover 2/e, 1999; ISBN: 0780334493.
2. Nelson Morgan and Ben Gold, Speech and Audio Signal Processing: Processing and Perception Speech and Music, July 1999, John Wiley & Sons, ISBN: 0471351547

References:

1. Donald G. Childers, Speech Processing and Synthesis Toolboxes, John Wiley & Sons, September 1999; ISBN: 0471349593
2. Rabiner and Juang, Fundamentals of Speech Recognition, Prentice Hall, 1994.
3. Rabiner and Schafer, Digital Processing of Speech Signals, Prentice Hall, 1978.
4. Thomas F. Quatieri, Discrete-Time Speech Signal Processing: Principles and Practice, Prentice Hall; ISBN: 013242942X; 1/e

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

VIII SEMESTER B. TECH DEGREE EXAMINATION

Course Code: ERT426

Course Name: SPEECH AND AUDIO PROCESSING

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all questions, each carries 3 marks

1. What is Zero Crossing Rate (ZCR)? How is it used for differentiating voiced and unvoiced speech?
2. Why short time analysis is preferred for analysing speech signal?
3. Express speech recognition in terms of probabilistic formulation and justify the importance of each term.
4. What is the need for Spectrogram representation of speech signals?
5. Differentiate between speaker identification and speaker verification.
6. How is 'bit allocation' used in MPEG?
7. What is threshold of hearing? Explain with the help of a diagram.
8. Draw and explain the concept of threshold of hearing.
9. What is redundancy removal in audio compression?
10. What is cone of confusion? How do listeners resolve it?

PART B

Answer any one full question from each module carries 14 marks.

MODULE 1

11 a) Draw the source system model of speech production. Derive equations of LP analysis using autocorrelation method. 7

b) Write mathematical expression for the computation of short time energy and short time auto correlation for a speech segment. 7

OR

12	Describe human speech production mechanism using a diagram and the role of following organs in speech production (i) Velum (ii) Vocal folds (iii) Lips (iv) Tongue	14

MODULE II

13	a) Define mathematically the need of STFT for analyzing speech signals.	7
	b) Describe with the help of a block diagram the steps involved in obtaining MFCC coefficients of a speech signal.	7

OR

14	a) Formulate 'automatic speech recognition' using probabilistic terms.	7
	b) Explain any one speech coding technique in detail.	7

MODULE III

15	a) Draw and explain the concept of auditory filter banks.	7
	b) With the help of neat diagram explain the anatomy of hearing system.	7

OR

16	a) Differentiate between simultaneous masking and temporal masking	6
	b) Explain MPEG psycho acoustic model. How is masking useful for implementing audio compression?	8

MODULE IV

17	a) Explain mathematically the concept of MDCT and its properties.	7
	b) Explain MPEG2-AAC coding standard.	7

OR

18	a) Describe pre-echo suppression in audio signals.	7
	b) Briefly explain lossless coding of audio signals.	7

MODULE V

19	a) Differentiate between Interaural level difference (ILD) and Interaural time difference (ITD) in perception with help of diagrams.	7
	b) Explain any two spatial audio standards.	7

OR

20	a) Describe objective analysis method to analyze the audio quality.	8
	b) Mention the significance of MOS score and MUSHRA score	6

Course content and Lecture plan

No	TOPIC	No of Lectures
	MODULE 1	
1.1	Introduction, The process of Speech production	1
1.2	Acoustic theory of speech production	1
1.3	Speech signal	1
1.4	Digital Model for speech signal	1
1.5	Short-time analysis of speech, Time domain analysis (Short time energy)	1
1.6	Time domain analysis (short time zero crossing Rate, ACF)	1
1.4	LPC Analysis	1
	MODULE II	
2.1	Frequency domain analysis (Filter Banks, STFT)	1
2.2	Frequency domain analysis (Spectrogram)	1
2.3	Cepstral Analysis	1
2.4	MFCC.	1
2.5	Fundamentals of Speech recognition, Speech coding, Speech Enhancement	1
2.6	Speaker Verification,	1
2.7	Language Identification	1
	MODULE III	
3.1	Signal Processing Models of Audio Perception	1
3.2	Basic anatomy of hearing System.	1
3.3	Auditory Filter Banks	1
3.4	Psycho-acoustic analysis.	1
3.5	Critical Band Structure, Absolute Threshold of Hearing.	1
3.6	Simultaneous Masking, Temporal Masking,	1
3.7	MPEG psycho-acoustic model	1
	MODULE IV	
4.1	Sampling rate and bandwidth requirement for digital audio (Lecture 1)	1
4.2	Sampling rate and bandwidth requirement for digital audio (Lecture 2)	1
4.3	Redundancy removal and perceptual irrelevancy removal,	1

4.4	Transform coding of digital audio: MPEG2-AAC coding standard	1
4.5	MDCT and its properties,	1
4.6	Pre-echo and pre-echo suppression,	1
4.7	Lossless coding methods.	1
	MODULE V	
5.1	Spatial Audio Perception and rendering. (Lecture 1)	1
5.2	Spatial Audio Perception and rendering. (Lecture 2)	1
5.3	The physical and psycho-acoustical basis of sound localization and space perception. (Lecture 1)	1
5.4	The physical and psycho-acoustical basis of sound localization and space perception. (Lecture 2)	1
5.5	Spatial audio standards.	1
5.6	Audio quality analysis: Objective analysis methods- PEAQ	1
5.7	Subjective analysis methods - MOS score, MUSHRA score	1

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
ERT 436	COMMUNICATION ENGINEERING	PEC	2	1	0	3

Prerequisite: Nil.

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand the different analog modulation schemes **(Cognitive Knowledge Level: Understand)**
CO 2	Explain the principle and working of analog transmitters and receivers. **(Cognitive Knowledge Level: Understand)**
CO 3	Understand PAM, PPM and PWM. **(Cognitive Knowledge Level: Understand)**
CO 4	Demonstrate the different types of multiplexing in communication system. **(Cognitive Knowledge Level: Understand)**
CO 5	Explain the concepts of wireless communication. **(Cognitive Knowledge Level: Understand)**

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	✓	✓	✓									
CO 2	✓	✓	✓									
CO 3	✓	✓	✓									
CO 4	✓	✓										

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	20	20	40
Understand	30	30	60
Apply	-	-	-
Analyse	-	-	-
Evaluate	-	-	-
Create	-	-	-

Mark Distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance: 10 marks

Continuous Assessment Test (2 Numbers): 25 marks

Assignment/Quiz/Course project: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub- divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

4. Define AM and derive the equation for AM wave.
5. Explain the need for modulation.
6. Mention the elements of a communication system

Course Outcome 2 (CO2):

34. Draw and explain the basic block diagram of AM receiver.
35. Draw typical AGC circuit for a super heterodyne receiver and explain its working.
36. Show that the maximum transmitting power of an AM signal is 1.5 times the carrier power.

Course Outcome 3 (CO3):

1. Differentiate between PPM and PWM with sketches.
2. Describe the sampling process.
3. Describe the demodulation of DPCM signal.

Course Outcome 4 (CO4):

1. Compare the basic principles of TDMA and FDMA.
2. Explain the working of an optical fibre communication system.
3. Write notes on step index and graded index fibres.

Course Outcome 5 (CO5):

1. Explain how cell splitting improves the capacity.
2. Explain the architecture of Zigbee system.
3. Differentiate between Wi-fi and Wi-max.

Module 1 (6 Hours)

AM and FM fundamentals

Introduction, Elements of communication systems, Need for Modulation, Amplitude modulation: Modulation index, Average power, Frequency modulation, Frequency spectrum, Modulation index, Average power, Comparison of AM and FM.

Module 2 (7 Hours)

AM and FM transmitters and receivers

Block diagrams of low power and high-power AM transmission – AM receivers: straight receivers, super heterodyne receiver - choice of intermediate frequency - simple AVC circuit Block diagrams of direct FM transmitter and Armstrong transmitter - FM receivers (balanced - slope detector and Foster-Seely discriminator only).

Module 3 (6 Hours)

Digital communication

Principles of digital communication – Sampling process-pulse modulation Techniques- sampling process-PAM, PWM and PPM concepts - PCM encoder and decoder Applications of data communication

Module 4 (8 Hours)

Satellite communication

Multiple access (MA) techniques-FDMA, TDMA, CDMA, SDMA - applications in satellite communication, MA techniques applications in wired communication. in satellite communication, earth station; Fibers – types: sources, detectors used, digital filters, optical link.

Module 5 (6 Hours)

Cellular telephone

Basic concepts, frequency reuse, interference cell splitting, sectoring, cell system layout, cell processing. Bluetooth, Zig-Bee, GPS, Wi-Fi, Wi-Max based communication

Text Books

1. Kennedy G., *Electronic Communication Systems*, McGraw-Hill, New York, 2008.
2. Roody and Coolen, *Electronic Communication*, Prentice Hall of India LTD., New Delhi, 2007.

References

1. William Scheweber, *Electronic Communication Systems*, Prentice Hall of India LTD, New Delhi, 2004.

2. Wayne Tomasi, *Electronic Communication Systems*, Prentice Hall of India LTD, New Delhi, 2004.
3. Simon Haykins, *Communication Systems*, John Wiley, USA, 2006

Model Question Paper

Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B. TECH. DEGREE EXAMINATION,

MONTH AND YEAR

Course Code: ERT 436

Course Name: COMMUNICATION ENGINEERING

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all questions, each carries 3 marks

4. Define AM and derive the equation for AM wave.
5. What does modulation actually do to a message and carrier'?
6. Draw the block diagram of super heterodyne receiver and explain the function of mixer stage.
7. Draw and explain the basic block diagram of AM receiver.
8. Differentiate between PPM and PWM with sketches.
9. Write short note on natural sampling and flat top sampling process in digital communication.
10. Compare the basic principles of TDMA and FDMA.
11. Explain the principle of any two Photo-detection methods in optical fiber communication.
12. Explain how cell splitting improves the capacity.
13. Explain the architecture of Zigbee system.

PART B

Answer any one full question from each module. Each question carries 14 Marks

Module 1

14. (a) A modulating signal vm(t)= 5 sin (6280 t) is used to modulate a carrier signal vc(t)= 15 sin (62800 t). Determine the modulation index, amplitudes and bandwidth. Also draw the frequency spectrum.

(6)

(b) Explain the need for modulation.

(8)

15. (a) Mention the elements of a communication system. Describe their functionality.

(8)

(b) Derive the expression for the instantaneous voltage of AM wave?

(6)

Module 2

16. (a) With a neat schematic explain the function of each block in FM transmitter using Armstrong Modulator. (7)

(b) Explain the operation of balanced slope detector. (7)

17. (a) Draw typical AGC circuit for a super heterodyne receiver and explain its working. (10)

(b) Show that the maximum transmitting power of an AM signal is 1.5 times the carrier power.

(4)

Module 3

18. (a) Describe the generation of PAM signal. (7)

(b) Describe the generation of PPM signals. (7)

19. (a) Describe the sampling process. (7)

(b) Describe the demodulation of DPCM signal. (7)

Module 4

20. (a) Differentiate between FDMA and CDMA?

(6)

(b) Write notes on step index and graded index fibres. (8)

21. (a) Explain the block diagram of fibre optical link. (7)

(b With block diagram, explain the working of an optical fibre communication system (7)

Module 5

22. (a) Explain different techniques to improve the capacity in cellular system. (10)

(b) Explain the various interferences associated with cellular communication. (4)

23. (a) What is co-channel interference and how is it reduced? (8)

(b) Differentiate between Wi-fi and Wi-max. (6)

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**AM and FM fundamentals**	**6**
1.1	Introduction, Elements of communication systems	1
1.2	Need for Modulation	1
1.3	Amplitude modulation: Modulation index, Average power	1
1.4	Frequency modulation	1
1.5	Frequency spectrum, Modulation index, Average power	1
1.6	Comparison of AM and FM	1
2	**AM and FM transmitters and receivers**	**7**
2.1	Block diagrams of low power and high-power AM transmission	1
2.2	AM receivers: straight receivers	1
2.3	super heterodyne receiver	1
2.4	choice of intermediate frequency - simple AVC circuit	1
2.5	Block diagrams of direct FM transmitter	2
2.6	Armstrong transmitter	
2.7	FM receivers (balanced - slope detector and Foster-Seely discriminator only)	1
3	**Digital communication**	**6**
3.1	Principles of digital communication	2
3.2	Sampling process	1
3.3	Pulse modulation Techniques- sampling process-PAM	1
3.4	PWM and PPM concepts	1
3.5	PCM encoder and decoder	1
3.6	Applications of data communication	1
4	**Satellite communication**	**8**
4.1	Multiple access (MA) techniques-FDMA	1
4.2	TDMA	1
4.3	CDMA	2
4.4	SDMA - applications in satellite communication	1

4.5	MA techniques applications in wired communication	1
4.6	MA techniques applications in satellite communication, earth station	1
4.7	Fibers – types: sources	1
4.8	Detectors used, digital filters, optical link	1
5	**Cellular telephone**	**6**
5.1	Basic concepts, frequency reuse	1
5.2	Interference, cell splitting	1
5.3	Sectoring, cell system layout, Cell processing	1
5.4	Bluetooth, Zig-Bee	1
5.5	Wi-Fi	1
5.6	Wi-Max based communication	1

ERT 446	Python Basics for Machine Learning	Category	L	T	P	Credit
		PEC	2	1	0	3

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO1	Write, test and debug Python programs **(Cognitive Knowledge level: Apply)**
CO2	Illustrate uses of conditional (if, if-else, if-elif-else and switch-case) and iterative (while and for) statements in Python programs **(Cognitive Knowledge level: Apply)**
CO3	Develop programs by utilizing the modules Lists, Tuples, Sets and Dictionaries in Python **(Cognitive Knowledge level: Apply)**
CO4	Implement Object Oriented programs with exception handling **(Cognitive Knowledge level: Apply)**
CO5	Write programs in Python to process data stored in files by utilizing the modules Numpy and Pandas **(Cognitive Knowledge level: Apply)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓		✓						✓	✓
CO2	✓	✓	✓		✓					✓		✓
CO3	✓	✓	✓		✓	✓	✓					✓
CO4	✓	✓	✓		✓		✓					✓
CO5	✓	✓	✓	✓	✓	✓						✓

Abstract POs defined by National Board of Accreditation

#PO	Broad PO	#PO	Broad PO
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Lifelong learning

Assessment Pattern

Bloom's Category	Test 1 (*Marks in percentage*)	Test 2 (*Marks in percentage*)	End Semester Examination (*Marks in percentage*)
Remember	20	20	20
Understand	35	35	35
Apply	45	45	45
Analyse			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	**50**	**100**	**3**

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Test : 25 marks

Continuous Assessment Assignment : 15 marks

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. The first series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing the remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part

A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each questioncan have a maximum of 2 sub-divisions and carries 14 marks.

SYLLABUS

Module I

Programming Environment and Python Basics:

Getting Started with Python Programming - Running code in the interactive shell, Editing, Saving, and Running a script. Using editors - IDLE, Jupyter.

Basic coding skills - Working with data types, Numeric data types and Character sets, Keywords, Variables and Assignment statement, Operators, Expressions, Working with numeric data, Type conversions, Comments in the program. Input, Processing, and Output. Formatting output.

Module II

Building Python Programs:

Control statements - Selection structure (if-else, switch-case), Iteration structure(for, while), Testing the control statements, Lazy evaluation. Functions - Hiding redundancy and complexity, Arguments and return values, Variable scopes and parameter passing, Named arguments, Main function, Working with recursion, Lambda functions. Strings and number systems - String function, Handling numbers in various formats.

Module III

Data Representation:

Lists - Basic list Operations and functions, List of lists, Slicing, Searching and sorting list, List comprehension. Work with tuples. Sets. Work with dates and times. Dictionaries - Dictionary functions, dictionary literals, adding and removing keys, accessing and replacing values, traversing dictionaries, reverse lookup.

Module IV

Object Oriented Programming:

Design with classes - Objects and Classes, Methods, Instance Variables, Constructor, Accessors and Mutators. Structuring classes with Inheritance and Polymorphism. Abstract Classes. Exceptions - Handle a single exception, handle multiple exceptions.

Module V

Data Processing:

The *os* and *sys* modules. Introduction to file I/O - Reading and writing text files, Manipulating binary files. NumPy - Basics, Creating arrays, Arithmetic, Slicing, Matrix Operations, Random numbers. Plotting and visualization. Working with CSV files. – Pandas - Reading, Manipulating, and Processing Data.

Text Books:

1. Kenneth A Lambert., Fundamentals of Python : First Programs, 2/e, Cengage Publishing, 2016
2. Wes McKinney, Python for Data Analysis, 2/e, Shroff / O'Reilly Publishers, 2017

Reference Books:

1. Allen B. Downey, Think Python: How to Think Like a Computer Scientist, 2/e, Schroff, 2016
2. Michael Urban and Joel Murach, Python Programming, Shroff/Murach, 2016
3. David M.Baezly, Python Essential Reference. Addison-Wesley Professional; 4/e, 2009.
4. Charles Severance. Python for Informatics: Exploring Information,
5. http://swcarpentry.github.io/python-novice-gapminder/

Sample Course Level Assessment Questions

Course Outcome1 (CO1):

1. What is type conversion?
2. How is it done in Python?

Course Outcome 2(CO2):

1. Write a Python program which takes a positive integer **n** as input and finds the sum of cubes all positive even numbers less than or equal to the number.

Course Outcome 3(CO3):

1. Given is a list of of words, *wordlist*, and a string, *name.*
2. Write a Python function which takes *wordlist* and *name* as input and returns a tuple.
3. The first element of the output tuple is the number of words in the *wordlist* which have *name* as a substring in it. The second element of the tuple is a list showing the index at which the *name* occurs in each of the words of the *wordlist* and a 0 if it doesn't occur.

Course Outcome 4(CO4):

1. Write a Python program to implement the addition, subtraction, and multiplication of complex numbers using classes. Use constructors to create objects. The input tothe program consists of real and imaginary parts of the complex numbers.

Course Outcome 5(CO5):

1. Given a file "auto.csv" of automobile data with the fields *index, company, body-style, wheel-base, length, engine-type, num-of-cylinders, horsepower, average-mileage,* and *price***,** write python code to

1) Clean and Update the CSV file
2) Print total cars of all companies

3) Find the average mileage of all companies
4) Find the highest priced car of all companies.

Model Question Paper

QP CODE: PAGES:

Reg No:_____

Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B.TECH. (MINOR) DEGREE EXAMINATION, MONTH & YEAR

Course Code: ERT 446

Course name: PYTHON BASICS FOR MACHINE LEARNING

Max Marks: 100 Duration: 3 Hours

PART-A

(Answer All Questions. Each question carries 3 marks)

1. Explain the basic data types available in Python, with examples.
2. Write a Python program to reverse a number and also find the sum of digits of the number. Prompt the user for input.
3. Explain the concept of scope and lifetime of variables in Python programming language, with a suitable example.
4. Discuss format specifiers and escape sequences with examples.
5. Discuss the relation between tuples, lists, and dictionaries in detail.

6. Discuss the following dictionary methods with an example.
i. *get( )* ii. *Keys( )* iii. *pop( )* iv. *update( )* v. *values( )* vi. *items( )*

7. What is polymorphism? Give an example in the context of OOP in Python.
8. How is exception handling accomplished in Python programs?
9. Write a note on the **os** and **os.path** modules in Python. Also, discuss the *walk( )* and *getcwd( )* methods of the **os** module.
10. Describe the characteristics of the CSV format.

PART-B

(Answer any one full question from each module)

11. (a) Compare and contrast interpreted languages and compiled languages. How does it affect the quality of program development and execution of the program? (6)

(b) Write a Python program to print the value of 2^{2n+n+5} for n provided by the user. (8)

OR

12. (a) Describe Arithmetic operators, Assignment operators, Comparison operators, Logical operators, and Bitwise operators in detail with examples. (6)

(b) Explain the software development process in detail. (8)

13. (a) Write a Python code to check whether a given year is a leap year or not [An year is a leap year if it's divisible by 4 but not divisible by 100 except for those divisible by 400]**.** (5)

(b) Input 4 integers (+ve and −ve). Write a Python code to find the sum of negative numbers, positive numbers, and print them. Also, find the averages of these two groups of numbers and print. (9)

OR

14. (a) Write a Python program to find the value for *sin(x)* up to *n* terms using the series (8)

$$\sin(x) = \frac{x}{1!} - \frac{x^3}{3!} + \frac{x^5}{5!} - \frac{x^7}{7!} + \cdots$$ where x is in degrees

(b) Write a Python code to determine whether the given string is a Palindromeor not using slicing. Do not use any string function. (6)

15. (a) Write a Python code to create a function called *list_of_frequency* that takes a string and prints the letters in non-increasing order of the frequency of their occurrences. Use dictionaries. (5)

(b) Write a Python program to read a list of numbers and sort the list in a non-decreasing order without using any built in functions. Separate function should be written to sort the list wherein the name of the list is passed as the parameter. (9)

OR

16 (a) Illustrate the following Set methods with an example. 6

i. *intersection( )* ii. *Union( )* iii. *Issubset( )* iv. *Difference( )* v. *update( )* vi. *discard( )*

(b) Write a Python program to check the validity of a password given by theuser. 8

The Password should satisfy the following criteria:

1. Contains at least one letter between **a** and **z**

2. Contains at least one number between **0** and **9**

3. Contains at least one letter between **A** and **Z**

4. Contains at least one special character from **$, #, @**

5. Minimum length of password: **6**

17 (a) How can a class be instantiated in Python? Write a Python program to express the instances as return values to define a class RECTANGLE with parameters *height, width, corner_x,* and *corner_y* and member functions to find center, area, and perimeter of an instance. 10

(b) Explain inheritance in Python. Give examples for each type of inheritance. 4

OR

18 (a) Write a Python class named ***Circle*** constructed by a radius and twomethods which will compute the area and the perimeter of a given circle 6

(b) Write Python program to create a class called as **Complex** and implement 8

__add__( ) method to add two complex numbers. Display the result byoverloading the + Operator.

19 (a) Write a Python program to add two matrices and also find the transpose of the resultant matrix. 8

(b) Given a file "auto.csv" of automobile data with the fields *index, company, body-style, wheel-base, length, engine-type, num-of-cylinders, horsepower, average-mileage,* and *price***,** write Python codes using Pandas to 6

1) Clean and Update the CSV file
2) Print total cars of all companies
3) Find the average mileage of all companies
4) Find the highest priced car of all companies.

OR

20 (a) Write Python program to write the data given below to a CSV file. 9

SN	Name	Country	Contribution	Year
1	Linus Torvalds	Finland	Linux Kernel	1991

2	Tim Berners-Lee	England	World Wide Web	1990
3	Guido van Rossum	Netherlands	Python	1991

(b) Perform arithmetic operations on two NumPy arrays and explain the broadcasting rules in NumPy. Illustrate with examples. 5

Teaching Plan

Module 1: Programming Environment and Python Basics		**(6 hours)**
1.1	Getting Started with Python Programming: Running code in the interactive shell Editing, Saving, and Running a script	**1 hour**
1.2	Using editors: IDLE	**1 hour**
1.3	Jupyter	**1 hour**
1.5	Basic coding skills: Working with data types, Numeric data types and Character sets, Keywords, Variables and Assignment statement, Operators, Expressions,	**1 hour**
1.5	Working with numeric data, Type conversions, Comments in the program	**1 hour**
1.6	Input, Processing, and Output, Formatting output.	**1 hour**
Module 2: Building Python Programs		**(7 hours)**
2.1	Control statements: Selection structure (if-else, switch-case),	**1 hour**
2.2	Iteration structure(for, while), Testing the control statements, Lazy evaluation	**1 hour**
2.3	Functions: Hiding redundancy and complexity, Arguments and return values,	**1 hour**
2.4	Variable scopes and parameter passing, Named arguments, Main function,	**1 hour**
2.5	Working with recursion, Lambda functions	**1 hour**
2.6	Strings and number systems: String function	**1 hour**
2.7	Handling numbers in various format	**1 hour**
Module 3: Data Representation		**(7 hours)**
3.1	Lists: Basic list Operations and functions, List of lists	**1 hour**

3.2	Slicing, Searching and sorting list, List comprehension	**1 hour**
3.3	Work with tuples, Sets	**1 hour**
3.4	Work with dates and times	**1 hour**
3.5	Dictionaries: Dictionary functions,	**1 hour**
3.6	Dictionary literals, adding and removing keys, accessing & replacing values	**1 hour**
3.7	Traversing dictionaries, reverse lookup	**1 hour**
Module 4: Object Oriented Programming		**(7 hours)**
4.1	Design with classes : Objects and Classes, Methods, Instance Variables	**1 hour**
4.2	Constructor, Accessors and Mutators	**1 hour**
4.3	Structuring classes with Inheritance	**1 hour**
4.4	Polymorphism	**1 hour**
4.5	Abstract Classes	**1 hour**
4.6	Exceptions : Handle a single exception	**1 hour**
4.7	handle multiple exceptions	**1 hour**
Module 5: Data Processing		**(8 hours)**
5.1	The *os* and *sys* modules	**1 hour**
5.2	Introduction to file I/O: Reading and writing text files	**1 hour**
5.3	Manipulating binary files	**1 hour**
5.4	NumPy : Basics, Creating arrays, Arithmetic, Slicing	**1 hour**
5.5	Matrix Operations, Random numbers.	**1 hour**
5.6	Working with CSV files	**1 hour**
5.7	Pandas : Reading, Manipulating	**1 hour**
5.8	Pandas : Processing Data and Visualize.	**1 hour**

ERT 456	SYSTEM SOFTWARE	Category	L	T	P	Credit
		PEC	2	1	0	3

Preamble:

The purpose of this course is to create awareness about the low-level codes which are very close to the hardware and about the environment where programs can be developed and executed. This course helps the learner to understand the machine dependent and machine independent system software features and to design/implement system software like assembler, loader, linker, macroprocessor and device drivers. Study of system software develops ability to design interfaces between software applications and computer hardware**.**

Prerequisite: A sound knowledge in Data Structures, and Computer Organization

Course Outcomes: After the completion of the course the student will be able to

CO#	Course Outcomes
CO1	Distinguish **softwares** into system and application software categories. **(Cognitive Knowledge Level: Understand)**
CO2	Identify **standard** and extended architectural features of machines. (**Cognitive Knowledge Level: Apply)**
CO3	Identify machine dependent features of system software (**Cognitive Knowledge Level: Apply)**
CO4	Identify machine independent features of system software. (**Cognitive Knowledge Level: Understand)**
CO5	Design **algorithms** for system softwares and analyze the effect of data structures. (**Cognitive Knowledge Level: Apply)**
CO6	Understand the features of device drivers and editing & debugging tools.(**Cognitive Knowledge Level: Understand)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓			✓							✓
CO2	✓	✓	✓									✓
CO3	✓	✓	✓									✓
CO4	✓	✓										✓
CO5	✓	✓	✓	✓								✓
CO6	✓	✓			✓							✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Lifelong learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End SemesterExamination Marks(%)
	Test 1 (%)	Test 2 (%)	
Remember	**30**	**30**	**30**
Understand	**30**	**30**	**30**
Apply	**40**	**40**	**40**
Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	**50**	**100**	**3**

Continuous Internal Evaluation Pattern:

Attendance : **10 marks**

Continuous Assessment Test (Average of series Tests 1&2) : **25 marks**

Continuous Assessment Assignment **: 15 marks**

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Syllabus

Module-1 (Introduction)

System Software vs Application Software, Different System Software– Assembler, Linker, Loader, Macro Processor, Text Editor, Debugger, Device Driver, Compiler, Interpreter, Operating System (Basic Concepts only). SIC & SIC/XE Architecture, Addressing modes, SIC &SIC/XE Instruction set , Assembler Directives.

Module-2 (Assembly language programming and Assemblers)

SIC/XE Programming, Basic Functions of Assembler, Assembler Output Format – Header, Text and End Records. Assembler Data Structures, Two Pass Assembler Algorithm, Hand Assembly of SIC/XE Programs.

Module-3 (Assembler Features and Design Options)

Machine Dependent Assembler Features-Instruction Format and Addressing Modes, Program Relocation. Machine Independent Assembler Features –Literals, Symbol Defining Statements, Expressions, Program Blocks, Control Sections and Program Linking. Assembler Design Options-One Pass Assembler, Multi Pass Assembler. Implementation Example-MASM Assembler.

Module-4 (Loader and Linker)

Basic Loader Functions - Design of Absolute Loader, Simple Bootstrap Loader. Machine Dependent Loader Features- Relocation, Program Linking, Algorithm and Data Structures of Two Pass Linking Loader. Machine Independent Loader Features -Automatic Library Search, Loader Options. Loader Design Options.

Module-5 (Macro Preprocessor, Device driver, Text Editor and Debuggers)

Macro Preprocessor - Macro Instruction Definition and Expansion, One pass Macro processor Algorithm and data structures, Machine Independent Macro Processor Features, Macro processor design options. Device drivers - Anatomy of a device driver, Character and block device drivers, General design of device drivers. Text Editors- Overview of Editing, User Interface, Editor Structure. Debuggers - Debugging Functions and Capabilities, Relationship with other parts ofthe system, Debugging Methods- By Induction, Deduction and Backtracking.

Text book

1. Leland L. Beck, System Software: An Introduction to Systems Programming, 3/E, Pearson Education Asia

References

1. D.M. Dhamdhere, Systems Programming and Operating Systems, Second Revised Edition, Tata McGraw Hill.
2. John J. Donovan, Systems Programming, Tata McGraw Hill Edition 1991.

3. George Pajari, Writing UNIX Device Drivers, Addison Wesley Publications (Ebook : http://tocs.ulb.tu-darmstadt.de/197262074.pdf).
4. Peter Abel, IBM PC Assembly Language and Programming, Third Edition, Prentice Hall of India.
5. Jonathan Corbet, Alessandro Rubini, Greg Kroah-Hartman, Linux Device Drivers, Third Edition, O.Reilly Books
6. M. Beck, H. Bohme, M. Dziadzka, et al., Linux Kernel Internals, Second Edition, Addison Wesley Publications,
7. J Nithyashri, System Software, Second Edition, Tata McGraw Hill.
8. The C Preprocessor http://gcc.gnu.org/onlinedocs/gcc-2.95.3/cpp_1.html -

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. List out two system software and two application software.

Course Outcome 2 (CO2):

1. How is upward compatibility between SIC and SIC/XE machines maintained?
2. Write a sequence of instructions for SIC/XE to divide BETA by GAMMA, setting
3. ALPHA to the integer portion of the quotient and DELTA to the remainder. Use register-to-register instructions to make the calculation as efficient as possible.

Course Outcome 3 (CO3):

1. How do control sections and program blocks differ?
2. Can an assembler incorporating program blocks function using the same data structures as that of a normal two pass assembler? Justify your answer

Course Outcome 4 (CO4):

1. What are literals used for? Does the use of literals change the design of an assembler?

Course Outcome 5 (CO5):

1. Design an assembler that can assemble a source program with different control sections.

Course Outcome 6 (CO6):

1. Describe any one commonly used debugging method.

Model Question Paper

QP CODE:

Reg No: _____

Name:_____ **PAGES : 3**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B.TECH. DEGREE EXAMINATION, MONTH & YEAR

Course Code: ERT 456

Course Name: System Software

Max.Marks:100 **Duration: 3 Hours**

PART A

Answer All Questions. Each Question Carries 3 Marks

1. Differentiate between system software and application software.
2. What are assembler directives? List out any five assembler directives in SIC.
3. Explain the different data structures used in the implementation of Assemblers.
4. List out the functions performed by an assembler.
5. What is a Literal? How is a literal handled by an assembler.
6. What are control sections? What is the advantage of using them?
7. Differentiate between linking loader and linkage editor? Which of these is preferable in a program development environment?
8. What is Automatic Library Search?
9. How should a programmer decide whether to use a macro or a subroutine to accomplish a given logical function?
10. Differentiate between character and block device drivers

(10x3=30)

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11. (a) Differentiate between compilers and Interpreters. . **(4)**

    (b) Explain the architecture and addressing modes of SIC machine. **(10)**

12. (a) Explain the addressing modes supported by SIC/ XE machine with suitable illustrations. **(8)**

    (b) Explain the difference between **(6)**

    5. A1 RESW 3 and A1 WORD 3
    6. B BYTE C'23' and B BYTE X'23'
    7. END and END LABEL

13. (a) Let NUMBERS be an array of 100 words. Write a sequence of SIC/XE instructions to find the maximum of these numbers. **(6)**

OR

14. (a) Write down and explain the second pass of a two pass assembler algorithm**.** **(8)**

    (b) What is a Program Block. What is its advantage? With suitable example,explain how Program Blocks are handled by SIC assembler. **(6)**

15. (a) What is a Program Block. What is its advantage? With suitable example,explain how Program Blocks are handled by SIC assembler. **(7)**

    (b) What is a forward reference? With example, illustrate how forwardreferences are handled by a single pass assembler? **(7)**

OR

16. (a) With suitable examples explain machine dependent assembler features. **(8)**

    (b) Explain with examples, the need and working of multipass assembler. **(6)**

17. (a) With the data structures used, state and explain two pass algorithm for alinking loader. **(10)**

    (b) Explain about bootstrap loader. **(4)**

OR

18. (a) Explain about machine independent loader features **(9)**

    (b) What is Dynamic Linking? With example, illustrate how dynamic linkingis performed. **(5)**

19. (a) Write down the single pass macro processor algorithm and with suitable example illustrate its working. **(10)**

    (b) How are unique labels generated during Macro Expansion? **(4)**

OR

20. (a) Explain Text Editor structure in detail with a neat diagram. **(7)**

    (b) Explain the different debugging methods in detail. **(7)**

Teaching Plan

No	Contents	No: of Lecture Hours
Module -1 (Introduction) (6 hours)		
1.1	System Software Vs. Application Software, Different System Software– Assembler, Linker, Loader, Macro Processor	1 hour
1.2	Text Editor, Debugger, Device Driver, Compiler, Interpreter, Operating System (Basic Concepts only)	1 hour
1.3	SIC Architecture, SIC Addressing modes	1 hour
1.4	SIC Instruction set & Assembler directives	1 hour
1.5	SIC/XE Architecture, SIC/XE Instruction format	1 hour
1.6	SIC/XE Addressing modes, SIC/XE Instruction set	1 hour
Module -2 (Assembly language programming and Assemblers) (6 hours)		
2.1	SIC Programming, SIC/XE Programming	1 hour
2.2	Basic Functions of Assembler, Assembler output format – Header, Text and End Records	1 hour
2.3	Assembler data structures	1 hour
2.4	Pass 1 of two pass SIC assembler algorithm	1 hour
2.5	Pass 2 of two pass SIC assembler algorithm	1 hour
2.6	Hand assembly of SIC Program	1 Hour
Module-3 (Assembler design options) (10 hours)		

3.1	Machine dependent assembler features-Instruction format and addressing modes, program relocation	1 hour
3.2	Hand assembly of SIC/XE program	1 Hour
3.3	Machine Independent assembler features – Literals	1 hour
3.4	Machine Independent assembler features – Symbol defining statements, expression	1 hour
3.5	Machine Independent assembler features – program blocks	1 hour
3.6	Machine Independent assembler features – program blocks illustration with examples	1 hour
3.7	Machine Independent assembler features – Control sections and program linking.	1 hour
3.8	Machine Independent assembler features – Control sections and program linking. Illustration with example	1 hour
3.9	Assembler design options- One Pass assembler, Multi pass assembler	1 hour
3.10	Implementation example: MASM Assembler	1 hour
Module-4 (Linker and Loader) (7 hours)		
4.1	Basic Loader functions - Design of absolute loader	1 hour
4.2	Simple bootstrap Loader, Machine dependent loader features- Relocation	1 hour
4.3	Machine dependent loader features- Program Linking algorithm and data structures of First pass of two pass Linking Loader	1 hour
4.4	Machine dependent loader features- Program Linking algorithm and data structures of Second pass of two pass Linking Loader	1 hour
4.5	Machine independent loader feature - Automatic library search	1 hour
4.6	Machine independent loader features - Loader options	1 hour
4.7	Loader Design Option- Linking Loader, Linkage Editor, Dynamic Linking	1 hour
Module –5 (Macro Preprocessor, Device drivers, Text Editors, Debuggers) (8 hours)		
5.1	Macro Preprocessor- Macro Instruction Definition and Expansion	1 hour

5.2	One pass Macro processor algorithm and data structures	1 hour
5.3	One pass Macro processor Algorithm and data structures illustration with example	1 hour
5.4	Machine Independent Macro Processor Features- generation of unique labels, Concatenation of macro parameter, Keyword macro parameters	1 hour
5.5	Machine Independent Macro Processor Features- Conditional Macro Expansion, Macro processor design options	1 hour
5.6	Device drivers- Anatomy of a device driver, Character and block device drivers, General design of device drivers	1 hour
5.7	Text Editors- Overview of Editing, User Interface, Editor Structure	1 hour
5.8	Debuggers :- Debugging Functions and Capabilities, Debugging Methods- By Induction, Deduction and Backtracking.	1 hour

CST 426	CLIENT SERVER ARCHITECTURE	Category	L	T	P	Credits	Year of Introduction
		PEC	2	1	0	3	2022

Preamble: The syllabus is prepared with the view of preparing the Engineering Graduates to build effective Client/Server applications. This course aims at providing a foundation in decentralized computer systems, using the client/server model. The course content is decided to cover the essential fundamentals which can be taught within the given slots in the curriculum. .

Prerequisite: Basic knowledge in Computer

Course Outcomes: After the completion of the course, the student will be able to

Course Outcomes	
CO1	Identify the basics of client/server systems and the driving force behind the development of client/server systems **(Cognitive Knowledge Level: Understand)**
CO2	Outline the architecture and classifications of client/server systems **(Cognitive Knowledge Level: Understand)**
CO3	Summarize the client/server network services for an application **(Cognitive Knowledge Level: Understand)**
CO4	Identify management services and issues in network **(Cognitive Knowledge Level: Understand)**
CO5	Outline the Client/Server technology in respect of databases and Client/Server database architecture **(Cognitive Knowledge Level: Understand)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✔	✔										✔
CO2	✔	✔										✔
CO3	✔	✔										✔
CO4	✔											✔
CO5	✔	✔										✔

Abstract POs defined by National Board of Accreditation			
PO#	Broad PO	PO#	Broad PO
PO1	Engineering Knowledge	PO7	Environment and Sustainability
PO2	Problem Analysis	PO8	Ethics
PO3	Design/Development of solutions	PO9	Individual and team work
PO4	Conduct investigations of complex problems	PO10	Communication
PO5	Modern tool usage	PO11	Project Management and Finance
PO6	The Engineer and Society	PO12	Life long learning

Assessment Pattern

Bloom's Category	Test 1 (%)	Test 2 (%)	End Semester Examination (%)
Remember	**40**	**40**	**40**
Understand	**40**	**40**	**40**
Apply	**20**	**20**	**20**
Analyse			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	**50**	**100**	**3**

Continuous Internal Evaluation Pattern:

Attendance : **10 marks**

Continuous Assessment Test : **25 marks**

Continuous Assessment Assignment : **15 marks**

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of

the 7 questions, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

Syllabus

Module-1 (Introduction)

Introduction to Client/Server computing - Basic Client/Server Computing Model, Server for Every Client- File Server, Print Server, Application Server, Mail Server, Directory Services Server, Web Server, Database Server, Transaction Servers. Client/Server-Fat or Thin, Stateless or Stateful, Servers and Mainframes, Client/Server Functions. Driving Forces behind Client/Server Computing- Business Perspective, Technology Perspective

Module-2 (Client/Server Classification)

Client/Server Types-Single Client/Single Server, Multiple Clients/Single Server, Multiple Clients/Multiple Servers, Integration With Distributed Computing, Alternatives To Client/Server Systems. Classification of Client/Server Systems- Two-Tier Computing, Middleware, Three-Tier Computing- Model View Controller (MVC), Principles behind Client/Server Systems. Client/Server Topologies. Existing Client/Server Architecture.

Module-3 (Client/Server Application Components)

Client- Services, Request for services, RPC, Windows services, Print services, Remote boot services, other remote services, Utility Services.

Server- Detailed server functionality, Network operating system, Available platforms, Server operating system. Organizational Expectations,

Improving performance of client/server applications, Single system image, Downsizing and Rightsizing, Advantages and disadvantages of Client/Server computing, Applications of Client/Server.

Module-4 (Client/ Server Systems Services and Support)

Services and Support- System administration, Availability, Reliability, Scalability, Observability, Agility, Serviceability. Software Distribution, Performance, Network management. Remote Systems Management- RDP, Telnet, SSH, Security.

Module-5 (Client/Server Technology and Databases)

Client/Server Technology and Databases - Storing Data, Database System Architectures. Client/Server Databases, Client/Server Database Computing, Database Computing Vs. Mainframe, PC/File Server Computing. Client/Server Database Architecture - Process-Per-Client Architecture, Multi-Threaded Architecture, Hybrid Architecture.

Text Books

1. Patrick Smith &Steve Guengerich, Client / Server Computing, PHI
2. Subhash Chandra Yadav, Sanjay Kumar Singh, An Introduction to Client/Server Computing, New Age International Publishers

References

1. Jeffrey D.Schank, "Novell's Guide to Client-Server Application & Architecture" Novell Press
2. Robert Orfali, Dan Harkey, Jeri Edwards, Client/Server Survival Guide, Wiley-India Edition, Third Edition
3. Dawna Travis Dewire, Client Server Computing — McGraw Hill
4. W.H.Inman, Developing Client Server Applications, BPB.

Sample Course Level Assessment Questions

Course Outcome 1 (CO1):

Computing in client server architecture over Mainframe architecture has certain advantages and disadvantages. Describe at least three advantages and disadvantages for each architecture.

Course Outcome 2 (CO2):

3. Classification of Client/Server Systems.
4. Client/Server topologies

Course Outcome 3 (CO3):

3. Advantages and disadvantages of Client/Server computing
4. Categories of Client/Server Applications

Course Outcome 4 (CO4):

3. Client/Server services and support
4. Remote system Management

Course Outcome 5 (CO5):

3. Client/ Server databases
4. Client/Server Database Architecture

Model Question Paper

QP CODE: **PAGES: ___**

Reg No:_____

Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: CST 426

Course Name: Client Server Systems

Max Marks: 100 **Duration: 3 Hours**

PART A

(Answer All Questions. Each question carries 3 marks)

1.	Differentiate between Stateful and Stateless servers	
2.	List the different phases and activities of client/server system development methodology.	
3.	How does transmission protocol work in client/server applications?	
4.	List any six services in single system image environment.	
5.	Specify the role of the client in Client/Server computing and also list any six services provided by the client.	
6.	Why do most RPC system support call by value semantics for parameter passing?	
7.	What do you mean by a thin client network? List three advantages of the Thin	

	Client Network system		
8.	How are connectivity and interoperability between client/server achieved?		
9.	One disadvantage of the Client/Server system is lack of control in a Database Management environment. Justify.		
10.	With a neat sketch explain client/server database computing		**(10x3=30)**
	Part B **(Answer any one question from each module. Each question carries 14 Marks)**		
11.	(a)	Differentiate between Transaction server and Data server system with examples.	**(7)**
	(b)	Computing in client server architecture over Mainframe architecture has certain advantages and disadvantages. Describe at least three advantages and disadvantages for each architecture.	**(7)**
OR			
12.	(a)	With a neat sketch explain Client/Server computing model	**(7)**
	(b)	Classify and describe the driving forces that drive the move to Client/Server computing	**(7)**
13.	(a)	Differentiate two-tier and three-tier computing	**(8)**
	(b)	Describe client/server topologies	**(6)**
OR			

14.	(a)	Illustrate how client/server is integrated to distributed computing	**(8)**
	(b)	What is the importance of model view controller?	**(6)**
15.	(a)	Explain advantages and disadvantages of client/server computing	**(8)**
	(b)	Illustrate any 5 applications of client/server computing	**(6)**
OR			
16.	(a)	In Client/Server computing, explain the following with examples i. Dynamic Data Exchange ii. ii. RPC, Remote Procedure Call iii. iii. Remote Boot Service	**(6)**
	(b)	Explain the functions and features of Network Operating System	**(8)**
17.	(a)	Explain about network management and remote system management. How can security be provided to the network?	**(10)**
	(b)	In client server architecture, what do you mean by Availability, Reliability, Serviceability and Security? Explain with examples.	**(4)**
OR			
18.	(a)	Client server is modular infrastructure, this is intended to improve Usability, Flexibility, Interoperability and Scalability. Explain each term with an example, in each case how it helps to improve the functionality of client server architecture.	**(8)**
	(b)	Explain about network management and remote system management. How can security be provided to network?	**(6)**
19.	(a)	Explain the different types of Client/Server Database Architecture	**(8)**

	(b)	List and explain the main components of Database middleware	**(6)**
OR			
20.	(a)	Discuss types of database utilities, tools and their functions	**(8)**
	(b)	Discuss about the role of traditional and web databases in handling client/server based applications.	**(6)**

TEACHING PLAN

No	Contents	No.of Lecture Hrs
Module- 1(Introduction) (11hrs)		
1.1	Basic Client/Server Computing Model	1
1.2	Server for Every Client- File Server, Print Server	1
1.3	Application Server, Mail Server, Directory Services Server	1
1.4	Web Server, Database Server	1
1.5	Transaction Servers	1
1.6	Client/Server-Fat or Thin	1
1.7	Stateless or Stateful	1
1.8	Servers and Mainframes	1
1.9	Client/Server Functions	1
1.10	Driving Forces behind Client/Server Computing- Business Perspective, Technology Perspectiv	2

Module-2 (Client/Server Classification) (10 hrs)		
2.1	Client/Server Types-Single Client/Single Server	1
2.2	Multiple Clients/Single Server, Multiple Clients/Multiple Servers	1
2.3	Integration with Distributed Computing	1
2.4	Alternatives to Client/Server Systems	1
2.5	Classification of Client/Server Systems- Two-Tier Computing, Middleware	1
2.6	Three-Tier Computing- Model View Controller (MVC)	1
2.7	Principles behind Client/Server Systems.	1
2.8	Client/Server Topologies	2
2.9	Existing Client/Server Architecture	1
Module-3 (Client/Server Application Components) (11 hrs)		
3.1	The client: Services, Request for services, RPC	2
3.2	Windows services, Print services, Remote boot services and Utility Services	2
3.3	Server- Detailed server functionality, Network operating system	1
3.4	Available platforms, Server operating system	1
3.5	Organizational Expectations, Improving performance of client/server applications	1
3.6	Single system image, Downsizing and Rightsizing	2
3.7	Advantages and disadvantages of Client/Server computing	1

3.8	Applications of Client/Server	1
Module-4 (Client/ Server Systems Services and Support) (9hrs)		
4.1	Services and Support, System administration	1
4.2	Availability, Reliability	1
4.3	Scalability, Observability, Agility	1
4.4	Serviceability, Software Distribution	1
4.5	Performance	1
4.6	Network management	1
4.7	Remote Systems Management- RDP, Telnet, SSH	2
4.8	Security	1
Module-5 (Client/Server Technology and Databases) (11hrs)		
5.1	Client/Server Technology and Databases - Storing Data	1
5.2	Database System Architectures	2
5.3	Client/Server Databases	1
5.4	Client/Server Database Computing	1
5.5	Database Computing Vs. Mainframe, PC/File Server Computing	1
5.6	Client/Server Database Architecture - Process-Per-Client Architecture	3
5.7	Multi-Threaded Architecture, Hybrid Architecture	2

ELECTIVE V

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
ERT 418	PLC AND DATA ACQUISITION SYSTEMS	PEC	2	1	0	3

Prerequisite: Fundamentals of Digital Electronics

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand the fundamental of PLC. (**Cognitive Knowledge level: Understand**)
CO 2	Develop programs of PLC with timers. (**Cognitive Knowledge level: Understand**)
CO 3	Discuss various industrial applications of PLCs. (**Cognitive Knowledge level: Understand**)
CO 4	Understand the need of computer in Automation. (**Cognitive Knowledge level: Understand**)
CO 5	Understand the basics of data conversion and data acquisition. (**Cognitive Knowledge level: Understand**)

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
CO 1	✓	✓	✓	✓	✓	-	-	-	-	-	-	✓
CO 2	✓	✓	✓	✓	✓	✓	-	-	-	-	-	✓
CO 3	✓	✓	✓	✓	✓	✓	✓	-	-	-	-	✓
CO 4	✓	✓	-	-	-	-	-	-	-	-	-	✓
CO 5	✓	✓	-	-	-	-	-	-	-	-	-	✓

Abstract POs defined by National Board of Accreditation

PO#	Broad PO	PO#	Broad PO
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	20
Understand	20	20	40
Apply	20	20	40
Analyse			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Test (2 numbers) : 25 marks

Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B.

Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions.

Part B contains 2 questions from each module of which student should answer any one. Each question carries 14 marks and can have maximum 2 sub-divisions.

Course Level Assessment Questions

Course Outcome 1 (CO1)

1. Explain the architecture of PLC with neat schematic.
2. Discuss various types of PLC.
3. Write the steps for connecting PLC in computer.

Course Outcome 2 (CO2)

1. Explain the working of timers with an example.

2. Demonstrate the working of counters with an example.

3. Write a short note on data comparison instructions.

Course Outcome 3 (CO3)

1. Describe various Jump and Move instructions.

2. Discuss about various analog modules used in PLC.

3. Explain about multi bit data processing.

Course Outcome 4 (CO4)

1. Explain Functional block diagram of a computer control system.

2. Explain data loggers in detail.

3. Explain about direct digital control system.

Course Outcome 5 (CO5)

1. Sketch and explain sampling and quantization.
2. Explain objectives of Data Acquisition Systems.
3. Explain the interfacing between ADC and microprocessor with the help of neat diagram

Model Question Paper

QP Code: Pages: 2

Reg No: _____ Name: ___

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B.TECH. DEGREE EXAMINATION, MONTH & YEAR

Course Code: ERT 418

Course Name: **PLC AND DATA ACQUISITION SYSTEMS**

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all Questions. Each question carries 3 Marks

1. Discuss the advantages of PLC.
2. Describe ladder logic programming of PLC.
3. Define the following terms.
   (a) Pre-set Value (b) Accumulator Value (c) Time base Value.
4. Discuss about Math Instructions used in PLC.

5. How analog signal processing is carried out in PLC?
6. Discuss about Master Control Reset (MCR).
7. Write about direct digital control system.
8. Discuss about Supervisory computer control system.
9. Define sampling and sampling rate.
10. Write main objectives of Data Acquisition System.

PART B

Answer any one full question from each module.

Each question carries 14 Marks

Module 1

11. Explain the architecture of PLC with the help of neat block diagram. **(14)**
12. (a) Explain various types of PLCs. **(9)**
    (b) Explain Scan cycle of PLC **(5)**

Module 2

13 (a) Explain in detail TON and TOF instructions **(10)**
   (b) Discuss the difference between TON and RTO function. **(4)**
14. Explain in detail about Counters in PLC **(14)**

Module 3

15. (a) Explain various program control instructions used in PLC. **(8)**
    (b) Describe sequencer instructions in PLC **(6)**
16. Draw and explain ladder diagram for sequential motor control using timers.
    The conditions are as follows:
    i. Motor 1 should be turned ON after 10 seconds the main switch has been switched ON.
    ii. Motor 2 should be turned ON for 15 seconds after Motor 1 is turned ON.
    iii. Motor 3 should be turned ON after Motor 2 is turned OFF. **(14)**

Module 4

17. (a) Explain the need of computer in a control system. **(7)**
    (b) Explain different types of data loggers. **(7)**
18. Explain in detail about Supervisory Control And Data Acquisition (SCADA) system.

(14)

Module 5

19. (a) Explain the block diagram of Data Acquisition System. **(10)**
    (b) Discuss the principle of quantization of an analog signal **(4)**
20. (a) Explain multi-channel data acquisition system with neat schematic. **(10)**
    (b) Describe the need of sample and hold circuit. **(4)**

Syllabus

Module 1: Introduction to Programmable Logic Controllers (PLCs):

Basics of PLC-PLC advantages and disadvantages- Architecture of PLC - Scan Cycles–Types of PLC- PLC Programming languages – Relay logic – Ladder logic – connecting PLC to computer - PLC Troubleshooting and Maintenance.

Module 2: Essential PLC Functions

Programming of Timers – ON delay, OFF delay, Retentive Timers – PLC Timer functions – Examples of timer function Industrial application. Programming Counters – Up/Down counter – Examples of counter function Industrial application. PLC Arithmetic Functions – PLC number Comparison function

Module 3: PLC Control Flow and Analog Processing for Industrial Automation

PLC Program Control Instructions: Master Control Reset - Skip – Jump and Move Instructions. Sequencer instructions - Types of PLC Analog modules and systems, PLC analog signal processing –Case study of Tank level control system, bottle filling system and Sequential switching of motors

Module 4: Computers in Control Systems

Need of computer in a control system-Functional block diagram of a computer control system-Data loggers- Supervisory computer control- Direct digital control-Digital control interfacing-SCADA.

Module 5: Fundamentals of Data Acquisition

Sampling theorem – Sampling and digitizing – Aliasing – Sample and hold circuit – Practical implementation of sampling and digitizing – Definition, design and need for data acquisition systems – Interfacing ADC and DAC with Microprocessor / Multiplexer - Multiplexed channel operation –Microprocessor/PC based acquisition systems.

Text Books

1. Petrezeulla, “Programmable Logic Controllers”, McGraw Hill, 1989.

2. Curtis D. Johnson," Process Control Instrumentation Technology", 8th edition Prentice Hall June 2005
3. John W.Webb & Ronald A.Reis., "Programmable logic controllers- principles and applications", 5th Edition – PHI Learning Pvt. LTd, New Delhi -2010.

Reference Books

1. Hughes .T, *"*Programmable Logic Controllers*"*, ISA Press, 1989.
2. G. B. Clayton," Data Converters", The Mac Millian Press Ltd., 1982.
3. D.Roy Choudhury and Shail B.Jain, "Linear Integrated circuits", New age International Pvt .Ltd, 2003.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**BASICS OF PLC (10 hours)**	
1.1	Basics of PLC-PLC advantages and disadvantages- Architecture of PLC	3
1.2	Scan Cycles–Types of PLC	3
1.3	PLC Programming language – Relay logic – Ladder logic	2
1.4	Connecting PLC to computer - PLC Troubleshooting and Maintenance.	2
2	**PLC PROGRAMMING (9 hours)**	
2.1	Programming of Timers – Introduction - ON delay, OFF delay, Retentive Timers – PLC Timer functions – Examples of timer function Industrial application.	3
2.2	Programming Counters – Up/Down counter – Examples of counter function Industrial application.	3
2.3	PLC Arithmetic Functions – PLC number Comparison function	3
3	**PLC DATA HANDLING FUNCTIONS (9 hours)**	
3.1	PLC Program Control Instructions: Master Control Reset - Skip – Jump and Move Instruction. Sequencer instructions	3
3.2	Types of PLC Analog modules and systems, PLC analog signal processing.	3

3.3	Case study of Tank level control system, bottle filling system and Sequential switching of motors.	3
4	**COMPUTER CONTROL – INTRODUCTION (8 hours)**	
4.1	Need of computer in a control system-Functional block diagram of a computer control system	2
4.2	Data loggers- Supervisory computer control	2
4.3	Direct digital control-Digital control interfacing-SCADA.	4
5	**DATA ACQUISITION SYSTEMS (9 hours)**	
5.1	Sampling theorem – Sampling and digitizing – Aliasing – Sample and hold circuit – Practical implementation of sampling and digitizing	3
5.2	Definition, design and need for data acquisition systems – Interfacing ADC and DAC with Microprocessor / Multiplexer	3
5.3	Multiplexed channel operation –Microprocessor/PC based acquisition systems.	3

ERT428	POWER ELECTRONICS	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble: This course aims to develop the skill of the design of various power electronic circuits.

Prerequisite: ERT205 Electronic Devices and Circuits

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand the characteristics of important power semiconductor switches **(Cognitive Knowledge Level: Understand)**
CO 2	Apply the principle of drive circuits and snubber circuits for power semiconductorswitches. **(Cognitive Knowledge Level: Apply)**
CO 3	Build diode bridge rectifiers and Controlled rectifiers. **(Cognitive Knowledge Level: Apply)**
CO 4	Develop DC – DC Switch-Mode Converter. **(Cognitive Knowledge Level: Apply)**
CO 5	Illustrate the principle of DC – AC Switch-Mode Inverter. **(Cognitive Knowledge Level: Understand)**
CO 6	Apply the principle of power electronics for various applications. **(Cognitive Knowledge Level: Apply)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		✓	✓		✓							
CO2		✓	✓		✓							
CO3		✓	✓		✓							
CO4		✓	✓		✓							
CO5		✓	✓		✓							

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management andFinance
PO6	The Engineer and Society	**PO12**	Lifelong learning

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1	**2**	
Remember K1	10	10	10
Understand K2	25	25	60
Apply K3	15	15	30
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	**CIE**	**ESE**	**ESE Duration**
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Test (2 numbers): 25 marksAssignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

SYLLABUS

Module 1: Power Semiconductor Switches

Power diodes, Power BJT, Power MOSFET and IGBT - static and dynamic characteristics, SCR and GTO.

Module 2: Protection circuits and Rectifiers

BJT and MOSFET drive circuits, Snubber circuits, three phase diode bridge rectifiers, Single phase and three phase-controlled rectifiers.

Module 3: DC – DC Switch Mode Converters

Buck, Boost and Buck-boost DC-DC converters, Waveforms and expression of DC-DC converters for output voltage, voltage and current ripple under continuous conduction mode. (No derivation required) Isolated converters: Flyback, Forward, Push Pull, half bridge and Full bridge converters waveform and governing equations (No derivation required).

Module 4: DC-AC Switch Mode Inverters

Inverter topologies, Driven Inverters: Push-Pull, half bridge and Full bridge configurations, Three phase inverter, Pulse width modulation.

Module 5: Applications

DC Motor Drives, Induction Motor Drives, Residential and Industrial applications.

Text Books

1. Umanand L, “Power Electronics: Essentials & Applications”, Wiley India, 2015
2. Ned Mohan, Tore M Undeland, William P Robbins., “Power Electronics: Converters, Applications, and Design”., Wiley India Pvt. Ltd, 3/e, 2015

Reference Books

1. Muhammad H. Rashid., “Power Electronics: Circuits, Devices, and Applications”, PearsonEducation India, 4/e, 2014.
2. Daniel W. Hart, Power Electronics, McGraw Hill, 2011.

Course Level Assessment Questions

Course Outcome 1 (CO1): Understand the characteristics of important power semiconductor switches.

1. Illustrate the static and dynamic characteristics, Power BJT, Power MOSFET and IGBT.
2. Illustrate the construction and characteristics of SCR and GTO
3. Model and simulate power semiconductor switches.

Course Outcome 2 (CO2): Apply the principle of drive circuits and snubber circuits for power semiconductor switches.

1. Design the base drive circuits for Power BJT.
2. Design the gate drive circuits for Power MOSFET.

3. Outline the principle of snubber circuits for power switches.
4. Model and simulate above circuits.

Course Outcome 3 (CO3): Build diode bridge rectifiers and Controlled Rectifiers.

1. Explain the operation of three phase diode rectifier and the effect of various loads on the rectifier function
2. Explain the operation of controlled rectifiers and the effect of various loads on the rectifierfunction.
3. Model and simulate diode rectifiers and controlled rectifiers for various loads.

Course Outcome 4 (CO4): Develop the principle of DC – DC Switch-Mode Converter

1. Illustrate the principle of DC-DC converters under steady state conditions.
2. Design non-isolated and isolated DC-DC converters for given specifications.
3. Model and simulate non-isolated and isolated DC-DC Switch-Mode converters

Course Outcome 5 (CO5): Illustrate the principle of DC – AC Switch-Mode Inverter.

1. Understand the different types of inverters
2. Construct Driven Inverters for given specifications.
3. Model and simulate Driven Inverters

Course Outcome 6 (CO6): Apply the principle of power electronics for various applications.

1. Illustrate the principle of Adjustable-speed DC drive.
2. Explain the principle of Variable frequency PWM-VSI Induction Motor drives
3. Give at least two applications of power electronic circuits for residential applications.
4. Explain at least two applications of power electronic circuits for industrial applications

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B.TECH. DEGREE EXAMINATION, MONTH & YEAR

Course Code: ERT428

Course Name: Power Electronics

Max.Marks: 100 Duration: 3Hours

PART A

Answer ALL Questions. Each Carries 3 mark.

1	What is meant by reverse recovery time for a diode.	K2	CO1

2	What is the tail current in IGBT?	K2	CO1
3	What is the purpose of snubber circuits?	K2	CO2
4	Obtain the expression for average load voltage in three phase full wavebridge rectifier.	K3	CO3
5	Describe the working principle of a flyback converter.	K2	CO4
6	What is the flux walking problem in push-pull converter?	K2	CO4
7	What is the distinction between chopper, oscillators and inverters?	K3	CO5
8	Distinguish between driven and self-driven inverters.	K2	CO5
9	How converters are used in induction heating?	K2	CO6
10	What is regenerative breaking in PWM-VSI drive?	K2	CO6

PART – B

Answer one question from each module; each question carries 14 marks.

Module – I

11(a)	Compare and contrast power BJT, MOSFET and IGBT for switching applications.	7	CO1	K2
11(b)	A diode and a 10 Ω resistor are connected in series to a square wave voltage source of 50V peak. The reverse recovery time for the diode is 200nsec. Find the switching loss of the diode when the input frequency is 100 KHz.	7	CO1	K3

OR

12(a)	With the two-transistor model of SCR, explain the working principle of SCR	7	CO1	K2
12(b)	Illustrate the dynamic characteristics of GTO.	7	CO1	K2

Module – II

13(a)	Illustrate the base current requirement of power BJT.	7	CO2	K2
13(b)	Explain the operation of any one type of the power BJT base drive circuit.	7	CO2	K2

OR

14(a)	Illustrate the principle of operation of a single-phase, 2 pulse, fully controlled rectifier for RL load with circuit diagram and waveforms.	10	CO3	K2

14(b)	Deduce the expression for average load voltage in the circuit.	4	CO3	K2

Module – III

15(a)	Explain the operation of Buck-Boost converter and illustrate the operation with the inductor current and switching waveforms.	8	CO4	K2
15(b)	A Buck-Boost converter that switching at 50 KHz is supplied with aninput voltage that varies between 5V to 10V. The output is required to be regulated at 15V. A load resistor of 15Ω is connected across the output. If the maximum allowable inductor current ripple is 10% of the average inductor current, estimate the value of the inductance to be used in the Buck-Boost converter.	6	CO4	K3

OR

16(a)	Describe the principle of operation of the full-bridge converter with circuit diagram and waveforms.	8	CO4	K2
16(b)	What is flux walking? How is the flux walking problem solved in full-bridge converter?	6	CO4	K2

Module – IV

17(a)	Explain the operation of push-pull inverter.	8	CO5	K2
17(b)	Illustrate the PWM switching scheme for sine wave output of the inverter.	6	CO5	K2

OR

18(a)	Enumerate the principle of operation of three phase inverters.	8	CO5	K2
18(b)	What is Space vector modulation in three phase inverters.	6	CO5	K2

Module – V

19(a)	Explain the principle of adjustable speed DC drive using switched modeDC-DC converter.	8	CO6	K2
19(b)	Compare adjustable speed DC drives using switched mode DC-DC converter and line frequency-controlled converter.	6	CO6	K2

OR

20 (a)	Illustrate the principle of operation of Variable frequency PWM-VSI Induction Motor drive.	9	CO6	K2

20(b) Explain dissipative braking scheme in Induction Motor drive. 5 CO6 K2

Course Contents and Lecture Schedule

Teaching Plan		
No	**Contents**	**Hours(35)**
	Module 1: Power Semiconductor Switches	
1.1	Power diodes– structure, static and dynamic characteristics	1
1.2	Bipolar power transistors – structure, static and dynamic characteristics	1
1.3	Power MOSFET structure, static and dynamic characteristics (Lecture 1)	1
1.4	Power MOSFET structure, static and dynamic characteristics (Lecture 2)	1
1.5	IGBT – structure, static and dynamic characteristics	1
1.6	SCR – construction and characteristics	1
1.7	GTO – construction and characteristics	1
	Module 2: Protection circuits and Rectifiers	
2.1	BJT driver circuits (at least two circuits)	1
2.2	MOSFET driver circuits (at least two circuits)	1
2.3	Snubber circuits – ON and OFF snubbers	1
2.4	Three phase diode bridge rectifiers – basic principles only	1
2.5	Single phase and three phase Controlled rectifiers with R load – basic principles only	1
2.6	Single phase and three phase Controlled rectifiers with RL load – basic principles only	1
2.7	Single phase and three phase Controlled rectifiers with RLE load– basic principles only	1
	Module 3: DC – DC Switch Mode Converters	
3.1	Buck, Boost DC-DC converters	1
3.2	Buck-Boost DC-DC converters	1

3.3	Waveforms and expression of DC-DC converters for output voltage, voltage and current ripple under continuous conduction mode. (Lecture 1) (No derivation required)	1
3.4	Waveforms and expression of DC-DC converters for output voltage, voltage and current ripple under continuous conduction mode. (Lecture 2)	1
3.5	Waveforms and expression of DC-DC converters for output voltage, voltage and current ripple under continuous conduction mode. (Lecture 3)	1
3.6	Isolated converters: Flyback, Forward converters – Waveforms and governing equations. (No derivation required)	1
3.7	Isolated converters: Push Pull, Half bridge converters – Waveforms and governing equations. (No derivation required)	1
3.8	Isolated converters: Full bridge converters – Waveforms and governing equations. (No derivation required)	1
	Module 4: DC-AC Switch Mode Inverters	
4.1	Inverter topologies. (Lecture 1)	1
4.2	Inverter topologies. (Lecture 2)	1
4.3	Driven Inverters: Push-Pull configurations	1
4.4	Driven Inverters: Half bridge and Full bridge configurations	1
4.5	Three phase inverters.	1
4.6	Sinusoidal and Space vector modulation PWM in three phase inverters (Lecture 1)	1
4.7	Sinusoidal and Space vector modulation PWM in three phase inverters (Lecture 2)	1
	Module 5: Applications	
5.1	DC Motor Drives	1
5.2	Adjustable-speed DC drive	1
5.3	Induction Motor Drives	1
5.4	Variable frequency PWM-VSI drives	1

5.5	Residential applications	1
5.6	Industrial applications	1

Assignment:

At least one assignment should be simulation of power electronic circuits using any circuitsimulation software.

Simulation Assignments (ERT 428)

The following simulations can be done in LT spice or any other circuit simulation software.

1. Model and simulate BJT test circuit Fig. 1.50 of Umanand L., Power Electronics Essentials and Applications, Wiley India, 2015, page no.48.
2. Model and simulate MOSFET test circuit Fig. 1.51 of Umanand L., Power Electronics Essentials and Applications, Wiley India, 2015, page no.49.
3. Model and simulate IGBT test circuit Fig. 1.52 of Umanand L., Power Electronics Essentials and Applications, Wiley India, 2015, page no.50.
4. Model and simulate BJT drive test circuit Fig. 2.33 of Umanand L., Power Electronics Essentials and Applications, Wiley India, 2015, page no.86.
5. Model and simulate MOSFET drive test circuit Fig. 2.36 of Umanand L., Power Electronics Essentials and Applications, Wiley India, 2015, page no.88.
6. Model and simulate MOSFET shunt snubber test circuit Fig. 2.37of Umanand L., PowerElectronics Essentials and Applications, Wiley India, 2015, page no.89.
7. Model and simulate MOSFET seriessnubber test circuit Fig. 2.39of Umanand L., PowerElectronics Essentials and Applications, Wiley India, 2015, page no.90.
8. Model and simulate diode rectifiers and controlled rectifiers for various loads.
9. Model and simulate Buck converter circuit Fig. 5.68of Umanand L., Power ElectronicsEssentials and Applications, Wiley India, 2015, page no.277.
10. Model and simulate Boost converter circuit Fig. 5.70of Umanand L., Power ElectronicsEssentials and Applications, Wiley India, 2015, page no.278.
11. Model and simulate Buck-boost converter circuit Fig. 5.71of Umanand L., Power Elec-tronics Essentials and Applications, Wiley India, 2015, page no.279.
12. Model and simulate Forward converter circuit Fig. 5.72of Umanand L., Power

ElectronicsEssentials and Applications, Wiley India, 2015, page no.280.

13. Model and simulate Flyback converter circuit Fig. 5.73of Umanand L., Power ElectronicsEssentials and Applications, Wiley India, 2015, page no.281.
14. Model and simulate Driven Inverters
15. Model and simulate Pulse Width Modulator

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
ERT438	LOW POWER VLSI		2	1	0	3

Prerequisite: Digital Circuits

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand the Basic MOS Structure (**Cognitive Knowledge level: Understand**)
CO 2	Identify the sources of power dissipation in digital IC systems (**Cognitive Knowledge level: Understand**)
CO 3	Understand leakage sources and reduction techniques (**Cognitive Knowledge level: Understand**)
CO 4	Design low power circuits (**Cognitive Knowledge level: Understand**)
CO 5	Identify the mechanisms of power dissipation in CMOS integrated circuits (**Cognitive Knowledge level: Understand**)

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	✓		✓	✓								
CO 2	✓		✓		✓							
CO 3	✓		✓	✓	✓							
CO 4	✓		✓	✓	✓							
CO 5	✓		✓		✓							

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	10
Understand	20	20	50
Apply	20	20	40
Analyse	-	-	-
Evaluate	-	-	-
Create	-	-	-

Mark Distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance: 10 marks1

Continuous Assessment Test (2 Numbers): 25 marks

Assignment/Quiz/Course project: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub- divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Draw the MOS structure.
2. Energy band diagram of MOS at different biased conditions.
3. Threshold voltage expression.
4. Discuss Short channel effects.

Course Outcome 2 (CO2):

1. Identify the different sources of power dissipation
2. Derive the expression for power dissipation.
3. Obtain the need for low power Circuit design.

Course Outcome 3 (CO3):

1. Discuss different leakage power reduction.
2. Discuss the different submicron device design issues
3. Discuss power minimization methods.
4. Discuss methods for reducing short channel effects.

Course Outcome 4 (CO4):

1. Draw different clocked style CMOS circuits
2. Design a combinational circuit using Domino CMOS logic
3. Draw and Explain DCS logic.

Course Outcome 5 (CO5):

1. Design a Fully complementary logic circuit.
2. Compare Pass transistor logic and fully complementary logic
3. Design circuits using Pass transistor logic
4. Discuss adiabatic charging and adiabatic switching circuits.

SYLLABUS

Module 1: Designing Low-Power MOS Circuits

Basics of MOS circuits and Fundamentals of Low Power: MOS Transistor structure Threshold voltage, body effects, MOS Inverters, MOS Combinational Circuits. Need for low power circuit design, Short channel effects-surface scattering, punch through, velocity saturation, impact ionization Hot electron effects, drain induced barrier lowering, narrow width effects

Module 2: Power Management in Electronics

Sources of Power Dissipation: Dynamic Power Dissipation Short Circuit Power dissipation, Switching Power dissipation Gliching Power dissipation, Static Power Dissipation, Leakage power dissipation, Transistor leakage mechanisms of deep submicron transistors.

Module 3: Circuit Design Techniques for Low-Power CMOS

Circuit techniques for leakage power reduction: – standby leakage control using transistor stacks, multiple Vth techniques, Dynamic Vth techniques, supply voltage scaling techniques, Deep submicron devices design issues, Minimizing short channel effect.

Module 4: Low-Power CMOS Design

Design and test of low voltage CMOS: Circuit design style-clocked design style- Basic concept Domino logic (domino NAND gate), Differential Current Switch Logic

Module 5: Non-Clocked Design Styles for Low-Power CMOS Circuits

Non clocked circuit design style: fully complementary logic, NMOS and pseudo –NMOS logic, differential cascade voltage switch logic (DCVS), pass transistor logic, Adiabatic Switching Circuits

Text Books:

1. Kaushik Roy, Sharat C Prasad, Low power CMOS VLSI circuit design, Wiley India, 2000
2. Neil H. E. Weste and K. Eshraghian, Principles of CMOS VLSI Design, 2nd Edition, Addison Wesley (Indian reprint).

3. Anatha P Chandrakasan, Robert W Brodersen, Low power digital CMOS Design, Kluwer Academic, 1995

References:

1. Sung Mo Kang, Yusuf Leblebici, CMOS Digital Integrated Circuits, Tata Mcgrag Hill.
2. Abdellatif Bellaouar, Mohamed I Elmasry, Low power digital VLSI design, Kluwer Academic, 1995

Model Question Paper

Reg No.:_____ Name:__

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY EIGHTH SEMESTER B. TECH DEGREE EXAMINATION

MONTH AND YEAR

Course Code: ERT438

Course Name: LOW POWER VLSI

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all questions, each carries 3 marks

1. What is threshold voltage of MOSFET?
2. What is Hot electron effect? Explain with diagram
3. What are the sources of power dissipation?
4. What is switching power dissipation and how it can be minimized?
5. What is the significance of Miller effect on high frequency amplifiers?
6. Derive the maximum efficiency of the complementary-symmetry class B power amplifiers
7. Explain how cross over distortion is avoided in class AB amplifier
8. Design a Wein bridge oscillator to generate a sinusoidal waveform of 2 kHz
9. What are the advantages of DCVS logic over fully complementary logic?
10. What do you meant by adiabatic logic?

PART B

Answer any one full question from each module. Each question carries 14 Marks

Module 1

11. A) Draw the energy band diagrams of MOS structure at different bias conditions (10 marks)

B) When MOSFET is considered as a short channel MOSFET? (4 marks)

12. A) Why low power circuit design? (4 marks)

B) What is threshold voltage of MOSFET? Write down the mathematical expression. What is the effect of body voltage on threshold voltage? (10 marks)

Module2

13. A) Explain the transistor leakage mechanisms of deep submicron transistors. (10 marks)

B) Derive an expression for short circuit power dissipation of a CMOS inverter. (5 Marks)

14. What are the sources of power dissipation in CMOS? Explain in detail with derivations of static and active power dissipation? (14 marks)

Module 3

15. What do you meant by stacking effect? Explain leakage reduction using stacking effect. (14 marks)

16. Explain various submicron device design issues and what are the difficulties for low-power and low-voltage operation? (14 marks)

Module 4

17. A) Explain the working of clocked CMOS circuits. (6 marks)

B) What is charge sharing in clocked CMOS circuits? How it can be overcome? (8 marks)

18. A) What is Domino CMOS logic? What is its advantage? (4 marks)

B) Implement the function Z = AB (C + D)(E + F) using three units of Domino CMOS logic.(10 marks)

Module5

19. Implement the function F=(A'B+AB') using

1. Fully complementary logic
2. Pass transistor Logic
3. Pseudo NMOS Logic (14 marks)

20. A) What is a pass transistor logic and complementary pass transistor logic? What is the advantage of pass transistor logic? (10 marks)

B) Implement F= A+B and F'=(A+B)' using pass transistor logic. (4 marks)

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Designing Low-Power MOS Circuits**	**10**
1.1	MOS Transistor structure	2
1.2	Threshold voltage, body effects	1
1.3	MOS Inverters	1
1.4	MOS Combinational Circuits	1
1.5	Need for low power circuit design	1
1.6	Short channel effects-surface scattering, punch through, velocity saturation, impact ionization	2
1.7	Hot electron effects, drain induced barrier lowering, narrow width effects	2
2	**Power Management in Electronics**	**8**
2.1	Dynamic Power Dissipation, Short Circuit Power dissipation, Switching Power dissipation Gliching Power dissipation	3
2.2	Static Power Dissipation	1
2.3	Leakage power dissipation	2
2.4	Transistor leakage mechanisms of deep submicron transistors.	2
3	**Circuit Design Techniques for Low-Power CMOS**	**8**
3.1	Standby leakage control using transistor stacks	2
3.2	multiple Vth techniques, Dynamic Vth techniques	2
3.3	supply voltage scaling techniques,	2
3.4	Deep submicron devices design issues Minimizing short channel effect	2

4	**Low-Power CMOS Design**	**6**
4.1	Circuit design style-clocked design style- Basic concept	2
4.2	Domino logic (domino NAND gate)	2
4.3	Differential Current Switch Logic.	2
5	**Non-Clocked Design Styles for Low-Power CMOS Circuits**	**8**
5.1	fully complementary logic	2
5.2	NMOS and pseudo –NMOS logic	1
5.3	differential cascade voltage switch logic(DCVS),	2
5.4	pass transistor logic	1
5.5	Adiabatic Switching Circuits	2

CST 428	BLOCK CHAIN TECHNOLOGIES	Category	L	T	P	Credits
		PEC	2	1	0	3

Preamble: This course helps the learners to understand the basics in Blockchain Technologies. This course covers fundamentals of Blockchain concepts like the evolution of currency and ledger, principles and technologies underlying Blockchain, Bitcoin working, Consensus Algorithms, hyper ledger fabric, Etherum and Blockchain Applications. The concepts covered in this course enable the learners in Understanding and developing practical use-cases of Blockchain in industry sectors such as Healthcare, Supply chain, Governance, Banking, and more.

Prerequisite: Basic understanding of programming and cryptography.

Course Outcomes: After the completion of the course, the student will be able to

CO1	Explain Blockchain technology and key concepts such as cryptography and Cryptocurrency concepts **Cognitive Knowledge Level: Understand)**
CO2	Identify technical gaps existing between theory and practice in Cryptocurrency domain by the study of Bitcoin and its network. **(Cognitive Knowledge Level: Understand)**
CO3	Summarize the function of Blockchain as a method of securing distributed ledgers, how consensus on their contents is achieved, and the new applications that they enable. **(Cognitive Knowledge Level: Apply)**
CO4	Apply Hyperledger Fabric and Etherum platform to implement the Block chain Application **(Cognitive Knowledge Level: Apply)**
CO5	Explain the far-reaching implications of Blockchain for society and the economy. **(Cognitive Knowledge Level: Understand)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✔	✔	✔									✔
CO2	✔	✔	✔									✔
CO3	✔	✔	✔									✔
CO4	✔	✔	✔			✔						✔
CO5	✔	✔	✔									✔

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Lifelong learning

Assessment Pattern

Bloom's Category	Test 1 (%)	Test 2 (%)	End Semester Examination (%)
Remember	20	20	20
Understand	50	50	50
Apply	30	30	30
Analyse			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3

Continuous Internal Evaluation Pattern:

Attendance : **10 marks**

Continuous Assessment Test : **25 marks**

Continuous Assessment Assignment : **15 marks**

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

Syllabus

Module-1 (Introduction to Blockchain)

Blockchain- Public Ledgers, Blockchain as Public Ledgers -Bitcoin, Blockchain 2.0, Smart Contracts, Block in a Blockchain, Transactions-Distributed Consensus, The Chain and the Longest Chain -Crypto currency to Blockchain 2.0 - Permissioned Model of Blockchain, Principles and technologies underlying Blockchain including Hashing, Merkle trees, Public-Key Cryptography, Digital Signatures.

Module-2 (Cryptocurrency)

Overview of Bitcoin Blockchain, Creation of coins, Payments and double spending, Bitcoin scripting, Bitcoin Scripts, Bitcoin P2P Network, Transaction in Bitcoin Network, Block Mining, Block propagation and block relay, Consensus introduction, Distributed consensus in open environments-Consensus in a Bitcoin network.

Module-3 (Distributed Consensus)

Nakamoto consensus, Bitcoin Consensus, Proof of Work (PoW)- Hashcash PoW , Bitcoin PoW, Attacks on PoW ,monopoly problem- Proof of Stake- Proof of Burn - Proof of Elapsed Time - Bitcoin Miner, Mining Difficulty, Mining Pool-Permissioned model and use cases, Design issues for Permissioned Blockchain, Execute contracts- Consensus models for permissioned Blockchain-Distributed consensus in closed environment-Paxos.

RAFT Consensus-Byzantine general problem, Byzantine fault tolerant system-Agreement Protocol, Lamport-Shostak-Pease BFT Algorithm-BFT over Asynchronous systems, Practical Byzantine Fault Tolerance.

Module-4 (Hyper Ledger Fabric & Ethereum)

Introduction to Hyperledger projects- Fabric, Sawtooth, Indy, Iroha. Understanding tools like Composer, Caliper and Aries. Familiarization of steps to run Hyperledger network and deploy sample applications.

Ethereum: Ethereum network, EVM, Transaction fee, Mist Browser, Ether, Gas, Solidity, Smart contracts, Truffle-Design and issue Cryptocurrency, Mining, DApps, DAO.

Module-5 (Cryptocurrency Regulations and Blockchain Applications)

Stakeholders, Roots of Bit coin, Legal Aspects-Crypto currency Exchange, Black Market and Global Economy**.**

Applications: Internet of Things-Medical Record Management System-Blockchain in Government and Blockchain Security-Blockchain Use Cases –Finance, Supply chain.

Text Books

1. Mastering Blockchain: Deeper insights into decentralization, cryptography, Bitcoin, and popular Blockchain frameworks by Bashir, Imran, 2017.
2. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, and Steven Goldfeder. Bitcoin and cryptocurrency technologies: a comprehensive introduction. Princeton University Press, 2016.

References

1. Joseph Bonneau et al, SoK: Research perspectives and challenges for Bitcoin and cryptocurrency, IEEE Symposium on security and Privacy, 2015.
2. Satoshi Nakamoto, Bitcoin: A Peer-to-Peer Electronic Cash System.
3. Antonopoulos, Mastering Bitcoin: Unlocking Digital Cryptocurrencies.
4. Dr.Gavin Wood, “ETHEREUM: A Secure Decentralized Transaction Ledger,”Yellow paper.2014.
5. Nicola Atzei, Massimo Bartoletti, and Tiziana Cimoli, A survey of attacks on Ethereum smart contracts.

Sample Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Identify two major properties of a Blockchain network.
2. Explain the meaning of a distributed ledger.

Course Outcome 2 (CO2):

1. Explain the Transaction flow in Bitcoin Network.
2. Identify two major properties of a Blockchain network.

Course Outcome 3 (CO3):

5. Discuss whether the SHA-256 hash is appropriate for most Blockchain.

6. Discuss on the design issues for Permissioned Blockchain.

Course Outcome 4 (CO4):

5. Explain the difference between fungible and no-fungible tokens and identify the appropriate Ethereum token standards for each.
6. Describe the Hyperledger Sawtooth.

Course Outcome 5 (CO5):

5. Write a shot note on exploring a Blockchain application?
6. How Blockchain is Revolutionizing the Traditional Business Network? Explain with Example?
7. Explain how a lack of Blockchain standards impede wider adoption of Blockchain technology and platforms.

Model Question Paper

QP CODE: **PAGES: ___**

Reg No:_____

Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: CST 428

Course Name: BLOCK CHAIN TECHNOLOGIES

Max Marks: 100 **Duration: 3 Hours**

PART A

(Answer All Questions. Each question carries 3 marks)

1	Specify the significance of Smart Contracts in Blockchain.	
2	Write a Short Note on Merkle trees.	
3	Explain the emergence of bitcoin?	
4	How Consensus is achieved in a Bitcoin network?	
5	Explain Proof of Work and various attacks on it.	
6	Describe the RAFT Consensus protocol.	
7	Mention some Ethereum networks.	
8	Explain Ethereum.	
9	Write a Short Note on Cryptocurrency Exchange.	
10	List out some relatively new areas where Blockchain might have applications.	**(10x3=30)**

	Part B (Answer any one question from each module. Each question carries 14 Marks)		
11	(a)	Describe the concept of a block and its components.	**(8)**
	(b)	Define a Merkle hash tree, describe its role in Blockchain, and explain the Meaning of a Merkle root in the block header.	**(6)**
OR			
12	(a)	Explain what constitutes a Blockchain network, including a main property of that network.	**(8)**
	(b)	Identify two major benefits of using Blockchain in supply chain management.	**(6)**
13	(a)	Proof of Work (PoW) consensus protocols have been criticized due to their high and continuously increasing mining cost. Discuss how mining cost affects the tamper resistance attribute of public Blockchain.	**(8)**
	(b)	Discuss whether a public Blockchain requires issuing its own native Cryptocurrency to provide incentives to its validator network.	**(6)**
OR			
14	(a)	Differentiate between a public/permission- less and a private/permissioned Blockchain.	**(8)**
	(b)	Differentiate between stable-coins and decentralized Cryptocurrency.	**(6)**
15	(a)	Describe the process of PoW.	**(8)**
	(b)	Explain whether the electrical energy and equipment costs required by PoW are justified.	**(6)**
OR			
16	(a)	Explain what is likely to happen to the PoW mining industry after the most recent halving of bitcoin.	**(8)**
	(b)	Discuss whether business owners are likely to be comfortable with a Proof-of-Stake (PoS) Blockchain.	**(6)**
17	(a)	Write a short note on Hyperledger Fabric.	**(6)**
	(b)	Explain in detail the steps to run Hyperledger network and deploy sample applications on it.	**(8)**
OR			
18	(a)	How Does the Ethereum Mining Process Work?	**(8)**
	(b)	List out the Features of Ethereum	**(6)**
1	(a)	Explain whether a standard commercial crime policy affords coverage to a business for Blockchain breaches and Cryptocurrency losses.	**(8)**

9	(b)	Give some reasons a single enterprise might find effectively implementing a Blockchain solution difficult.	**(6)**
2 0	(a)	Discuss the various attacks of vectors and vulnerabilities that may be present in Blockchain.	**(8)**
	(b)	Describe the current system of shareholder voting and how Blockchain may improve the process.	**(6)**

TEACHING PLAN

No	Contents	No.of Lecture Hrs
Module-1 (Introduction to Blockchain)(7hrs)		
1.1	Blockchain- Public Ledgers, Blockchain as Public Ledgers	1
1.2	Bitcoin, Blockchain 2.0	1
1.4	Smart Contracts, Block in a Blockchain, Transactions-Distributed Consensus	1
1.5	The Chain and the Longest Chain -Cryptocurrency to Blockchain 2.0	1
1.6	Permissioned Model of Blockchain, Principles and technologies underlying Blockchain including Hashing	1
1.7	Permissioned Model of Blockchain, Principles and technologies underlying Blockchain including Hashing	1
Module-2 (Cryptocurrency) (6 hrs)		
2.1	Overview of Bitcoin Blockchain, Creation of coins Payments and double spending,	1
2.2	Bitcoin scripting, Bitcoin Scripts, Bitcoin P2P Network	1
2.3	Transaction in Bitcoin Network	1
2.4	Block Mining, Block propagation and block relay	1

2.5	Consensus introduction, Distributed consensus in open environments	1
2.6	Consensus in a Bitcoin network	1
Module-3 (Distributed Consensus**)(8 hrs)**		
3.1	Nakamoto consensus, Bitcoin Consensus	1
3.2	Proof of Work (PoW)- Hashcash PoW , Bitcoin PoW, Attacks on PoW ,monopoly problem.	1
3.3	Proof of Stake- Proof of Burn - Proof of Elapsed Time.	1
3.4	Bitcoin Miner, Mining Difficulty, Mining Pool-Permissioned model and use cases	1
3.5	Design issues for Permissioned Blockchain, Execute contracts-Consensus models for permissioned Blockchain	1
3.6	Distributed consensus in closed environment-Paxos	1
3.7	RAFT Consensus-Byzantine general problem, Byzantine fault tolerant system-Agreement Protocol, Lamport-Shostak-Pease BFT Algorithm	1
3.8	BFT over Asynchronous systems, Practical Byzantine Fault Tolerance	1
Module-4 (Real-time Security and Application Layer Security)(10hrs)		
4.1	Introduction to Hyperledger projects- Fabric, Sawtooth, Indy, Iroha.	1
4.2	Understanding tools like Composer, Caliper and Aries.	1
4.3	Familiarization of steps to run Hyperledger network and deploy sample applications (Part 1)	1
4.4	Familiarization of steps to run Hyperledger network and deploy sample applications (Part 2)	1
4.5	Ethereum: Ethereum network, EVM, Transaction fee.	1

4.6	Mist Browser, Ether, Gas, Solidity.	1
4.7	Smart contracts, Truffle.	1
4.8	Design and issue Cryptocurrency.	1
4.9	Mining, DApps, DAO.	1
Module-5 (Cryptocurrency Regulations and Blockchain Applications)(5 hrs)		
5.1	Stakeholders, Roots of Bit coin, Legal Aspects.	1
5.2	Crypto currency Exchange, Black Market and Global Economy**.**	1
5.3	Applications: Internet of Things-Medical Record Management System.	1
5.4	Blockchain in Government and Blockchain Security.	1
5.5	Blockchain Use Cases –Finance.	1

ERT458	WIRELESS SENSOR NETWORKS	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Prerequisite: CST303 Computer Networks, ERT306 Data Communication and Networking

Course Outcomes: After the completion of the course the student will be able to

CO 1	Explain the fundamentals, concepts and terminologies of sensors and wireless sensornetworks. **(Cognitive Knowledge Level: Understand)**
CO 2	Illustrate the functionalities characteristics of the building blocks of WSN and understand software hardware requirements of WSN. **(Cognitive Knowledge Level: Understand)**
CO 3	Discuss the routing protocols and different QoS issues of WSNs. **(Cognitive Knowledge Level: Apply)**
CO 4	Analyze different security issues in WSN and evaluate defensive techniques. **(Cognitive Knowledge Level: Apply)**
CO 5	Evaluate critically, the domain specific applications of WSNs. **(Cognitive Knowledge Level: Understand**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓		✓								✓
CO2	✓	✓			✓							✓
CO3	✓	✓			✓				✓	✓		✓
CO4					✓				✓	✓		✓
CO5	✓	✓		✓								✓

Assessment Pattern

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management andFinance
PO6	The Engineer and Society	**PO12**	Lifelong learning

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1	**2**	
Remember K1	10	10	10
Understand K2	20	20	50
Apply K3	20	20	40
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	**CIE**	**ESE**	**ESE Duration**
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers): 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

SYLLABUS

Module - 1 (Introduction Sensors and Wireless Sensor Networks)

Introduction to sensors- Sensor basics, Classification of measurement errors- Sensor deviations, Resolution. Types of sensors-Chemical sensor, Biosensor, Neuromorphic sensors, MOS sensors.

Introduction to wireless sensor networks (WSN)- Network architecture and protocol stack, MAC access control – fundamental MAC protocols, MAC design for WSNs, MAC protocols for WSN (Contention based, Contention free, and Hybrid protocols), IEEE 802.15.4, Zigbee.

Module -2 (Characteristics of WSNs)

Characteristics of WSNs- Power consumption constraints for nodes, mobility of nodes, Heterogeneity and Homogeneity of nodes. Scalability, resilience. WSN platforms- Hardware, Wireless, Software. Operating systems for WSN- TinyOS, LiteOS, Contiki, RIOT. Online collaborative sensor data management platforms. Localization, Sensor Data Calibration and Fault Tolerance, Macroprogramming and reprogramming. Distributed sensor Networks.

Module 3 (Routing Protocols for WSNs)

Routing and data dissemination – Fundamentals and challenges, taxonomy of routing and data dissemination protocols, Overview of routing and data dissemination protocols – Sensor Protocol for Information via Negotiation (SPIN), geographic adaptive fidelity, LEACH, Sensor protocols for information via negotiation, joint mobility and routing protocol. Transport Protocols and Quality of Service – Transport protocol design for WSNs, Transport protocols for WSNs.

Module -4 (Security in WSNs)

Security requirements in WSNs, Security vulnerabilities in WSNs – DoS attacks, physical layer attacks, link layer, network layer, transport layer attacks, Attacks on secrecy and authentication, Security mechanisms for WSNs – cryptography in WSNs, Key management protocols, Defense against DoS attacks, Defense against routing attacks - TESLA, SPINS , Intrusion detection in WSNs.

Module- 5 (Application domains of WSNs)

Area/Habitat monitoring, Health care monitoring, Environmental/Earth sensing- Air quality monitoring, Forest fire detection, Landslide detection, Water quality monitoring, Natural disaster prevention. WSNs for Industrial monitoring- Machine health monitoring, Data logging, Water/waste water monitoring, Structural health monitoring. Advanced Topics in WSNs- Mobile WSNs, Wireless Adhoc networks, Virtual Sensor Networks.

Text Book

1. Jun Zheng, Abbas Jamalipour, “Wireless Sensor Networks: A Networking Perspective”, John Wiley, 2009
2. C.Siva Ram Murthy and B.S.Manoj, “Ad Hoc Wireless Networks – Architectures and 2 Protocols”, Pearson Education, 2006.
3. Sohraby, K., Minoli, D., Znati, T. (2007). Wireless sensor networks: technology, protocols, and

applications. John Wiley and Sons. pp. 203–209. ISBN 978-0-471-74300-2.

Reference Books

1. Holger Karl, Andreas Willig, “Protocols and Architectures for Wireless Sensor Networks”, Wiley, 2005
2. Guowang Miao; Jens Zander; Ki Won Sung; Ben Slimane (2016). Fundamentals of Mobile Data Networks. Cambridge University Press. ISBN 978-1107143210.
3. Ullo, Silvia Liberata; Sinha, G. R. (2020-05-31). "Advances in Smart Environment Monitoring Systems Using IoT and Sensors". Sensors (Basel, Switzerland). 20 (11): 3113. Bibcode:2020Senso..20.3113U. doi:10.3390/s20113113. ISSN 1424-8220. PMC 7309034. PMID 32486411.
4. Dargie, W. and Poellabauer, C. (2010). Fundamentals of wireless sensor networks: theory and practice. John Wiley and Sons. pp. 168–183, 191–192. ISBN.
5. Tiwari, Ankit; et al. (2007). "Energy-efficient wireless sensor network design and implementation for condition-based maintenance". ACM Transactions on Sensor Networks. 3: 1–es. CiteSeerX 10.1.1.188.8180. doi:10.1145/1210669.1210670. S2CID 7278286.
6. Silva, D.; Ghanem, M.; Guo, Y. (2012). "WikiSensing: An Online Collaborative Approach for Sensor Data Management". Sensors. 12 (10): 13295–332. Bibcode:2012Senso..1213295S. doi:10.3390/s121013295. PMC 3545568. PMID 23201997.

Course Level Assessment Questions

Course Outcome 1 (CO1): Explain the fundamentals, concepts and terminologies of sensors and wireless sensor networks.

1. Categorize different measurement errors associated with sensors.
2. Classify the sensors according to their domain of application.
3. Discuss the network architecture and protocol stack for WSNs

Course Outcome 2 (CO2): Illustrate the functionalities characteristics of the building blocksof WSN and understand software hardware requirements of WSN.

1. Critically investigate the mobility and power consumption issues of nodes in WSNs.
2. Discuss the suitability of homogeneous and heterogeneous nodes for WSNs
3. What are the hardware and software requirements for WSNs?
4. Compare and contrast between the following operating systems for WSN- TinyOS,and LiteOS.
5. What do you mean by localization in WSNs?
6. Comment on sensor data calibration. Discuss issues in sensor data calibration.
7. Explain steps in sensor node reprogramming.

Course Outcome 3 (CO3): Discuss the routing protocols and different QoS issues ofWSNs.

1. Explain different routing and data dissemination protocols for WSNs.
2. What do you mean by QoS. Discuss different QoS issues associated with WSNs.
3. Discuss LEACH protocol. Explain how LEACH organizes the cluster such that the energy is

equally divided in all the sensor nodes in the network.

Course Outcome 4 (CO4): Analyze different security issues in WSN and evaluatedefensive techniques.

1. Discuss the security vulnerabilities of WSNs.
2. Discuss how DoS attacks are realized in WSNs? How WSNs can be protected from DoS attacks?

Course Outcome 5 (CO5): Evaluate critically, the domain specific applications of WSNs.

1. Discuss the broad application domains for WSNs.
2. Discuss the suitability of WSNs in environmental/earth sensing such as air quality monitoring and Forest fire detection.
3. Explain Structural health monitoring using WSNs.

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B.TECH. DEGREE EXAMINATION, MONTH & YEAR

Course Code: ERT458

Course Name: WIRELESS SENSOR NETWORKS

Max.Marks: 100 Duration: 3Hours

PART A

Answer ALL Questions. Each Carries 3 mark.

1	Explain the principle of operation of chemical sensors. Discuss some applications	CO1	K3
2	Compare and contrast between IEEE 802.15.4 and Zigbee protocols forwireless communication.	CO1	K2
3	Discuss the issues in power consumption constraints for sensor nodes.	CO2	K2
4	Briefly explain the requirements for operating systems suitable for WSN.	CO2	K2
5	List the challenges in routing and data dissemination in WSNs.	CO3	K3
6	Explain why Sensor Protocol for Information via Negotiation (SPIN) is calleda data centric dissemination protocol?	CO3	K3
7	Explain how DoS attacks are realized in WSNs?		
8	Comment on the role of cryptography in WSNs.	CO4	K3
9	Discuss the use of WSNs in water quality monitoring and Natural disasterprevention.	CO5	K2
10	Briefly explain mobile WSNs.	CO5	K2

PART – B

Answer one question from each module; each question carries 14 marks.

	Module – I			
11(a)	Categorize sensors used in WSNs. Explain different measurement errors associated with sensors.	8	CO1	K3
11(b)	Compare and contrast between the functionalities of Biosensors and Neuromorphic sensors.	6	CO2	K3
	OR			
12(a)	Discuss MAC access control protocols used for WSNs. Also comment on issues considered in the MAC design for WSNs.	8	CO1	K3
12(b)	Explain features of contention based, contention free, and hybrid MAC protocols for WSNs.	6	CO2	K3
	Module – II			
13(a)	Discuss scalability issues of WSNs. Also comment on the suitability ofhomogeneous and heterogeneous nodes for WSNs.	8	CO2	K2
13(b)	Compare and contrast between the following operating systems for WSN- TinyOS, and LiteOS.	6	CO2	K2
	OR			
14(a)	What do you mean by localization in WSNs? Also comment on sensor data calibration. Discuss issues in sensor data calibration.	9	CO2	K2
14(b)	What do you mean by reprogramming of sensor nodes? Explain steps insensor node reprogramming.	5	CO2	K2
	Module – III			
15(a)	Discuss LEACH protocol. Explain how LEACH organizes the cluster suchthat the energy is equally divided in all the sensor nodes in the network.	9	CO3	K3
15(b)	What do you mean by QoS. Discuss different QoS issues associated with WSNs.	5	CO3	K3
	OR			
16(a)	Explain how the Sensor Protocol for Information via Negotiation (SPIN) efficiently disseminates data among other nodes in the network?	8	CO3	K2
16(b)	Explain different routing and data dissemination protocols for WSNs.	6	CO3	K2
	Module – IV			

17(a)	Explain steps in Intrusion detection in WSNs. Also discuss the vulnerability of WSN in different layers of its layered architecture.	9	CO4	K2
17(b)	Comment on attacks on secrecy and authentication in WSNs. Also explaindefensive techniques.	5	CO4	K2
	OR			
18(a)	Discuss different security mechanisms for WSNs. Also explain use of cryptography in WSNs and explain different key management protocols.	9	CO4	K2
18(b)	Comment on routing attacks in WSNs. Also discuss defense against routing attacks.	5	CO4	K2
	Module – V			
19(a)	Discuss the suitability of WSNs in environmental/earth sensing such as airquality monitoring and Forest fire detection.	8	CO5	K3
19(b)	Illustrate the use of WSNs in industrial monitoring such as machine healthmonitoring.	6	CO5	K3
	OR			
20 (a)	Illustrate network intrusion with example. Explain steps involved ininvestigating network intrusions.	7	CO5	K3
20(b)	With an illustrative example explain how WSNs are used in health care monitoring.	7	CO5	K3

Course Contents and Lecture Schedule

Teaching Plan		
No	**Contents**	**Hours(35)**
Module 1: Introduction Sensors and Wireless Sensor Networks		(6 hours)
1.1	Introduction to sensors- Sensor basics.	1 hour
1.2	Classification of measurement errors- Sensor deviations, Resolution.	1 hour
1.3	Types of sensors-Chemical sensor, Biosensor, Neuromorphic sensors, MOS sensors.	1 hour
1.4	Introduction to wireless sensor networks (WSN)- Network architecture and protocol stack.	1 hour

1.5	MAC access control – fundamental MAC protocols, MAC design for WSNs.	1 hour
1.6	MAC protocols for WSN (Contention based, Contention free, and Hybrid protocols), IEEE 802.15.4, Zigbee.	1 hour
Module 2: Characteristics of WSNs		(7 hours)
2.1	Characteristics of WSNs- Power consumption constraints for nodes,mobility of nodes, Heterogeneity of nodes and Homogeneity of nodes.	2 hours
2.2	Scalability, resilience. WSN platforms- Hardware, Wireless, Software.	1 hour
2.3	Operating systems for WSN- TinyOS, LiteOS, Contiki, RIOT.	1 hour
2.4	Online collaborative sensor data management platforms.	1 hour
2.5	Localization, Sensor Data Calibration and Fault Tolerance.	1 hour
2.6	Macroprogramming and reprogramming. Distributed sensor Networks.	1 hour
Module 3: Routing Protocols for WSNs		(8 hours)
3.1	Routing and data dissemination – Fundamentals and challenges.	1 hour
3.2	Taxonomy of routing and data dissemination protocols.	1 hour
3.4	Overview of routing and data dissemination protocols, Sensor Protocol for Information via Negotiation (SPIN) – geographic adaptive fidelity, LEACH.	1 hour
3.5	Sensor protocols for information via negotiation.	1 hour
3.6	Joint mobility and routing protocol.	1 hour
3.7	Transport Protocols and Quality of Service – Transport protocol design for WSNs.	1 hour
3.8	Transport protocol design for WSNs.	1 hour
3.9	Transport protocols for WSNs.	1 hour
Module 4: Security in WSNs		(7 hours)
4.1	Security requirements in WSNs, Security vulnerabilities in WSNs.	1 hour
4.2	DoS attacks, physical layer attacks, link layer, network layer.	1 hour
4.3	Transport layer attacks, Attacks on secrecy and authentication,	1 hour

4.4	Security mechanisms for WSNs – cryptography in WSNs, Key management protocols.	1 hour
4.5	Defense against DoS attacks, Defense against routing attacks.	1 hour
4.6	TESLA, SPINS	1 hour
4.7	Intrusion detection in WSNs.	1 hour
	Module 5: Application domains of WSNs	(7 hours)
5.1	Area/Habitat monitoring, Health care monitoring.	1 hour
5.2	Environmental/Earth sensing- Air quality monitoring, Forest fire detection, Landslide detection.	1 hour
5.3	Water quality monitoring, Natural disaster prevention.	1 hour
5.4	WSNs for Industrial monitoring- Machine health monitoring, Data logging.	1 hour
5.5	Water/waste water monitoring, Structural health monitoring.	1 hour
5.6	Advanced Topics in WSNs- Mobile WSNs.	1 hour
5.7	Wireless Adhoc networks, Virtual Sensor Networks.	1 hour

Assignments:

Assignment 1: Opnet/NetSim/NS based simulation of a wireless sensor network.

Assignment 2: Case Study: WSN for Natural disaster prevention.

Assignment 3: Case Study: WSNs for Industrial monitoring

ERT468	REAL TIME OPERATING SYSTEMS	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Prerequisite: ERT 302 Operating Systems

Course Outcomes: After the completion of the course the student will be able to

CO1	Summarize the functions and structure of general-purpose operating systems.**(Cognitive knowledge Level: Understand)**
CO2	Use different scheduling algorithms on processes and threads. .**(Cognitive knowledge Level: Apply)**
CO3	Interpret a real time operating system along with its synchronization, communication and interrupt handling tools. **(Cognitive knowledge: Understand)**
CO4	Illustrate task constraints and analyze the different scheduling algorithms on tasks. .**(Cognitive knowledge Level: Analyze)**
CO5	Illustrate the applications of real time operating systems. .**(Cognitive knowledge Level: Apply)**

Mapping of course outcomes with program outcomes

	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CO 1		✓	✓									
CO 2	✓	✓										✓
CO 3	✓	✓					✓					✓
CO 4	✓	✓					✓					✓
CO 5	✓	✓	✓				✓				✓	✓

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	20
Understand	25	25	50
Apply	10	10	20
Analyze	5	5	10
Evaluate			
Create			

Mark distribution:

TotalMarks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance: 10 marks

Continuous Assessment Test (2 numbers): 25 marks

Assignment/Quiz/Case study: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of whichstudent should answer any one. Each question can have maximum 2 sub-divisions and carry14 marks.

Course Level Assessment Questions:

Course Outcome 1 (CO1): Summarize the functions and structure of general-purpose operating systems.

1. List the functions of operating systems.
2. Describe the importance of Kernel in operating system functions.
3. Explain monolithic and layered architecture of operating systems.
4. Draw the process state diagram and explain.

Course Outcome 2 (CO2): Use different scheduling algorithms on processes and threads.

1. Schedule the following processes with FCFS and Round Robin algorithm for a timeof2mS. Assuming all the processes arrives at time zero. Also state the performance of the system.

Process	Burst time
P1	4
P2	5
P3	2
P4	3

2. Compare user level threads and Kernel level threads.
3. Discuss the different types of multiprocessor scheduling operations.
4. Explain the possible scheduling of user level threads with a 50mS process quantumand threads that run 5mS per CPU time.

Course Outcome 3 (CO3): Interpret a real time operating system along with its synchronization, communication and interrupt handling tools.

1. Explain the different types of semaphores used for process synchronization.
2. Explain how the priority inversion problem in RTOS is solved.
3. Draw the structure and explain the working of a message queue.
4. Differentiate between exceptions and interrupts.
5. What are the different classifications of exceptions?

Course Outcome 4 (CO4): Illustrate task constraints and analyze the different scheduling algorithms on tasks.

1. Explain the different timing constraints of a real time task.
2. Illustrate Jackson's algorithm with an example.
3. Explain EDF algorithm with precedence constraints.
4. Verify the schedulability under EDF and construct the schedule of the following task set

	Ci	Di	T1
τ_1	2	5	6
τ_2	2	4	8
τ_3	4	8	12

5. Draw the state transition diagram of a real time kernel.

Course Outcome 5 (CO5): Illustrate the applications of real time operating systems.

1. Illustrate the implementation of a real time system with an example,
2. With a block schematic explain the real time control system used in an adaptive cruise control.

Syllabus

Module 1: Introduction

Operating system: Types, Objectives and functions, Kernel, Process - States, Process Control Block, Operations on processes.

Module 2: Process Scheduling

Process Scheduling: FCFS, SJF, Priority, Round-Robin, Multilevel Queue and Multilevel Feedback Queue Scheduling. Thread: Structure. User and kernel level threads, multi-threading models, multiprocessor scheduling.

Module 3: Real Time Operating Systems

Real Time Operating Systems: Structure and characteristics of Real Time Systems, Task: Task states, Task synchronization -Semaphores- types, Inter task communication mechanisms: message queues, pipes, event registers, signals, Exceptions and interrupt handling.

Module 4: Task scheduling

Task constraints, Task scheduling: Aperiodic task scheduling: EDD. EDF, LDF, EDF with precedence constraints. Periodic task scheduling: Rate monotonic and Deadline monotonic, real time Kernel- Structure, State transition diagram, Kernel primitives.

Module 5: Features of FreeRTOS and Linux

Commercial real time operating systems: PSOS, VRTX, RT Linux- Features and application only. Case study of (Kernel design, threads and task scheduling) RTOS: MicroC/OS-II. RTOS control system used in real life applications - in adaptive cruise control.

Text Books

1. Abraham Silberschatz- 'Operating System Principles': Wiley India, 7th edition, 2011
2. William Stallings –'Operating systems- Internals and design principles', Prentice Hall, 7th edition, 2011
3. Qing Li – 'Real-Time Concepts for Embedded Systems ', CMP Books, 2013
4. Giorgio C. Buttazzo, -'HARD REAL-TIME COMPUTING SYSTEMS Predictable Scheduling Algorithms and Applications', Kluwer Academic Publishers.

Reference Books:

1. Tanenbaum -'Modern Operating Systems' ,Pearson Edition, 3/e, 2007.
2. Jean J Labrosse , 'Micro C/OS-II, The Real Time Kernel' , CMP Books, 2011
3. Rajib Mall, 'Real-Time Systems: Theory and Practice ' , 2008.
4. David E. Simon 'An Embedded Software Primer', Pearson 2012
5. Raj Kamal, 'Embedded Systems – Architecture, Programming and Design', Tata McGraw Hill

Model Question Paper

A P J Abdul Kalam Technological University

Sixth Semester B Tech Degree Examination

Branch: Electronics and Computer Engineering

Course: ERT 468 REAL TIME OPERATING SYSTEMS

Time: 3 Hrs Max. Marks: 100

PART A

Answer All Questions. Each question carries 3 marks

1.	List any six functions of an operating system.	3
2	Differentiate microkernel and exokernel structures of operating systems.	3
3	Explain the different operations on processes.	3
4	Explain the differences between Pre-emptive and Non pre-emptive scheduling policies.	3
5	Draw the state diagram of RTOS queue and explain.	3
6	What you mean by priority inversion in real time systems? How the operating system manages this issue?	3
7	Explain EDD algorithm with an example.	3
8	Explain the task control block of a real time kernel.	3
9	List the features of FreeRTOS.	3
10	Illustrate the threads in MicroC/OS-II operating system.	3
	PART B **Answer any one full question from each module Each question carries14 marks.**	
	MODULE 1	
11	a. Explain the functions of operating system as Resource Manager.	7
	b. Describe the structure of a Process Control Block	7
	OR	
12	a. Explain the monolithic and microkernel architectures of OS kernel.	7
	b. Draw the process state diagram and explain the different states.	7
	MODULE II	

<table>
<tr><td>13</td><td>a. Explain the Shortest Remaining Time First algorithm with a suitable example.</td><td>7</td></tr>
<tr><td></td><td>b. Schedule the given 5 processes with Round Robin scheduling.
<table><tr><th>Process ID</th><th>Arrival Time</th><th>Burst Time</th></tr><tr><td>P1</td><td>0</td><td>5</td></tr><tr><td>P2</td><td>1</td><td>3</td></tr><tr><td>P3</td><td>2</td><td>1</td></tr><tr><td>P4</td><td>3</td><td>2</td></tr><tr><td>P5</td><td>4</td><td>3</td></tr></table>Draw the Gantt chart and calculate the average waiting time andturnaround time for these processes if time quantum is 2 units,</td><td>7</td></tr>
<tr><td></td><td>OR</td><td></td></tr>
<tr><td>14</td><td>Compare FCFS and Round -Robin scheduling algorithms</td><td>7</td></tr>
<tr><td></td><td>b. Explain thread scheduling algorithms used in operating systems in detail.</td><td>7</td></tr>
<tr><td></td><td>MODULE III</td><td></td></tr>
<tr><td>15</td><td>a .Draw the structure of a real time operating system and explain.</td><td>7</td></tr>
<tr><td></td><td>b. Differentiate between exceptions and interrupts. What are the different classifications of exceptions</td><td>7</td></tr>
<tr><td></td><td>OR</td><td></td></tr>
<tr><td>16</td><td>a. Explain how synchronization is achieved between different tasks in a realtime operating system</td><td>7</td></tr>
<tr><td></td><td>b. Describe any two inter task communication mechanisms in a real timeoperating systems.</td><td>7</td></tr>
<tr><td></td><td>MODULE IV</td><td></td></tr>
<tr><td>17</td><td>a. Illustrate Horn’s algorithm with an example.</td><td>7</td></tr>
<tr><td></td><td>b. Explain EDF algorithm with precedence constraints.</td><td>7</td></tr>
<tr><td></td><td>OR</td><td></td></tr>
<tr><td>18</td><td>a. Explain the precedence constraints of a real time task.</td><td>7</td></tr>
</table>

	b. Verify the schedulability and construct the scheduling according to therate monotonic algorithm for the following set of periodic tasksr_1, r_2 and r_3. Where Ci and Ti are the computation time activation period of the task.	7
	MODULE V	
19	a. Illustrate the implementation of a real time system with an example,	7
	b. Explain the inter-process communication techniques used in Micro C/OS-II	7
	OR	
20	a. Compare the features of PSOS, VRTX and RT Linux	7
	b. Prepare suitable requirements table for an RTOS control system used in adaptive cruise control.	7

	Ci	Ti
r_1	3	5
r_2	1	8
r_3	1	10

Teaching Plan

No	TOPIC	Hours (34)
	Module 1	**6**
1.1	Introduction to Operating system- Types	1
1.2	Objective and functions	1
1.3	Kernel - Importance and functions Lecture 1	1
1.4	Kernel - Importance and functions Lecture 2	1
1.5	Process - States, Process Control Block	1
1.6	Operations on processes	1
	Module 2	**6**
2.1	Process Scheduling: FCFS, SJF, Priority, Round-Robin	1
2.2	Process Scheduling: Priority, Round-Robin	1
2.3	Multilevel Queue and Multilevel Feedback Queue Scheduling	1
2.4	Thread- Structure. User and kernel level threads	1
2.5	Multi-threading models	1
2.6	Multiprocessor scheduling	1
	Module 3	**8**

3.1	Real Time Operating Systems: Structure and characteristics of Real Time Systems	1
3.2	Task: Task states	1
3.3	Task synchronization -Semaphores- types Lecture 1	1
3.4	Task synchronization -Semaphores- types Lecture 2	1
3.5	Inter task communication mechanisms: message queues, pipes	1
3.6	Event registers, signals	1
3.7	Exceptions and interrupt handling Lecture 1	1
3.8	Exceptions and interrupt handling Lecture 1	1
	Module 4	**8**
4.1	Task constraints	1
4.2	Task scheduling: Aperiodic task scheduling: EDD. EDF	1
4.3	LDF	1
4.4	EDF with precedence constraints	1
4.5	Periodic task scheduling: Rate monotonic	1
4.6	Deadline monotonic	1
4.7	Real time Kernel- Structure,	1
4.8	State transition diagram, Kernel primitives	1
	Module 5	**6**
5.1	Features of FreeRTOS and Linux	1
5.2	Commercial real time operating systems: PSOS, VRTX	1
5.3	RT Linux- Features and application only.	1
5.4	Case study of RTOS: MicroC/OS-II real time operating systems-Lecture 1	1
5.5	Case study of RTOS: MicroC/OS-II real time operating systems-Lecture 1	1
5.6	RTOS control system used in real life applications - in adaptive cruise control.	1

ERT404	COMPREHENSIVE VIVA VOCE	CATEGORY	L	T	P	CREDIT
		PCC	1	0	0	1

The objective of this Course viva is to ensure the basic knowledge of each student in the most fundamental core courses in the curriculum. The viva voce shall be conducted based on the core subjects studied from third to eighth semester. This course helps the learner to become competent in placement tests and other competitive examinations.

Guidelines

1. The course should be mapped with a faculty and classes shall be arranged for practicing questions based on the core courses listed in the curriculum.
2. The viva voce will be conducted by the same three-member committee assigned for final project phase II evaluation. It comprises of Project coordinator, expert from Industry/research Institute and a senior faculty from a sister department.
3. The pass minimum for this course is 25.
4. The mark will be treated as internal and should be uploaded along with internal marks of other courses.
5. Comprehensive Viva should be conducted along with final project evaluation by the three-member committee.

Mark Distribution

Total marks: 50, only CIE, minimum required to pass : **25**

ERD416	PROJECT PHASE II	CATEGORY	L	T	P	CREDIT
		PWS	0	0	12	4

Preamble: The course 'Project Work' is mainly intended to evoke the innovation and invention skills in a student. The course will provide an opportunity to synthesize and apply the knowledge and analytical skills learned, to be developed as a prototype or simulation. The project extends to 2 semesters and will be evaluated in the 7th and 8th semester separately, based on the achieved objectives. One third of the project credits shall be completed in 7th semester and two third in 8th semester. It is recommended that the projects may be finalized in the thrust areas of the respective engineering stream or as interdisciplinary projects. Importance should be given to address societal problems and developing indigenous technologies.

Course Objectives

1. To apply engineering knowledge in practical problem solving.
2. To foster innovation in design of products, processes or systems.
3. To develop creative thinking in finding viable solutions to engineering problems.

Course Outcomes [COs]: After successful completion of the course, the students will be able to:

CO1	Model and solve real world problems by applying knowledge across domains (Cognitive knowledge level: **Apply**).
CO2	Develop products, processes or technologies for sustainable and socially relevant applications (Cognitive knowledge level: **Apply**).
CO3	Function effectively as an individual and as a leader in diverse teams and to comprehend and execute designated tasks (Cognitive knowledge level: **Apply**).
CO4	Plan and execute tasks utilizing available resources within timelines, following ethical and professional norms (Cognitive knowledge level: **Apply**).
CO5	Identify technology/research gaps and propose innovative/creative solutions (Cognitive knowledge level: **Analyze**).
CO6	Organize and communicate technical and scientific findings effectively in written and oral forms (Cognitive knowledge level: **Apply**).

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO2	✓	✓	✓		✓	✓	✓	✓	✓		✓	✓
CO3									✓	✓	✓	✓
CO4					✓			✓	✓	✓	✓	✓
CO5	✓	✓	✓	✓	✓							✓
CO6					✓			✓	✓	✓	✓	✓

Abstract POs defined by National Board of Accreditation			
PO #	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	PO7	Environment and Sustainability
PO2	Problem Analysis	PO8	Ethics
PO3	Design/Development of solutions	PO9	Individual and team work
PO4	Conduct investigations of complex problems	PO0	Communication
PO5	Modern tool usage	PO11	Project Management and Finance
PO6	The Engineer and Society	PO12	Lifelong learning

PROJECT PHASE II

Phase 2 Targets

1. In depth study of the topic assigned in the light of the report prepared under Phase - I;
2. Review and finalization of the approach to the problem relating to the assigned topic.
3. Preparing a detailed action plan for conducting the investigation, including teamwork.
4. Detailed Analysis/ Modeling / Simulation/ Design/ Problem Solving/Experiment as needed.
5. Final development of product/ process, testing, results, conclusions and future directions.
6. Preparing a paper for Conference Presentation/ Publication in Journals, if possible.
7. Presenting projects in Project Expos conducted by the University at the cluster level and/ or state level as well as others conducted in India and abroad.
8. Filing Intellectual Property Rights (IPR) if applicable.
9. Preparing a report in the standard format for being evaluated by the Department Assessment Board.
10. Final project presentation and viva voce by the assessment board including the external expert.

Evaluation Guidelines & Rubrics

Total: 150 marks (Minimum required to pass: 75 marks).

1. Project progress evaluation by guide: 30 Marks.
2. Two interim evaluations by the Evaluation Committee: 50 Marks (25 marks for each evaluation).
3. Final evaluation by the Final Evaluation committee: 40 Marks
4. Quality of the report evaluated by the evaluation committee: 30 Marks

(The evaluation committee comprises HoD or a senior faculty member, Project coordinator and project supervisor. The final evaluation committee comprises of Project coordinator, expert from Industry/research/academic Institute and a senior faculty from a sister department).

Evaluation by the Guide

The guide/supervisor must monitor the progress being carried out by the project groups on regular basis. In case it is found that progress is unsatisfactory it should be reported to the Department Evaluation Committee for necessary action. The presence of each student in the group and their involvement in all stages of execution of the project shall be ensured by the guide. Project evaluation by the guide: 30 Marks. This mark shall be awarded to the students in his/her group by considering the following aspects:

Project Scheduling & Distribution of Work among Team members: Detailed and extensive Scheduling with timelines provided for each phase of project. Work breakdown structure well defined. (5)

Literature survey: Outstanding investigation in all aspects. (4)

Student's Diary/ Daily Log: The main purpose of writing daily diary is to cultivate the habit of documenting and to encourage the students to search for details. It develops the students' thought process and reasoning abilities. The students should record in the daily/weekly activity diary the day to day account of the observations, impressions, information gathered and suggestions given, if any. It should contain the sketches & drawings related to the observations made by the students. The daily/weekly activity diary shall be signed after every day/week by the guide. (7)

Individual Contribution: The contribution of each student at various stages. (9)

Completion of the project: The students should demonstrate the project to their respective guide. The guide shall verify the results and see that the objectives are met. (5)

EVALUATION RUBRICS for PROJECT Phase II: Interim Evaluation - 1

No.	Parameters	Marks	Poor	Fair	Very Good	Outstanding
2-a	Novelty of idea, and Implementation scope [CO5] [Group Evaluation]	5	The project is not addressing any useful requirement. The idea is evolved into a non-implementable one. The work presented so far is lacking any amount of original work by the team.	Some of the aspects of the proposed idea can be implemented. There is still lack of originality in the work done so far by the team. The project is a regularly done theme/topic without any freshness in terms of specifications, features, and/or improvements.	Good evidence of an implementable project. There is some evidence for the originality of the work done by the team . There is fresh specifications/ features/improvements suggested by the team. The team is doing a design from fundamental principles, and there is some independent learning and engineering ingenuity.	The project has evolved into incorporating an outstandingly novel idea. Original work which is not yet reported anywhere else. Evidence for ingenious way of innovation which is also Implementable. Could be a patentable / publishable work.
			(0 – 1 Marks)	(2 – 3 Marks)	(4 Marks)	(5 Marks)
2-b	Effectiveness of task distribution among team members. [CO3] [Group Evaluation]	5	No task distribution of any kind. Members are still having no clue on what to do.	Task allocation done, but not effectively, some members do not have any idea of the tasks assigned. Some of the tasks were identified but not followed individually well.	Good evidence of task allocation being done, supported by project journal entries, identification of tasks through discussion etc. However, the task distribution seems to be skewed, and depends a few members heavily than others. Mostly the tasks are being followed by the individual members.	Excellent display of task identification and distribution backed by documentary evidence of team brainstorming, and project journal entries. All members are allocated tasks according to their capabilities, and as much as possible in an equal manner. The individual members are following the tasks in an excellent manner.
			(0 – 1 Marks)	(2 – 3 Marks)	(4 Marks)	(5 Marks)
2-c	Adherence to project schedule. [CO4] [Group Evaluation]	5	Little or no evidence of continued planning or scheduling of the project. The students did not stick to the plan what they were going to build nor plan on what materials / resources to use in the project. The students do not have any idea on the budget required even after the end of phase - I. No project journal kept or the journal.	There is some improvement in the primary plan prepared during phase I. There were some ideas on the materials /resources required, but not really thought out. The students have some idea on the finances required, but they have not formalized a budget plan. Schedules were not prepared. The project journal has no useful details on the project.	Good evidence of planning done and being followed up to a good extent after phase I. Materials were listed and thought out, but the plan wasn't followed completely. Schedules were prepared, but not detailed, and needs improvement. Project journal is presented but it is neither complete nor updated regularly.	Excellent evidence of enterprising and extensive project planning and follow-up since phase I. Continued use of project management/version control tool to track the project. Material procurement if applicable is progressing well. Tasks are updated and incorporated in the schedule. A well-kept project journal showed evidence for all the above, in addition to the interaction with the project guide.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)

2-d	Interim Results. [CO6] [Group assessment]	**5**	There are no interim results to show.	The team showed some interim results, but they are not complete / consistent to the current stage, Some corrections are needed.	The interim results showed were good and mostly consistent/correct with respect to the current stage. There is room for improvement.	There were significant interim results presented which clearly shows the progress.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
2-e	Presentation [Individual assessment]	**5**	Very poor presentation and there is no interim results. The student has no idea about the project proposal.	Presentation is average, and the student has only a feeble idea about the team work.	Good presentation. Student has good idea about the team's project. The overall presentation quality is good.	Exceptionally good presentation. Student has excellent grasp of the project. The quality of presentation is outstanding.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
Phase-II Interim Evaluation - 1 Total Marks: 25						

EVALUATION RUBRICS for PROJECT Phase II: Interim Evaluation – 2

No	Parameters	Marks	Poor	Fair	Very Good	Outstanding
2-f	Application of engineering knowledge [CO1] [Individual Assessment]	**10**	The student does not show any evidence of applying engineering knowledge on the design and the methodology adopted. The student's contribution in application of engineering knowledge in the project is poor.	The student appears to apply some basic knowledge, but not able to show the design procedure and the methodologies adopted in a comprehensive manner.	The student is able to show some evidence of application of engineering knowledge in the design and development of the project to good extent.	Excellent knowledge in design procedure and its adaptation. The student is able to apply knowledge from engineering domains to the problem and develop solutions.
			(0 – 3 Marks)	(4 – 6 Marks)	(7 - 9 Marks)	(10 Marks)
2-g	Involvement of individual members [CO3] [Individual Assessment]	**5**	No evidence of any Individual participation in the project work.	There is evidence for some amount of individual contribution, but is limited to some of the superficial tasks.	The individual contribution is evident. The student has good amount of involvement in core activities of the project.	Evidence available for the student acting as the core technical lead and has excellent contribution to the project.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
2-h	Results and inferences upon execution [CO5] [Group Assessment]	**5**	None of the expected outcomes are achieved yet. The team is unable to derive any inferences on the failures/ issues observed. Any kind o f observations or studies are not made.	Only a few of the expected outcomes are achieved. A few inferences are made on the observed failures/issues. No further work suggested.	Many of the expected outcomes are achieved. Many observations and inferences are made, and attempts to identify the issues are done. Some suggestions are made for further work.	Most of the stated outcomes are met. Extensive studies are done and inferences drawn. Most of the failures are addressed and solutions suggested. Clear and valid suggestions made for further work.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
2-i	Documentation and presentation. .[CO6] [Individual assessment]	**5**	The individual student has no idea on the presentation of his/her part. The presentation is of poor quality.	Presentation's overall quality needs to be improved.	The individual’s presentation performance is satisfactory.	The individual's presentation is done professionally and with great clarity. The individual’s performance is excellent.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
Phase-II Interim Evaluation - 2 Total Marks: 25						

EVALUATION RUBRICS for PROJECT Phase II: Final Evaluation						
No	**Parameters**	**Marks**	**Poor**	**Fair**	**Very Good**	**Outstanding**
2-j	Engineering knowledge. [CO1] [Group Assessment]	10	The team does not show any evidence of applying engineering knowledge on the design and the methodology adopted.	The team is able to show some of the design procedure and the methodologies adopted, but not in a comprehensive manner.	The team is able to show evidence of application of engineering knowledge in the design and development of the project to good extent. There is scope for improvement.	Excellent knowledge in design procedure and its adaptation. The team is able to apply knowledge from engineering domains to the problem and develop an excellent solution.
			(0 – 3 Marks)	(4 – 6 Marks)	(7 - 9 Marks)	(10 Marks)
2-k	Relevance of the project with respect to societal and/or industrial needs. [Group Assessment] [CO2]	5	The project as a whole do not have any societal / industrial relevance at all.	The project has some relevance with respect to social and/or industrial application. The team has however made not much effort to explore further and make it better.	The project is relevant to the society and/or industry. The team is mostly successful in translating the problem into an engineering specification and managed to solve much of it.	The project is exceptionally relevant to society and/or industry. The team has made outstanding contribution while solving the problem in a professional and/ or ethical manner.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
2-i	Innovation / novelty / Creativity [CO5] [Group Assessment]	5	The project is not addressing any useful requirement. The idea is evolved into a non-implementable one. The work presented so far is lacking any amount of original work by the team.	Some of the aspects of the proposed idea appears to be practical. There is still lack of originality in the work done. The project is a regularly done theme/topic without any freshness in terms of specifications, features, and/ or improvements.	Good evidence of an implementable project. There is some evidence for the originality of the work done by the team. There is fresh specifications/ features/improvements suggested by the team. The team is doing a design from fundamental principles, and there is some independent learning and engineering ingenuity. Could be translated into a product / process if more work is done.	The project has evolved into incorporating an outstandingly novel idea. Original work which is not yet reported anywhere else. Evidence for ingenious way of innovation which is also Implementable. Could be a patentable publishable work.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
2-m	Quality of results / conclusions / solutions. [CO1] [Group Assessment]	10	None of the expected outcomes are achieved. The team is unable to derive any inferences on the failures/issues observed. Any kind of observations or studies is not made.	Only a few of the expected outcomes are achieved. A few inferences are made on the observed failures/issues. No further work suggested.	Many of the expected outcomes are achieved. Many observations and inferences are made, and attempts to identify the issues are done. Some suggestions are made for further work.	Most of the stated outcomes are met. Extensive studies are done and inferences drawn. Most of the failures are addressed and solutions suggested. Clear and valid suggestions made for further work.
			(0 – 3 Marks)	(4 – 6 Marks)	(7 - 9 Marks)	(10 Marks)

2-n	Presentation - Part I Preparation of slides. [CO6] [Group Assessment].	5	The presentation slides are shallow and in a clumsy format. It does not follow proper organization.	Presentation slides follow professional style formats to some extent. However, its organization is not very good. Language needs to be improved. All references are not cited properly, or acknowledged. Presentation slides needs to be more professional.	Presentation slides follow a good style format and there are only a few issues. Organization of the slides is good. Most of references are cited properly. The flow is good and team presentation is neatly organized. Some of the results are not clearly shown. There is room for improvement.	The presentation slides are exceptionally good. Neatly organized. All references cited properly. Diagrams/Figures, Tables and equations are properly numbered, and l i s ted. Results/ inferences clearly highlighted and readable.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
	Presentation - Part II: Individual Communication [CO6] [Individual Assessment].	5	The student is not communicating properly. Poor response to questions.	The student is able to explain some of the content. The student requires a lot of prompts to get to the idea. There are language issues.	Good presentation/ communication by the student. The student is able to explain most of the content very well. There are however, a few areas where the student shows lack of preparation. Language is better.	Clear and concise communication exhibited by the student. The presentation is outstanding. Very confident and tackles all the questions without hesitation. Exceptional traits of communicator.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
Phase-II Final Evaluation, Marks: 40						

EVALUATION RUBRICS for PROJECT Phase II: Report Evaluation						
Sl. No.	**Parameters**	**Marks**	**Poor**	**Fair**	**Very Good**	**Outstanding**
2-o	Report [CO6]	30	The prepared report is shallow and not as per standard format. It does not follow proper organization. Contains mostly unacknowledged content. Lack of effort in preparation is evident. References are not cited. Unprofessional and inconsistent formatting.	Project report follows the standard format to some extent. However, its organization is not very good. Language needs to be improved. All references are not cited properly in the report. There is lack of formatting consistency.	Project report shows evidence of systematic documentation. Report is mostly following the standard style format and there are only a few issues. Organization of the report is good. Mostly consistently formatted. Most of references/sources are cited/ acknowledged properly.	The report is exceptionally good. Neatly organized. All references cited properly. Diagrams/Figures, Tables and equations are properly numbered, and listed and clearly shown. Language is excellent and follows professional styles. Consistent formatting and exceptional readability.
			(0 - 11 Marks)	(12 - 18 Marks)	(19 - 28 Marks)	(29 - 30 Marks)
Phase - II Project Report Marks: 30						

SEMESTER VIII
MINOR

ERD482	MINI PROJECT	CATEGORY	L	T	P	CREDIT
		PWS	0	0	4	4

Course Outcomes: After the completion of the course the student will be able to

CO#	CO
CO1	Identify technically and economically feasible problems **(Cognitive Knowledge Level: Apply)**
CO2	Identify and survey the relevant literature for getting exposed to relatedsolutions. **(Cognitive Knowledge Level: Apply)**
CO3	Perform requirement analysis, identify design methodologies and develop adaptable & reusable solutions of minimal complexity by using modern tools. (**Cognitive Knowledge Level: Apply)**
CO4	Prepare technical report and deliver presentation **(Cognitive Knowledge Level: Apply)**
CO5	Apply engineering and management principles to achieve the goal of the project **(Cognitive Knowledge Level: Apply)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓
CO3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO4	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓
CO5	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓

Abstract POs defined by National Board of Accreditation			
PO#	**BroadPO**	**PO#**	**BroadPO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development ofsolutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Lifelong learning

Course Plan

Student Groups with 4 or 5 members should identify a topic of interest in consultation with a Faculty Advisor/Project Coordinator/Guide. Review the literature and gather information pertaining to the chosen topic. State the objectives and develop a methodology to achieve the objectives. Carryout the design/fabrication or develop codes/programs to achieve the objectives. Innovative design concepts, performance, scalability, reliability considerations, aesthetics/ergonomic, user experience and security aspects taken care of in the project shall be given due weight.

The progress of the mini project is evaluated based on a minimum of two reviews. The review committee may be constituted by a senior faculty member, Mini Project coordinator and project guide. The internal evaluation shall be made based on the progress/outcome of the project,reports and a viva-voce examination, conducted internally by a 3-member committee. A project report is required at the end of the semester. The project has to be demonstrated for its full designspecifications.

Assessment Pattern

Mark Distribution

Total Marks	CIE Marks	ESE Marks
150	**75**	**75**

Continuous Internal Evaluation Pattern:

Attendance **10 marks**

Project Guide **15 marks**

Project Report **10 marks**

Evaluation by the Committee (will be evaluating the level of completion and demonstration of functionality/specifications, presentation, oral examination, work knowledge and involvement) : **40 marks**

End Semester Examination Pattern:

The marks will be distributed as

Presentation : **30 marks**

Demo : **20 marks**

Viva : **25 marks.**

Total : 75 marks.

Guidelines for the Report preparation

- A bonafide report on the mini project shall be submitted within one week after the final presentation. Minimum number of pages should be 40.
- Use Times New Roman font for the entire report – Chapter/Section Title – Times New Roman18, Bold; Heading 2 – Times New Roman16, Bold; Heading 3 – Times New Roman14, Bold; Body- Times New Roman 12, Normal.
- Line Spacing – Between Heading 2 – 3 lines, between lines in paragraph 1.5 lines.
- Alignments – Chapter/Section Title – Center, heading 2 & 3 should be Left Aligned. Ensure that all body text is paragraph justified.
- Figures & Tables – Ensure that all Figures and Tables are suitably numbered and givenproper names/headings. Write figure title under the figure and table title above the table.

Suggestive order of documentation:

xi. Top Cover

xii. Title page

xiii. Certification page

xiv. Acknowledgement

xv. Abstract

xvi. Table of Contents

xvii. List of Figures and Tables

xviii. Chapters

xix. Appendices, if any

xx. References/Bibliography

SEMESTER VIII
HONOURS

ERD482	MINI PROJECT	CATEGORY	L	T	P	CREDIT
		PWS	0	0	4	4

Course Outcomes: After the completion of the course the student will be able to

CO#	CO
CO1	Identify technically and economically feasible problems **(Cognitive Knowledge Level: Apply)**
CO2	Identify and survey the relevant literature for getting exposed to relatedsolutions. **(Cognitive Knowledge Level: Apply)**
CO3	Perform requirement analysis, identify design methodologies and develop adaptable & reusable solutions of minimal complexity by using modern tools. (**Cognitive Knowledge Level: Apply)**
CO4	Prepare technical report and deliver presentation **(Cognitive Knowledge Level: Apply)**
CO5	Apply engineering and management principles to achieve the goal of the project **(Cognitive Knowledge Level: Apply)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓
CO3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO4	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓
CO5	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓

Abstract POs defined by National Board of Accreditation			
PO#	**BroadPO**	**PO#**	**BroadPO**
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Assessment Pattern

Mark Distribution

Total Marks	CIE Marks	ESE Marks
150	**75**	**75**

Continuous Internal Evaluation Pattern:

Attendance	**10 marks**
Project Guide	**15 marks**
Project Report	**10 marks**

Evaluation by the Committee (will be evaluating the level of completion and demonstration of functionality/specifications, presentation, oral examination, work knowledge and involvement) : **40 marks**

End Semester Examination Pattern:

The marks will be distributed as

Presentation : **30 marks**

Demo : **20 marks**

Viva : **25 marks.**

Total : **75 marks**.

Guidelines for the Report preparation

- A bonafide report on the mini project shall be submitted within one week after the final presentation. Minimum number of pages should be 40.
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xxx. References/Bibliography