NEHRU COLLEGE OF ENGINEERING AND RESEARCH CENTRE

(Accredited by NAAC, Approved by AICTE New Delhi, Affiliated to APJKTU)

Pampady, Thiruvilwamala(PO), Thrissur(DT), Kerala 680 588

DEPARTMENT OF MECHATRONICS

SYLLABUS BOOK FOR STUDENTS

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY 2019 SCHEME SYLLABUS FOR MECHATRONICS

VISION OF THE INSTITUTION

To mould true citizens who are millennium leaders and catalysts of change through excellence in education.

MISSION OF THE INSTITUTION

NCERC is committed to transform itself into a center of excellence in Learning and Research in Engineering and Frontier Technology and to impart quality education to mould technically competent citizens with moral integrity, social commitment and ethical values.

We intend to facilitate our students to assimilate the latest technological know-how and to imbibe discipline, culture and spiritually, and to mould them in to technological giants, dedicated research scientists and intellectual leaders of the country who can spread the beams of light and happiness among the poor and the underprivileged.

ABOUT DEPARTMENT

- Established in: 2013
- Course offered: B.Tech Mechatronics Engineering
- Approved by AICTE New Delhi and Accredited by NAAC
- Affiliated to the University of A P J Abdul Kalam Technological University.

DEPARTMENT VISION

To develop professionally ethical and socially responsible Mechatronics engineers to serve the humanity through quality professional education.

DEPARTMENT MISSION

1) The department is committed to impart the right blend of knowledge and quality education to create professionally ethical and socially responsible graduates.
2) The department is committed to impart the awareness to meet the current challenges in technology.
3) Establish state-of-the-art laboratories to promote practical knowledge of mechatronics to meet the needs of the society

PROGRAMME EDUCATIONAL OBJECTIVES

PEO1: Graduates shall have the ability to work in multidisciplinary environment with good professional and commitment.

PEO2: Graduates shall have the ability to solve the complex engineering problems by applying electrical, mechanical, electronics and computer knowledge and engage in lifelong learning in their profession.

PEO3: Graduates shall have the ability to lead and contribute in a team with entrepreneur skills, professional, social and ethical responsibilities.

PEO4: Graduates shall have ability to acquire scientific and engineering fundamentals necessary for higher studies and research.

PROGRAM OUTCOMES (POs)

Engineering Graduates will be able to:

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write

effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one‟s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSO):

1. Design and develop Mechatronics systems to solve the complex engineering problem by integrating electronics, mechanical and control systems.

2. Apply the engineering knowledge to conduct investigations of complex engineering problem related to instrumentation, control, automation, robotics and provide solutions.

CURRICULUM S1-S8

CURRICULUM I TO VIII: B. TECH MECHATRONICS

Every course of B. Tech. Program shall be placed in one of the nine categories as listed in 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 the Table 1.

Table 1: Code for the courses

Code	Description
T	Theory based courses (other 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 Engg	AO	20	Food Technology	FT
2	Applied Electronics & Instrumentation	AE	21	Humanities	HU
3	Artificial Intelligence	AI	22	Industrial Engg	IE
4	Artificial Intelligence & Data Science	AD	23	Information Technology	IT
5	Automobile	AU	24	Instrumentation & Control	IC
6	Biomedical Engg	BM	25	Mandatory Courses	MC
7	Biotechnology	BT	26	Mathematics	MA
8	Chemical Engg	CH	27	Mechanical Engg	ME
9	Chemistry	CY	28	Mechatronics	MR
10	Civil Engg	CE	29	Metallurgy	MT
11	Computer Science	CS	30	Mechanical (Auto)	MU
12	Computer Science (Artificial Intelligence)	CA	31	Mechanical (Prod)	MP
13	Computer Science (Artificial Intelligence & Machine Learning)	CM	32	Naval & Ship Building	SB
14	Computer Science (Data	CD	33	Physics	PH

	Science)				
15	Computer Science Cyber Security	CC	34	Polymer Engg	PO
16	Electronics & Biomedical	EB	35	Production Engg	PE
17	Electronics & Communication	EC	36	Robotics and Automation	RA
18	Electrical and Computer Engineering	EO	37	Safety & Fire Engg	FS
19	Electrical & Electronics	EE			

SEMESTER II

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 110	ENGINEERING PHYSICSB	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 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 110	ENGINEERING PHYSICS B	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 B 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 B in SI and Engineering Chemistry in S2 & vice versa. Students opting for Engineering Physics B 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, METTULURGY, 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	MAT201	PARTIAL DIFFERENTIAL EQUATION AND COMPLEX ANALYSIS	3-1-0	4	4
B	MRT201	ELECTRICAL MACHINES & DRIVES	3-1-0	4	4
C	MRT203	ANALOG AND DIGITAL ELECTRONICS	3-1-0	4	4
D	MRT205	MECHANICS OF SOLIDS	3-1-0	4	4
E 1/2	EST200	DESIGN & ENGINEERING	2-0-0	2	2
	HUT200	PROFESSIONAL ETHICS	2-0-0	2	2
F	MCN201	SUSTAINABLE ENGINEERING	2-0-0	2	--
S	MRL201	ELECTRICAL TECHNOLOGY LAB	0-0-3	3	2
T	MRL203	ANALOG & DIGITAL ELECTRONICS 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 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 IV

SLOT	COURSE NO.	COURSES	L-T-P	HOURS	CREDIT
A	MAT202	PROBABILITY, STATISTICS AND NUMERICAL METHODS	3-1-0	4	4
B	MRT202	THERMODYNAMICS	3-1-0	4	4
C	MRT204	SENSORS AND ACTUATORS	3-1-0	4	4
D	MRT206	MICROPROCESSOR & EMBEDDED SYSTEMS	3-1-0	4	4
E 1/2	EST200	DESIGN & ENGINEERING	2-0-0	2	2
	HUT200	PROFESSIONAL ETHICS	2-0-0	2	2
F	MCN202	CONSTITUTION OF INDIA	2-0-0	2	--
S	MRL202	MECHANICAL ENGINEERING LAB	0-0-3	3	2
T	MRL204	MICROPROCESSOR & EMBEDDED SYSTEM 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 Remedial class/Minor course (Thursdays from 3 to 5 PM and Fridays from 2 to 4 PM). If a student doesnot opt for

minor programme, he/she can be given remedial class.

SEMESTER V

SLOT	COURSE NO.	COURSES	L-T-P	HOURS	CREDIT
A	MET301	MECHANICS OF MACHINERY	3-1-0	4	4
B	MRT303	LINEAR CONTROL SYSTEMS	3-1-0	4	4
C	MRT305	PLC & DATA AQUISTION SYSTEMS	3-1-0	4	4
D	MRT307	SOFT COMPUTING TECHNIQUES	3-1-0	4	4
E 1/2	HUT300	INDUSTRIAL ECONOMICS & FOREIGN TRADE	3-0-0	3	3
	HUT310	MANAGEMENT FOR ENGINEERS	3-0-0	3	3
F	MCN301	DISASTER MANAGEMENT	2-0-0	2	--
S	MRL331	PLC & DATA ACQUISTION LAB	0-0-3	3	2
T	MRL333	INSRTUMENTATION 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 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

minor/honours programme, he/she can be given remedial class.

SEMESTER VI

SLOT	COURSE NO.	COURSES	L-T-P	HOURS	CREDIT
A	MRT302	ROBOTICS & AUTOMATION	3-1-0	4	4
B	MRT304	DIGITAL IMAGE PROCESSING & MACHINE VISION	3-1-0	4	4
C	MRT306	INDUSTRIAL HYDRAULICS & PNEUMATICS	3-1-0	4	4
D	MRTXXX	PROGRAM ELECTIVE I	2-1-0	3	3
E 1/2	HUT300	INDUSTRIAL ECONOMICS & FOREIGN TRADE	3-0-0	3	3
	HUT310	MANAGEMENT FOR ENGINEERS	3-0-0	3	3
F	MRT308	COMREHENSIVE COURSE WORK	1-0-0	1	1
S	MRL332	MECHATRONIC SYSTEMS LAB	0-0-3	3	2
T	MRD334	MINIPROJECT	0-0-3	3	2
R/M/H	VAC	REMEDIAL/MINOR/HONOURS COURSE	3-1-0	4*	4
TOTAL				**25/29**	**23/27**

PROGRAM ELECTIVE I

SLOT	COURSE NO.	COURSES	L-T-P	HOURS	CREDIT
D	MRT312	OBJECT ORIENTED PROGRAMMING	2-1-0	3	3
	MRT322	BIOMEDICAL INSTRUMENTATION	2-1-0		
	MRT332	POWER ELECTRONICS	2-1-0		
	MRT342	AUTOMOBILE ENGINEERING	2-1-0		
	MRT352	INDUSTRIAL ENGINEERING	2-1-0		
	MRT362	DESIGN FOR MANUFACTURE	2-1-0		
	MRT372	OPERATIONS RESEARCH	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 Remedial class/Minor/Honours course (Tuesdays from 3 to 5 PM and Wednesdays from 2 to 4 PM). If a student does not opt for minor/honours programme, he/she can be given remedial class.
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 by the University. **Syllabus for 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 practising questions based on the core courses listed in the curriculum.
4. Mini project: It is introduced in sixth semester with a specific objective to strengthen the understanding of student's fundamentals through effective 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 internally 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)

SEMESTER VII

SLOT	COURSE NO.	COURSES	L-T-P	HOURS	CREDIT
A	MRT401	ADVANCED AUTOMATION SYSTEMS	2-1-0	3	3
B	MRTXXX	PROGRAM ELECTIVE II	2-1-0	3	3
C	MRTXXX	OPEN ELECTIVE	2-1-0	3	3
D	MCN401	INDUSTRIAL SAFETY ENGINEERING	2-1-0	3	---
S	MRL411	CAD LAB	0-0-3	3	2
T	MRQ413	SEMINAR	0-0-3	3	2
U	MRD415	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	MRT413	NETWORK AND DATA SECURITY	2-1-0	3	3
	MRT423	MICRO ELECTRO MECHANICAL SYSTEMS	2-1-0		
	MRT433	RENEWABLE ENERGY	2-1-0		
	MRT443	MANUFACTURING TECHNOLOGY	2-1-0		
	MRT453	ENTREPRENEURSHIP	2-1-0		
	MRT463	FLUID MECHANICS & MACHINERY	2-1-0		
	MRT473	MAINTENANCE ENGINEERING	2-1-0		

OPEN ELECTIVE (OE)

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. For example, the courses listed below are offered by **the Department of MECHATRONICS ENGINEERING for students of other undergraduate branches offered in the college under KTU**

SLOT	COURSE NO.	COURSES	L-T-P	HOURS	CREDIT
C	MRT 415	BASICS OF ROBOTICS & AUTOMATION	2-1-0	3	3
	MRT 425	AUTOMATION SYSTEMS	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

Guide 20

Technical Content of the Report 30

Presentation 40

3. Project Phase I: A Project topic must be selected either from research literature or the students themselves may propose suitable topics in consultation with their guides. The object of Project Work I is to enable the student to take up investigative study in the broad field of Mechatronics either fully theoretical/practical or involving both theoretical and practical work to be assigned by the Department on a group of three/four students, under the guidance of a Supervisor. This is expected to provide a good initiation for the student(s) in R&D work. The assignment to normally include:
    - Survey and study of published literature on the assigned topic;
    - Preparing an Action Plan for conducting the investigation, including team work;
    - Working out a preliminary Approach to the Problem relating to the assigned topic;
    - Block level design documentation
    - Conducting preliminary Analysis/ Modelling/ Simulation/ Experiment/

Design/ Feasibility;

- Preparing a Written Report on the Study conducted for presentation to the Department;
- Final Seminar, as oral Presentation before the evaluation committee.

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

Guide 30

Interim evaluation by the evaluation committee 20

Final Seminar 30

The report evaluated by the 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	MRT402	AUTOTRONICS	2-1-0	3	3
B	MRTXXX	PROGRAM ELECTIVE III	2-1-0	3	3
C	MRTXXX	PROGRAM ELECTIVE IV	2-1-0	3	3
D	MRTXXX	PROGRAM ELECTIVE V	2-1-0	3	3
T	MRT404	COMPREHENSIVE COURSE VIVA	1-0-0	1	1
U	MRD416	PROJECT PHASE II	0-0-12	12	4
R/M/H	VAC	REMEDIAL/MINOR/HONOURS COURSE	3-1-0	4*	4
TOTAL				**25/29**	**17/21**

PROGRAM ELECTIVE III

SLOT	COURSE NO.	COURSES	L-T-P	HOURS	CREDIT
B	MRT414	IOT & APPLICATIONS	2-1-0	3	3
	MRT424	COMMUNICATION ENGINEERING	2-1-0		
	MRT434	SPECIAL ELECTRICAL MACHINES AND APPLICATIONS	2-1-0		
	MRT444	METALLURGY & MATERIALS ENGINEERING	2-1-0		
	MRT454	STATISTICAL QUALITY CONTROL	2-1-0		
	MRT464	HYBRID AND ELECTRIC VEHICLES	2-1-0		
	MRT474	OPERATIONS MANAGEMENT	2-1-0		

PROGRAM ELECTIVE IV

SLOT	COURSE NO.	COURSES	L-T-P	HOURS	CREDIT
C	MRT416	ADVANCED MICROPROCESSORS AND MICROCONTROLLERS	2-1-0	3	3
	MRT426	NANO-ELECTRONICS	2-1-0		
	MRT436	NON LINEAR SYSTEMS AND CONTROL	2-1-0		
	MRT446	DYNAMICS OF MACHINERY	2-1-0		
	MRT456	ERGONOMICS	2-1-0		
	MRT466	ENERGY MANAGEMENT AND AUDITING	2-1-0		
	MRT476	SIX SIGMA	2-1-0		

PROGRAM ELECTIVE V

SLOT	COURSE NO.	COURSES	L-T-P	HOURS	CREDIT
D	MRT418	WIRELESS AND SENSOR NETWORKS	2-1-0	3	3
	MRT428	BIO-MECHATRONICS	2-1-0		
	MRT438	INDUSTRIAL INSTRUMENTATION	2-1-0		
	MRT448	HEAT & MASS TRANSFER	2-1-0		
	MRT458	SUPPLY CHAIN MANAGEMENT	2-1-0		
	MRT468	OPTIMIZATION TECHNIQUES	2-1-0		
	MRT478	ARTIFICIAL INTELLIGENCE	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 PM). If a student does not opt for minor/honours programme, he/she can be given remedial class.
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 core subjects studied from third to eighth 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 practising 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 a 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 PhaseI;
- Review and finalization of the Approach to the Problem relating to the assigned topic;
- Detailed Analysis/Modelling/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 the evaluation 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 a three-member 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 course viva 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 Minor 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 miniproject based on the chosen area. They can do miniproject 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 minor program will commence from semester 3 and the all academic units offering minors in their discipline should prescribe set of such courses. The courses shall be grouped into maximum of 3baskets. 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. 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 MECHATRONICS** can opt to study the courses listed below:

Semester	BASKET I				BASKET II			
	Course No.	**Course Name**	**HOURS**	**CREDIT**	**Course No.**	**Course Name**	**HOURS**	**CREDIT**
S3	MRT 281	INTRODUCTION TO SENSORS AND ACTUATORS	4	4	MRT281	INTRODUCTION TO SENSORS AND ACTUATORS	4	4
S4	MRT 282	FUNDAMENTALS OF ANALOG AND DIGITAL ELECTRONICS	4	4	MRT 284	BASICS OF INDUSTRIAL HYDRAULICS & PNEUMATICS	4	4
S5	MRT 381	EMBEDDED SYSTEMS	4	4	MRT 383	DATA AQUISTION & PLC SYSTEMS	4	4
S6	MRT 382	INTRODUCTION TO ROBOTICS & AUTOMATION	4	4	MRT 384	ADVANCED AUTOMATION SYSTEMS	4	4
S7	MRD 481	MINIPROJECT	4	4	MRD 481	MINIPROJECT	4	4
S8	MRD 482	MINIPROJECT	4	4	MRD 482	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/specialise 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 maximum of 3 groups, each group representing a particular specialization in the branch. The students shall select only the courses from 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 the all-academic units offering honours in their discipline should prescribe set of such courses. The courses shall be grouped into maximum of 3 groups, each group representing a particular specialization in the branch. The students shall select only the courses from same group in all semesters. It means that the specialization is to be fixed by the student and cannot be changed subsequently. 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 MECHATRONICS** can opt to study the courses listed below:

Semester	GROUP I				GROUP II			
	Course No	**Course Name**	**HOURS**	**CREDIT**	**Course No**	**Course Name**	**HOURS**	**CREDIT**
S4	MRT292	MICRO MECHATRONIC SYSTEMS	4	4	MRT294	INDUSTRIAL AUTOMATION	4	4
S5	MRT 393	DRIVES & CONTROL SYSTEM FOR AUTOMATION	4	4	MRT395	ADVANCED CONTROL SYSTEMS	4	4
S6	MRT 394	ARTIFICIAL INTELLIGENCE & EXPERT SYSTEM IN AUTOMATION	4	4	MRT396	ADVANCED COMPUTER CONCEPT FOR AUTOMATION	4	4
S7	MRT 495	ADVANCED APPLICATIONS OF MECHATRONICS	4	4	MRT497	CNC MACHINE SYSTEMS DESIGN	4	4
S8	MRD 496	MINIPROJECT	4	4	MRD496	MINIPROJECT	4	4

INDUCTION PROGRAM

There will be 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 mould 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 in at as concerned citizens of the world.
- **Physical Activities & Sports**: Engage students in sports and physical activity to ensure healthy physical and mental growth.

SYLLABUS

SYLLABUS S3 & S4

COMMON COURSES S3 & S4

SEMESTER -3

CODE MCN201	SUSTAINABLE ENGINEERING	CATEGORY	L	T	P	CREDIT
			2	0	0	NIL

Preamble: Objective of this course is to inculcate in students an awareness of environmental issues and the global initiatives towards attaining sustainability. The student should realize the potential of technology in bringing in sustainable practices.

Prerequisite: NIL

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

CO 1	Understand the relevance and the concept of sustainability and the global initiatives in this direction
CO 2	Explain the different types of environmental pollution problems and their sustainable solutions
CO 3	Discuss the environmental regulations and standards
CO 4	Outline the concepts related to conventional and non-conventional energy
CO 5	Demonstrate the broad perspective of sustainable practices by utilizing engineering knowledge and principles

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	3					2
CO 2						2	3					2
CO 3						2	3					2
CO 4						2	3					2
CO 5						2	3					2

Assessment Pattern

Mark distribution

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			

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.

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Level Assessment Questions

Course Outcome 1 (CO1): Understand the relevance and the concept of sustainability and the global initiatives in this direction

1. Explain with an example a technology that has contributed positively to sustainable development.
2. Write a note on Millennium Development Goals.

Course Outcome 2 (CO2): Explain the different types of environmental pollution problems and their sustainable solutions

1. Explain the 3R concept in solid waste management?
2. Write a note on any one environmental pollution problem and suggest a sustainable solution.
3. In the absence of green house effect the surface temperature of earth would not have been suitable for survival of life on earth. Comment on this statement.

Course Outcome 3(CO3): Discuss the environmental regulations and standards

1. Illustrate Life Cycle Analysis with an example of your choice.
2. "Nature is the most successful designer and the most brilliant engineer that has ever evolved". Discuss.

Course Outcome 4 (CO4): Outline the concepts related to conventional and non-conventional energy

1. Suggest a sustainable system to generate hot water in a residential building in tropical climate.
2. Enumerate the impacts of biomass energy on the environment.

Course Outcome 5 (CO5): Demonstrate the broad perspective of sustainable practices by utilizing engineering knowledge and principles

1. Suggest suitable measures to make the conveyance facilities used by your institution sustainable.

Model Question paper

Part A

(Answer all questions. Each question carries 3 marks each)

1. Define sustainable development.
2. Write a short note on Millennium Development Goals.
3. Describe carbon credit.
4. Give an account of climate change and its effect on environment.
5. Describe biomimicry? Give two examples.
6. Explain the basic concept of Life Cycle Assessment.
7. Name three renewable energy sources.

8. Mention some of the disadvantages of wind energy.

9. Enlist some of the features of sustainable habitat.

10. Explain green engineering.

Part B

(Answer one question from each module. Each question carries 14 marks)

11. Discuss the evolution of the concept of sustainability. Comment on its relevance in the modern world.

OR

12. Explain Clean Development Mechanism.

13. Explain the common sources of water pollution and its harmful effects.

OR

14. Give an account of solid waste management in cities.

15. Explain the different steps involved in the conduct of Environmental Impact Assessment.

OR

16. Suggest some methods to create public awareness on environmental issues.

17. Comment on the statement, "Almost all energy that man uses comes from the Sun".

OR

18. Write notes on:

    a. Land degradation due to water logging.

    b. Over exploitation of water.

19. Discuss the elements related to sustainable urbanisation.

OR

20. Discuss any three methods by which you can increase energy efficiency in buildings.

Syllabus

Sustainability- need and concept, technology and sustainable development-Natural resources and their pollution, Carbon credits, Zero waste concept. Life Cycle Analysis, Environmental Impact Assessment studies, Sustainable habitat, Green buildings, green materials, Energy, Conventional and renewable sources, Sustainable urbanization, Industrial Ecology.

Module 1

Sustainability: Introduction, concept, evolution of the concept; Social, environmental and economic sustainability concepts; Sustainable development, Nexus between Technology and Sustainable development; Millennium Development Goals (MDGs) and Sustainable Development Goals (SDGs), Clean Development Mechanism (CDM).

Module 2

Environmental Pollution: Air Pollution and its effects, Water pollution and its sources, Zero waste concept and 3 R concepts in solid waste management; Greenhouse effect, Global warming, Climate change, Ozone layer depletion, Carbon credits, carbon trading and carbon foot print, legal provisions for environmental protection.

Module 3

Environmental management standards: ISO 14001:2015 frame work and benefits, Scope and goal of Life Cycle Analysis (LCA), Circular economy, Bio-mimicking, Environment Impact Assessment (EIA), Industrial ecology and industrial symbiosis.

Module 4

Resources and its utilisation: Basic concepts of Conventional and non-conventional energy, General idea about solar energy, Fuel cells, Wind energy, Small hydro plants, bio-fuels, Energy derived from oceans and Geothermal energy.

Module 5

Sustainability practices: Basic concept of sustainable habitat, Methods for increasing energy efficiency in buildings, Green Engineering, Sustainable Urbanisation, Sustainable cities, Sustainable transport.

Reference Books

1. Allen, D. T. and Shonnard, D. R., Sustainability Engineering: Concepts, Design and Case Studies, Prentice Hall.
2. Bradley. A.S; Adebayo,A.O., Maria, P. Engineering applications in sustainable design and development, Cengage learning
3. Environment Impact Assessment Guidelines, Notification of Government of India, 2006
4. Mackenthun, K.M., Basic Concepts in Environmental Management, Lewis Publication, London, 1998
5. ECBC Code 2007, Bureau of Energy Efficiency, New Delhi Bureau of Energy Efficiency Publications-Rating System, TERI Publications - GRIHA Rating System
6. Ni bin Chang, Systems Analysis for Sustainable Engineering: Theory and Applications, McGraw-Hill Professional.
7. Twidell, J. W. and Weir, A. D., Renewable Energy Resources, English Language Book Society (ELBS).
8. Purohit, S. S., Green Technology - An approach for sustainable environment, Agrobios Publication

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	Sustainability	
1.1	Introduction, concept, evolution of the concept	1
1.2	Social, environmental and economic sustainability concepts	1
1.3	Sustainable development, Nexus between Technology and Sustainable development	1
1.4	Millennium Development Goals (MDGs) and Sustainable Development Goals (SDGs)	1
1.5	Clean Development Mechanism (CDM)	1
2	Environmental Pollution	
2.1	Air Pollution and its effects	1
2.2	Water pollution and its sources	1
2.3	Zero waste concept and 3 R concepts in solid waste management	1
2.4	Greenhouse effect, Global warming, Climate change, Ozone layer depletion	1
2.5	Carbon credits, carbon trading and carbon foot print.	1
2.6	Legal provisions for environmental protection.	1
3	Environmental management standards	
3.1	Environmental management standards	1
3.2	ISO 14001:2015 frame work and benefits	1
3.3	Scope and Goal of Life Cycle Analysis (LCA)	1
3.4	Circular economy, Bio-mimicking	1
3.5	Environment Impact Assessment (EIA)	1
3.6	Industrial Ecology, Industrial Symbiosis	1
4	Resources and its utilisation	
4.1	Basic concepts of Conventional and non-conventional energy	1
4.2	General idea about solar energy, Fuel cells	1
4.3	Wind energy, Small hydro plants, bio-fuels	1
4.4	Energy derived from oceans and Geothermal energy	1
5	Sustainability Practices	
5.1	Basic concept of sustainable habitat	1
5.2	Methods for increasing energy efficiency of buildings	1
5.3	Green Engineering	1
5.4	Sustainable Urbanisation, Sustainable cities, Sustainable transport	1

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
			2	0	0	2
EST 200	DESIGN AND ENGINEERING					

Preamble:

The purpose of this course is to

i) introduce the undergraduate engineering studentsthe fundamental principles of design engineering,

ii) make them understand the steps involved in the design process and

iii) familiarize them with the basic tools used and approaches in design.

Students are expected to apply design thinking in learning as well as while practicing engineering, which is very important and relevant for today. Case studies from various practical situations will help the students realize that design is not only concerned about the function but also many other factors like customer requirements, economics, reliability, etc. along with a variety of life cycle issues.

The course will help students to consider aesthetics, ergonomics and sustainability factors in designs and also to practice professional ethics while designing.

Prerequisite:

Nil. The course will be generic to all engineering disciplines and will not require specialized preparation or prerequisites in any of the individual engineering disciplines.

Course Outcomes:

After the completion of the course the student will be able to

CO 1	Explain the different concepts and principles involved in design engineering.
CO 2	Apply design thinking while learning and practicing engineering.
CO 3	Develop innovative, reliable, sustainable and economically viable designs incorporating knowledge in engineering.

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					1			1		
CO 2		2				1		1				2
CO 3			2			1	1		2	2		1

Assessment Pattern

Continuous Internal Evaluation (CIE) Pattern:

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

End Semester Examination (ESE) Pattern: There will be two parts; Part A and Part B.
Part A : 30 marks
part B : 70 marks
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 case study questions from each module of which student should answer any one. Each question carry 14 marks and can have maximum 2 sub questions.

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	5	5	10
Understand	10	10	20
Apply	35	35	70
Analyse	-	-	-
Evaluate	-	-	-
Create	-	-	-

Course Level Assessment Questions

Course Outcome 1 (CO1): Appreciate the different concepts and principles involved in design engineering.

1. State how engineering design is different from other kinds of design

2. List the different stages in a design process.

3. Describedesign thinking.

4. State the function of prototyping and proofing in engineering design.

5. Write notes on the following concepts in connection with design engineering 1) Modular Design, 2) Life Cycle Design , 3) Value Engineering, 4) Concurrent Engineering, and 5) Reverse Engineering

6. State design rights.

Course Outcome 2 (CO2) Apply design thinking while learning and practicing engineering.

1. Construct the iterative process for design thinking in developing simple products like a pen, umbrella, bag, etc.

2. Show with an example how divergent-convergent thinking helps in generating alternative designs and then how to narrow down to the best design.

3. Describe how a problem-based learning helps in creating better design engineering solutions.

4. Discuss as an engineer, how ethics play a decisive role in your designs

Course Outcome 3(CO3): Develop innovative, reliable, sustainable and economically viable designs incorporating different segments of knowledge in engineering.

1. Illustratethe development of any simple product by passing through the different stages of design process

2. Show thegraphical design communication with the help of detailed 2D or 3D drawings for any simple product.

3. Describe how to develop new designs for simple products through bio-mimicry.

Model Question paper

Reg No.:_______________ Name:__________________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

THIRD/FOURTH SEMESTER B.TECH DEGREE EXAMINATION

Course Code: EST 200

Course Name: DESIGN AND ENGINEERING

Max. Marks: 100Duration: 3 Hours

PART A

Answer all questions, each question carries 3 marks
Use only hand sketches

(1)Write aboutthe basic design process.

(2) Describe how to finalize the design objectives.

(3) State the role of divergent-convergent questioning in design thinking.

(4) Discuss how to perform design thinking in a team managing the conflicts.

(5) Show how engineering sketches and drawings convey designs.

(6)Explain the role of mathematics and physics in design engineering process.

(7) Distinguish between project-based learning and problem-based learning in design engineering.

(8) Describe how concepts like value engineering , concurrent engineering and reverse engineering influence engineering designs?

(9) Show how designs are varied based on the aspects of production methods, life span, reliability and environment?

(10) Explain how economics influence the engineering designs?

(10x3 marks =30 marks)

Part B

Answer any ONE question from each module. Each question carry 14 marks

Module 1

(11) Show the designing of a wrist watch going through the various stages of the design process. Use hand sketches to illustrate the processes.

or

(12)Find the customer requirements for designing a new car showroom. Show how the design objectives were finalized considering the design constraints?

Module 2

(13)Illustrate the design thinking approach for designing a bag for college students within a limited budget. Describe each stage of the process and the iterative procedure involved. Use hand sketches to support your arguments.

or

(14)Construct a number of possible designs and then refine them to narrow down to the best design for a drug trolley used in hospitals. Show how the divergent-convergent thinking helps in the process. Provide your rationale for each step by using hand sketches only.

Module 3

(15) Graphically communicate the design of a thermo flask used to keep hot coffee. Draw the detailed 2D drawings of the same with design detailing, material selection, scale drawings, dimensions, tolerances, etc. Use only hand sketches.

or

(16)Describe the role of mathematical modelling in design engineering. Show how mathematics and physics play a role in designing a lifting mechanism to raise 100 kg of weight to a floor at a height of 10 meters in a construction site.

Module 4

(17) Show the development of a nature inspired design for a solar poweredbus waiting shed beside a highway. Relate between natural and man-made designs. Use hand sketches to support your arguments.

or

(18)Show the design of a simple sofa and then depict how the design changes when considering 1) aesthetics and 2) ergonomics into consideration. Give hand sketches and explanations to justify the changes in designs.

Module 5

(19)Examine the changes in the design of a foot wear with constraints of 1) production methods, 2) life span requirement, 3) reliability issues and 4) environmental factors. Use hand sketches and give proper rationalization for the changes in design.

or

(20)Describe the how to estimate the cost of a particular design using ANY of the following: i) a website, ii) the layout of a plant, iii) the elevation of a building, iv) anelectrical or electronic system or device and v) a car.

Show how economics will influence the engineering designs. Use hand sketches to support your arguments.

(5x14 marks =70 marks)

Syllabus

Module 1

Design Process:- Introduction to Design and Engineering Design, Defining a Design Process-:Detailing Customer Requirements, Setting Design Objectives, Identifying Constraints, Establishing Functions, Generating Design Alternatives and Choosing a Design.

Module 2

Design Thinking Approach:-Introduction to Design Thinking, Iterative Design Thinking Process Stages: Empathize, Define, Ideate, Prototype and Test. Design Thinking as Divergent-Convergent Questioning. Design Thinking in a Team Environment.

Module 3

Design Communication (Languages of Engineering Design):-Communicating Designs Graphically, Communicating Designs Orally and in Writing. Mathematical Modeling In Design, Prototyping and Proofing the Design.

Module 4

Design Engineering Concepts:-Project-based Learning and Problem-based Learning in Design.Modular Design and Life Cycle Design Approaches. Application of Bio-mimicry,Aesthetics and Ergonomics in Design. Value Engineering, Concurrent Engineering, and Reverse Engineering in Design.

Module 5

Expediency, Economics and Environment in Design Engineering:-Design for Production, Use, and Sustainability. Engineering Economics in Design. Design Rights. Ethics in Design

Text Books

1) YousefHaik, SangarappillaiSivaloganathan, Tamer M. Shahin, Engineering Design Process, Cengage Learning 2003, Third Edition, ISBN-10: 9781305253285,

2) Voland, G., Engineering by Design, Pearson India 2014, Second Edition, ISBN 9332535051

Reference Books

1.Philip Kosky, Robert Balmer, William Keat, George Wise, Exploring Engineering, Fourth Edition: An Introduction to Engineering and Design, Academic Press 2015, 4th Edition, ISBN: 9780128012420.

2. Clive L. Dym, Engineering Design: A Project-Based Introduction, John Wiley & Sons, New York 2009, Fourth Edition, ISBN: 978-1-118-32458-5

3. Nigel Cross, Design Thinking: Understanding How Designers Think and Work, Berg Publishers 2011, First Edition, ISBN: 978-1847886361

4. Pahl, G., Beitz, W., Feldhusen, J., Grote, K.-H., Engineering Design: A Systematic Approach, Springer 2007, Third Edition, ISBN 978-1-84628-319-2

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Module 1: Design Process**	
1.1	Introduction to Design and Engineering Design. *What does it mean to design something? How Is engineering design different from other kinds of design? Where and when do engineers design? What are the basic vocabularyin engineering design? How to learn and do engineering design.*	1
1.2	*Defining a Design Process*-: Detailing Customer Requirements. *How to do engineering design? Illustrate the process with an example. How to identify the customer requirements of design?*	1
1.3	*Defining a Design Process*-: Setting Design Objectives, Identifying Constraints, Establishing Functions. *How to finalize the design objectives? How to identify the design constraints? How to express the functions a design in engineering terms?*	1
1.4	*Defining a Design Process*-: Generating Design Alternatives and Choosing a Design. *How to generate or create feasible design alternatives? How to identify the "best possible design"?*	1
1.5	Case Studies:- Stages of Design Process. *Conduct exercises for designing simple products going through the different stages of design process.*	1
2	**Module 2: Design Thinking Approach**	
2.1	Introduction to Design Thinking *How does the design thinking approach help engineers in creating innovative and efficient designs?*	1
2.2	Iterative Design Thinking Process Stages: Empathize, Define, Ideate, Prototype and Test. *How can the engineers arrive at better designs utilizing the iterative design thinking process (in which knowledge acquired in the later stages can be applied back to the earlier stages)?*	1
2.3	Design Thinking as Divergent-Convergent Questioning. *Describe how to create a number of possible designs and then how to refine and narrow down to the 'best design'.*	1
2.4	Design Thinking in a Team Environment. *How to perform design thinking as a team managing the conflicts ?*	1
2.5	Case Studies: Design Thinking Approach. *Conduct exercises using the design thinking approach for*	1

	designing any simple products within a limited time and budget	
3	**Module 3: Design Communication (Languages of Engineering Design)**	
3.1	Communicating Designs Graphically. *How do engineering sketches and drawings convey designs?*	1
3.2	Communicating Designs Orally and in Writing. *How can a design be communicated through oral presentation or technical reports efficiently?*	1
	First Series Examination	
3.3	Mathematical Modelling in Design. *How do mathematics and physics become a part of the design process?*	1
3.4	Prototyping and Proofing the Design. *How to predict whether the design will function well or not?*	1
3.5	Case Studies: Communicating Designs Graphically. *Conduct exercises for design communication through detailed 2D or 3D drawings of simple products with design detailing, material selection, scale drawings, dimensions, tolerances, etc.*	1
4	**Module 4: Design Engineering Concepts**	
4.1	Project-based Learning and Problem-based Learning in Design. *How engineering students can learn design engineering through projects?* *How students can take up problems to learn design engineering?*	1
4.2	Modular Design and Life Cycle Design Approaches. *What is modular approach in design engineering? How it helps?* *How the life cycle design approach influences design decisions?*	1
4.3	Application of Bio-mimicry, Aesthetics and Ergonomics in Design. *How do aesthetics and ergonomics change engineering designs?* *How do the intelligence in nature inspire engineering designs? What are the common examples of bio-mimicry in engineering?*	1
4.4	Value Engineering, Concurrent Engineering, and Reverse Engineering in Design. *How do concepts like value engineering , concurrent engineering and reverse engineering influence engineering designs?*	1
4.5	Case Studies: Bio-mimicry based Designs. *Conduct exercises to develop new designs for simple*	1

	products using bio-mimicry and train students to bring out new nature inspired designs.	
5	**Module 5: Expediency, Economics and Environment in Design Engineering**	
5.1	Design for Production, Use, and Sustainability. *How designs are finalized based on the aspects of production methods, life span, reliability and environment?*	1
5.2	Engineering Economics in Design. *How to estimate the cost of a particular design and how will economics influence the engineering designs?*	1
5.3	Design Rights. *What are design rights and how can an engineer put it into practice?*	1
5.4	Ethics in Design. *How do ethics play a decisive role in engineering design?*	1
5.5	Case Studies: Design for Production, Use, and Sustainability. *Conduct exercises using simple products to show how designs change with constraints of production methods, life span requirement, reliability issues and environmental factors.*	1
	Second Series Examination	

Code.	Course Name	L	T	P	Hrs	Credit
HUT 200	Professional Ethics	2	0	0	2	2

Preamble: To enable students to create awareness on ethics and human values.

Prerequisite: Nil

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

CO 1	Understand the core values that shape the ethical behaviour of a professional.
CO 2	Adopt a good character and follow an ethical life.
CO 3	Explain the role and responsibility in technological development by keeping personal ethics and legal ethics.
CO 4	Solve moral and ethical problems through exploration and assessment by established experiments.
CO 5	Apply the knowledge of human values and social values to contemporary ethical values and global issues.

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	PO10	PO11	PO12
CO 1								2			2	
CO 2								2			2	
CO 3								3			2	
CO 4								3			2	
CO 5								3			2	

Assessment Pattern

Bloom's category	Continuous Assessment Tests		End Semester Exam
	1	2	
Remember	15	15	30
Understood	20	20	40
Apply	15	15	30

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	:	10 marks
Continuous Assessment Tests (2 Nos)	:	25 marks
Assignments/Quiz	:	15 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 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. Define integrity and point out ethical values.
2. Describe the qualities required to live a peaceful life.
3. Explain the role of engineers in modern society.

Course Outcome 2 (CO2)
1. Derive the codes of ethics.
2. Differentiate consensus and controversy.
3. Discuss in detail about character and confidence.

Course Outcome 3(CO3):
1. Explain the role of professional's ethics in technological development.
2. Distinguish between self interest and conflicts of interest.
3. Review on industrial standards and legal ethics.

Course Outcome 4 (CO4):
1. Illustrate the role of engineers as experimenters.
2. Interpret the terms safety and risk.
3. Show how the occupational crimes are resolved by keeping the rights of employees.

Course Outcome 5 (CO5):
1. Exemplify the engineers as managers.
2. Investigate the causes and effects of acid rain with a case study.
3. Explorate the need of environmental ethics in technological development.

Model Question paper

QP CODE: **Reg No:______________**

PAGES:3 **Name :______________**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY THIRD/FOURTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: HUT 200
Course Name: PROFESSIONAL ETHICS

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

(2019-Scheme)

PART A

(Answer all questions, each question carries 3 marks)

1. Define empathy and honesty.

2. Briefly explain about morals, values and ethics.

3. Interpret the two forms of self-respect.

4. List out the models of professional roles.

5. Indicate the advantages of using standards.

6. Point out the conditions required to define a valid consent?

7. Identify the conflicts of interests with an example?

8. Recall confidentiality.

9. Conclude the features of biometric ethics.

10. Name any three professional societies and their role relevant to engineers.

(10x3 = 30 marks)

PART B

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

MODULE I

11. a) Classify the relationship between ethical values and law?

b) Compare between caring and sharing. (10+4 = 14 marks)

Or

12. a) Exemplify a comprehensive review about integrity and respect for others.

b) Discuss about co-operation and commitment. (8+6 = 14 marks)

MODULE II

13.a) Explain the three main levels of moral developments, deviced by Kohlberg.

b) Differentiate moral codes and optimal codes. (10+4 = 14 marks)

Or

14. a) Extrapolate the duty ethics and right ethics.

b) Discuss in detail the three types of inquiries in engineering ethics (8+6 = 14 marks)

MODULE III

15.a) Summarize the following features of morally responsible engineers.

(i) Moral autonomy **(ii)** Accountability

b)Explain the rights of employees (8+6 = 14 marks)

Or

16. a) Explain the reasons for Chernobyl mishap ?

b) Describe the methods to improve collegiality and loyalty. (8+6 = 14 marks)

MODULE IV

17.a) Execute collegiality with respect to commitment, respect and connectedness.

b) Identify conflicts of interests with an example. (8+6 = 14 marks)

Or

18. a) Explain in detail about professional rights and employee rights.

b) Exemplify engineers as managers.

MODULE V

19.a) Evaluate the technology transfer and appropriate technology.

b) Explain about computer and internet ethics. (8+6 = 14 marks)

Or

20. a) Investigate the causes and effects of acid rain with a case study.

b) Conclude the features of ecocentric and biocentric ethics. (8+6 = 14 marks)

Syllabus

Module 1 – Human Values.

Morals, values and Ethics – Integrity- Academic integrity-Work Ethics- Service Learning- Civic Virtue-Respect for others- Living peacefully- Caring and Sharing- Honestly- courage-Cooperation commitment-Empathy-Self Confidence -Social Expectations.

Module 2 - Engineering Ethics & Professionalism.

Senses of Engineering Ethics - Variety of moral issues- Types of inquiry- Moral dilemmas –Moral Autonomy – Kohlberg's theory- Gilligan's theory- Consensus and Controversy-Profession and Professionalism- Models of professional roles-Theories about right action –Self interest-Customs and Religion- Uses of Ethical Theories.

Module 3- Engineering as social Experimentation.

Engineering as Experimentation – Engineers as responsible Experimenters- Codes of Ethics- Plagiarism- A balanced outlook on law - Challenges case study- Bhopal gas tragedy.

Module 4- Responsibilities and Rights.

Collegiality and loyalty – Managing conflict- Respect for authority- Collective bargaining- Confidentiality- Role of confidentiality in moral integrity-Conflicts of interest- Occupational crime- Professional rights- Employee right- IPR Discrimination.

Module 5- Global Ethical Issues.

Multinational Corporations- Environmental Ethics- Business Ethics- Computer Ethics -Role in Technological Development-Engineers as Managers- Consulting Engineers- Engineers as Expert witnesses and advisors-Moral leadership.

Text Book

1. M Govindarajan, S Natarajan and V S Senthil Kumar, Engineering Ethics, PHI Learning Private Ltd, New Delhi,2012.
2. R S Naagarazan, A text book on professional ethics and human values, New age international (P) limited ,New Delhi,2006.

Reference Books

1. Mike W Martin and Roland Schinzinger, Ethics in Engineering,4th edition, Tata McGraw Hill Publishing Company Pvt Ltd, New Delhi,2014.
2. Charles D Fleddermann, Engineering Ethics, Pearson Education/ Prentice Hall of India, New Jersey,2004.
3. Charles E Harris, Michael S Protchard and Michael J Rabins, Engineering Ethics- Concepts and cases, Wadsworth Thompson Learning, United states,2005.
4. http://www.slideword.org/slidestag.aspx/human-values-and-Professional-ethics.

Course Contents and Lecture Schedule

SL.No	Topic	No. of Lectures 25
1	**Module 1 – Human Values.**	
1.1	Morals, values and Ethics, Integrity, Academic Integrity,Work Ethics	1
1.2	Service Learning, Civic Virtue, Respect for others, Living peacefully	1
1.3	Caring and Sharing, Honesty, Courage, Co-operation commitment	2
1.4	Empathy, Self Confidence, Social Expectations	1
2	**Module 2- Engineering Ethics & Professionalism.**	
2.1	Senses of Engineering Ethics, Variety of moral issues, Types of inquiry	1
2.2	Moral dilemmas, Moral Autonomy, Kohlberg's theory	1
2.3	Gilligan's theory, Consensus and Controversy,Profession& Professionalism, Models of professional roles, Theories about right action	2
2.4	Self interest-Customs and Religion, Uses of Ethical Theories	1
3	**Module 3- Engineering as social Experimentation.**	
3.1	Engineering as Experimentation, Engineers as responsible Experimenters	1
3.2	Codes of Ethics,Plagiarism, A balanced outlook on law	2
3.3	Challenger case study, Bhopal gas tragedy	2
4	**Module 4- Responsibilities and Rights.**	
4.1	Collegiality and loyalty, Managing conflict, Respect for authority	1
4.2	Collective bargaining, Confidentiality, Role of confidentiality in moral integrity, Conflicts of interest	2
4.3	Occupational crime, Professional rights, Employee right, IPR Discrimination	2
5	**Module 5- Global Ethical Issues.**	
5.1	Multinational Corporations, Environmental Ethics, Business Ethics, Computer Ethics	2
5.2	Role in Technological Development, Moral leadership	1
5.3	Engineers as Managers, Consulting Engineers, Engineers as Expert witnesses and advisors	2

SEMESTER -4

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
MCN202	CONSTITUTION OF INDIA		2	0	0	NIL

Preamble:

The study of their own country constitution and studying the importance environment as well as understanding their own human rights help the students to concentrate on their day to day discipline. It also gives the knowledge and strength to face the society and people.

Prerequisite: Nil

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

CO 1	Explain the background of the present constitution of India and features.
CO 2	Utilize the fundamental rights and duties.
CO 3	Understand the working of the union executive, parliament and judiciary.
CO 4	Understand the working of the state executive, legislature and judiciary.
CO 5	Utilize the special provisions and statutory institutions.
CO 6	Show national and patriotic spirit as responsible citizens of the country

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		
CO 2						3	3	3		3		
CO 3						3	2	3		3		
CO 4						3	2	3		3		
CO 5						3	2	3		3		
CO 6						3	3	3		2		

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 Discuss the historical background of the Indian constitution.

2 Explain the salient features of the Indian constitution.

3 Discuss the importance of preamble in the implementation of constitution.

Course Outcome 2 (CO2)

1 What are fundamental rights ? Examine each of them.

2 Examine the scope of freedom of speech and expression underlying the constitution.

3 The thumb impression of an accused is taken by the police against his will. He contends that this is a violation of his rights under Art 20(3) of the constitution. Decide.

Course Outcome 3(CO3):

1 Explain the powers of the President to suspend the fundamental rights during emergency.

2 Explain the salient features of appeal by special leave.

3. List the constitutional powers of President.

Course Outcome 4 (CO4):

1 Discuss the constitutional powers of Governor.

2 Examine the writ jurisdiction of High court.

3 Discuss the qualification and disqualification of membership of state legislature.

Course Outcome 5 (CO5):

1 Discuss the duties and powers of comptroller of auditor general.

2 Discuss the proclamation of emergency.

3 A state levies tax on motor vehicles used in the state, for the purpose of maintaining roads in the state. X challenges the levy of the tax on the ground that it violates the freedom of interstate commerce guaranteed under Art 301. Decide.

Course Outcome 6 (CO6):

1 Explain the advantages of citizenship.

2 List the important principles contained in the directive principles of state policy.

3 Discuss the various aspects contained in the preamble of the constitution

Model Question paper

PART A

(Answer all questions. Each question carries 3 marks)

1 Define and explain the term constitution.

2 Explain the need and importance of Preamble.

3 What is directive principle of state policy?

4 Define the State.

5 List the functions of Attorney general of India.

6 Explain the review power of Supreme court.

7 List the qualifications of Governor.

8 Explain the term and removal of Judges in High court.

9 Explain the powers of public service commission.

10 List three types of emergency under Indian constitution.

(10X3=30marks)

PART B

(Answer on question from each module. Each question carries 14 marks)

Module 1

11 Discuss the various methods of acquiring Indian citizenship.

12 Examine the salient features of the Indian constitution.

Module 2

13 A high court passes a judgement against X. X desires to file a writ petition in the supreme court under Art32, on the ground that the judgement violates his fundamental rights. Advise him whether he can do so.

14 What is meant by directive principles of State policy? List the directives.

Module3

15 Describe the procedure of election and removal of the President of India.

16 Supreme court may in its discretion grant special leave to appeal. Examine the situation.

Module 4

17 Discuss the powers of Governor.

18 X filed a writ petition under Art 226 which was dismissed. Subsequently, he filed a writ petition under Art 32 of the constitution, seeking the same remedy. The Government argued that the writ petition should be dismissed, on the ground of res judicata. Decide.

Module 5

19 Examine the scope of the financial relations between the union and the states.

20 Discuss the effects of proclamation of emergency.

(14X5=70marks)

Syllabus

Module 1 Definition, historical back ground, features, preamble, territory, citizenship.

Module 2 State, fundamental rights, directive principles, duties.

Module 3 The machinery of the union government.

Module 4 Government machinery in the states

Module 5 The federal system, Statutory Institutions, miscellaneous provisions.

Text Books

1 D D Basu, Introduction to the constitution of India, Lexis Nexis, New Delhi, 24e, 2019

2 PM Bhakshi, The constitution of India, Universal Law, 14e, 2017

Reference Books

1 Ministry of law and justice, The constitution of India, Govt of India, New Delhi, 2019.

2 JN Pandey, The constitutional law of India, Central Law agency, Allahabad, 51e, 2019

3 MV Pylee, India's Constitution, S Chand and company, New Delhi, 16e, 2016

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Module 1**	
1.1	Definition of constitution, historical back ground, salient features of the constitution.	1
1.2	Preamble of the constitution, union and its territory.	1
1.3	Meaning of citizenship, types, termination of citizenship.	2
2	**Module 2**	
2.1	Definition of state, fundamental rights, general nature, classification, right to equality ,right to freedom , right against exploitation	2

2.2	Right to freedom of religion, cultural and educational rights, right to constitutional remedies. Protection in respect of conviction for offences.	2
2.3	Directive principles of state policy, classification of directives, fundamental duties.	2
3	**Module 3**	
3.1	The Union executive, the President, the vice President, the council of ministers, the Prime minister, Attorney-General, functions.	2
3.2	The parliament, composition, Rajya sabha, Lok sabha, qualification and disqualification of membership, functions of parliament.	2
3.3	Union judiciary, the supreme court, jurisdiction, appeal by special leave.	1
4	**Module 4**	
4.1	The State executive, the Governor, the council of ministers, the Chief minister, advocate general, union Territories.	2
4.2	The State Legislature, composition, qualification and disqualification of membership, functions.	2
4.3	The state judiciary, the high court, jurisdiction, writs jurisdiction.	1
5	**Module 5**	
5.1	Relations between the Union and the States, legislative relation, administrative relation, financial Relations, Inter State council, finance commission.	1
5.2	Emergency provision, freedom of trade commerce and inter course, comptroller and auditor general of India, public Services, public service commission, administrative Tribunals.	2
5.3	Official language, elections, special provisions relating to certain classes, amendment of the Constitution.	2

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
			2	0	0	2
EST 200	DESIGN AND ENGINEERING					

Preamble:

The purpose of this course is to

i) introduce the undergraduate engineering studentsthe fundamental principles of design engineering,

ii) make them understand the steps involved in the design process and

iii) familiarize them with the basic tools used and approaches in design.

Students are expected to apply design thinking in learning as well as while practicing engineering, which is very important and relevant for today. Case studies from various practical situations will help the students realize that design is not only concerned about the function but also many other factors like customer requirements, economics, reliability, etc. along with a variety of life cycle issues.

The course will help students to consider aesthetics, ergonomics and sustainability factors in designs and also to practice professional ethics while designing.

Prerequisite:

Nil. The course will be generic to all engineering disciplines and will not require specialized preparation or prerequisites in any of the individual engineering disciplines.

Course Outcomes:

After the completion of the course the student will be able to

CO 1	Explain the different concepts and principles involved in design engineering.
CO 2	Apply design thinking while learning and practicing engineering.
CO 3	Develop innovative, reliable, sustainable and economically viable designs incorporating knowledge in engineering.

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					1			1		
CO 2		2				1		1				2
CO 3			2			1	1		2	2		1

Assessment Pattern

Continuous Internal Evaluation (CIE) Pattern:

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

End Semester Examination (ESE) Pattern: There will be two parts; Part A and Part B.
Part A : 30 marks
part B : 70 marks
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 case study questions from each module of which student should answer any one. Each question carry 14 marks and can have maximum 2 sub questions.

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	5	5	10
Understand	10	10	20
Apply	35	35	70
Analyse	-	-	-
Evaluate	-	-	-
Create	-	-	-

Course Level Assessment Questions

Course Outcome 1 (CO1): Appreciate the different concepts and principles involved in design engineering.

1. State how engineering design is different from other kinds of design

2. List the different stages in a design process.

3. Describedesign thinking.

4. State the function of prototyping and proofing in engineering design.

5. Write notes on the following concepts in connection with design engineering 1) Modular Design, 2) Life Cycle Design , 3) Value Engineering, 4) Concurrent Engineering, and 5) Reverse Engineering

6. State design rights.

Course Outcome 2 (CO2) Apply design thinking while learning and practicing engineering.

1. Construct the iterative process for design thinking in developing simple products like a pen, umbrella, bag, etc.

2. Show with an example how divergent-convergent thinking helps in generating alternative designs and then how to narrow down to the best design.

3. Describe how a problem-based learning helps in creating better design engineering solutions.

4. Discuss as an engineer, how ethics play a decisive role in your designs

Course Outcome 3(CO3): Develop innovative, reliable, sustainable and economically viable designs incorporating different segments of knowledge in engineering.

1. Illustratethe development of any simple product by passing through the different stages of design process

2. Show thegraphical design communication with the help of detailed 2D or 3D drawings for any simple product.

3. Describe how to develop new designs for simple products through bio-mimicry.

Model Question paper

Reg No.:_______________ Name:__________________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

THIRD/FOURTH SEMESTER B.TECH DEGREE EXAMINATION

Course Code: EST 200

Course Name: DESIGN AND ENGINEERING

Max. Marks: 100Duration: 3 Hours

PART A

Answer all questions, each question carries 3 marks
Use only hand sketches

(1)Write aboutthe basic design process.

(2) Describe how to finalize the design objectives.

(3) State the role of divergent-convergent questioning in design thinking.

(4) Discuss how to perform design thinking in a team managing the conflicts.

(5) Show how engineering sketches and drawings convey designs.

(6)Explain the role of mathematics and physics in design engineering process.

(7) Distinguish between project-based learning and problem-based learning in design engineering.

(8) Describe how concepts like value engineering , concurrent engineering and reverse engineering influence engineering designs?

(9) Show how designs are varied based on the aspects of production methods, life span, reliability and environment?

(10) Explain how economics influence the engineering designs?

(10x3 marks =30 marks)

Part B

Answer any ONE question from each module. Each question carry 14 marks

Module 1

(11) Show the designing of a wrist watch going through the various stages of the design process. Use hand sketches to illustrate the processes.

or

(12)Find the customer requirements for designing a new car showroom. Show how the design objectives were finalized considering the design constraints?

Module 2

(13)Illustrate the design thinking approach for designing a bag for college students within a limited budget. Describe each stage of the process and the iterative procedure involved. Use hand sketches to support your arguments.

or

(14)Construct a number of possible designs and then refine them to narrow down to the best design for a drug trolley used in hospitals. Show how the divergent-convergent thinking helps in the process. Provide your rationale for each step by using hand sketches only.

Module 3

(15) Graphically communicate the design of a thermo flask used to keep hot coffee. Draw the detailed 2D drawings of the same with design detailing, material selection, scale drawings, dimensions, tolerances, etc. Use only hand sketches.

or

(16)Describe the role of mathematical modelling in design engineering. Show how mathematics and physics play a role in designing a lifting mechanism to raise 100 kg of weight to a floor at a height of 10 meters in a construction site.

Module 4

(17) Show the development of a nature inspired design for a solar poweredbus waiting shed beside a highway. Relate between natural and man-made designs. Use hand sketches to support your arguments.

or

(18)Show the design of a simple sofa and then depict how the design changes when considering 1) aesthetics and 2) ergonomics into consideration. Give hand sketches and explanations to justify the changes in designs.

Module 5

(19)Examine the changes in the design of a foot wear with constraints of 1) production methods, 2) life span requirement, 3) reliability issues and 4) environmental factors. Use hand sketches and give proper rationalization for the changes in design.

or

(20)Describe the how to estimate the cost of a particular design using ANY of the following: i) a website, ii) the layout of a plant, iii) the elevation of a building, iv) anelectrical or electronic system or device and v) a car.

Show how economics will influence the engineering designs. Use hand sketches to support your arguments.

(5x14 marks =70 marks)

Syllabus

Module 1

Design Process:- Introduction to Design and Engineering Design, Defining a Design Process-:Detailing Customer Requirements, Setting Design Objectives, Identifying Constraints, Establishing Functions, Generating Design Alternatives and Choosing a Design.

Module 2

Design Thinking Approach:-Introduction to Design Thinking, Iterative Design Thinking Process Stages: Empathize, Define, Ideate, Prototype and Test. Design Thinking as Divergent-Convergent Questioning. Design Thinking in a Team Environment.

Module 3

Design Communication (Languages of Engineering Design):-Communicating Designs Graphically, Communicating Designs Orally and in Writing. Mathematical Modeling In Design, Prototyping and Proofing the Design.

Module 4

Design Engineering Concepts:-Project-based Learning and Problem-based Learning in Design.Modular Design and Life Cycle Design Approaches. Application of Bio-mimicry,Aesthetics and Ergonomics in Design. Value Engineering, Concurrent Engineering, and Reverse Engineering in Design.

Module 5

Expediency, Economics and Environment in Design Engineering:-Design for Production, Use, and Sustainability. Engineering Economics in Design. Design Rights. Ethics in Design

Text Books

1) YousefHaik, SangarappillaiSivaloganathan, Tamer M. Shahin, Engineering Design Process, Cengage Learning 2003, Third Edition, ISBN-10: 9781305253285,

2) Voland, G., Engineering by Design, Pearson India 2014, Second Edition, ISBN 9332535051

Reference Books

1.Philip Kosky, Robert Balmer, William Keat, George Wise, Exploring Engineering, Fourth Edition: An Introduction to Engineering and Design, Academic Press 2015, 4th Edition, ISBN: 9780128012420.

2. Clive L. Dym, Engineering Design: A Project-Based Introduction, John Wiley & Sons, New York 2009, Fourth Edition, ISBN: 978-1-118-32458-5

3. Nigel Cross, Design Thinking: Understanding How Designers Think and Work, Berg Publishers 2011, First Edition, ISBN: 978-1847886361

4. Pahl, G., Beitz, W., Feldhusen, J., Grote, K.-H., Engineering Design: A Systematic Approach, Springer 2007, Third Edition, ISBN 978-1-84628-319-2

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Module 1: Design Process**	
1.1	Introduction to Design and Engineering Design. *What does it mean to design something? How Is engineering design different from other kinds of design? Where and when do engineers design? What are the basic vocabularyin engineering design? How to learn and do engineering design.*	1
1.2	*Defining a Design Process*-: Detailing Customer Requirements. *How to do engineering design? Illustrate the process with an example. How to identify the customer requirements of design?*	1
1.3	*Defining a Design Process*-: Setting Design Objectives, Identifying Constraints, Establishing Functions. *How to finalize the design objectives? How to identify the design constraints? How to express the functions a design in engineering terms?*	1
1.4	*Defining a Design Process*-: Generating Design Alternatives and Choosing a Design. *How to generate or create feasible design alternatives? How to identify the "best possible design"?*	1
1.5	Case Studies:- Stages of Design Process. *Conduct exercises for designing simple products going through the different stages of design process.*	1
2	**Module 2: Design Thinking Approach**	
2.1	Introduction to Design Thinking *How does the design thinking approach help engineers in creating innovative and efficient designs?*	1
2.2	Iterative Design Thinking Process Stages: Empathize, Define, Ideate, Prototype and Test. *How can the engineers arrive at better designs utilizing the iterative design thinking process (in which knowledge acquired in the later stages can be applied back to the earlier stages)?*	1
2.3	Design Thinking as Divergent-Convergent Questioning. *Describe how to create a number of possible designs and then how to refine and narrow down to the 'best design'.*	1
2.4	Design Thinking in a Team Environment. *How to perform design thinking as a team managing the conflicts ?*	1
2.5	Case Studies: Design Thinking Approach. *Conduct exercises using the design thinking approach for*	1

	designing any simple products within a limited time and budget	
3	**Module 3: Design Communication (Languages of Engineering Design)**	
3.1	Communicating Designs Graphically. *How do engineering sketches and drawings convey designs?*	1
3.2	Communicating Designs Orally and in Writing. *How can a design be communicated through oral presentation or technical reports efficiently?*	1
	First Series Examination	
3.3	Mathematical Modelling in Design. *How do mathematics and physics become a part of the design process?*	1
3.4	Prototyping and Proofing the Design. *How to predict whether the design will function well or not?*	1
3.5	Case Studies: Communicating Designs Graphically. *Conduct exercises for design communication through detailed 2D or 3D drawings of simple products with design detailing, material selection, scale drawings, dimensions, tolerances, etc.*	1
4	**Module 4: Design Engineering Concepts**	
4.1	Project-based Learning and Problem-based Learning in Design. *How engineering students can learn design engineering through projects?* *How students can take up problems to learn design engineering?*	1
4.2	Modular Design and Life Cycle Design Approaches. *What is modular approach in design engineering? How it helps?* *How the life cycle design approach influences design decisions?*	1
4.3	Application of Bio-mimicry, Aesthetics and Ergonomics in Design. *How do aesthetics and ergonomics change engineering designs?* *How do the intelligence in nature inspire engineering designs? What are the common examples of bio-mimicry in engineering?*	1
4.4	Value Engineering, Concurrent Engineering, and Reverse Engineering in Design. *How do concepts like value engineering , concurrent engineering and reverse engineering influence engineering designs?*	1
4.5	Case Studies: Bio-mimicry based Designs. *Conduct exercises to develop new designs for simple*	1

	products using bio-mimicry and train students to bring out new nature inspired designs.	
5	**Module 5: Expediency, Economics and Environment in Design Engineering**	
5.1	Design for Production, Use, and Sustainability. *How designs are finalized based on the aspects of production methods, life span, reliability and environment?*	1
5.2	Engineering Economics in Design. *How to estimate the cost of a particular design and how will economics influence the engineering designs?*	1
5.3	Design Rights. *What are design rights and how can an engineer put it into practice?*	1
5.4	Ethics in Design. *How do ethics play a decisive role in engineering design?*	1
5.5	Case Studies: Design for Production, Use, and Sustainability. *Conduct exercises using simple products to show how designs change with constraints of production methods, life span requirement, reliability issues and environmental factors.*	1
	Second Series Examination	

Code.	Course Name	L	T	P	Hrs	Credit
HUT 200	**Professional Ethics**	2	0	0	2	2

Preamble: To enable students to create awareness on ethics and human values.

Prerequisite: Nil

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

CO 1	Understand the core values that shape the ethical behaviour of a professional.
CO 2	Adopt a good character and follow an ethical life.
CO 3	Explain the role and responsibility in technological development by keeping personal ethics and legal ethics.
CO 4	Solve moral and ethical problems through exploration and assessment by established experiments.
CO 5	Apply the knowledge of human values and social values to contemporary ethical values and global issues.

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	PO10	PO11	PO12
CO 1								2			2	
CO 2								2			2	
CO 3								3			2	
CO 4								3			2	
CO 5								3			2	

Assessment Pattern

Bloom's category	Continuous Assessment Tests		End Semester Exam
	1	2	
Remember	15	15	30
Understood	20	20	40
Apply	15	15	30

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	:	10 marks
Continuous Assessment Tests (2 Nos)	:	25 marks
Assignments/Quiz	:	15 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 student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

<u>Course Level Assessment Questions</u>

Course Outcome 1 (CO1):
1. Define integrity and point out ethical values.
2. Describe the qualities required to live a peaceful life.
3. Explain the role of engineers in modern society.

Course Outcome 2 (CO2)
1. Derive the codes of ethics.
2. Differentiate consensus and controversy.
3. Discuss in detail about character and confidence.

Course Outcome 3(CO3):
1. Explain the role of professional's ethics in technological development.
2. Distinguish between self interest and conflicts of interest.
3. Review on industrial standards and legal ethics.

Course Outcome 4 (CO4):
1. Illustrate the role of engineers as experimenters.
2. Interpret the terms safety and risk.
3. Show how the occupational crimes are resolved by keeping the rights of employees.

Course Outcome 5 (CO5):
1. Exemplify the engineers as managers.
2. Investigate the causes and effects of acid rain with a case study.
3. Explorate the need of environmental ethics in technological development.

Model Question paper

QP CODE: **Reg No:______________**

PAGES:3 **Name :______________**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY THIRD/FOURTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: HUT 200
Course Name: PROFESSIONAL ETHICS

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

(2019-Scheme)

PART A

(Answer all questions, each question carries 3 marks)

1. Define empathy and honesty.
2. Briefly explain about morals, values and ethics.
3. Interpret the two forms of self-respect.
4. List out the models of professional roles.
5. Indicate the advantages of using standards.
6. Point out the conditions required to define a valid consent?
7. Identify the conflicts of interests with an example?
8. Recall confidentiality.
9. Conclude the features of biometric ethics.
10. Name any three professional societies and their role relevant to engineers.

(10x3 = 30 marks)

PART B

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

MODULE I

11. a) Classify the relationship between ethical values and law?

b) Compare between caring and sharing. (10+4 = 14 marks)

Or

12. a) Exemplify a comprehensive review about integrity and respect for others.

b) Discuss about co-operation and commitment. (8+6 = 14 marks)

MODULE II

13.a) Explain the three main levels of moral developments, deviced by Kohlberg.

b) Differentiate moral codes and optimal codes. (10+4 = 14 marks)

Or

14. a) Extrapolate the duty ethics and right ethics.

b) Discuss in detail the three types of inquiries in engineering ethics (8+6 = 14 marks)

MODULE III

15.a) Summarize the following features of morally responsible engineers.

(i) Moral autonomy **(ii)** Accountability

b)Explain the rights of employees (8+6 = 14 marks)

Or

16. a) Explain the reasons for Chernobyl mishap ?

b) Describe the methods to improve collegiality and loyalty. (8+6 = 14 marks)

MODULE IV

17.a) Execute collegiality with respect to commitment, respect and connectedness.

b) Identify conflicts of interests with an example. (8+6 = 14 marks)

Or

18. a) Explain in detail about professional rights and employee rights.

b) Exemplify engineers as managers.

MODULE V

19.a) Evaluate the technology transfer and appropriate technology.

b) Explain about computer and internet ethics. (8+6 = 14 marks)

Or

20. a) Investigate the causes and effects of acid rain with a case study.

b) Conclude the features of ecocentric and biocentric ethics. (8+6 = 14 marks)

Syllabus

Module 1 – Human Values.

Morals, values and Ethics – Integrity- Academic integrity-Work Ethics- Service Learning- Civic Virtue-Respect for others- Living peacefully- Caring and Sharing- Honestly- courage-Cooperation commitment-Empathy-Self Confidence -Social Expectations.

Module 2 - Engineering Ethics & Professionalism.

Senses of Engineering Ethics - Variety of moral issues- Types of inquiry- Moral dilemmas –Moral Autonomy – Kohlberg's theory- Gilligan's theory- Consensus and Controversy-Profession and Professionalism- Models of professional roles-Theories about right action –Self interest-Customs and Religion- Uses of Ethical Theories.

Module 3- Engineering as social Experimentation.

Engineering as Experimentation – Engineers as responsible Experimenters- Codes of Ethics- Plagiarism-A balanced outlook on law - Challenges case study- Bhopal gas tragedy.

Module 4- Responsibilities and Rights.

Collegiality and loyalty – Managing conflict- Respect for authority- Collective bargaining- Confidentiality-Role of confidentiality in moral integrity-Conflicts of interest- Occupational crime- Professional rights-Employee right- IPR Discrimination.

Module 5- Global Ethical Issues.

Multinational Corporations- Environmental Ethics- Business Ethics- Computer Ethics -Role in Technological Development-Engineers as Managers- Consulting Engineers- Engineers as Expert witnesses and advisors-Moral leadership.

Text Book

1. M Govindarajan, S Natarajan and V S Senthil Kumar, Engineering Ethics, PHI Learning Private Ltd, New Delhi,2012.
2. R S Naagarazan, A text book on professional ethics and human values, New age international (P) limited ,New Delhi,2006.

Reference Books

1. Mike W Martin and Roland Schinzinger, Ethics in Engineering,4th edition, Tata McGraw Hill Publishing Company Pvt Ltd, New Delhi,2014.
2. Charles D Fleddermann, Engineering Ethics, Pearson Education/ Prentice Hall of India, New Jersey,2004.
3. Charles E Harris, Michael S Protchard and Michael J Rabins, Engineering Ethics- Concepts and cases, Wadsworth Thompson Learning, United states,2005.
4. http://www.slideword.org/slidestag.aspx/human-values-and-Professional-ethics.

Course Contents and Lecture Schedule

SL.No	Topic	No. of Lectures 25
1	**Module 1 – Human Values.**	
1.1	Morals, values and Ethics, Integrity, Academic Integrity,Work Ethics	1
1.2	Service Learning, Civic Virtue, Respect for others, Living peacefully	1
1.3	Caring and Sharing, Honesty, Courage, Co-operation commitment	2
1.4	Empathy, Self Confidence, Social Expectations	1
2	**Module 2- Engineering Ethics & Professionalism.**	
2.1	Senses of Engineering Ethics, Variety of moral issues, Types of inquiry	1
2.2	Moral dilemmas, Moral Autonomy, Kohlberg's theory	1
2.3	Gilligan's theory, Consensus and Controversy,Profession& Professionalism, Models of professional roles, Theories about right action	2
2.4	Self interest-Customs and Religion, Uses of Ethical Theories	1
3	**Module 3- Engineering as social Experimentation.**	
3.1	Engineering as Experimentation, Engineers as responsible Experimenters	1
3.2	Codes of Ethics,Plagiarism, A balanced outlook on law	2
3.3	Challenger case study, Bhopal gas tragedy	2
4	**Module 4- Responsibilities and Rights.**	
4.1	Collegiality and loyalty, Managing conflict, Respect for authority	1
4.2	Collective bargaining, Confidentiality, Role of confidentiality in moral integrity, Conflicts of interest	2
4.3	Occupational crime, Professional rights, Employee right, IPR Discrimination	2
5	**Module 5- Global Ethical Issues.**	
5.1	Multinational Corporations, Environmental Ethics, Business Ethics, Computer Ethics	2
5.2	Role in Technological Development, Moral leadership	1
5.3	Engineers as Managers, Consulting Engineers, Engineers as Expert witnesses and advisors	2

CORE COURSES S3 & S4

SEMESTER -3

MRT201	ELECTRICAL MACHINES & DRIVES	CATEGORY	L	T	P	CREDIT
		PCC	3	1	0	4

Preamble:

This course aims the students to learn about the introduction of all basics machines of electrical and basic concept of machine drives

Prerequisite:

EST-130 BASICS OF ELECTRICAL AND ELECTRONICS

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

CO 1	Explain the basic concept of dc generator and motor
CO 2	The basic concepts of transformer and 3 phase induction motor
CO 3	The basic concepts of single phase induction motor and alternators
CO 4	The basic concept of special electrical machines & introduction to power electronics
CO 5	The basic concept of machine drives

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	-	-	2	2	1	-	-	-	3
CO2	3	3	2	1	-	2	2	1	-	-	-	3
CO3	3	3	2	1	-	2	2	1	-	-	-	3
CO4	3	1	1	1	-	2	2	1	-	-	-	2
CO5	3	1	1	1	-	2	2	1	-	-	-	2

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.

SYLLABUS

Module 1 – DC MACHINES

DC generator - constructional details and Working principle – EMF equation – types of dc generators – no load and load characteristics of dc generator. DC motor - Working principle - back emf – types of dc motor - equations for torque & power (simple numerical problems) - Necessity of starters and their types—power flow diagram.

Module 2 - TRANSFORMERS & 3-PHASE INDUCTION MOTORS

TRANSFORMERS
Working principle - Construction - core and shell type - emf equation – voltage transformation ratio (simple numerical problems) – concept of ideal transformer- phasor diagram -ideal, no-load, load – short circuit and open circuit test on transformer (basic concept only) - lossesin transformer
3-PHASE INDUCTION MOTORS
Constructional details – operation – concept of rotating magnetic field – slip - torque equation - (simple numerical problems) - torque–slip characteristics – starting methods of 3-pahse induction motors

Module 3 1-PHASE INDUCTION MOTORS &ALTERNATOR

1-PHASE INDUCTION MOTORS- Working principle – double revolving field theory – different types – split phase – capacitor start – capacitor start- run

ALTERNATOR - Constructional details – working principle - emf equation –voltage regulation – determination of voltage regulation – EMF method only (numerical problems).

Module 4 -- SPECIAL ELECTRICAL MACHINES & INTRODUCTION TO POWER ELECTRONICS

SPECIAL ELECTRICAL MACHINES

Universal motor – stepper motor -different types – servomotor (mechanism only) - Synchronous motor

INTRODUCTION TO POWER ELECTRONICS

Introduction – SCR -symbol, construction and modes of operation – V-I characteristics- Basic concepts of Rectifier – single phase half-wave controlled rectifier with R load – fully controlled bridge rectifier with R load – basic concept of inverter

Module 5 --ELECTRICAL DRIVES

Electrical Drives - Parts of electrical drives - Choice of electric drives - Status of DC and AC drives - Dynamics of Electric drives - Fundamental torque equations – Speed torque conventions and multi-quadrant operation - Components of load torque - Nature and classification of load torque – Steadystate stability – load equalization - Three phase Induction motor drives - Stator voltage control - Frequency control - Voltage and frequency control

Text Books

1. J.B. Gupta, Electrical Machines, Katson Books
2. P.S. Bimbhra, Power Electronics, Khanna Publishers, New Delhi
3. Gopal K. Dubey, Fundamentals of Electrical Drives, Narosa Publishing House, New Delhi.

Reference Books

1. Theraja B.L., Theraja A.K. A Text Book of Electrical Technology, Vol.II “AC & DC Machines”, publication division of Nirja construction & development (p) Ltd., New Delhi, 1994.
2. V.K. Mehta, Rohit Mehta, Principles Of Electrical Machines, S Chand Publication
3. M. H. Rashid, Power Electronics Circuits, Devices and Applications, Pearson Education
4. VedamSubrahmanyam, Electric Drives, Concepts & Applications, Tata McGraw Hill Education Pvt. Ltd, New Delhi

Model Question paper

QP CODE:

Reg. No:--------------------

Name: ---------------------

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

Course code: MRT 201 **Duration: 3hours**

ELECTRICAL MACHINES & DRIVES

(2019- Scheme)

Mechatronics Branch

PART A

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

1. Explain different types of DC motor according to the excitation method.
2. Explain back EMF and its significance.
3. Narrate the properties of ideal transformer. Sketch its phasor diagram
4. Sketch and explain Torque-Slip characteristics of 3 phase induction motor.
5. Explain the working principle of single phase induction motor.
6. Briefly explain the construction of alternator
7. Briefly explain different types of stepper motor.
8. Draw and explain the V-I characteristics of SCR.
9. Describe the block diagram of electrical drives.
10. Briefly explain the fundamentals of torque equation.

PART B

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

Module 1

11. (a) With neat sketch explain No load and load characteristics of dc generator. (10 marks)

    (b) Explain back EMF and its significance. (4 marks)

12. (a) Explain the working of three point starter . (10 marks)

    (b) Derive equation for torque of a dc motor. (4 marks)

Module 2

12. (a) Explain the phasor diagram of transformer. (10 marks)

(b) Derive emf equation of a transformer. (4 marks)

13. Explain the starting methods of three phase induction motors . (14 marks)

Module 3

14. (a) Explain different types of single phase induction motors. (10 marks)

(b) Why single phase induction motors are not self-starting. (4 marks)

15. Narrate the steps for obtaining the voltage regulation of alternator using emf method . (14 marks)

Module 4

16. Explain different types of stepper motor. (14 marks)

17. (a)Explain the modes of operation of SCR. (10 marks)

(b) Explain the basic concept of a rectifier circuit. (4 marks)

Module 5

18. Explain with neat sketch the multi quadrant operation . (14 marks)

19. Explain in detail the stator voltage control of a motor drive. (14 marks)

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**DC MACHINES**	
1.1	DC generator - constructional details and Working principle	2
1.2	EMF equation – types of dc generators	1
1.3	No load and load characteristics of dc generator.	2
1.4	DC motor - Working principle - back emf – types of dc motor	1
1.5	equations for torque & power (simple numerical problems)	2
1.6	Necessity of starters and their types—power flow diagram	2
2	**TRANSFORMERS**	
2.1	Working principle - Construction - core and shell type	1
2.2	emf equation – voltage transformation ratio (simple numerical problems)	1
2.3	concept of ideal transformer- phasor diagram - ideal, no-load, load	2
2.4	short circuit and open circuit test on transformer - losses in transformer	1

	3-PHASE INDUCTION MOTORS	
2.5	Constructional details – operation – concept of rotating magnetic field	2
2.6	slip - torque equation - (simple numerical problems) - torque–slip characteristics	2
2.7	starting methods of 3-pahse induction motors	1
3	**1-PHASE INDUCTION MOTORS**	
3.1	Working principle – double revolving field theory – different types	1
3.2	split phase – capacitor start – capacitor start- run	1
	ALTERNATOR	
3.3	Constructional details – working principle	2
3.4	emf equation – voltage regulation	1
3.5	determination of voltage regulation – EMF method	3
4	**SPECIAL ELECTRICAL MACHINES**	
4.1	Universal motor	1
4.2	stepper motor -different types	2
4.3	servomotor (mechanism only)	1
4.4	Synchronous motor	1
	INTRODUCTION TO POWER ELECTRONICS	
4.5	Introduction – SCR - symbol, construction and modes of operation	2
4.6	V-I characteristics	1
4.7	Basic concepts of Rectifier – single phase half-wave controlled rectifier with R load – fully controlled bridge rectifier with R load	1
4.8	basic concept of inverter	1
5	**ELECTRICAL DRIVES**	
5.1	Electrical Drives - Parts of electrical drives - Choice of electric drives - Status of DC and AC drives - Dynamics of Electric drives	1
5.2	Fundamental torque equations – Speed torque conventions and multi-quadrant operation	2
5.3	Components of load torque - Nature and classification of load torque – Steady state stability – load equalization	2
5.4	Stator voltage control - Frequency control	1
5.5	Voltage and frequency control	1

MRT 203	ANALOG AND DIGITAL ELECTRONICS	CATEGORY	L	T	P	CREDIT
		PCC	3	1	-	4

Preamble:

This course enables students to analyse, design and implement analog and digital circuits and systems for the given specification and function.

Prerequisite:*Basics of Electronics*

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

CO 1	Understand the working of amplifiers and oscillators.
CO 2	Familiarisation of Op-amp and its different applications.
CO 3	Analysis of multivibrators and principles of PLL.
CO 4	Learn different simplification methods in digital electronics and also learn to design its combinational circuits
CO 5	Design of sequential circuits.

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	-	2	1	2	-	-	-	-	-
CO2	3	3	2	1	2	1	2	-	-	-	-	-
CO3	3	3	2	1	2	1	2	-	-	-	-	-
CO4	3	3	3	1	2	1	2	-	-	-	-	-
CO5	3	3	3	1	2	1	2	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination (100 marks)
	Test 1	Test 2	
Remember	5	5	10
Understand	10	10	20
Apply	20	15	30
Analyse	10	10	15
Evaluate	5	5	15
Create		5	10

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. List out the applications of oscillators
2. Differentiate positive feedback from negative feedback.
3. Compare BJT with FET .Mention the usage of both.

Course Outcome 2 (CO2) :

1. Define offset current and offset voltage.
2. What are the characteristics of an ideal opamp?
3. Mention the disadvantages of ideal differentiator. Suggest a method to overcome it.
4. Explain the importance of isolation amplifier.
5. Design an inverting amplifier of gain 10.

Course Outcome 3(CO3):

1. Discuss on the output waveforms of different filters.
2. Design a circuit to generate a waveform of duty cycle 50%.
3. List out the applications of astable and monostablemultivibrator.
4. Define capture range and lock range.
5. Explain any one application of PLL.

Course Outcome 4 (CO4):

1. Why are NAND and NOR called as universal gates?Justify.
2. State and prove De-Morgan's Theorems.
3. Reduce f= $\sum$ m(0,2,4,6,7,8,10,12,13,15) using K-map& Quine Mc Cluskey Method.
4. Implement the function F(a,b,c,d)= ab' + bd +b'cd' using 8:1 MUX.

Course Outcome 5 (CO5):

1. Explain race round condition.
2. Differentiate combinational circuit form sequential circuits.
3. Design a3 bit synchronous down counter.
4. Explain ring counters with neat diagram.

Model Question paper

QP CODE:

Reg. No:--------------------

Name: ---------------------

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

Course code: MRT 203 **Duration :3hours**

ANALOG AND DIGITAL ELECTRONICS

(2019- Scheme)

Mechatronics Branch

PART A

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

1. Explain the working of Hartley Oscillators.
2. Compare Class A with Class B amplifiers.
3. Briefly explain S/H circuit using opamp.
4. Design a non inverting amplifier of gain 11.Given input voltage is 2 Vpp.
5. Derive an expression for calculating gain of a first order active LPF.
6. Explain the principle of PLL.
7. Reduce the expression f= ΠM (0,1,2,3,4,7) using mapping and implement it in AOI logic.
8. Design a full adder circuit using universal gates.
9. Discuss on twisted ring counter.
10. Design a 2 bit ripple up-down counter using negative edge triggered flip flops.

PART B

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

Module 1

11. (a) Explain the construction, working and characteristics of depletion MOSFET. (10 marks)

    (b) State and explain the condition for sustained oscillations.(4 marks)

12. (a) Explain the working of RC phase shift oscillators .Derive an expression for resonant frequency. (10 marks)

    (b) Explain how tank circuits aid in oscillations. (4 marks)

Module 2

12. (a)Explain ideal integrator using opamp.Suggest method to overcome its disadvantages. (10 marks)

    (b) List out the characteristics of op-amp. (4 marks)

13. (a) Explain V-I and I-V converters. (9 marks)

    (b) Write notes on isolation amplifier. (5 marks)

Module 3

14. (a) Explain the importance of VCO. (4 marks)

    (b) Define duty cycle . Explain the working of monostablemultivibrator. (10 marks)

15. (a) Distinguish band pass and band stop filters. (6 marks)

    (b) Explain the functional diagram of IC 555. (8 marks)

Module 4

16. (a) Design and implement 3 bit gray to binary code converter. (8 marks)

    (b) Implement F(x,y,z)= $\sum$ m (0,2,3,5) using 8 to 1 MUX. (6 marks)

17. Using tabular method , obtain minimal expression for f=$\sum$ m (6,7,8,9) + d(10,11,12,13,14,15). (14 marks)

Module 5

18. Design a Mod-6 asynchronous counter using T FFs. (14 marks)

19. Design 3 bit synchronous up counter using JK Flip flops. (14 marks)

Syllabus

Module 1-Amplifiers & Oscillators (9 hours)

BJT as an amplifier (CE configuration) - Concept of feedback-FET-construction and characteristics of JFET & MOSFET-Comparison of BJT & FET.Power amplifiers-class A,B,AB & C amplifiers.Oscillators-Barkhausen criteria-Classification- analysis of RC phase shift oscillators-Working of Hartley and Colpitts Oscillator.

Module 2- Op-amp & its applications (9 hours)

Op-amp –ideal characteristics –offset voltage & offset current –frequency response-voltage series feedback and shunt feedback amplifiers- Integrator , Differentiator- Comparator, S/H, Isolation amplifier, V/I & I/V Converter.

Module 3- Filters &Timers (9 hours)

Active Filters- Analysis of first order LPF & HPF filter- Working of Band Pass & Band stop Filters- Timer IC 555 –Functional diagram, Astable and Monostable modes. Phase Locked Loops-Principles- building blocks of PLL-VCO-lock and capture ranges-capture process-frequency multiplication using PLL.

Module 4- Digital circuits (9 hours)

Logic gates-De-Morgan's theorem –Minimization of Boolean function using K-Map and Quine Mc Cluskey method. Combinational Circuits- Adder, Subtractor, Code converters (gray to binary & binary to gray). Encoders(3x8), Decoders(8x3), Multiplexers (1x8), De-multiplexers (8x1).

Module 5-Sequential Circuits (9 hours)

Flip Flop –SR,D,JK,T and master slave flip flop- Shift Registers- Counters –3 bit Synchronous and asynchronous- Modulo 3 Counter- Ring Counter, Sequence detector

Text Books

1. Robert L.Boylestad and Louis Nashelsky, "*Electronic Devices and Circuit Theory*", Prentice Hall, Tenth Edition, 2009.

2.Ramakant A Gayakward, "*Op-amps and Linear Integrated* Circuits", IV edition ,Pearson Education,2002

3.M.Morris Mano, "*Digital Logic and Computer Design*", Pearson Education,2002

Reference Books

1. Allen Mottershead, "*Electronic Devices and Circuits:AnIntroduction*",Prentice Hall of India,2013

2.D.RoyChoudhury,Shail B Jain, "*Linear Integrated Circuits*",Fifthedition,New Age ,2018

3.Thomas L Floyd, "*Digital Fundamentals*",Eleventhedition,Pearson Education,2011

4. A.Anand Kumar, "*Fundamentals of Digital Circuits*",Second Edition,PHI,2009

Course Contents and Lecture Schedule
`

No	Topic	No. of Lectures
1	**Amplifiers and Oscillators**	
1.1	BJT as an amplifier(CE configuration)- concept of feedback	1
1.2	FET- Construction and characteristics of JFET & MOSFET, Comparison of BJT & FET	2
1.3	Power Amplifiers- Class A,B,AB,C amplifiers	3
1.4	Oscillators-Barkhausen criteria-Classification	1
1.5	Operation and analysis of RC phase shift oscillators	1
1.6	Working of Hartley and ColpittsOscillators	1
2	**OP-AMP & its Applications**	
2.1	Ideal characteristics, offset voltage and offset current, frequency response	2

2.2	Voltage shunt feedback and voltage series feedback amplifiers	1
2.3	Applications : Integrator , Differentiator&Schmitt Trigger	3
2.4	Comparator, S/H, Isolation amplifier,V/I&I/V Converter	3
3	**Filters & Timers**	
3.1	Active Filters- Analysis of first order LPF & HPF filter	1
3.2	Working of Band Pass & Band stop Filters	2
3.3	Timer IC 555 –Functional diagram ,Astable and Monostable modes	3
3.4	Phase Locked Loops-Principles- building blocks of PLL-importance of VCO-lock and capture ranges-capture process-frequency multiplication using PLL	3
4	**Digital Circuits**	
4.1	Logic gates-De-Morgan's theorem –Minimization of Boolean function using K-Map (3 & 4 variables) and Quine Mc Cluskey method.	3
4.2	Combinational Circuits- Adder,Subtractor,Code converters (gray to binary & binary to gray)	2
4.3	Encoders(3x8),Decoders(8x3),	2
4.4	Multiplexers (1x8), De-multiplexers (8x1)	2
5	**Sequential Circuits**	
5.1	Flip Flop –SR,D,JK,T and master slave flip flop	2
5.2	Shift Registers	1
5.3	Counters –3 bit Synchronous and asynchronous	2
5.4	Up-Down Counters	1
5.5	ModulonCounter	1
5.6	Ring Counter, Sequence detector	2

MRT205	MECHANICS OF SOLIDS	CATEGORY	L	T	P	CREDIT
		PCC	3	1	0	4

Preamble:

This course helps the students to understand the concept of stress and strain in different types of structure/machine under various loading conditions. The course also covers simple and compound stresses due to forces, stresses and deflection in beams due to bending, torsion in circular section, strain energy, different theories of failure, stress in thin cylinder thick cylinder and spheres due to external and internal pressure.

Prerequisite: EST100 ENGINEERING MECHANICS

Course Outcomes:

After the completion of the course the student will be able to

CO 1	Determine the stresses, strains and displacements of structures by tensorial and graphical (Mohr's circle) approaches
CO 2	Analyse the strength of materials using stress-strain relationships for structural and thermal loading
CO 3	Perform basic design of shafts subjected to torsional loading and analyse beams subjected to bending moments
CO 4	Determine the deformation of structures subjected to various loading conditions using strain energy methods
CO 5	Estimate the strength of thin cylinders, spherical vessels and columns, and appreciate the theories of failures and its relevance in mechanical design

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	2									1
CO 2	3	3	2									1
CO 3	3	3	1									2
CO 4	3	3	1									1
CO 5	3	3	1									1

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember			
Understand	10	10	20
Apply	20	20	30
Analyse	20	20	50
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 and 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 a maximum of 2 subdivisions.

COURSE LEVEL ASSESSMENT QUESTIONS

Course Outcome 1 (CO1):

1. Determine the resultant traction at a point in a plane using the stress tensor.

2. Evaluate the principal stresses, principal strains and their directions from a given state of stress or strain.

3. Write the stress tensor and strain tensor.

Course Outcome 2 (CO2)

1. Write the generalized Hooke's law for stress-strain relations.

2. Estimate the state of strain from a given state of stress.

3. Analyse the strength of a structure subjected to thermal loading.

Course Outcome 3(CO3):

1. Design a shaft to transmit power and torque.

2. Draw the shear force and bending moment diagrams.

3. Determine the bending stress on a beam subjected to pure bending.

Course Outcome 4 (CO4):

1. Apply strain energy method to estimate the deformation of a structure.

2. Use strain energy method to calculate deformations for multiple loads.

3. Use strain energy method to estimate the loads acting on a structure for a maximum deflection.

Course Outcome 5 (CO5):

1. Analyse a column for buckling load.

2. A bolt is subjected to a direct tensile load of 20 kN and a shear load of 15 kN. Suggest suitable size of this bolt according to various theories of elastic failure, if the yield stress in simple tension is 360 MPa. A factor of safety 2 should be used. Assume Poisson's ratio as 0.3.

3. Estimate the stresses on a thin cylinder or spherical vessel.

SYLLABUS

Module 1

Deformation behaviour of elastic solids in equilibrium under the action of a system of forces, method of sections. Stress vectors on Cartesian coordinate planes passing through a point, stress at a point in the form of a matrix. Equality of cross shear, Cauchy's equation. Displacement, gradient of displacement, Cartesian strain matrix, strain- displacement relations (small-strain only), Simple problems to find strain matrix.Stress tensor and strain tensor for plane stress and plane strain conditions. Principal planes and principal stress, meaning of stress invariants, maximum shear stress. Mohr's circle for 2D case.

Module 2

Stress-strain diagram, Stress–Strain curves of Ductile and Brittle Materials, Poisson's ratio.

Constitutive equations-generalized Hooke's law, equations for linear elastic isotropic solids in in terms of Young's Modulus and Poisson's ratio, Hooke's law for Plane stress and plane strain conditions Relations between elastic constants E, G, ν and K.

Calculation of stress, strain and change in length in axially loaded members with single and composite materials, Effects of thermal loading – thermal stress and thermal strain. Thermal stress on a prismatic bar held between fixed supports.

Module 3

Torsional deformation of circular shafts, assumptions for shafts subjected to torsion within elastic deformation range, derivation of torsion formula Torsional rigidity, Polar moment of inertia, basic design of transmission shafts. Simple problems to estimate the stress in solid and hollow shafts. Shear force and bending moment diagrams for cantilever and simply supported beams. Differential equations between load, shear force and bending moment. Normal and shear stress in beams: Derivation of flexural formula, section modulus, flexural rigidity, numerical problems to evaluate bending stress, economic sections. Shear stress formula for beams: Derivation, shear stress distribution for a rectangular section.

Module 4

Deflection of beams using Macauley's method

Elastic strain energy and Complementary strain energy. Elastic strain energy for axial loading, transverse shear, bending and torsional loads. Expressions for strain energy in terms of load, geometry and material properties of the body for axial, shearing, bending and torsional loads.

Castigliano's second theorem, reciprocal relation, proof for Castigliano's second theorem. Simple problems to find the deflections using Castigliano's theorem.

Module 5

Fundamentals of bucking and stability, critical load, equilibrium diagram for buckling of an idealized structure. Buckling of columns with pinned ends, Euler's buckling theory for long columns. Critical stress, slenderness ratio, Rankine's formula for short columns.

Introduction to Theories of Failure, Rankine's theory for maximum normal stress, Guest's theory for maximum shear stress, Saint-Venant's theory for maximum normal strain, Hencky-von Mises theory for maximum distortion energy, Haigh's theory for maximum strain energy

Circumferential and Longitudinal stress in a thin cylindrical vessel, stresses in a thin spherical vessel

Text Books

1. Mechanics of materials in S.I.units, R .C. Hibbeler, Pearson Higher Education 2018

2. Advanced Mechanics of Solids, L. S. Srinath, TMH

3. Design of Machine Elements, V. B Bhandari

Reference Books

1. Strength of Materials, Surendra Singh, S. K. Kataria& Sons

2. Engineering Mechanics of Solids, Popov E., PHI 2002

3. Mechanics of Materials S. I. units, Beer, Johnston, Dewolf, McGraw Hills 2017

4. Mechanics of Materials, Pytel A. and Kiusalaas J. Cengage Learning India Private Limited, 2ndEdition, 2015

5. Strength of Materials, Rattan, McGraw Hills 2011

COURSE PLAN

No	Topic	No of lectures
1	Module 1: Stress and Strain Analysis	9 hours
1.1	Describe the deformation behaviour of elastic solids in equilibrium under the action of a system of forces. Describe method of sections to illustrate stress asresisting force per unit area. Stress vectors on Cartesian coordinate planes passing through a point and writing stress at a point in the form of a matrix.	2 hr
1.2	Equality of cross shear (Derivation not required). Write Cauchy's equation (Derivation not required),Find resultant stress, Normal and shear stress on a plane given stress tensor and direction cosines (no questions for finding direction cosines).	2 hr
1.3	Displacement, gradient of displacement, Cartesian strain matrix, Write strain- displacement relations (small-strain only), Simple problems to find strain matrix given displacement field (2D and 3D), write stress tensor and strain tensor for Plane stress and plane strain conditions.	1 hr
1.4	Concepts of principal planes and principal stress, characteristic equation of stress matrix and evaluation of principal stresses and principal planes as an eigen value problem, meaning of stress invariants, maximum shear stress	2 hrs
1.5	Mohr's circle for 2D case: find principal stress, planes, stress on an arbitrary plane, maximum shear stress graphically using Mohr's circle	2 hrs
2	Module 2: Stress - Strain Relationships	9 hours
2.1	Stress-strain diagram, Stress–Strain curves of Ductile and Brittle Materials, Poisson's ratio	1 hr
2.2	Constitutive equations-generalized Hooke's law, equations for linear elastic isotropic solids in in terms of Young's Modulus and Poisson's ratio (3D). Hooke's law for Plane stress and plane strain conditions Relations between elastic constants E, G, v and K, Numerical problems	2 hrs
2.3	Calculation of stress, strain and change in length in axially loaded members with single and composite materials, Effects of thermal loading – thermal stress and thermal strain. Thermal stress on a prismatic bar held between fixed supports.	2 hrs
2.4	Numerical problems for axially loaded members	4 hrs
3	Module 3: Torsion of circular shafts, Shear Force-Bending Moment Diagrams and Pure bending	9 hours
3.1	Torsional deformation of circular shafts, assumptions for shafts subjected to torsion within elastic deformation range, derivation of torsion formula	1 hr
3.2	Torsional rigidity, Polar moment of inertia, comparison of solid and hollow shaft. Simple problems to estimate the stress in solid and hollow shafts	1 hr
3.3	Numerical problems for basic design of circular shafts subjected to	1 hr

	externally applied torques	
3.4	Shear force and bending moment diagrams for cantilever and simply supported beams subjected to point load, moment, UDL and linearly varying load	2 hrs
3.5	Differential equations between load, shear force and bending moment.	1 hrs
3.6	Normal and shear stress in beams: Derivation of flexural formula, section modulus, flexural rigidity, numerical problems to evaluate bending stress, economic sections Shear stress formula for beams: Derivation, numerical problem to find shear stress distribution for rectangular section	3 hrs
4	Module 4: Deflection of beams, Strain energy	8 hours
4.1	Deflection of cantilever and simply supported beams subjected to point load, moment and UDL using Macauley's method (procedure and problems with multiple loads)	2 hrs
4.2	Linear elastic loading, elastic strain energy and Complementary strain energy. Elastic strain energy for axial loading, transverse shear, bending and torsional loads (short derivations in terms of loads and deflections).	2 hr
4.3	Expressions for strain energy in terms of load, geometry and material properties of the body for axial, shearing, bending and torsional loads. Simple problems to solve elastic deformations	2 hrs
4.4	Castigliano's second theorem to find displacements, reciprocal relation, proof for Castigliano's second theorem.	1 hr
4.5	Simple problems to find the deflections using Castigliano's theorem	1 hr
5	Module 5: Buckling of Columns, Theories of Failure, Thin pressure vessels	8 hours
5.1	Fundamentals of bucking and stability, critical load, Euler's formula for long columns, assumptions and limitations, effect of end conditions(derivation only for pinned ends), equivalent length	2 hr
5.2	Critical stress, slenderness ratio, Rankine's formula for short columns, Problems	2 hr
5.3	Introduction to Theories of Failure. Rankine's theory for maximum normal stress, Guest's theory for maximum shear stress, Saint-Venant's theory for maximum normal strain	1 hr
5.4	Hencky-von Mises theory for maximum distortion energy, Haigh's theory for maximum strain energy	1 hr
5.5	Circumferential and Longitudinal stress in a thin cylindrical vessel, stresses in a thin spherical vessel (short derivations) and numerical problems	2 hrs

MODEL QUESTION PAPER

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

THIRD SEMESTER B.TECH DEGREE EXAMINATION

Course Code : MRT205

Course Name : MECHANICS OF SOLIDS

Max. Marks : 100 Duration : 3 Hours

PART – A

(ANSWER ALL QUESTIONS, EACH QUESTION CARRIES 3 MARKS)

1. Express the stress invariants in terms of Cartesian components of stress and principal stress.
2. Write down the Cauchy's strain displacement relationships.
3. Distinguish between the states of plane stress and plane strain.
4. Represent the generalized Hooke's law for a Linear elastic isotropic material.
5. List any three important assumptions in the theory of torsion.
6. Write the significance of flexural rigidity and section modulus in the analysis of beams.
7. Discuss reciprocal relation for multiple loads on a structure.
8. Express the strain energy for a cantilever beam subjected to a transverse point load at free end.
9. Discuss Saint-Venant's theory of failure.
10. Compare the strength of a thin spherical vessel and a thin cylindrical vessel on the basis of hoop stress.

PART – B

(ANSWER ONE FULL QUESTION FROM EACH MODULE)

MODULE – 1

11.a) The state of stress at a point is given by σ_{xx} = 12.31 MPa, σ_{yy} = 8.96 MPa, σ_{zz} = 4.34 MPa, τ_{xy} = 4.2 MPa, τ_{yz} = 5.27 MPa, τ_{xz} = 0.84 MPa. Determine the principal stresses. (7 marks) b) The displacement field for a body is given by u= $(x^2 + y)i + (3 + z)j + (x^2 + 2y)k$. What is the deformed position of a point originally at (3,1,–2)? Write the strain tensor at the point (−3,−1,2).

(7 marks)

OR

12.a) The state of plane stress at a point is given by σ_{xx} = 40 MPa, σ_{yy} = 20 MPa andτ_{xy} = 16 MPa. Using Mohr's circle determine the i) principal stresses and principal planes and ii) maximum shear stress. (7 marks) b) The state of stress at a point is given below. Find the resultant stress vector acting on a plane with direction cosines n_x=0.47, n_y=0.82 and n_z=0.33. Find the normal and tangential stresses acting on this plane. (7 marks)

$$\sigma_{ij} = \begin{bmatrix} 10 & 5 & -10 \\ 5 & 20 & -15 \\ -10 & -15 & -10 \end{bmatrix} MPa$$

MODULE – 2

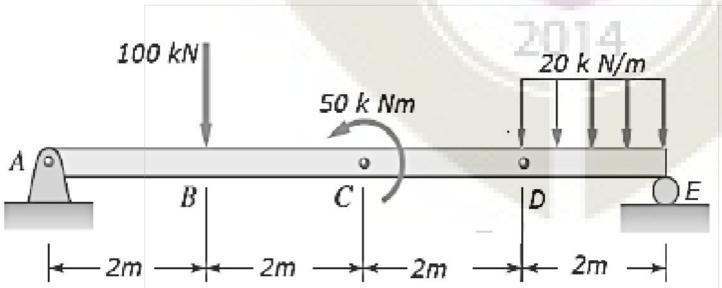
13.a) Calculate Modulus of Rigidity and Young's Modulus of a cylindrical bar of diameter 30 mm and of 1.5 m length if the longitudinal strain in a bar during a tensile stress is four times the lateral strain. Find the change in volume when the bar is subjected to a hydrostatic pressure of 100 N/mm^2. Take E = 10^5 N/mm (9 marks) b) A straight bar 450 mm long is 40 mm in diameter for the first 250 mm length and 20 mm diameter for the remaining length. If the bar is subjected to an axial pull of 15 kNfind the maximum axial stress produced and the total extension of the bar. Take E = $2x10^5 N/mm^2$ (5 marks)

OR

14.a) A brass bar 20mm diameter is enclosed in a steel tube of 25mm internal diameter and 50mm external diameter. Both bar and tube is of same length and fastened rigidly at their ends. The composite bar is free of stress at 20°C. To what temperature the assembly must be heated to generate a compressive stress of 48MPa in brass bar? Also determine the stress in steel tube. E_{steel} = 200GPa and E_{brass} = 84GPa, α_{steel} = 12 × 10^{-6} / °C and α_{brass}= 18 × 10^{-6} / °C. (9 marks)

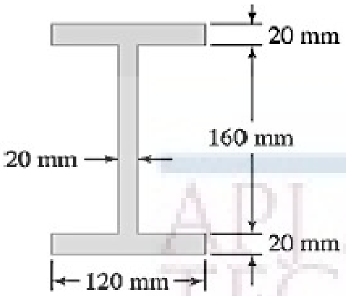
b) Draw the stress-strain diagram for a ductile material and explain the salient points.
(5 marks) MODULE – 3

15.a) Draw shear force and bending moment diagram for the beam given in the figure. (9 marks)



b) Compare the strength of a hollow shaft of diameter ratio 0.75 to that of a solid shaft by considering the permissible shear stress. Both the shafts are of same material, of same length and weight. (5 marks) OR

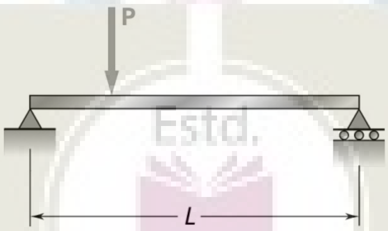
16.a) A simply supported beam of span of 10 m carries a UDL of 40 kN/m. The cross section is of I shape as given below. Calculatethe maximum stress produced due to bending and plot thebending stress distribution.   (9 marks)



b) The shear stress of a solid shaft is not to exceed 40 N/mm^2 when the power transmitted is 20 kW at 200 rpm. Determine the minimum diameter of the shaft. (5 marks) MODULE – 4

17.a) A horizontal girder of steel having uniform section is 14 m long and is simply supported at its ends. It carries concentrated loads of 120 kN and 80 kN at two points 3 m and 4.5 m from the two ends respectively. Moment of inertia for the section of the girder is 16×10^8 mm^4 and E_s = 210 kN/mm^2. Calculate the deflection of the girder at points under the two loads and maximum deflection using Macaulay's method. (8 marks) b) Derive the expressions for elastic strain energy in terms of applied load/moment and material property for the cases of a) Axial force b) Bending moment. (6 marks) OR

18.a) Calculate the displacement in the direction of load P applied at a distance of L/3 from the left end for a simply supported beam of span L as shown in the figure.



(8 marks)

b) State and prove Castigliano's second theorem.   (6 marks)

MODULE – 5

19.a) Find the crippling load for a hollow steel column 50mm internal diameter and 5mm thick. The column is 5m long with one end fixed and other end hinged. Use Rankine's formula and Rankine's constant as 1/7500 and σ_c = 335 N/mm^2. Compare this load by crippling load given by Euler's formula. Take E = 110 GPa. (8 marks) b) Explain the maximum normal stress theory, maximum strain energy theory and maximum shear stress theory of failure. (6 marks)

OR

20.a) A cylindrical shell 3m long closed at the ends has an internal diameter of 1m and wall thickness 15mm. Calculate the circumferential and longitudinal stresses induced and also the change in dimensions of the shell, if it is subjected to an internal pressure of 1.5MPa. Take E = 2×10^5 N/mm^2 and ν = 0.3. (9 marks)

b) Derive Euler's formula for a column with both ends hinged. (5 marks)

MRL201	ELECTRICAL TECHNOLOGY LAB	CATEGORY	L	T	P	CREDIT
		PCC	0	0	3	2

Preamble:

This course aims the students to learn about the introduction, working and testing methods of main basics machines of electrical.

Prerequisite: Nil

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

CO 1	Test and validate different types of dc motors.
CO 2	Test and validate different types of dc generators.
CO 3	Validate and to do different test in transformer.
CO 4	To measure power in a three phase system
CO 5	Test and validate different types of three phase induction motors
CO 6	Measure regulation of a given alternator

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	-	-	3	2	2	3	2	1	3
CO 2	3	2	1	-	-	3	2	2	3	2	1	3
CO 3	3	2	1	-	-	3	2	2	3	2	1	3
CO 4	3	2	1	-	-	3	2	2	3	2	1	3
CO 5	3	2	1	-	-	3	2	2	3	2	1	3
CO 6	3	2	1	-	-	3	2	2	3	2	1	3

Assessment Pattern

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	75	75	2.5 hours

Continuous Internal Evaluation Pattern:

Attendance : 15 marks
Continuous Assessment : 30 marks
Internal Test (Immediately before the second series test) : 30 marks

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 equipments and trouble shooting) : 25 Marks
(d) Viva voce : 20 marks
(e) Record : 5 Marks

General instructions: Mandatorily a minimum of nine experiments should be done among the following given experiments. 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

1. Brake test on DC series motor
2. Brake test on DC shunt motor.
3. Open circuit characteristics of dc shunt generator
4. Load test on dc shunt generator
5. Retardation test on a DC machine.
6. Load test on single phase transformer
7. OC and SC test on single phase transformer
8. Three phase power measurement using two wattmeter method
9. Load test on three phase squirrel cage induction motor
10. Load test on three phase slip ring induction motor
11. No load and block rotor test on three phase slip ring induction motor
12. Regulation of alternator by direct loading
13. Static characteristics of SCR.
14. Static characteristics of MOSFET.
15. Obtain output waveform of single phase bridge rectifier using SCR.

N.B Minimum of TEN experiments from the above list are to be done.

Text books

1. J.B. Gupta , Electrical machines, Katson books.
2. Theraja B. L, A textbook of electrical technology, S. Chand &company, New Delhi, 2008.
3. P.S. Bimbhra, Power Electronics, Khanna Publishers, New Delhi

Reference Books

1. Bimbra P. S., Electrical machinery, 7/e, Khanna publishers, 2011.

2. V.K. Mehta, Rohit Mehta, Principles of Electrical Machines, S Chand Publication

3. M. H. Rashid, Power Electronics Circuits, Devices and Applications, Pearson Education

MRL 203	ANALOG AND DIGITAL ELECTRONICS LAB	CATEGORY	L	T	P	CREDIT
		PCC	-	-	3	2

Preamble: This lab course is intended to impart working knowledge and design skills in analog and digital circuits. It also helps the students to demonstrate various applications in analog and digital circuits.

Prerequisite: ESL130 Electronics Workshop

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

CO 1	Set up an experiment to obtain the characteristics of BJT and FET.
CO 2	Acquire skills in designing and testing various applications of analog and digital integrated circuits
CO 3	Analyse and interpret the circuits using the softwares which are available for complex design methodologies.
CO 4	Design and implement analog and digital modules based on specifications.
CO 5	Enhance the ability to function effectively as an individual and in a team to accomplish the given task.

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	2	-	2	1	-	-	3	2	-	2
CO 2	3	3	3	3	2	1	1	1	3	2	2	3
CO 3	2	2	2	3	3	1	1	1	3	2	2	2
CO 4	3	3	2	2	2	1	1	1	3	2	2	2
CO 5	1	2	2	2	2	1	1	3	3	2	2	2

Assessment Pattern

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	75	75	2.5 hours

Continuous Internal Evaluation Pattern:

Attendance : 15 marks
Continuous Assessment : 30 marks
Internal Test (Immediately before the second series test) : 30 marks

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 equipments and trouble shooting) : 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.

Course Assessment Questions

1. For the given JFET, find out the pinch off voltage.
2. Design an inverting amplifier of gain 10.
3. Design a circuit to obtain the following transfer characteristics.

4. Generate a waveform with 50% duty cycle using IC 555.
5. Determine the lock in range and capture range of IC 565.
6. Design a 3 bit synchronous counter.
7. Design a full adder and implement it with universal gates.
8. Design a 4 bitgray to binary code converter.
9. Implement an 8:1 multiplexer.
10. Set up an experiment to learn the working of shift registers.

<u>LIST OF EXPERIMENTS</u> (At least 14 of the following experiments)

Any 5 experiments can be simulated using SPICE, Proetus, Scilab, Verilog or Matlab; any relevant package may be used.

1. Characteristics of CE amplifier.
2. Characteristics of JFET/MOSFET.
3. Design of RC Phase shift oscillator using BJT.
4. Study the characteristics of operational amplifier IC 741.
5. Inverting, non inverting amplifier and voltage follower.
6. Design of Differentiator / Integrator and Schmitt Trigger.
7. Design of Astable/monostable using IC 555.

8. Study the response of active first order LPF and HPF filters.
9. Design of PLL.
10. Study and Verify the truth tables of logic gates and flip flops.
11. Design and implementation of 3 bit full adder and subtractor.
12. Design and implementation of code converters using logic gates
    i. Binary to gray and Gray to Binary Code converter.
    ii. BCD to Excess 3 code and Excess 3 to BCD converter.
13. Design and implement Multiplexer and De-multiplexer using logic gates.
14. Design and implement encoder and decoder using logic gates.
15. Implementation of SISO, SIPO, PISO and PIPO shift registers using Flip- flops.
16. Design and implementation of 3bit synchronous and asynchronous counters
17. Construction and verification of 4bit Mod-10/Mod-12 Ripple counters.

Text Books

1. K A Navas, "Electronics Lab Manual-volume 1",PHI Learning Private Limited,2015.

Reference Books

1. Franco S., "Design with Operational Amplifiers and Analog Integrated Circuits", 3/e, Tata McGraw Hill, 2008

2. David A. Bell, "Operational Amplifiers & Linear ICs", Oxford University Press, 2ndedition, 2010.

3. Donald DGivone, "Digital Principles and Design", Tata McGraw Hill, 2003.

SEMESTER -3

MINOR

MRT 281	INTRODUCTION TO SENSORS AND ACTUATORS	CATEGORY	L	T	P	CREDIT
		VAC	4	0	0	4

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 to day life.

Prerequisite: Nil

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

CO 1	Get an exposure to sensors and actuators and its importance in the real world.
CO 2	Explain the working of magnetic sensors and its applications in real time scenario
CO 3	Model linear actuators and differentiate various solenoids
CO 4	Explain the working principle of different types ofrotary actuators
CO 5	Understand the basic idea on the controls in NC machine and fluidic system.

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2						2			
CO2	3	2	2						2			
CO3	3	2	2						2			
CO4	3	2	2						2			
CO5	3	2	2						2			

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. 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 actuators

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

Course Code: MRT 281

Course Name: INTRODUCTION TO SENSORS AND ACTUATORS

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

PARTA

Answer all Questions. Each question carries 3 Marks

1. What is the difference between a sensor and actuators?
2. Why stepper motors are widely used in Robotic applications?
3. What are the applications of Magnetic Speed Sensors?
4. What do you mean by Solid-State Sensors?
5. What are the applications of Solenoid Actuators?
6. Define linear actuator with an example.
7. List the applications of Claw Pole Rotary Actuator.
8. What do you mean by Rotary actuator?
9. Define Coanda effect.
10. Write a short note on encoders.

PART B

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

Module 1

11. Explain about - Linear and Latching Solenoid Actuators
12. Differentiate between soft and hard magnetic materials with suitable examples.

Module 2

13. Explain about VR sensors with suitable sketches.
14. Explain magnetic sensor in detail and identify some of its applications.

Module 3

15. Explain the working of Gasoline Injectors with neat sketches.
16. Compare Disk, Plunger and Ball solenoids.

Module 4

17. Explain Cylindrical Rotary Actuators with neat sketches.
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.

Module 5

19. Explain the working principle of interruptible jet sensor with necessary sketches.

20. Write short notes on the following: i) Resolver ii) Inductosync

Syllabus

Module 1 (9 Hours)

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(9 Hours)

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 (9 Hours)

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 (9 Hours)

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 (9 Hours)

Controls in NC Machines and fluidic control- stepping motors- feedback devices- encoders - resolvers - inductosync –Tachogenerators - principles of fluid logic control -Coanda effect - basic fluidic devices - fluidic logic gates - bistableflipflop - 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

Reference Books

1.Andrew Parr, “Hydraulics and Pneumatics“, Jaico Publishing House, Mumbai

2.YoramKoren, ‘Computer control of Manufacturing Systems’, TataMc.Graw Hill Publishers, New Delhi

3. Robert H. Bishop, “Mechatronic systems, Sensors and Actuators Fundamentals and Modelling, Taylor & Francis Group, 2007

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	Sensors and Actuators	
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	2
1.6	Magnetic Materials and Technology - Soft Magnetic Materials - Hard Magnetic Materials	2
1.7	Coating Technologies - Magnetic Materials Market and Applications	1
2	Magnetic Sensors	
2.1	Theory of Magnetic Sensors	1
2.2	Magnetic Sensor Analysis	2
2.3	VR Sensors	1
2.4	Solid-State Sensors	1
2.5	Magnetic Sensor Applications, Magnetic Speed Sensor Requirements -	2
2.6	Magnetic Speed Sensor Applications , Magnetic Position Sensor Applications -	1
2.7	VR Sensor Noise	1
3	Linear Actuators	
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	2
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	2
4	Rotary Actuators	
4.1	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 -	3
4.2	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	3
4.3	Cylindrical Rotary Actuators - Cylindrical Rotary Actuator PM - Cylindrical Rotary Actuator Excitation Electromagnetic Circuit - Cylindrical Rotary Actuator Toothed Magnetic Structure	2
4.4	Rotary Actuator Applications - Disk Rotary Actuator Application - Claw Pole Rotary Actuator Application - Cylindrical Rotary Actuator	1

	Application.	
5	Controls in NC Machines and fluidic control	
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	2
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.	1
5.8	Cone jet proximity sensor, Interruptible jet sensor.	1

SEMESTER -4

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
MRT202	THERMODYNAMICS	PCC	3	1	-	4

Preamble :

Thermodynamics is the study of energy . Without energy life cannot exist. Activities from breathing to the launching of rockets involves energy transactions and are subject to thermodynamic analysis. Engineering devices like engines, turbines, refrigeration and air conditioning systems, propulsion systems etc., work on energy transformations and must be analysed using principles of thermodynamics. So, a thorough knowledge of thermodynamic concepts is essential for a mechanical engineer. This course offers an introduction to the basic concepts and laws of thermodynamics.

Prerequisite : NIL

Course Outcomes :

After completion of the course the student will be able to

CO1	Understand basic concepts and laws of thermodynamics
CO2	Conduct first law analysis of open and closed systems
CO3	Determine entropy and availability changes associated with different processes
CO4	Understand the application and limitations of different equations of state
CO5	Determine change in properties of pure substances during phase change processes
CO6	Evaluate properties of ideal gas mixtures

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2										2
CO2	2	2	1	1								1
CO3	3	3	2	2								1
CO4	2	2	2	2								1
CO5	3	3	2	1								1
CO6	3	3	2	2								1

Assessment Pattern

Blooms Category	CA			ESA
	Assignment	Test - 1	Test - 2	
Remember	25	20	20	10
Understand	25	40	40	20
Apply	25	40	40	70
Analyse	25			
Evaluate				
Create				

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Test (2 numbers) : 25 marks

Assignment/Quiz/Course project : 15 marks

Mark distribution & Duration of Examination :

Total Marks	CA	ESE	ESE Duration
150	50	100	3 Hours

End semester 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

1. Discuss the limitations of first law of thermodynamics.

2. Second law of thermodynamics is often called a directional law . Why?

3. Explain Joule-Kelvin effect. What is the significance of the inversion curve ?

Course Outcome 2

1. A mass of 2.4 kg of air at 150 kPa and 12°C is contained in a gas – tight, frictionless piston – cylinder device. The air is now compressed to a final pressure of 600 kPa . During this process, heat is transferred from the air such that the temperature inside the cylinder remains constant. Calculate the work input during this process.

2. Carbon dioxide enters an adiabatic nozzle steadily at 1 MPa and 500°C with a mass flow rate of 600 kg/hr and leaves at 100 kPa and 450 m/s. The inlet area of the nozzle is 40 cm^2. Determine (a) the inlet velocity and (b) the exit temperature

3. A vertical piston – cylinder device initially contains 0.25 m^3 of air at 600 kPa and 300°C. A valve connected to the cylinder is now opened and air is allowed to escape until three-quarters of the mass leave the cylinder at which point the volume is 0.05 m^3. Determine the final temperature in the cylinder and the boundary work during this process.

Course Outcome 3

1.An adiabatic vessel contains 2 kg of water at 25˚C. B paddle – wheel work transfer, the temperature of water is increased to 30˚C. If the specific heat of water is assumed to be constant at 4.186 kJ/kg.K, find the entropy change of the universe.

2. Two kilograms of water at 80°C is mixed adiabatically with 3 kg of water at 30°C in a constant pressure process at 1 atm. Find the increase in entropy of the total mass of water due to the mixing process.

3. Argon enters an insulated turbine operating under steady state at 1000˚C and 2 MPa and exhausts at 350 kPa. The mass flow rate is 0.5 kg/s and the turbine develops power at the rate of 120 kW. Determine (a)the temperature of the argon at the turbine exit, (b) the irreversibility of the turbine and (c) the second law efficiency. Neglect KE and PE effects. Take T_o = 20˚C and P_o = 1 bar

Course Outcome 4

1. What are the limitations of ideal gas equation and how does Van der Waals equation overcome these limitations ?

2. Discuss law of corresponding states and its role in the construction of compressibility chart.

3. A rigid tank contains 2 kmol of N_2 and 6 kmol of CH_4 gases at 200 K and 12 MPa. Estimate the volume of the tank, using (a) ideal gas equation of state (b) the compressibility chart and Amagat's law

Course Outcome 5

1.Steam is throttled from 3 MPa and 600˚C to 2.5 MPa. Determine the temperature of the steam at the end of the throttling process.

2. Determine the change in specific volume, specific enthalpy and quality of steam as saturated steam at 15 bar expands isentropically to 1 bar. Use steam tables

3. Estimate the enthalpy of vapourization of steam at 500 kPa, using the Clapeyron equation and compare it with the tabulated value

Course Outcome 6

1. A gaseous mixture contains , by volume, 21%nitrogen, 50% hydrogen and 29 % carbon dioxide. Calculate the molecular weight of the mixture, the characteristic gas constant of the mixture and the value of the reversible adiabatic expansion index - γ. At 10˚C, the C_p values of nitrogen, hydrogen and carbon dioxide are 1.039, 14.235 and 0.828 kJ/kg.K respectively.

2. A mixture of 2 kmol of CO_2 and 3 kmol of air is contained in a tank at 199 kPa and 20˚C. Treating air to be a mixture of 79% N_2 and 21% O_2 by volume , calculate (a) the individual mass of CO_2 , N_2 and O_2, (b) the percentage content of carbon by mass in the mixture and (c) the molar mass , characteristic gas constant and the specific volume of the mixture

3. A gas mixture in an engine cylinder has 12% CO_2, 11.5 % O_2 and 76.5% N_2 by volume. The mixture at 1000˚C expands reversibly, according to the law $PV^{1.25}$ = constant, to 7 times its initial volume. Determine the work transfer and heat transfer per unit mass of the mixture.

SYLLABUS

Module 1: Role of Thermodynamics and it's applications in Engineering and Science –Basic Concepts Macroscopic and Microscopic viewpoints, Concept of Continuum, Thermodynamic System and Control Volume, Surrounding, Boundaries, Types of Systems, Universe, Thermodynamic properties, Process, Cycle, Thermodynamic Equilibrium, Quasi – static Process, State, Point and Path function. Zeroth Law of Thermodynamics, Measurement of Temperature, reference Points, Temperature Scales.

Module 2: Energy - Work - Pdv work and other types of work transfer, free expansion work, heat and heat capacity. Joule's Experiment- First law of Thermodynamics - First law applied to Non flow Process- Enthalpy- specific heats- PMM1, First law applied to Flow Process, Mass and Energy balance in simple steady flow process. Applications of SFEE, Transient flow –Filling and Emptying Process, Limitations of the First Law.

Module 3: Second Law of Thermodynamics, Thermal Reservoir, Heat Engine, Heat pump – Kelvin-Planck and Clausius Statements, Equivalence of two statements, Reversibility, Irreversible Process, Causes of Irreversibility, PMM2, Carnot's theorem and its corollaries, Absolute Thermodynamic Temperature scale. Clausius Inequality, Entropy- Entropy changes in various thermodynamic processes, principle of increase of entropy and its applications, Entropy generation, Entropy and Disorder, Reversible adiabatic process- isentropic process, Third law of thermodynamics, Available Energy, Availability and Irreversibility- Second law efficiency.

Module 4: Pure Substances, Phase Transformations, Triple point, properties during change of phase, T-v, p-v and p-T diagram of pure substance, p-v-T surface, Saturation pressure and Temperature, T-h and T-s diagrams, h-s diagrams or Mollier Charts, Dryness Fraction, steam tables. Property calculations using steam tables. The ideal Gas Equation, Characteristic and Universal Gas constants, Deviations from ideal Gas Model: Equation of state of real substances, Vander Waals Equation of State, Virial Expansion, Compressibility factor, Law of corresponding state, Compressibility charts.

Module 5: Mixtures of ideal Gases – Mole Fraction, Mass fraction, Gravimetric and volumetric Analysis, Dalton's Law of partial pressure, Amagat's Laws of additive volumes, Gibbs-Dalton's law Equivalent Gas constant and Molecular Weight, Properties of gas mixtures: Internal Energy, Enthalpy, specific heats and Entropy, Introduction to real gas mixtures- Kay's rule. General Thermodynamic Relations – Combined First and Second law equations – Helmholtz and Gibb's functions - Maxwell's Relations, Tds Equations. The Clapeyron Equation, equations for internal energy, enthalpy and entropy, specific heats, Throttling process, Joule Thomson Coefficient, inversion curve.

Text Books

1. P. K. Nag, Engineering Thermodynamics, McGraw Hill, 2013

2. E. Rathakrishnan Fundamentals of Engineering Thermodynamics, PHI, 2005

3. Y. A. Cengel and M. A. Boles, Thermodynamics an Engineering Approach, McGraw Hill, 2011

Reference Books:

1. Moran J., Shapiro N. M., Fundamentals of Engineering Thermodynamics, Wiley, 2006

2. R. E. Sonntag and C. Borgnakke, Fundamentals of Thermodynamics, Wiley, 2009

3. Holman J. P. Thermodynamics, McGraw Hill, 2004

4. M. Achuthan, Engineering Thermodynamics, PHI, 2004

COURSE PLAN

Module	Topics	Hours Allotted
1	Role of Thermodynamics and it's applications in Engineering and Science – Basic Concepts Macroscopic and Microscopic viewpoints, Concept of Continuum, Thermodynamic System and Control Volume, Surrounding, Boundaries, Types of Systems, Universe	1L
	Thermodynamic properties, Process, Cycle, Thermodynamic Equilibrium, Quasi – static Process, State, Point and Path function.	1L
	Zeroth Law of Thermodynamics, Measurement of Temperature, reference Points, Temperature Scales.	2L + 1T
2	Energy - Work - Pdv work and other types of work transfer, free expansion work, heat and heat capacity.	2L + 1T
	Joule's Experiment- First law of Thermodynamics - First law applied to Non flow Process- Enthalpy- specific heats- PMM1	2L + 1T
	First law applied to Flow Process, Mass and Energy balance in simple steady flow process. Applications of SFEE	2L + 1T
	Transient flow –Filling and Emptying Process, Limitations of the First Law.	1L + 1T
3	Second Law of Thermodynamics, Thermal Reservoir, Heat Engine, Heat pump – Kelvin-Planck and Clausius Statements, Equivalence of two statements	2L
	Reversibility, Irreversible Process, Causes of Irreversibility, PMM2, Carnot's theorem and its corollaries, Absolute Thermodynamic Temperature scale.	2L + 1T
	Clausius Inequality, Entropy- Entropy changes in various thermodynamic processes, principle of increase of entropy and its applications, Entropy generation, Entropy and Disorder, Reversible adiabatic process- isentropic process, Third law of thermodynamics	2L + 1T
	Available Energy, Availability and Irreversibility- Second law efficiency.	2L + 1T
	Pure Substances, Phase Transformations, Triple point, properties during change of phase, T-v, p-v and p-T diagram of pure substance, p-v-T surface,	2L

4	Saturation pressure and Temperature, T-h and T-s diagrams, h-s diagrams or Mollier Charts, Dryness Fraction, steam tables. Property calculations using steam tables	2L + 1T
	The ideal Gas Equation, Characteristic and Universal Gas constants, Deviations from ideal Gas Model: Equation of state of real substances, Vander Waals Equation of State, Virial Expansion, Compressibility factor, Law of corresponding state, Compressibility charts.	2L +1T
5	Mixtures of ideal Gases – Mole Fraction, Mass fraction, Gravimetric and volumetric Analysis, Dalton's Law of partial pressure, Amagat's Laws of additive volumes, Gibbs-Dalton's law.	2L
	Equivalent Gas constant and Molecular Weight, Properties of gas mixtures: Internal Energy, Enthalpy, specific heats and Entropy	1L +1T
	Introduction to real gas mixtures- Kay's rule	1L
	General Thermodynamic Relations – Combined First and Second law equations – Helmholtz and Gibb's functions - Maxwell's Relations	2L
	Tds Equations. The Clapeyron Equation, equations for internal energy, enthalpy and entropy, specific heats, Throttling process, Joule Thomson Coefficient, inversion curve.	2L + 1T

MODEL QUESTION PAPER

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FOURTH SEMESTER B.TECH DEGREE

EXAMINATION **Course Code : MRT202**

Course Name : THERMODYNAMICS

(Permitted to use Steam Tables and Mollier Chart)

Max. Marks : 100 Duration : 3 Hours

Part – A

Answer all questions.

1. Define thermodynamics. List a few of its applications

2.Differentiate between intensive and extensive properties.

3. Differentiate between heat and work.

4. Explain system approach and control volume approach as applied in the analysis of a flow process.

5. An inventor claims to have developed an engine that delivers 26 kJ of work using 82 kJ of heat while operating between temperatures 120°C and 30°C. Is his claim valid ? Give the reason for your answer.

6. Show that two reversible adiabatics cannot intersect

7.Define (i)critical point and (ii) triple point, with respect to water

8. Why do real gases deviate from ideal gas behaviour? When do they approach ideal behaviour?

9. Define Helmholtz function and Gibbs function and state their significance

10. Explain Kay's rule of real gas mixtures

(3 x 10 = 30 marks)

Part – B

Answer one full question from each module.

Module - 1

11.a] Explain macroscopic and microscopic approach to thermodynamics . (7 marks) b] With the aid of a suitable diagram, explain the working of constant volume gas thermometer. (7 marks)

OR

12.a] What is meant by thermodynamic equilibrium ? What are the essential conditions for a system to be in thermodynamic equilibrium ? (7 marks)

b] Express the temperature of 91^{o}C in (i) Farenhiet (ii) Kelvin (iii) Rankine. (7 marks)

Module – 2

13.a] A mass of 2.4 kg of air at 150 kPa and 12°C is contained in a gas – tight, frictionless piston – cylinder device. The air is now compressed to a final pressure of 600 kPa . During this process, heat is transferred from the air such that the temperature inside the cylinder remains constant. Calculate the work input during this process. (7 marks)

b] A 2 m^3 rigid tank initially contains air at 100 kPa and 22^{o}C. The tank is connected to a supply line through a valve. Air is flowing in the supply line at 600 kPa and 22^{o}C. The valve is opened, and air is allowed to enter the tank until the pressure in the tank reaches the line pressure, at which point the valve is closed. A thermometer placed in the tank indicates that the air temperature at the final state is 77^{o}C. Determine, (i) the mass of air that has entered the tank and (ii) the amount of heat transfer. (7 marks)

OR

14.a] A turbine operates under steady flow conditions, receiving steam at the following conditions : pressure 1.2 MPa, temperature 188°C, enthalpy 2785 kJ/kg, velocity 33.3 m/s and elevation 3m. The steam leaves the turbine at the following conditions : pressure 20 kPa, enthalpy 25kJ/kg, velocity 100 m/s, and elevation 0 m. Heat is lost to the surroundings at the rate of 0.29 kJ/s. If the rate of steam flow through the turbine is 0.42 kg/s, what is the power output of the turbine in kW ? (7 marks)

b] State the general energy balance equation for an unsteady flow system and from it, derive the energy balance equation for a bottle filling process, stating all assumptions. (7 marks)

Module – 3

15.a]State the Kelvin-Planck and Clausisus statements of the second law of thermodynamics and prove their equivalence. (7 marks)

b]A heat engine operating between two reservoirs at 1000 K and 300 K is used to drive a heat pump which extracts heat from the reservoir at 300 K at a rate twice that at which the engine rejects heat to it. If the efficiency of the engine is 40 % of the maximum possible and the COP of the heat pump is 50 % of the maximum possible, what is the temperature of the reservoir to which the heat pump rejects heat ? What is the rate of heat rejection from the heat pump, if the rate of heat supply to the engine is 50kW ? (7 marks)

OR

16.a] A house is to be maintained at 21°C during winter and at 26°C during summer. Heat leakage through the walls, windows and roof is about 3000 kJ/hr per degree temperature difference between the interior of the house and the environment. A reversible heat pump is proposed for realising the desired heating and cooling. What is the minimum power required to run the heat pump in the reverse, if the outside temperature during summer is 36°C? Also find the lowest environment temperature during winter for which the inside of the house can be maintained at 21°C consuming the same power. (7 marks)

b] Air enters a compressor in steady flow at 140 kPa, 17°C and 70 m/s and leaves at 350 kPa, 127°C and 110 m/s. The environment is at 100 kPa and 7°C. Calculate per kg of air (a) the actual work required (b) the minimum work required and (c) the irreversibility of the process. (7 marks)

Module – 4

17.a]Show the constant pressure transformation of unit mass of ice at atmospheric pressure and -20°C to superheated steam at 220°C on P-v , T-v and P-T coordinate systems and explain their salient features . (7 marks)

b] A rigid vessel of volume 0.3 m^3 contains 10 kg of oxygen at 300 K. Using (i) the perfect gas equation and (ii) the Van der Waal's equation of state, determine the pressure of oxygen in the vessel. Take the Van der Waal's constants for oxygen as a =0.1382 m^6 Pa/ mol^2 and b=0.03186 m^3/ kmol . (7 marks)

OR

18.a]Steam at 25 bar and 300°C expands isentropically to 5 bar. Calculate the change in enthalpy, volume and temperature of unit mass of steam during this process using steam tables and Mollier chart and compare the values (7 marks)

b]Explain law of corresponding states and its significance to the generalized compressibility chart. (7 marks)

Module – 5

19.a] Derive the expressions for the equivalent molecular weight and characteristic gas constant for a mixture of ideal gases. (6 marks)

b] 0.5 kg of Helium and 0.5 kg of Nitrogen are mixed at 20°C and at a total pressure of 100 kPa. Find (i) volume of the mixture (ii) partial volumes of the components (iii) partial pressures of the components (iv) the specific heats of the mixture and (v) the gas constant of the mixture. Take ratio of specific heats for Helium and Nitrogen to be 1.667 and 1.4 respectively. (8 marks)

OR

20.a] 2 kg of carbon dioxide at 38°C and 1.4 bar is mixed with 5 kg of nitrogen at 150°C and 1.03 bar to form a mixture at a final pressure of 70 kPa. The process occurs adiabatically in a steady flow apparatus. Calculate the final temperature of the mixture and the change in entropy during the mixing process. Take specific heat at constant pressure for CO_2 and N_2 as 0.85 kJ/kg.K and 1.04 kJ/kg respectively. (7 marks)

b]Derive the Maxwell relations. Explain their significance ? (7 marks)

MRT 204	SENSORS AND ACTUATORS	CATEGORY	L	T	P	CREDIT
		PCC	3	1	0	4

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 to day life.

Prerequisite: Nil

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

CO 1	Get an exposure to sensors and actuators and its importance in the real world.
CO 2	Explain the working of magnetic sensors and its applications in real time scenario
CO 3	Model linear actuators and differentiate various solenoids
CO 4	Explain the working principle of different types of rotary actuators
CO 5	Understand the basic idea on the controls in NC machine and fluidic 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	2						2			
CO 2	3	2	2						2			
CO 3	3	2	2						2			
CO 4	3	2	2						2			
CO 5	3	2	2						2			

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. 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 actuators

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

Course Code: MRT 204

Course Name: SENSORS AND ACTUATORS

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

PARTA

Answer all Questions. Each question carries 3 Marks

1. What is the difference between a sensor and actuators?
2. Why stepper motors are widely used in Robotic applications?
3. What are the applications of Magnetic Speed Sensors?
4. What do you mean by Solid-State Sensors?
5. What are the applications of Solenoid Actuators?
6. Define linear actuator with an example.
7. List the applications of Claw Pole Rotary Actuator.
8. What do you mean by Rotary actuator?
9. Define Coanda effect.
10. Write a short note on encoders.

PART B

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

Module 1

11. Explain about - Linear and Latching Solenoid Actuators
12. Differentiate between soft and hard magnetic materials with suitable examples.

Module 2

13. Explain about VR sensors with suitable sketches.
14. Explain magnetic sensor in detail and identify some of its applications.

Module 3

15. Explain the working of Gasoline Injectors with neat sketches.
16. Compare Disk, Plunger and Ball solenoids.

Module 4

17. Explain Cylindrical Rotary Actuators with neat sketches.
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.

Module 5

19. Explain the working principle of interruptible jet sensor with necessary sketches.
20. Write short notes on the following: i) Resolver ii) Inductosync

Syllabus

Module 1 (9 Hours)

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 (9 Hours)

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 (9 Hours)

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 (9 Hours)

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 (9 Hours)

Controls in NC Machines and fluidic control- stepping motors- feedback devices- encoders - resolvers - inductosync –Tachogenerators - 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

Reference Books

1. Andrew Parr, "Hydraulics and Pneumatics", Jaico Publishing House, Mumbai

2. Yoram Koren, 'Computer control of Manufacturing Systems', TataMc.Graw Hill Publishers, New Delhi

3. Robert H. Bishop, "Mechatronic systems, Sensors and Actuators Fundamentals and Modelling, Taylor & Francis Group, 2007

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	Sensors and Actuators	
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	2
1.6	Magnetic Materials and Technology - Soft Magnetic Materials - Hard Magnetic Materials	2
1.7	Coating Technologies - Magnetic Materials Market and Applications	1
2	Magnetic Sensors	
2.1	Theory of Magnetic Sensors	1

2.2	Magnetic Sensor Analysis	2
2.3	VR Sensors	1
2.4	Solid-State Sensors	1
2.5	Magnetic Sensor Applications, Magnetic Speed Sensor Requirements -	2
2.6	Magnetic Speed Sensor Applications , Magnetic Position Sensor Applications -	1
2.7	VR Sensor Noise	1
3	Linear Actuators	
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	2
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	2
4	Rotary Actuators	
4.1	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 -	3
4.2	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	3
4.3	Cylindrical Rotary Actuators - Cylindrical Rotary Actuator PM - Cylindrical Rotary Actuator Excitation Electromagnetic Circuit - Cylindrical Rotary Actuator Toothed Magnetic Structure	2
4.4	Rotary Actuator Applications - Disk Rotary Actuator Application - Claw Pole Rotary Actuator Application - Cylindrical Rotary Actuator Application.	1
5	Controls in NC Machines and fluidic control	
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	2
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.	1
5.8	Cone jet proximity sensor, Interruptible jet sensor.	1

MRT206	MICROPROCESSOR & EMBEDDED SYSTEMS	CATEGORY	L	T	P	CREDIT
		PCC	3	1	0	4

Preamble:

The Purpose of the course is to provide the students the knowledge of Microprocessors, Microcontroller and embedded systems. This course is emphasis on architecture, Programming and system design of 8085 microprocessor and 8051 microcontrollers. The course is intended for making the basic knowledge in Embedded systems, Embedded C and development tools.

Prerequisite:

MRT203 DIGITAL AND ANALOG CIRCUITS

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

CO 1	**Understand the basic concepts of 8085 microprocessor**
CO 2	**Understand the basic concepts of 8085 interfacing with input output devices and memory device**
CO 3	**Understand the overview of an Embedded Systems**
CO 4	**Interpret the basic concepts of 8051 microcontroller**
CO 5	**Interface peripheral devices with 8051 microcontrollers**
CO 6	**Write C/Assembly Program for a microcontroller**

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	3				1			3
CO 2	3	3	3	3	3				1			3
CO 3	3	2	2	2	1				1			3
CO 4	3	2	2	2	1				1			3
CO 5	3	3	3	3	3				1			3
CO 6	3	3	3	3	3				1			3

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. Describe various interrupt sources on a 8085 processor

2. List the various jump instructions by 8085 processor

3. Develop a assembly program to sort N number in ascending order

Course Outcome 2 (CO2)

1. State the functionality of Program counter in a microprocessor

2. Describe memory interface in 8085 processor

3. Define the instruction cycle for an 8085 processor

Course Outcome 3(CO3):

1. List the various tools used in embedded systems development

2. Differentiate a Microprocessor and Microcontroller

3. Describe the features and characteristics of embedded systems

Course Outcome 4 (CO4):

1. Describe 8051 architecture with a neat block diagram.

2. Illustrate Memory organization in 8051 microcontrollers.

3. Describe addressing modes of 8051 with example

Course Outcome 5 (CO5):

1. Show the program for generating 1 KHz signal

2. Demonstrate the working of serial peripheral in 8051

3. Design a system to actuate a stepper motor to 45 degree clock wise

Course Outcome 6 (CO6):

1.Show the program to add two 16-bit number using 8051 controllers

2. Write a C program to send string "Hello" through serial port

3. Demonstrate bit manipulating instruction with example

Model Question paper

Course Code: MRT206

Course Name: MICROPROCESSOR & EMBEDDED SYSTEMS

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

PARTA

Answer all Questions. Each question carries 3 Marks

1. Describe flag register in the 8085 microprocessors

2. Differentiate register and memory addressing mode with an example

3. Discuss mode 1 of 8255 PPI with diagram

4. Draw the timing diagram for Memory Read operation.

5. Differentiate between hard & soft real time systems.

6. What are the demerits of Waterfall Model?

7. Explain the following instructions used in 8051 microcontrollers.

i) MOV R1, #05H ii) ADD A, #01H iii) MOV R2, 07H

8. Explain with neat diagram the RAM of 8051.

9. Define the structure of an Embedded C program

10. Explain I/O ports and its functions in 8051.

PART B

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

Module 1

11.a. Draw and explain 8085 Architecture with neat diagram

b. List the various jump instructions by 8085 processor

12 a. Develop an assembly program to sort N number in ascending order

Module 2

13. Design a LED blinking system with 8085 and 8255

14.a. Explain Fetch cycle & Execute cycle in 8085.

b. Describe memory interface in 8085 processor

Module 3

15. Explain i) Compiler ii) Assembler iii) Linker iv) Loaders.

16. a. List the field of applications for an embedded system.

b. List out the challenges in Embedded Systems.

Module 4

17 a. Write an ALP in 8051 to add two 32-bit numbers & store the result.

b. Explain with neat diagram the Register organisation and SFR in 8051.

18 Explain with neat block diagram the architecture of 8051 Microcontroller

Module 5

19. Write a C program to send string “Hello” through serial port

20. Explain with suitable diagram and program, how an ADC can be interfaced with 8085 Microprocessor.

Syllabus

Module	Topics	Hr
1	8085 Microprocessor: Evolution of Microprocessors- 8085 Architecture – Addressing modes- Classification of Instruction set- Interrupts-introduction to assembly language programming –code conversion, sorting–binary and BCD arithmetic.	**9**
2	Timing and control–Machine cycles, instruction cycle and T states–fetch and execute cycles– Timing diagram for instructions. IO and memory interfacing –Address decoding–I/O ports – Programmable peripheral interface PPI 8255 -Modes of operation. Interfacing of LEDs	**9**
3	Introduction to Embedded Systems-Application domain of embedded systems, features and characteristics, System model, Microprocessor Vs Microcontroller, current trends and challenges, hard and soft real time systems, Embedded product development, Life Cycle Management (water fall model), Tool Chain System, Assemblers, Compilers, linkers, Loaders, Debuggers Profilers & Test Coverage Tools-cross compilation	**9**
4	8051 Microcontroller: Selection of Microcontrollers - 8051 Microcontroller Architecture-Memory organization –Special function registers –Addressing modes – Instruction set - Introduction to assembly language programming using 8051(basic arithmetic operations)- Interrupts.	**9**
5	Embedded C Programming: structure of an embedded C program -data type-key words- basic programming using embedded C (bit level manipulations-accessing and configuring of different status, control and peripheral registers) Peripheral Programming: I/O port programming – Timer programming – Serial communication programming – Peripheral Interfacing diagram and programming of A/D and D/A converters, Stepper motor.	**9**

Text Books

1. Ramesh S Gaonkar, Microprocessor Architecture, Programming and applications with the 8085, Architecture, Programming and Applications, Penram International Publishing PVT Ltd. 6th Edition

2.Mazidi Muhammad Ali, Mazidi Janice Gillispie and McKinlayRolin, ―The 8051 Microcontroller and Embedded Systems, 2 nd Edition, Prentice Hall of India, New Delhi, 2013.

3. Lyla B Das – Embedded Systems – An Integrated Approach, Pearson Publication, sixth edition 2014

Reference Books

1.Douglas V. Hall, Microprocessors and Interfacing, Tata McGraw Hill, Education, New

2. Mathur A., Introduction to Microprocessors, Tata McGraw Hill, New Delhi,1992.

3. Rafiquzzaman, Microprocessor Theory and Application, PHI Learning, First Edition. 7.

4. Ray A joy and Burchandi, Advanced Microprocessor & Peripherals, Tata McGraw Hill, Education, New Delhi, Second Edition.

5. Scott MacKenzie, Raphael C W Phan, "The8051Microcontroller", Fourth Edition, Pearson education Delhi, Third Edition. /Prentice hall of India International Publishing; Sixth edition,2014.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	8085 Microprocessor	
1.1	Evolution of Microprocessors- 8085 Architecture	1
1.2	Addressing modes	1
1.3	Classification of Instruction set	3
1.4	Interrupts	2
1.5	Introduction to assembly language programming –code conversion, sorting–binary and BCD arithmetic.	2
2	8085 Interfacing	
2.1	Timing and control–Machine cycles, instruction cycle and T states	2
2.2	fetch and execute cycles– Timing diagram for instructions.	2
2.3	IO and memory interfacing	1
2.4	Address decoding–I/O ports	1
2.5	Programmable peripheral interface PPI8255 -Modes of operation.	2
2.6	Interfacing of LEDs	1

3	Introduction to Embedded Systems	
3.1	Application domain of embedded systems, features and characteristics, System model	2
3.2	Microprocessor Vs Microcontroller, current trends and challenges, hard and soft real time systems,	2
3.3	Embedded product development, Life Cycle Management (water fall model)	2
3.4	Tool Chain System, Assemblers, Compilers, linkers, Loaders, Debuggers Profilers & Test Coverage Tools-cross compilation	3
4	8051 Microcontroller	
4.1	Selection of Microcontrollers - 8051 Microcontroller Architecture	1
4.2	Memory organization	1
4.3	Special function registers	1
4.4	Addressing modes	1
4.5	Instruction set	2
4.6	Introduction to assembly language programming using 8051(basic arithmetic operations)	2
4.7	Interrupts.	1
5	Embedded C Programming	
5.1	structure of an embedded C program -data type-key words- basic programming using embedded C (bit level manipulations-accessing and configuring of different status, control and peripheral registers)	3
5.2	I/O port programming	1
5.3	Timer programming	1
5.4	Serial communication programming	1
5.5	Peripheral Interfacing diagram and programming of A/D and D/A converters, Stepper motor.	3

MRL202	MECHANICAL ENGINEERING LAB	CATEGORY	L	T	P	CREDIT
		PCC	0	0	3	2

Preamble: The main objective of this course is to demonstrate the applications of heat transfer, heat exchangers, and the principles of dynamics of machinery.

Prerequisite: MRT202 Thermodynamics,

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

CO 1	Estimate heat transfer coefficient, LMTD and assess the performance of heat exchangers.
CO 2	Acquire necessary skills to conduct experiments on modes of heat transfer, collect data, perform analysis and interpret results to draw valid conclusions through standard test procedures.
CO 3	Asses the performance of vapour compression refrigeration and air conditioning systems.
CO 4	Evaluate the performance of heat pipes.
CO 5	Perform calibration of thermometers and pressure gauges.
CO 6	Demonstrate the effect of unbalances resulting from rotary motions.
CO 7	Visualise the effect of dynamics on vibrations in single and multi degree of freedom systems.
CO 8	Demonstrate the working principle of governor/ gyroscope and demonstrate the effect of forces and moments on their motion.

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	2	1	1	-	-	-	-	2	1	-	-
CO 2	3	2	1	1	-	-	-	-	2	1	-	-
CO 3	3	2	1	1	-	-	-	-	2	1	-	-
CO 4	3	2	1	1	-	-	-	-	2	1	-	-
CO 5	3	2	1	1	-	-	-	-	2	1	-	-
CO 6	3	3	1	2	-	-	-	-	2	1	-	-
CO 7	3	3	1	2	-	-	-	-	2	1	-	-
CO 8	3	3	1	2	-	-	-	-	2	1	-	-

Assessment pattern
Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	75	75	2.5 hours

Continuous internal evaluation pattern:
Attendance : **15 Marks**
Continuous Assessment : **30 Marks**
Internal Test (Immediately before the second series test) : **30 Marks**

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 equipments and trouble shooting) : 25 Marks
(d) Viva voce : 20 marks
(e) Record : 5 Marks

Course level assessment questions:
Course Outcome 1 (CO 1):
1. Define effectiveness of a heat exchanger.
2. Under what conditions is the effectiveness NTU method preferred over LMTD method as a method of analysis of a heat exchanger?
3. Under what conditions can a counter flow heat exchanger have an effectiveness of one? What would be your answer for a parallel flow heat exchanger?
4. Explain LMTD for counter flow heat exchanger

Course Outcome 2 (CO 2)
1. Does the use of insulation (outside a heated cylindrical tube) always result in a decrease in heat loss? Justify your answer.
2. What are the differences between forced and free convection?
3. What are the factors that affect the magnitude of convective heat transfer coefficient for:
(i) Free convection and (ii) Forced convection for flow in a pipe
4. Can the overall heat transfer coefficient (U) for heat flow from a composite slab to (with convection and conduction taking place) be greater than the convective heat transfer coefficient (h)? Explain.
5. When does one use (i) Fourier number (ii) Nusselt Number (iii) Stanton Number ?
7. Explain why the temperature boundary layer grows much more rapidly than the velocity boundary layer in liquid metals.
8. What is the physical significance of the Schmidt number (S_c)? What is the heat transfer equivalent of this number? What does S_c = 1 signify?
6. What is a (i) gray surface (ii) diffuse surface?

Course Outcome 3 (CO 3):
1. The outside air at 31°C dry bulb temperature and 18.5°C wet bulb temperature enters a cooling coil at the rate of 40 m^3 /min. the effective surface temperature of the cooling coil is 4.5°C and its cooling capacity is 12.5kW of refrigeration. Find (a) dry bulb temperatures of the air leaving the coil, (b) enthalpy of air leaving the coil, (c) by pass factor of the coil.
2. Explain the following terms in brief. DBT, WBT, DPT
3. Explain the effect of Sub-cooling and Super-heating of on the performance of a simple vapour compression refrigeration system.

Course Outcome 4 (CO 4):
1. What are the primary heat transport limitations of a heat pipe?
2. What is the major heat transfer mechanism in a heat pipe?
3. What are the major operation limits of a heat pipe
4. A heat pipe with copper shell, copper wick and water as the working fluid is transferring 100W thermal power at steady-state operating conditions. The heat pipe dimensions are as follows: evaporator length = 0.1 m, condenser length = 0.1 m, adiabatic section length = 0.1

m and an outer diameter = 0.01 m. The average evaporator and condenser section temperatures of the heat pipe are measured as 105C and 95C respectively, calculate (a) the thermal resistance and (b) the effective thermal conductivity of the heat pipe.

5. What is a thermosyphon heat pipe? Comment on the thermal conductivity of a typical thermosyphon heat pipe?

Course Outcome 5 (CO 5):

1. Name three types of thermocouples with their respective composition and polarity. 2. What do you mean by: (i) cold junction compensation (ii) linearization?
3. What are the measuring ranges of different types of thermocouples?
4. What is a thermopile?
5. What is the difference between a RTD and PRT sensor?
6. What is automatic cold junction compensation?
7. What are the application advantages of a dead weight tester and a gauge comparator?
8. Write the types of Bourdon tubes? Explain the purpose of different Bourdon tubes.

Course Outcome 6 (CO 6):

1. What do you mean by static and dynamic balance of machinery
2. What do you mean by whirling of shaft?
3. What are the factors that affect the critical speed of a shaft?
4. What is (i) swaying couple (ii) Tractive force?

Course Outcome 7 (CO 7):

1. What is meant by free vibration and forced vibrations?
2. What is the significance of the node point in the case of vibration?
3. What do you mean by damping coefficient?
4. Define damping ratio (i) Damping ratio (ii) Logarithmic decrement
5. What is meant by dynamic magnifier or magnification factor?
6. Specify the importance of vibration isolation?
7. What is the condition to be satisfied for complete balance of in-line engine?
8. What are the effects of an unbalanced primary force along the line of stroke of two cylinder locomotive?

Course Outcome 8 (CO 8):

1. What is gyroscopic couple?
2. What is meant by active and reactive gyroscopic couple?
3. What is the effect of gyroscopic couple on a two wheeled vehicle while taking a turn?
4. Describe the right-hand rule to find the direction of angular velocity, momentum, and torque in a gyroscope.
5. What is meant by isochronous governor?
6. What is meant by hunting in a governor?

LIST OF EXPERIMENTS

Hear transfer

1. Determination of LMTD and effectiveness of parallel flow, counter flow and cross flow heat exchangers (double pipe heat exchanger).
2. Determination of heat transfer coefficients in free convection (free convection apparatus).

3. Determination of heat transfer coefficients in forced convection (forced convection apparatus).
4. Determination of thermal conductivity of solids (composite wall).
5. Determination of thermal conductivity of powder.
6. Determination of thermal conductivity of liquids.
7. Determination of emissivity of a specimen (emissivity apparatus).
8. Determination of Stefan Boltzman constant (Stefan Boltzmann apparatus).
9. Study and performance test on refrigeration (refrigeration test rig).
10. Study and performance test air conditioning equipments (air conditioning test rig).
11. Performance study on heat pipe (heat pipe).
12. Calibration of thermocouples.
13. Calibration of pressure gauge.

Dynamics

14. Whirling of shaft.
15. Gyroscope.
16. Universal governor apparatus.
17. Free vibration analysis.
18. Forced vibration analysis.

Note: Minimum 9 experiments in heat transfer and 3 experiments in dynamics are mandatory

Reference Books:

1. Y. A. Cengel, A. J. Ghajar, Heat and Mass Transfer: Fundamentals and Applications, 5^{th} Ed., McGraw Hill, 2015.
2. J. P. Holman, S. Bhattacharyya, Heat Transfer, 10^{th} Ed., McGraw Hill, 2011.
3. Frank P. Incropera, David P. Dewitt, T. L. Bergman, A. S. Lavine, Incropera's Principle of Heat and Mass Transfer, Wiley, 2018.
4. R. C. Sachdeva, Fundamentals of Engineering Heat and Mass Transfer, 5^{th} Ed., New Age International Publishers, 2017.
5. R. K. Rajput, Heat and mass transfer, 7^{th} Ed., S. Chand & Co., 2018.
6. C. P. Kothandaraman, Fundamentals of Heat and Mass Transfer, 4^{th} Ed., New Age International, 2012.
7. R. J. Dossat, T. J. Horan, Principles of Refrigeration, 5^{th} Ed., Pearson Education, 2001
8. W. F. Stoecker, J. W. Jones, Refrigeration and Air-Conditioning, 2^{nd} Ed., McGraw-Hill Education, 2009.
9. C. P. Arora, Refrigeration and Air Conditioning, 3^{rd} Ed., McGraw Hill Education, 2017.
10. W. T. Thompson, M. D. Dahleh, C. Padmanabhan, Theory of vibration with applications, 5^{th} Ed., Pearson, 2008.
11. D. H. Myskza, Machines and Mechanisms Applied Kinematic Analysis, 4^{th} Ed., Pearson Education, 2012.
12. V. P. Singh, Theory of Machines, 6th Ed., Dhanpat Rai & Co., 2017.
13. J. J. Uicker Jr., G. R. Pennock, J. E. Shigley, Theory of Machines and Mechanisms, 4^{th} Ed., Oxford University Press, 2014.
14. C. E. Wilson, J. P. Sadler, Kinematics and Dynamics of Machinery, 3^{rd} Ed., Pearson Education, 2003.

15. S. S. Rattan, Theory of Machines, McGraw Hill, 2017.
16. P. L. Ballaney, Theory of Machines and Mechanisms, 25th Ed., Khanna Publishers, 2015.
17. A. Ghosh, A. K. Malik, Theory of Mechanisms and Machines, Affiliated East West Press, 2008.
18. A. R. Holowenko, Dynamics of Machinery, John Wiley, 1955.

MRL204	MICROPROCESSOR & EMBEDDED SYSTEM LAB	CATEGORY	L	T	P	CREDIT
		PCC	0	0	3	2

Preamble: Microprocessor and Embedded Systems Lab course helps the students to develop their knowledge on processor architecture and the programming skills. This laboratory course provides hands-on experience to interface I/O devices, perform A/D and D/A conversions, motor interfacing etc. The skills acquired through the experiments help the students to do their projects and enhance their knowledge on the latest trends and technologies.

Prerequisite: Nil

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

CO 1	**Execute new assembly language programs using instruction sets of 8085.**
CO 2	**Develop assembly and C Programs for 8051 microcontrollers.**
CO 3	**Design interfacing circuits with 8051 microcontrollers.**
CO 4	**Adapt and analyse various interfacing devices with 8085 microprocessors.**
CO 5	**Develop a microcontroller-based system for mechatronics 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	2	3	2	-	-	3	1	2	3
CO 2	3	3	3	2	3	3	-	-	3	1	2	3
CO 3	3	3	3	2	3	3	-	-	3	1	2	3
CO 4	3	3	3	2	3	2	-	-	3	1	2	3
CO 5	3	3	3	2	3	3	-	-	3	1	2	3

Assessment Pattern

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	75	75	2.5 hours

Continuous Internal Evaluation Pattern:

Attendance : 15 marks
Continuous Assessment : 30 marks
Internal Test (Immediately before the second series test) : 30 marks

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.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Construct an 8085 program to find sum of two 16-bit numbers
2. Develop an 8085 program to find square root of a number
3. Create 8085 program to sort N number in ascending order

Course Outcome 2 (CO2)

1. Develop an 8051 program to convert Binary to BCD
2. Construct an 8051 program to transfer N elements
3. Write an 8051 program to multiply two 8-bit number

Course Outcome 3(CO3):

1. Design a system for Interfacing D/A converter with 8051
2. Develop a system to generate triangular wave with 8051
3. Construct a circuit for Interfacing A/D converter with 8051

Course Outcome 4 (CO4):

1. Design a system for Interfacing D/A converter with 8085
2. Develop a system to generate triangular wave with 8085
3. Construct a circuit for Interfacing stepper motor

Course Outcome 5 (CO5):

1. Setup an interface to run DC motor
2. Design a LED chaser with microcontroller board
3. Develop a program to display a string in LCD

LIST OF EXPERIMENTS

MICROPROCESSOR EXPERIMENTS :(Any Six experiments using trainer kit or open source simulator)

1. Addition and subtraction of 8-bit numbers

2. Multi byte addition

3. Addition and subtraction of two BCD numbers.

4. Programs on Data Transfer Instructions

5. Square, Square root and Cube program

6. Sorting

7. Largest and smallest number in an array

8. Interfacing with A/D or D/A converters

9. Interfacing with stepper motors

EMBEDDED SYSTEM EXPERIMENTS: (Out of first six, any four experiments using 8051 trainer kit or 8051 simulators. Out of the last 3 experiments, any two experiments using 8051 Development board or any other open source hardware platforms like PIC, Arduino, MSP430, ARM etc) (at least 6 experiments are mandatory)

1. Data transfer instructions using different addressing modes and block transfer.

2. Arithmetic operations in binary and BCD-addition, subtraction, multiplication and division

3. Logical instructions- sorting of arrays in ascending and descending order

4. Binary to BCD conversion and vice versa.

5. Interfacing D/A converter- generation of simple waveforms-triangular wave, ramp etc

6. Interfacing A/D converter

7. Square wave generation.

8. LED and LCD display interfacing

9. Motor control

Text Books

1. Ramesh S Goankar. 8085 Microprocessors Architecture Application and Programming. Penram international, 5th Edition.

2. Kenneth J Ayala, The 8051 Microcontroller, Cengage learning, 3rd edition.

3. Microprocessors and Microcontrollers: Lyla. B. Das, Pearson Education India

Reference Books

1.Douglas V. Hall, Microprocessors and Interfacing, Tata McGraw Hill, Education, New

2. Ray A joy and Burchandi, Advanced Microprocessor & Peripherals, Tata McGraw Hill, Education, New Delhi, Second Edition.

3. Scott MacKenzie, Raphael C W Phan, “The8051Microcontroller”, Fourth Edition, Pearson education Delhi, Third Edition. /Prentice hall of India International Publishing; Sixth edition,2014.

SEMESTER -4

MINOR

MRT 282	FUNDAMENTALS OF ANALOG AND DIGITAL ELECTRONICS	CATEGORY	L	T	P	CREDIT
		VAC	3	1	-	4

Preamble:

This course enables students to analyse, design and implement analog and digital circuits and systems for the given specification and function.

Prerequisite: *Basics of Electronics*

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

CO 1	Understand the working of amplifiers and oscillators.
CO 2	Familiarisation of Op-amp and its different applications.
CO 3	Analysis of multivibrators and principles of PLL.
CO 4	Learn different simplification methods in digital electronics and also learn to design its combinational circuits
CO 5	Design of sequential circuits.

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	1	2	-	-	-	-	-
CO 2	3	3	2	1	2	1	2	-	-	-	-	-
CO 3	3	3	2	1	2	1	2	-	-	-	-	-
CO 4	3	3	3	1	2	1	2	-	-	-	-	-
CO 5	3	3	3	1	2	1	2	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination (100 marks)
	Test 1	Test 2	
Remember	5	5	10
Understand	10	10	20
Apply	20	15	30
Analyse	10	10	15
Evaluate	5	5	15
Create		5	10

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. List out the applications of oscillators
2. Differentiate positive feedback from negative feedback.
3. Compare BJT with FET .Mention the usage of both.

Course Outcome 2 (CO2) :

1. Define offset current and offset voltage.
2. What are the characteristics of an ideal opamp?
3. Mention the disadvantages of ideal differentiator. Suggest a method to overcome it.
4. Explain the importance of isolation amplifier.
5. Design an inverting amplifier of gain 10.

Course Outcome 3(CO3):

1. Discuss on the output waveforms of different filters.
2. Design a circuit to generate a waveform of duty cycle 50%.
3. List out the applications of astable and monostable multivibrator.

4. Define capture range and lock range.
5. Explain any one application of PLL.

Course Outcome 4 (CO4):

1. Why are NAND and NOR called as universal gates? Justify.
2. State and prove De-Morgan's Theorems.
3. Reduce f= ∑ m(0,2,4,6,7,8,10,12,13,15) using K-map .
4. Implement the function F(a,b,c,d)= ab' + bd +b'cd' using 8:1 MUX.

Course Outcome 5 (CO5):

1. Explain race round condition.
2. Differentiate combinational circuit form sequential circuits.
3. Design a3 bit synchronous down counter.

Model Question paper

QP CODE:

Reg. No:--------------------

Name: ---------------------

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

Course code: MRT 282 **Duration :3hours**

FUNDAMENTALS OF ANALOG AND DIGITAL ELECTRONICS

(2019- Scheme)

Mechatronics Branch

PART A

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

1. Explain the working of Hartley Oscillators.
2. List out the differences between BJT and FET.
3. Briefly explain S/H circuit using opamp.
4. Design a non inverting amplifier of gain 11.Given input voltage is 2 Vpp.

5. Distinguish the different types of filter with its frequency response graph.

6. Explain the principle of PLL.

7. Reduce the expression f= Π M (0,1,2,3,4,7) using mapping and implement it in AOI logic.

8. Design a full adder circuit using universal gates.

9. Define race round condition. Explain a method to rectify it.

10. Explain parallel shift registers with necessary equations.

PART B

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

Module 1

11. (a) Explain the construction, working and characteristics of depletion MOSFET. (10 marks)

(b) State and explain the condition for sustained oscillations. (4 marks)

12. (a) Explain the working of RC phase shift oscillators . (10 marks)

(b) Explain how tank circuits aid in oscillations. (4 marks)

Module 2

12. (a) Explain ideal integrator using opamp. Suggest method to overcome its disadvantages. (10 marks)

(b) List out the characteristics of op-amp. (4 marks)

13. (a) Explain 3 bit comparator circuit. (9 marks)

(b) Write notes on isolation amplifier. (5 marks)

Module 3

14. (a) Explain the importance of VCO. (4 marks)

(b) Define duty cycle . Explain the working of monostable multivibrator. (10 marks)

15. (a) Distinguish band pass and band stop filters. (6 marks)

(b) Explain the working of astable multivibrator using IC555. (8 marks)

Module 4

16. (a) Design and implement 3 bit gray to binary code converter. (8 marks)

(b) Implement F(x,y,z)= $\sum$ m (0,2,3,5) using 8 to 1 MUX. (6 marks)

17. Using K-map , obtain minimal expression for f=$\sum$ m (6,7,8,9) + d(10,11,12,13,14,15). (14 marks)

Module 5

18. Design a 3 bit asynchronous counter using T FFs. (14 marks)

19. Design 3 bit synchronous up counter using JK Flip flops. (14 marks)

Syllabus

Module 1-Amplifiers & Oscillators (9 hours)

BJT as an amplifier (CE configuration) - Concept of feedback-FET-construction and characteristics of JFET & MOSFET-Comparison of BJT & FET. Oscillators-Barkhausen criteria-Classification-Working of RC phase shift oscillators and Hartley Oscillator (no analysis required).

Module 2- Op-amp & its applications (9 hours)

Op-amp –ideal characteristics –offset voltage & offset current –frequency response-Inverting & non inverting amplifier- Integrator & Differentiator- Comparator-inverting,non-inverting;zero crossing detector, S/H, Isolation amplifier.

Module 3- Filters &Timers (9 hours)

Active Filters- First order LPF & HPF filter- Band Pass & Band stop Filters- (no analysis required) .Astable and Monostable multivibrator. Phase Locked Loops-Principles- building blocks of PLL-VCO-lock and capture ranges-capture process-frequency multiplication using PLL.

Module 4- Digital circuits (9 hours)

Logic gates-De-Morgan's theorem –Minimization of Boolean function using K-Map Combinational Circuits- Adder, Subtractor, Code converters (gray to binary & binary to gray). Encoders(3x8), Decoders(8x3), Multiplexers (1x8), De-multiplexers (8x1).

Module 5-Sequential Circuits (9 hours)

Flip Flop –SR,D,JK,T and master slave flip flop- Shift Registers-SISO,SIPO,PIPO,PISO,

Counters –3 bit Synchronous and asynchronous- Modulo 3 Counter- Ring Counter, Sequence detector

Text Books

1. Robert L.Boylestad and Louis Nashelsky, "*Electronic Devices and Circuit Theory*", Prentice Hall, Tenth Edition, 2009.

2. Ramakant A Gayakward, "*Op-amps and Linear Integrated* Circuits", IV edition , Pearson Education, 2002

3. M.Morris Mano, "*Digital Logic and Computer Design*", Pearson Education,2002

Reference Books

1. Allen Mottershead, "*Electronic Devices and Circuits:An Introduction*",Prentice Hall of India,2013

2.D.Roy Choudhury,Shail B Jain, "*Linear Integrated Circuits*",Fifth edition,New Age ,2018

3. Thomas L Floyd, "*Digital Fundamentals*",Eleventh edition,Pearson Education,2011

4. A.Anand Kumar, "*Fundamentals of Digital Circuits*",Second Edition,PHI,2009

Course Contents and Lecture Schedule

`

No	Topic	No. of Lectures
1	**Amplifiers and Oscillators**	
1.1	BJT as an amplifier(CE configuration)- concept of feedback	1
1.2	FET- Construction and characteristics of JFET	2
1.3	MOSFET -depletion and Enhancement MOSFET	2
1.4	Comparison of BJT & FET	1
1.5	Oscillators-Barkhausen criteria-Classification	1
1.6	Working of RC and Hartley oscillator	2
2	**OP-AMP & its Applications**	
2.1	Ideal characteristics, offset voltage and offset current, frequency response	2
2.2	Applications-inverting & non inverting amplifier	1
2.3	Integrator & Differentiator	2
2.4	Comparator- zerocrossing detector	2
2.5	S/H, Isolation amplifier	2
3	**Filters & Timers**	
3.1	Active Filters- first order LPF & HPF filter	2
3.2	Band Pass & Band stop Filters	2

3.3	Astable and Monostable multivibrator using IC555	2
3.4	Phase Locked Loops-Principles- building blocks of PLL-VCO-lock and capture ranges-capture process-	2
3.5	Frequency multiplication using PLL	1
4	**Digital Circuits**	
4.1	Logic gates-De-Morgan's theorem –Minimization of Boolean function using K-Map (3 & 4 variables)	2
4.2	Combinational Circuits- Adder, Subtractor	2
4.3	Code converters (gray to binary & binary to gray)	1
4.4	Encoders(3x8), Decoders(8x3),	2
4.5	Multiplexers (1x8), De-multiplexers (8x1)	2
5	**Sequential Circuits**	
5.1	Flip Flop –SR,D,JK,T and master slave flip flop	2
5.2	Shift Registers-SISO,SIPO,PISO,PIPO	2
5.3	Counters –3 bit Synchronous -Problems	2
5.4	3 bit asynchronous Counters-Problems	1
5.4	Ring Counter	1
5.5	Sequence detector	1

MRT284	BASICS OF INDUSTRIAL HYDRAULICS AND PNEUMATICS	CATEGORY	L	T	P	CREDIT
		VAC	3	1	0	4

Preamble:
This course enables students to analyse, design and implement hydraulic and pneumatic systems for automation in industries.
Prerequisite: Nil

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

CO1 provide an insight into the capabilities of hydraulic and pneumatic fluid power.
CO2 describe concepts and relationships surrounding force, pressure, energy and power in fluid power systems.
CO3 Identify sources of hydraulic power, rotary and linear actuators, distribution systems, hydraulic flow in pipes, and control components in fluid power systems.
CO4 Construct hydraulic and pneumatic circuits related to industrial applications.
CO5 familiarize with logic controls and trouble shooting

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	2	1	1	1	-	3	1	-	2
CO 2	3	3	3	3	1	1	1	-	3	1	-	2
CO 3	3	3	3	3	2	1	1	-	3	3	-	2
CO 4	3	3	3	3	3	1	1	-	3	3	-	2
CO 5	3	3	3	3	3	1	-	-	3	3	-	2

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. Explain the need and scope of industrial automation.
2. List the components of an industrial automation system with examples.
3. Illustrate an automated material handling system.

Course Outcome 2 (CO2)
1. Classify sensors used in automation systems with examples
2. Outline the need of signal conditioning and processing.
3. List out different industrial bus configurations and applications.

Course Outcome 3(CO3):
1. Explain the operation of PLC.
2. Describe SCADA. Demonstrate an application.
3. Describe the features of distributed control systems.

Course Outcome 4 (CO4):
1. Give an example of a feedback system and explain.
2. Compare a feedback control structure with feed forward control.
3. Describe any two special control schemes.

Course Outcome 5 (CO5):
1. Illustrate the role of computers in automation.
2. Explain the operation of an FMS
3. Explain the operation of CNC machines.

Course Outcome 6 (CO6):
1. Illustrate the geometric configurations of industrial robots.
2. Demonstrate how IoT can influence industrial automation.
3. List the applications of machine vision in automation.

Module 1: Introduction to fluid power systems

Fluid power system: components, advantages and applications. Transmission of power at static and dynamic states. Pascal's law and its applications.

Fluids for hydraulic system: types, properties, and selection. Additives, effect of temperature and pressure on hydraulic fluid. Seals, sealing materials, compatibility of seal with fluids. Types of pipes, hoses, and quick acting couplings. Pressure drop in hoses/pipes. Fluid conditioning through filters, strainers; sources of contamination and contamination control **9 Hours**

Module 2: Pumps and actuators

Pumps: Classification of pumps, pumping theory of positive displacement pumps, construction and working of Gear pumps, Vane pumps, Piston pumps, fixed and variable displacement pumps, Pump performance characteristics, pump selection factors, problems on pumps.

Accumulators: Types, selection/ design procedure, applications of accumulators. Types of Intensifiers, Pressure switches /sensor, Temperature switches/sensor, Level sensor. Actuators: Classification cylinder and hydraulic motors, Hydraulic cylinders, single and double acting cylinder, mounting arrangements, cushioning, special types of cylinders, problems on cylinders.

Construction and working of rotary actuators such as gear, vane, piston motors, and Hydraulic Motor. Theoretical torque, power, flow rate, and hydraulic motor performance; numerical problems. Symbolic representation of hydraulic actuators (cylinders and motors). **9 Hours**

Module3: Components and hydraulic circuit design

Components: Classification of control valves, Directional Control Valves-symbolic representation, constructional features of poppet, sliding spool, rotary type valves solenoid and pilot operated DCV, shuttle valve, and check valves. Pressure control valves - types, direct operated types and pilot operated types. Flow Control Valves -compensated and non-compensated FCV, needle valve, temperature compensated, pressure compensated, pressure and temperature compensated FCV, symbolic representation.

Hydraulic Circuit Design: Control of single and Double -acting hydraulic cylinder, regenerative circuit, pump unloading circuit, double pump hydraulic system, counter balance valve application, hydraulic cylinder sequencing circuits, cylinder synchronizing circuit using different methods, hydraulic circuit for force multiplication; speed control of hydraulic cylindermetering in, metering out and bleed off circuits. Pilot pressure operated circuits. Hydraulic circuit examples with accumulator. **9 Hours**

Module4: Pneumatic power systems

Introduction to pneumatic systems: Pneumatic power system, advantages, limitations, applications, Choice of working medium. Characteristics of compressed air and air compressors. Structure of pneumatic control System, fluid conditioners-dryers and FRL unit. Pneumatic Actuators: Linear cylinder – types of cylinders, working, end position cushioning, seals, mounting arrangements, and applications. Rotary cylinders- types, construction and application, symbols.

Pneumatic control valves: DCV such as poppet, spool, suspended seat type slide valve, pressure control valves, flow control valves, types and construction, use of memory valve, Quick exhaust valve, time delay valve, shuttle valve, twin pressure valve, symbols.

9 Hours

Module5: Pneumatic control circuits

Simple pneumatic control: Direct and indirect actuation pneumatic cylinders, speed control of cylinders - supply air throttling and exhaust air throttling. Signal Processing Elements: Use of Logic gates - OR and AND gates in pneumatic applications. Practical examples involving the use of logic gates.

Multi- cylinder Application: Coordinated and sequential motion control, motion and control diagrams. Signal elimination methods, Cascading method- principle, Practical application examples (up to two cylinders) using cascading method (using reversing valves).

Electro-pneumatic control: Principles - signal input and output, pilot assisted solenoid control of directional control valves, use of relay and contactors. Control circuitry for simple signal cylinder application. **9 Hours**

Text Books

1. Anthony Esposito, “Fluid Power with applications”, Pearson edition,2000 .
2. Majumdar S.R., “Oil Hydraulics”, Tata McGRawHllL, 2002 .
3. Majumdar S.R., “Pneumatic systems - Principles and Maintenance”, Tata McGraw-Hill, NewDelhi, 2005

REFERENCE BOOKS:

1. John Pippenger, Tyler Hicks, “Industrial Hydraulics”, McGraw Hill International Edition, 1980.
2. Andrew Par, Hydraulics and pneumatics, Jaico Publishing House, 2005.
3. FESTO, Fundamentals of Pneumatics, Vol. I, II and III.
4. Herbert E. Merritt, “Hydraulic Control Systems”, John Wiley and Sons, Inc.
5. Thomson, Introduction to Fluid power, PrentcieHaIl, 2004.
6. John Watton, “Fundamentals of fluid power control”, Cambridge University Press, 2012.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1.1	Fluid power system, its components, advantages and applications	1
1.2	Transmission of power at static and dynamic states	1
1.3	Pascal’s law and its applications	1
1.4	Fluids for hydraulic system, types, properties, and selection	1
1.5	Additives, effect of temperature and pressure on hydraulic fluid	1
1.6	Seals, sealing materials, compatibility of seal with fluids	1
1.7	Types of pipes, hoses, and quick acting couplings	1
1.8	Pressure drop in hoses/pipes	1
1.9	Fluid conditioning through filters, strainers, sources of contamination and contamination control	1
2.1	Classification of pumps, pumping theory of positive displacement pumps	1
2.2	Construction and working of Gear pumps, Vane pumps, Piston pumps, fixed and variable displacement pumps	1
2.3	Pump performance characteristics, pump selection factors, problems on pumps	1
2.4	Accumulators and intensidiers: Types, selection/ design procedure and applications	1
2.5	Pressure switches /sensor, Temperature switches/sensor, Level sensor. Actuators: Classification, cylinder and hydraulic motors	1

2.6	Hydraulic cylinders, single and double acting cylinder, mounting arrangements, cushioning, special types of cylinders, problems on cylinders	1
2.7	Construction and working of rotary actuators such as gear, vane, piston motors, and hydraulic motor	1
2.8	Theoretical torque, power, flow rate, and hydraulic motor performance; numerical problems	1
2.9	Symbolic representation of hydraulic actuators (cylinders and motors)	1
3.1	Components and Classification of control valves, Directional Control Valves-symbolic representation	1
3.2	Constructional features of poppet, sliding spool, rotary type valves solenoid and pilot operated DCV, shuttle valve, and check valves	1
3.3	Pressure control valves - types, direct operated types and pilot operated types. Flow Control Valves (FCV) -compensated and non-compensated FCV, needle valve, temperature compensated, pressure compensated, pressure and temperature compensated FCV, symbolic representation	2
3.4	Hydraulic Circuit Design: Control of single and Double -acting hydraulic cylinder, regenerative circuit, pump unloading circuit, double pump hydraulic system, counter balance valve application	2
3.5	hydraulic cylinder sequencing circuits, cylinder synchronizing circuit using different methods, hydraulic circuit for force multiplication; speed control of hydraulic cylinder metering in, metering out and bleed off circuits	2
3.6	Pilot pressure operated circuits. Hydraulic circuit examples with accumulator	1
4.1	Introduction to Pneumatic systems: Pneumatic power system, advantages, limitations, applications, Choice of working medium	1
4.2	Characteristics of compressed air and air compressors. Structure of pneumatic control System, fluid conditioners-dryers and FRL unit	2
4.3	Pneumatic Actuators: Linear cylinder – types of cylinders, working, end position cushioning, seals, mounting arrangements, and applications. Rotary cylinders- types, construction and application, symbols	2
4.4	Pneumatic Control Valves: DCV such as poppet, spool, suspended seat type slide valve, pressure control valves, flow control valves, types and construction, use of memory valve	3
4.5	Quick exhaust valve, time delay valve, shuttle valve, twin pressure valve, symbols	1
5.1	Simple Pneumatic Control: Direct and indirect actuation pneumatic cylinders, speed control of cylinders - supply air throttling and exhaust air throttling	1
5.2	Signal Processing Elements: Use of Logic gates - OR and AND gates in pneumatic applications. Practical examples involving the use of logic gates	2
5.3	Multi- Cylinder Application: Coordinated and sequential motion control, motion and control diagrams. Signal elimination methods	2
5.4	Cascading method- principle, Practical application examples (up to two cylinders) using cascading method (using reversing valves)	2
5.5	Electro- Pneumatic Control: Principles - signal input and output, pilot assisted solenoid control of directional control valves, use of relay and contactors. Control circuitry for simple signal cylinder application	2

Model Question Paper

Course Code: MRT 284

Course Name: BASICS OF INDUSTRIAL HYDRAULICS AND PNEUMATICS

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

PART-A

Answer all the questions. Each question carries 3 marks

1.What are the different types of oil additives? Why are they used in hydraulic oils?

2.What are the different types of pipes used in hydraulic & pneumatic circuit? List the different accessories used in the piping.

3.With neat sketch explain the construction & working of a balanced vane pump.

4.With neat sketch explain the construction and working of internal gear pump.

5.What are the different types of direction control valves? State their application by using symbolic representation.

6. What are the controls used for speed control in the hydraulic and pneumatics systems? Explain metering in, metering out & bleed off circuit.

7. State five advantages of using air instead of hydraulic oil.

8. Explain the construction of a double acting cylinder used in pneumatics with a neat sketch.

9. Explain supply air throttling and exhaust air throttling with a net circuit diagram.

10. Design and draw a sequential circuit for the operation of two cylinders X and Y using cascade method.

PART-B

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

Module 1

11. Describe the applications of fluid power system and list the main components required for a power pack with circuit.

12. Hydraulic oil of kinematic viscosity 0.9 strokes, flow through a 35mm diameter pipe at a velocity of 4 m/sec for a length of 100 m. Find the head loss due to friction (in units of bar). Assume sp.gravity of oil as 0.9.

Module 2

13. Classify the types of hydraulic cylinders. Describe the working of a double acting tandem cylinder and gear motor. Give its graphical symbols.

14. Explain the construction and operation of a variable discharge axial flow piston pump with a neat sketch. Describe how to estimate minimum and maximum discharge. Give its graphical method.

Module 3

15.Write short notes on:

(i) Direct acting pressure reducing valve

(ii) Pilot operated sequence valve

16.What is pressure compensation? Explain with a neat sketch the working of pressure compensated flow control valve.

Module 4

17. Sketch and explain commonly used 3-position 4 way direction control valves. Also state the applications for a closed centre, open centre and tandem centre valves.

18. Discuss the following with a neat sketch:

(i) Quick exhaust valves

(ii) Air control valves

Module 5

19. Design an electro pneumatic circuit for the following sequence: A+A-B+B-, where + is extension and - is retraction.
20. Explain logic OR function with a shuttle valve and double acting cylinder.

*****

SEMESTER -4
HONOURS

MRT 292	MICRO MECHATRONIC SYSTEMS	CATEGORY	L	T	P	CREDIT
		VAC	3	1	0	3

Preamble:

This course enables students to understand, design and analyse micro mechatronics systems.

Prerequisite: NIL

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

CO 1	The behavior of materials used in MEMS
CO 2	To impart knowledge on Micro actuation
CO 3	The technology for fabrication of MEMS
CO 4	To impart knowledge on Micro-fabrication special machining
CO 5	The applications of MEMS.

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	2	1	-	1	1	-	-
CO 2	3	2	3	2	2	2	1	1	1	1	1	1
CO 3	2	1	3	2	3	3	3	1	1	-	1	1
CO 4	2	1	3	2	3	2	2	1	1	-	1	1
CO 5	3	2	3	2	2	2	2	2	2	1	1	3

3	HIGH	1	LOW
2	MODERATE	-	NIL

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 can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. To impart knowledge on Micro Mechatronics Systems
2. To impart knowledge on Materials In Micro Mechatronics Systems

Course Outcome 2 (CO2)

1. To impart knowledge onMicrosensors
2. To impart knowledge on Microactuation
3. To impart knowledge on MEMS with micro actuators

Course Outcome 3(CO3):

1. To impart knowledge on the technology for fabrication of MEMS
2. To impart knowledge on Micro Manufacturing Techniques
3. To impart knowledge on Vapour Deposition

Course Outcome 4 (CO4):

1. To impart knowledge on Micro-fabrication special machining
2. To impart knowledge on environmental conditions of fabrication

Course Outcome 5 (CO5):

1. To impart knowledge on Applications of MEMS in various industries
2. To impart knowledge on Future of MEMS

Syllabus

Module 1 (9 hours)

Micro electro mechanical system: MEMS and microsystems– microsystems and miniaturization-Materials for MEMS, CZ Method- Microsystems packaging.

Module 2 (9 hours)

Microsensors:acoustic-biomedical-chemical-optical-pressure-thermal

Micro actuators : Concept of micro actuations- actuation using thermal forces-electrostatic forces -shape memory alloys-piezo electric crystals-. MEMS with micro actuators: microgrippers – micromotors-microvalves- Micro Accelerometers-micropumps.

Module 3 (9 hours)

Micro Manufacturing Techniques: Photolithography-chemical Vapour Deposition – Physical Vapour Deposition-Etching Processes-Bulk micro manufacturing-surface micro manufacturing-LIGA process.

Module 4 (9 hours)

Micro-fabrication special machining: Laser beam micro machining-Electrical Discharge Machining-Ultrasonic Machining-Electro chemical Machining-Electron beam machining. Clean room

Module 5 (9 hours)

Laws of scaling: Scaling in Geometry ,Scaling in Rigid-Body Dynamics ,Scaling in Electrostatic Forces, Scaling in Electromagnetic Forces.

Applications of MEMS in various industries : Automobile- Defense- Healthcare-Aerospace-industry-Future of MEMS

Text Books

1. Tai-Ran Hsu MEMS &Microsytems Design and Manufacture, Tata McGraw-Hill publishing company Ltd.
2. N. Maluf, an Introduction to Microelectro Mechanical Systems Engineering, Artech House, 2000.

Reference Books

1. V.C.Venaktesh , Precision Engineering, Tata McGraw-Hill Publishing Company Limited
2. Madou M.J., Fundamentals of micro fabrication, CRC Press, 1997.
3. Chang Liu, Foundation of MEMS, Illinois ECE Series, Pearson Prentice Hall 2006.

.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	Micro electro mechanical system:	
1.1	MEMS and microsystems	2
1.2	microsystems and miniaturization	2
1.3	Materials for MEMS, CZ Method-	3
1.4	Microsystems packaging.	2
2	Microsensors&Microactuation	
2.1	Microsensorsacoustic-biomedical-chemical-optical-pressure-thermal-	2
2.2	Microactuation : actuation using thermal forces-shape memory alloys-piezo electric crystals-electrostatic forces.	2
2.3	MEMS with micro actuators: microgrippers -micromotors- micro accelerometers- microvalves-micropumps.	5
3	Micro Manufacturing Techniques:	
3.1	Photolithography-chemical Vapour Deposition –Physical Vapour Deposition-Etching Processes-	4
2	Bulk micro manufacturing-surface micro manufacturing-	3
3.3	LIGA process.	2
4	Micro-fabrication special machining:	
4.1	Clean room, Laser beam micro machining-	3
4.2	Electrical Discharge Machining-Ultrasonic Machining-	3
4.3	Electro chemical Machining-Electron beam machining.	3
5	Laws of scaling&Applications of MEMS in various industries	
5.1	Scaling in Geometry ,Scaling in Rigid-Body Dynamics ,Scaling in Electrostatic Forces, Scaling in Electromagnetic Forces	4
5.2	Applications of MEMS in various industries : Automobile-defence-healthcare-Aerospace-industry-	4
5.3	Future of MEMS	1

Model Question paper

QP CODE: PAGES:2

RegNo:______________

Name :______________

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

Course Code:MRT292

Course Name: **MICRO MECHATRONIC SYSTEMS**

Duration: 3 Hours

Max.Marks:100

PART A

Answer all Questions.

Each question carries 3 Marks

1. Draw and explain components of microsystem.
2. What are the advantages of silicon over other materials.
3. Explain with a neat block diagram of 'MEMS as a micro actuator'.
4. Explain the working principle of Shape memory alloys.
5. Explain Photolithography.
6. Draw the block diagram and steps behind LIGA process.
7. Describe the working principle of laser beam micro machining.
8. Explain about the standard clean room for micro machining.
9. What is scaling? Explain scaling in Geometry.
10. Explain about applications in Aerospace Industry. (10×3=30)

Part B

11 a) Explain CZ method for producing pure silicon crystal (10 marks)
b) Explain the importance of miniaturisation of MEMS (4 marks)

OR

12. Describe 3 level packaging systems (14 marks)

13. a) Write a short note on (10 marks)
I. Micro valves
II. Micro pumps
b) Explain the working principle of Micro accelerometer (4 marks)

OR

14. Discuss actuation using (14 marks)
I. Thermal force.

II. Electrostatic force.

15. Explain and Compare bulk and surface micro-manufacturing. (14 marks)

OR

16. a) Compare and explain different types of CVD process. (10 marks)
    b) What are the limitations of Photolithography. (4 marks)

17. a) Describe the working principle of Electro chemical micro machining. (7 marks)
    b) Explain ultrasonic machining with a neat diagram. (7 marks)

OR

18 Explain and compare the principle, working and application of laser beam micromachining and electron beam machining. (14 marks)

19 Discuss on Scaling in rigid body dynamics. (9 marks)

20 Discuss on future of MEMS. (5 marks)

(14×5=70)

MRT294	INDUSTRIAL AUTOMATION	CATEGORY	L	T	P	CREDIT
		VAC	3	1	0	4

Preamble:

This course enables students to understand automation, and its applications in industries.

Prerequisite: NIL

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

CO 1	Identify and justify potential areas and scope of industrial automation
CO 2	Understand the components of automation systems
CO 3	Select suitable control system for automation
CO 4	Select suitable control structure depending on the application
CO 5	Integrate computers in industrial automation
CO 6	Incorporate robots in automation structures

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	2	2			2			2			
CO 2	3	2	2			2			2			
CO 3	3	2	2			2			2			
CO 4	3	2	2			2			2			
CO 5	3	2	2			2			2			3
CO 6	3	2	2			2			2			3

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. Explain the need and scope of industrial automation.

2. List the components of an industrial automation system with examples.

3. Illustrate an automated material handling system.

Course Outcome 2 (CO2)

1. Classify sensors used in automation systems with examples

2. Outline the need of signal conditioning and processing.

3. List out different industrial bus configurations and applications.

Course Outcome 3(CO3):

1. Explain the operation of PLC.

2. Describe SCADA? Demonstrate an application.

3. Describe the features of distributed control systems.

Course Outcome 4 (CO4):

1. Give an example of a feedback system and explain.

2. Compare a feedback control structure with feed forward control.

3. Describe any two special control schemes.

Course Outcome 5 (CO5):

1. Illustrate the role of computers in automation.

2. Explain the operation of an FMS

3. Explain the operation of CNC machines.

Course Outcome 6 (CO6):

1. Illustrate the geometric configurations of industrial robots.

2. Demonstrate how IoT can influence industrial automation.

3. list the applications of machine vision in automation.

Model Question paper

Course Code: MRT 294

Course Name: INDUSTRIAL AUTOMATION

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

PARTA

Answer all Questions. Each question carries 3 Marks

1. What is the scope of industrial automation?
2. What do you mean by HMI?
3. What are the applications of Motion Actuators?
4. What is the need of signal conditioning?
5. What do you mean by ladder program? What are its components?
6. With an application, explain a Distributed Control System.
7. How does a CNC differ from conventional systems?
8. What do you mean by Manufacturing Cells?
9. Differentiate between a serial and parallel robot.
10. What is the role of IoT in industrial automation?

PART B

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

Module 1

11. Explain the need of industrial automation with reference to a material handling system.
12. What are the different measures adopted for industrial safety inautomation?

Module 2

13. Classify sensors used in automation and give examples for each.
14. What is the need of industrial bus systems? Give two examples and their applications.

Module 3

15. Explain a PLC based system for automation. Explain its ladder diagram.
16. What do you mean by SCADA? What is its role in automation?

Module 4

17. Explain any two control structures used in automation systems.
18. With an example, explain FMS.

Module 5

19. With illustrations, explain the basic robotic configurations.
20. Write short notes on the following: i) Machine Vision ii) Robotic Workcells

Syllabus

Module 1 (9 Hours)

Introduction: Potential areas and need of industrial automation. Architecture of industrial automation systems. Levels of automation. Examples of automation systems, Material Handling System. Transfer lines and automated assembly. Need of HMI systems. Safety Measures in Automation.

Module 2 (9 Hours)

Introduction to sensors and measurements: Motion actuators: types and applications. Sensors: Classifications and examples, Encoders and applications. Measurement of temperature, pressure, force, displacement, flow and level. Signal conditioning and processing: need and examples. Industrial bus systems: examples and applications.

Module 3 (9 Hours)

PLC and Supervisory Control: Programmable Logic Controllers: applications in industries. PLC programming: ladder diagram examples. SCADA systems: applications, Distributed Control Systems: Overview, features, applications.

Module 4 (9 Hours)

Computer controlled systems: Control structures: PID control, feed forward, ratio control and predictive control. Role of microcontrollers, microcomputers and computers in industrial control applications. Computer aided process control, CNC: overview, control and applications. Manufacturing Cells and Flexible Manufacturing Systems, examples.

Module 5 (9 Hours)

Robots and IoT in industrial automation: Basic robotic configurations and their applications in industries. Examples of automated work cells with robots. Machine vision and its applications. IoT in industrial automation- IoT enabled PLC, applications of IoT in automation systems.

Text Books

1. Automation, Production Systems and Computer Integrated Manufacturing M.P.Groover, Pearson Education.5th edition, 2009.

2.Computer Based Industrial Control- Krishna Kant, EEE-PHI, 2nd edition, 2010

Reference Books

1. Industrial Instrumentation and Control By. S.K. Singh The McGraw Hill Companies

2. Process Control Instrumentation Technology By. C.D. Johnson, PHI

3.Pessen, Industrial Automation: Circuit Design and Components

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	INTRODUCTION	
1.1	Potential areas and need of industrial automation	1
1.2	Architecture of industrial automation systems.	2
1.3	Levels of automation. Examples of automation systems	2
1.4	Material Handling System. Transfer lines and automated assembly.	2
1.5	Need of HMI systems	1
1.6	Safety Measures in Automation	1
2	INTRODUCTION TO SENSORS AND MEASUREMENTS	
2.1	Motion actuators: types and applications	1
2.2	Sensors: Classifications and examples. Encoders and applications	2
2.3	Measurement of temperature, pressure, force, displacement, flow and level.	2
2.4	Signal conditioning and processing: need and examples	2
2.5	Industrial bus systems: examples and applications.	2
3	PLC AND SUPERVISORY CONTROL	
3.1	Programmable Logic Controllers: applications in industries	2
3.2	PLC programming: ladder diagram examples.	3
3.3	SCADA systems: applications	2
3.4	Distributed Control Systems: Overview, features, applications.	2
4	COMPUTER CONTROLLED SYSTEMS	
4.1	Control structures: PID control, feed forward, ratio control and predictive	2

	control	
4.2	Role of microcontrollers, microcomputers and computers in industrial control applications.	2
4.3	Computer aided process control, CNC: overview, control and applications	3
4.4	Manufacturing Cells and Flexible Manufacturing Systems, examples	2
5	ROBOTS AND IoT IN INDUSTRIAL AUTOMATION	
5.1	Basic robotic configurations and their applications in industries.	2
5.2	Examples of automated work cells with robots	2
5.3	Machine vision and its applications	2
5.4	IoT in industrial automation- IoT enabled PLC, applications of IoT in automation systems.	3

COMMON COURSES S5 & S6

COMMON COURSES

(S5 & S6)

MCN 301	DISASTER MANAGEMENT	Category	L	T	P	CREDIT	YEAR OF INTRODUCTION
		Non - Credit	2	0	0	Nil	2019

Preamble: The objective of this course is to introduce the fundamental concepts of hazards and disaster management.

Prerequisite: Nil

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

CO1	Define and use various terminologies in use in disaster management parlance and organise each of these terms in relation to the disaster management cycle (Cognitive knowledge level: **Understand**).
CO2	Distinguish between different hazard types and vulnerability types and do vulnerability assessment (Cognitive knowledge level: **Understand**).
CO3	Identify the components and describe the process of risk assessment, and apply appropriate methodologies to assess risk (Cognitive knowledge level: **Understand**).
CO4	Explain the core elements and phases of Disaster Risk Management and develop possible measures to reduce disaster risks across sector and community (Cognitive knowledge level: **Apply**)
CO5	Identify factors that determine the nature of disaster response and discuss the various disaster response actions (Cognitive knowledge level: **Understand**).
CO6	Explain the various legislations and best practices for disaster management and risk reduction at national and international level (Cognitive knowledge level: **Understand**).

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		2				2				2		2
CO2	2	3	2		2	2	3			3		2
CO3	2	3	2	2	2	2	3			3		2
CO4	3	3	3		2	2	3					2
CO5	3	3			2	2	3					2
CO6	3					2	3	3				2

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	**10**	**10**	**20**
Understand	**25**	**25**	**50**
Apply	**15**	**15**	**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 - 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

MCN 301 Disaster Management

Module 1

Systems of earth

Lithosphere- composition, rocks, soils; Atmosphere-layers, ozone layer, greenhouse effect, weather, cyclones, atmospheric circulations, Indian Monsoon; hydrosphere- Oceans, inland water bodies; biosphere

Definition and meaning of key terms in Disaster Risk Reduction and Management- disaster, hazard, exposure, vulnerability, risk, risk assessment, risk mapping, capacity, resilience, disaster risk reduction, disaster risk management, early warning systems, disaster preparedness, disaster prevention, disaster mitigation, disaster response, damage assessment, crisis counselling, needs assessment.

Module 2

Hazard types and hazard mapping; Vulnerability types and their assessment- physical, social, economic and environmental vulnerability.

Disaster risk assessment –approaches, procedures

Module 3

Disaster risk management -Core elements and phases of Disaster Risk Management

Measures for Disaster Risk Reduction – prevention, mitigation, and preparedness.

Disaster response- objectives, requirements; response planning; types of responses.

Relief; international relief organizations.

Module 4

Participatory stakeholder engagement; Disaster communication- importance, methods, barriers; Crisis counselling

Capacity Building: Concept – Structural and Non-structural Measures, Capacity Assessment; Strengthening Capacity for Reducing Risk

Module 5

Common disaster types in India; Legislations in India on disaster management; National disaster management policy; Institutional arrangements for disaster management in India.

The Sendai Framework for Disaster Risk Reduction- targets, priorities for action, guiding principles

Reference Text Book

1. R. Subramanian, Disaster Management, Vikas Publishing House, 2018
2. M. M. Sulphey, Disaster Management, PHI Learning, 2016
3. UNDP, Disaster Risk Management Training Manual, 2016
4. United Nations Office for Disaster Risk Reduction, Sendai Framework for Disaster Risk Reduction 2015-2030, 2015

Sample Course Level Assessment Questions

Course Outcome 1 (CO1):

1. What is the mechanism by which stratospheric ozone protects earth from harmful UV rays?
2. What are disasters? What are their causes?
3. Explain the different types of cyclones and the mechanism of their formation
4. Explain with examples, the difference between hazard and risk in the context of disaster management
5. Explain the following terms in the context of disaster management (a) exposure (b) resilience (c) disaster risk management (d) early warning systems, (e) damage assessment (f) crisis counselling (g) needs assessment

Course Outcome 2 (CO2):

1. What is hazard mapping? What are its objectives?
2. What is participatory hazard mapping? How is it conducted? What are its advantages?
3. Explain the applications of hazard maps
4. Explain the types of vulnerabilities and the approaches to assess them

Course Outcome 3 (CO3):

1. Explain briefly the concept of ‘disaster risk’

2. List the strategies for disaster risk management ‘before’, ‘during’ and ‘after’ a disaster
3. What is disaster preparedness? Explain the components of a comprehensive disaster preparedness strategy

Course Outcome 4 (CO4):

1. What is disaster prevention? Distinguish it from disaster mitigation giving examples
2. What are the steps to effective disaster communication? What are the barriers to communication?
3. Explain capacity building in the context of disaster management

Course Outcome 5 (CO5):

1. Briefly explain the levels of stakeholder participation in the context of disaster risk reduction
2. Explain the importance of communication in disaster management
3. Explain the benefits and costs of stakeholder participation in disaster management
4. How are stakeholders in disaster management identified?

Course Outcome 6 (CO6):

1. Explain the salient features of the National Policy on Disaster Management in India
2. Explain the guiding principles and priorities of action according to the Sendai Framework for Disaster Risk Reduction
3. What are Tsunamis? How are they caused?
4. Explain the earthquake zonation of India

Model Question paper

QP CODE: **PAGES:3**

Reg No:______________ **Name :______________**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIFTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: MCN 301

Course Name: Disaster Management

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

PART A

Answer all Questions. Each question carries 3 Marks

1. What is the mechanism by which stratospheric ozone protects earth from harmful UV rays?
2. What are disasters? What are their causes?
3. What is hazard mapping? What are its objectives?
4. Explain briefly the concept of 'disaster risk'
5. List the strategies for disaster risk management 'before', 'during' and 'after' a disaster
6. What is disaster prevention? Distinguish it from disaster mitigation giving examples
7. Briefly explain the levels of stakeholder participation in the context of disaster risk reduction
8. Explain the importance of communication in disaster management
9. What are Tsunamis? How are they caused?
10. Explain the earthquake zonation of India

Part B

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

11. a. Explain the different types of cyclones and the mechanism of their formation [10]

b. Explain with examples, the difference between hazard and risk in the context of disaster management
[4]

OR

12. Explain the following terms in the context of disaster management [14]

(a) exposure (b) resilience (c) disaster risk management (d) early warning systems, (e) damage assessment (f) crisis counselling (g) needs assessment

13. a. What is participatory hazard mapping? How is it conducted? What are its advantages?

[8]

b. Explain the applications of hazard maps [6]

OR

14. Explain the types of vulnerabilities and the approaches to assess them [14]

15. a. Explain the core elements of disaster risk management [8]

b. Explain the factors that decide the nature of disaster response [6]

OR

16. a. What is disaster preparedness? Explain the components of a comprehensive disaster preparedness strategy [6]

b. Explain the different disaster response actions [8]

17. a. Explain the benefits and costs of stakeholder participation in disaster management [10]

b. How are stakeholders in disaster management identified? [4]

OR

18. a. What are the steps to effective disaster communication? What are the barriers to communication? [7]

b. Explain capacity building in the context of disaster management [7]

19. Explain the salient features of the National Policy on Disaster Management in India

[14]

OR

20. Explain the guiding principles and priorities of action according to the Sendai Framework for Disaster Risk Reduction [14]

Teaching Plan

	Module 1	**5 Hours**
1.1	Introduction about various Systems of earth, Lithosphere-composition, rocks, Soils; Atmosphere-layers, ozone layer, greenhouse effect, weather	1 Hour
1.2	Cyclones, atmospheric circulations, Indian Monsoon; hydrosphere-Oceans, inland water bodies; biosphere	1 Hour
1.3	Definition and meaning of key terms in Disaster Risk Reduction and Management- disaster, hazard,	1 Hour
1.4	Exposure, vulnerability, risk, risk assessment, risk mapping, capacity, resilience, disaster risk reduction, Disaster risk management, early warning systems	1 Hour
1.5	Disaster preparedness, disaster prevention, disaster, Mitigation, disaster response, damage assessment, crisis counselling, needs assessment.	1 Hour
	Module 2	**5 Hours**
2.1	Various Hazard types, Hazard mapping; Different types of Vulnerability types and their assessment	1 Hour
2.2	Vulnerability assessment and types, Physical and social vulnerability	1 Hour
2.3	Economic and environmental vulnerability, Core elements of disaster risk assessment	1 Hour
2.4	Components of a comprehensive disaster preparedness strategy approaches, procedures	1 Hour
2.5	Different disaster response actions	1 Hour
	Module 3	**5 Hours**
3.1	Introduction to Disaster risk management, Core elements of Disaster Risk Management	1 Hour
3.2	Phases of Disaster Risk Management, Measures for Disaster Risk Reduction	1 Hour
3.3	Measures for Disaster prevention, mitigation, and preparedness.	1 Hour

3.4	Disaster response- objectives, requirements. Disaster response planning; types of responses.	1 Hour
3.5	Introduction- Disaster Relief, Relief; international relief organizations.	1 Hour
	Module 4	**5 Hours**
4.1	Participatory stakeholder engagement	1 Hour
4.2	Importance of disaster communication.	1 Hour
4.3	Disaster communication- methods, barriers. Crisis counselling	1 Hour
4.4	Introduction to Capacity Building. Concept – Structural Measures, Non-structural Measures.	1 Hour
4.5	Introduction to Capacity Assessment, Capacity Assessment; Strengthening, Capacity for Reducing Risk	1 Hour
	Module 5	**5 Hours**
5.1	Introduction-Common disaster types in India.	1 Hour
5.2	Common disaster legislations in India on disaster management	1 Hour
5.3	National disaster management policy, Institutional arrangements for disaster management in India.	1 Hour
5.4	The Sendai Framework for Disaster Risk Reduction and targets	1 Hour
5.5	The Sendai Framework for Disaster Risk Reduction-priorities for action, guiding principles	1 Hour

HUT 300	Industrial Economics & Foreign Trade	Category	L	T	P	CREDIT
		HSMC	**3**	**0**	**0**	**3**

Preamble: To equip the students to take industrial decisions and to create awareness of economic environment.

Prerequisite: Nil

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

CO1	Explain the problem of scarcity of resources and consumer behaviour, and to evaluate the impact of government policies on the general economic welfare. (Cognitive knowledge level: **Understand**)
CO2	Take appropriate decisions regarding volume of output and to evaluate the social cost of production. (Cognitive knowledge level: **Apply**)
CO3	Determine the functional requirement of a firm under various competitive conditions. (Cognitive knowledge level: **Analyse**)
CO4	Examine the overall performance of the economy, and the regulation of economic fluctuations and its impact on various sections in the society. (Cognitive knowledge level: **Analyse**)
CO5	Determine the impact of changes in global economic policies on the business opportunities of a firm. (Cognitive knowledge level: **Analyse**)

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2										3	
CO2	2	2			2	2	3				3	
CO3	2	2	1								3	
CO4	2	2	1			1					3	
CO5	2	2	1								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 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 (Marks)	Test 2 (Marks)	
Remember	**15**	**15**	**30**
Understand	**20**	**20**	**40**
Apply	**15**	**15**	**30**

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
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	: 30 marks
Part B	: 70 marks

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 3 sub-divisions and carries 14 marks.

SYLLABUS

HUT 300 Industrial Economics & Foreign Trade

Module 1 (Basic Concepts and Demand and Supply Analysis)

Scarcity and choice - Basic economic problems- PPC – Firms and its objectives – types of firms – Utility – Law of diminishing marginal utility – Demand and its determinants – law of demand – elasticity of demand – measurement of elasticity and its applications – Supply, law of supply and determinants of supply – Equilibrium – Changes in demand and supply and its effects – Consumer surplus and producer surplus (Concepts) – Taxation and deadweight loss.

Module 2 (Production and cost)

Production function – law of variable proportion – economies of scale – internal and external economies – Isoquants, isocost line and producer's equilibrium – Expansion path – Technical progress and its implications – Cobb-Douglas production function - Cost concepts – Social cost: private cost and external cost – Explicit and implicit cost – sunk cost - Short run cost curves - long run cost curves – Revenue (concepts) – Shutdown point – Break-even point.

Module 3 (Market Structure)

Perfect and imperfect competition – monopoly, regulation of monopoly, monopolistic completion (features and equilibrium of a firm) – oligopoly – Kinked demand curve – Collusive oligopoly (meaning) – Non-price competition – Product pricing – Cost plus pricing – Target return pricing – Penetration pricing – Predatory pricing – Going rate pricing – Price skimming.

Module 4 (Macroeconomic concepts)

Circular flow of economic activities – Stock and flow – Final goods and intermediate goods - Gross Domestic Product - National Income – Three sectors of an economy- Methods of measuring national income – Inflation- causes and effects – Measures to control inflation- Monetary and fiscal policies – Business financing- Bonds and shares -Money market and Capital market – Stock market – Demat account and Trading account - SENSEX and NIFTY.

Module 5 (International Trade)

Advantages and disadvantages of international trade - Absolute and Comparative advantage theory - Heckscher - Ohlin theory - Balance of payments – Components – Balance of Payments deficit and devaluation – Trade policy – Free trade versus protection – Tariff and non-tariff barriers.

Reference Materials

1. Gregory N Mankiw, 'Principles of Micro Economics', Cengage Publications
2. Gregory N Mankiw, 'Principles of Macro Economics', Cengage Publications
3. Dwivedi D N, 'Macro Economics', Tata McGraw Hill, New Delhi.
4. Mithani D M, 'Managerial Economics', Himalaya Publishing House, Mumbai.
5. Francis Cherunilam, 'International Economics', McGraw Hill, New Delhi.

Sample Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Why does the problem of choice arise?
2. What are the central problems?
3. How do we solve the basic economic problems?
4. What is the relation between price and demand?
5. Explain deadweight loss due to the imposition of a tax.

Course Outcome 2 (CO2):

1. What is shutdown point?
2. What do you mean by producer equilibrium?
3. Explain break-even point;
4. Suppose a chemical factory is functioning in a residential area. What are the external costs?

Course Outcome 3 (CO3):

1. Explain the equilibrium of a firm under monopolistic competition.
2. Why is a monopolist called price maker?
3. What are the methods of non-price competition under oligopoly?

4. What is collusive oligopoly?

Course Outcome 4 (CO4):

1. What is the significance of national income estimation?
2. How is GDP estimated?
3. What are the measures to control inflation?
4. How does inflation affect fixed income group and wage earners?

Course Outcome 5 (CO5):

1. What is devaluation?
2. Suppose a foreign country imposes a tariff on Indian goods. How does it affect India's exports?
3. What is free trade?
4. What are the arguments in favour of protection?

Model Question paper

QP CODE: **PAGES:3**

Reg No:______________ **Name :______________**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY FIFTH /SIXTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: HUT 300

Course Name: Industrial Economics & Foreign Trade

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

PART A

Answer all Questions. Each question carries 3 Marks

1. Why does an economic problem arise?

2. What should be the percentage change in price of a product if the sale is to be increased by 50 percent and its price elasticity of demand is 2?

3. In the production function Q= $2L^{1/2}K^{1/2}$ if L=36 how many units of capital are needed to produce 60 units of output?

4. Suppose in the short run AVC 4. Suppose in the short run AVC<P<AC. Will this firm produce or shut down? Give reason.

5. What is predatory pricing?

6. What do you mean by non- price competition under oligopoly?

7. What are the important economic activities under primary sector?

8. Distinguish between a bond and share?

9. What are the major components of balance of payments?

10. What is devaluation? **(10 x 3 = 30 marks)**

PART B

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

MODULE I

11. a) Prepare a utility schedule showing units of consumption, total utility and marginal utility, and explain the law of diminishing marginal utility. Point out any three limitations of the law.

b) How is elasticity of demand measured according to the percentage method? How is the measurement of elasticity of demand useful for the government?

Or

12. a) Explain the concepts consumer surplus and producer surplus.

b) Suppose the government imposes a tax on a commodity where the tax burden met by the consumers. Draw a diagram and explain dead weight loss. Mark consumer surplus, producer surplus, tax revenue and dead weight loss in the diagram.

MODULE II

13. a) What are the advantages of large-scale production?

b) Explain Producer equilibrium with the help of isoquants and isocost line. What is expansion path?

Or

14. a) Explain break-even analysis with the help of a diagram.

b) Suppose the monthly fixed cost of a firm is Rs. 40000 and its monthly total variable cost is Rs. 60000.

i. If the monthly sales is Rs. 120000 estimate contribution and break-even sales.
ii. If the firm wants to get a monthly profit of Rs.40000, what should be the sales?

c) The total cost function of a firm is given as $TC=100+50Q-11Q^2+Q^3$. Find marginal cost when output equals 5 units.

MODULE III

15. a) What are the features of monopolistic competition?

b) Explain the equilibrium of a firm earning supernormal profit under monopolistic competition.

Or

16. a) Make comparison between perfect competition and monopoly.

b) Explain price rigidity under oligopoly with the help of a kinked demand curve.

MODULE IV

17. a) How is national income estimated under product method and expenditure method?

b) Estimate GDPmp, GNPmp and National income

Private consumption expenditure	= 2000 (in 000 cores)
Government Consumption	= 500
NFIA	= -(300)
Investment	= 800
Net=exports	=700
Depreciation	= 400
Net-indirect tax	= 300

Or

18. a) What are the monetary and fiscal policy measures to control inflation?

b) What is SENSEX?

MODULE V

19. a) What are the advantages of disadvantages of foreign trade?

b) Explain the comparative cost advantage.

Or

20. a) What are the arguments in favour protection?

b) Examine the tariff and non-tariff barriers to international trade.

(5 × 14 = 70 marks)

Teaching Plan

Module 1 (Basic concepts and Demand and Supply Analysis)		7 Hours
1.1	Scarcity and choice – Basic economic problems - PPC	1 Hour
1.2	Firms and its objectives – types of firms	1 Hour
1.3	Utility – Law of diminishing marginal utility – Demand – law of demand	1 Hour
1.4	Measurement of elasticity and its applications	1 Hour
1.5	Supply, law of supply and determinants of supply	1 Hour
1.6	Equilibrium – changes in demand and supply and its effects	1 Hour
1.7	Consumer surplus and producer surplus (Concepts) – Taxation and deadweight loss.	1 Hour
Module 2 (Production and cost)		**7 Hours**
2.1	Productions function – law of variable proportion	1 Hour
2.2	Economies of scale – internal and external economies	1 Hour
2.3	producers equilibrium – Expansion path	1 Hour
2.4	Technical progress and its implications – cob Douglas Production function	1 Hour
2.5	Cost concepts – social cost: private cost and external cost – Explicit and implicit cost – sunk cost	1 Hour
2.6	Short run cost curves & Long run cost curves	1 Hour
2.7	Revenue (concepts) – shutdown point – Break-even point.	1 Hour
Module 3 (Market Structure)		**6 hours**
3.1	Equilibrium of a firm, MC – MR approach and TC – TR approach	1 Hour
3.2	Perfect competition & Imperfect competition	1 Hour
3.3	Monopoly – Regulation of monopoly – Monopolistic competition	1 Hour
3.4	Oligopoly – kinked demand curve	1 Hour
3.5	Collusive oligopoly (meaning) – Non price competition	1 Hour
3.6	Cost plus pricing – Target return pricing – Penetration, Predatory pricing – Going rate pricing – price skimming	1 Hour

Module 4 (Macroeconomic concepts)		7 Hours
4.1	Circular flow of economic activities	1 Hour
4.2	Stock and flow – Final goods and intermediate goods – Gross Domestic Product - National income – Three sectors of an economy	1 Hour
4.3	Methods of measuring national income	1 Hour
4.4	Inflation – Demand pull and cost push – Causes and effects	1 Hour
4.5	Measures to control inflation – Monetary and fiscal policies	1 Hour
4.6	Business financing – Bonds and shares – Money market and capital market	1 Hour
4.7	Stock market – Demat account and Trading account – SENSEX and NIFTY	1 Hour
Module 5 (International Trade)		**8 Hours**
5.1	Advantages and disadvantages of international trade	1 Hour
5.2	Absolute and comparative advantage theory	2 Hour
5.3	Heckscher – Ohlin theory	1 Hour
5.4	Balance of payments - components	1 Hour
5.5	Balance of payments deficit and devaluation	1 Hour
5.6	Trade policy – Free trade versus protection	1 Hour
5.7	Tariff and non tariff barriers.	1 Hour

HUT 310	**Management for Engineers**	**Category**	**L**	**T**	**P**	**Credit**
		HMC	**3**	**0**	**0**	**3**

Preamble: This course is intended to help the students to learn the basic concepts and functions of management and its role in the performance of an organization and to understand various decision-making approaches available for managers to achieve excellence. Learners shall have a broad view of different functional areas of management like operations, human resource, finance and marketing.

Prerequisite: Nil

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

CO1	Explain the characteristics of management in the contemporary context (Cognitive Knowledge level: **Understand**).
CO2	Describe the functions of management (Cognitive Knowledge level: **Understand**).
CO3	Demonstrate ability in decision making process and productivity analysis (Cognitive Knowledge level: **Understand**).
CO4	Illustrate project management technique and develop a project schedule (Cognitive Knowledge level: **Apply**).
CO5	Summarize the functional areas of management (Cognitive Knowledge level: **Understand**).
CO6	Comprehend the concept of entrepreneurship and create business plans (Cognitive Knowledge level: **Understand**).

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2				1	2	2	2		2	1	1
CO2	2				1	1		2	1	2	1	1
CO3	2	2	2	2	1							
CO4	2	2	2	2	1						2	1
CO5	2					1	1		1	2	1	
CO6		2	2	2	1	1	1	1	1	1	1	1

Abstract POs defined by National Board of Accreditation			
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	15	15	30
Understand	15	15	30
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 : 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

HUT 310 Management for Engineers (35 hrs)

Module 1 (Introduction to management Theory- 7 Hours)

Introduction to management theory, Management Defined, Characteristic of Management, Management as an art-profession, System approaches to Management, Task and Responsibilities of a professional Manager, Levels of Manager and Skill required.

Module 2 (management and organization- 5 hours)

Management Process, Planning types , Mission, Goals, Strategy, Programmes, Procedures, Organising, Principles of Organisation, Delegation, Span of Control, Organisation Structures, Directing, Leadership, Motivation, Controlling..

Module 3 (productivity and decision making- 7 hours)

Concept of productivity and its measurement; Competitiveness; Decision making process; decision making under certainty, risk and uncertainty; Decision trees; Models of decision making.

. Module 4 (project management- 8 hours)

Project Management, Network construction, Arrow diagram, Redundancy. CPM and PERT Networks, Scheduling computations, PERT time estimates, Probability of completion of project, Introduction to crashing.

Module 5 (functional areas of management- 8 hours)

Introduction to functional areas of management, Operations management, Human resources management, Marketing management, Financial management, Entrepreneurship, Business plans, Corporate social responsibility, Patents and Intellectual property rights.

References:

1. H. Koontz, and H. Weihrich, Essentials of Management: An International Perspective. 8th ed., McGraw-Hill, 2009.
2. P C Tripathi and P N Reddy, Principles of management, TMH, 4th edition, 2008.
3. P. Kotler, K. L. Keller, A. Koshy, and M. Jha, Marketing Management: A South Asian Perspective. 14th ed., Pearson, 2012.
4. M. Y. Khan, and P. K. Jain, Financial Management, Tata-McGraw Hill, 2008.
5. R. D. Hisrich, and M. P. Peters, Entrepreneurship: Strategy, Developing, and Managing a New Enterprise, 4th ed., McGraw-Hill Education, 1997.
6. D. J. Sumanth, Productivity Engineering and Management, McGraw-Hill Education, 1985.
7. K.Ashwathappa, 'Human Resources and Personnel Management', TMH, 3 rd edition, 2005.
8. R. B. Chase, Ravi Shankar and F. R. Jacobs, Operations and Supply Chain Management, 14th ed. McGraw Hill Education (India), 2015.

Sample Course Level Assessment Questions

Course Outcome1 (CO1): Explain the systems approach to management?

Course Outcome 2 (CO2): Explain the following terms with a suitable example Goal, Objective, and Strategy.

Course Outcome 3 (CO3): Mr. Shyam is the author of what promises to be a successful novel. He has the option to either publish the novel himself or through a publisher. The publisher is offering Mr. Shyam Rs. 20,000 for signing the contract. If the novel is successful, it will sell 200,000 copies. Else, it will sell 10,000 copies only. The publisher pays a Re. 1 royalty per copy. A market survey indicates that there is a 70% chance that the novel will be successful. If Mr. Shyam undertakes publishing, he will incur an initial cost of Rs. 90,000 for printing and marketing., but each copy sold will net him Rs. 2. Based on the given information and the decision analysis method, determine whether Mr. Shyam should accept the publisher's offer or publish the novel himself.

Course Outcome 4 (CO4): Explain the concepts of crashing and dummy activity in project management.

Course Outcome 5 (CO5): Derive the expression for the Economic order quantity (EOQ)?

Course Outcome 6 (CO6): Briefly explain the theories of Entrepreneurial motivation.?

Model Question Paper

QP CODE: PAGES: 4

Reg No:_______________ Name:_________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FOURTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: HUT 310

Course name: Management for Engineers

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

PART-A (Answer All Questions. Each question carries 3 marks)

1. “Management is getting things done through other.” Elaborate.

2. Comment on the true nature of management. Is it a science or an art?

3. Planning is looking ahead and controlling is looking back. Comment with suitable examples

4. Explain the process of communication?

5. Explain the hierarchy of objectives?

6. Explain the types of decisions?

7. Describe the Economic man model?

8. Explain the concepts of crashing and dummy activity in project management.

9. Differentiate the quantitative and qualitative methods in forecasting.

10. What are the key metrics for sustainability measurement? What makes the measurement and reporting of sustainability challenging?

PART-B (Answer any one question from each module)

11. a) Explain the systems approach to management. **(10)**

b) Describe the roles of a manager **(4)**

OR

12. a) Explain the 14 principles of administrative management? **(10)**

b) Explain the different managerial skills (**4)**

13. a) What are planning premises, explain the classification of planning premises. **(10)**

b) Distinguish between strategy and policy. How can policies be made effective. **(4)**

OR

14 a) Explain three motivational theories. **(9)**

b) Describe the managerial grid. **(5)**

15. a) Modern forest management uses controlled fires to reduce fire hazards and to stimulate new forest growth. Management has the option to postpone or plan a burning. In a specific forest tract, if burning is postponed, a general administrative cost of Rs. 300 is incurred. If a controlled burning is planned, there is a 50% chance that good weather will prevail and burning will cost Rs. 3200. The results of the burning may be either successful with probability 0.6 or marginal with probability 0.4. Successful execution will result in an estimated benefit of Rs. 6000, and marginal execution will provide only Rs. 3000 in benefits. If the weather is poor, burning will be cancelled incurring a cost of Rs. 1200 and no benefit. i) Develop a decision tree for the problem. (ii) Analyse the decision tree and determine the optimal course of action. **(8)**

b) Student tuition at ABC University is $100 per semester credit hour. The Education department supplements the university revenue by matching student tuition, dollars per dollars. Average class size for typical three credit course is 50 students. Labour costs are $4000 per class, material costs are $20 per student, and overhead cost are $25,000 per class. (a) Determine the total factor productivity. (b) If instructors deliver lecture 14 hours per week and the semester lasts for 16 weeks, what is the labour productivity? **(6)**

OR

16. a) An ice-cream retailer buys ice cream at a cost of Rs. 13 per cup and sells it for Rs. 20 per cup; any remaining unsold at the end of the day, can be disposed at a salvage price of Rs. 2.5 per cup. Past sales have ranged between 13 and 17 cups per day; there is no reason to believe that

sales volume will take on any other magnitude in future. Find the expected monetary value and EOL, if the sales history has the following probabilities: **(9)**

Market Size	13	14	15	16	17
Probability	0.10	0.15	0.15	0.25	0.35

b) At Modem Lumber Company, Kishore the president and a producer of an apple crates sold to growers, has been able, with his current equipment, to produce 240 crates per 100 logs. He currently purchases 100 logs per day, and each log required 3 labour hours to process. He believes that he can hire a professional buyer who can buy a better quality log at the same cost. If this is the case, he increases his production to 260 crates per 100 logs. His labour hours will increase by 8 hours per day. What will be the impact on productivity (measured in crates per labour-hour) if the buyer is hired? What is the growth in productivity in this case? **(5)**

17. a) A project has the following list of activities and time estimates:

Activity	**Time (Days)**	**Immediate Predecessors**
A	1	-
B	4	A
C	3	A
D	7	A
E	6	B
F	2	C, D
G	7	E, F
H	9	D
I	4	G, H

(a) Draw the network. (b) Show the early start and early finish times. (c) Show the critical path. **(10)**

b) An opinion survey involves designing and printing questionnaires, hiring and training personnel, selecting participants, mailing questionnaires and analysing data. Develop the precedence relationships and construct the project network. **(4)**

OR

18. a) The following table shows the precedence requirements, normal and crash times, and normal and crash costs for a construction project:

Activity	Immediate Predecessors	Required Time (Weeks)		Cost (Rs.)	
		Normal	Crash	Normal	Crash
A	-	4	2	10,000	11,000
B	A	3	2	6,000	9,000
C	A	2	1	4,000	6,000
D	B	5	3	14,000	18,000
E	B, C	1	1	9,000	9,000
F	C	3	2	7,000	8,000
G	E, F	4	2	13,000	25,000
H	D, E	4	1	11,000	18,000
I	H, G	6	5	20,000	29,000

Draw the network. (b) Determine the critical path. (c) Determine the optimal duration and the associated cost. **(10)**

b) Differentiate between CPM and PERT. **(4)**

19. a) What is meant by market segmentation and explain the process of market segmentation **(8)**

b) The Honda Co. in India has a division that manufactures two-wheel motorcycles. Its budgeted sales for Model G in 2019 are 80,00,000 units. Honda's target ending inventory is 10,00, 000 units and its beginning inventory is 12, 00, 000 units. The company's budgeted selling price to its distributors and dealers is Rs. 40, 000 per motorcycle. Honda procures all its wheels from an outside supplier. No defective wheels are accepted. Honda's needs for extra wheels for replacement parts are ordered by a separate division of the company. The company's target ending inventory is 3,00,000 wheels and its beginning inventory is 2,00,000 wheels. The budgeted purchase price is Rs. 1,600 per wheel.

(a) Compute the budgeted revenue in rupees.

(b) Compute the number of motorcycles to be produced.

Compute the budgeted purchases of wheels in units and in rupees.? **(6)**

OR

20. a) a) "Human Resource Management policies and principles contribute to effectiveness, continuity and stability of the organization". Discuss. (b) What is a budget? Explain how sales budget and production budgets are prepared? **(10)**

b) Distinguish between the following: (a) Assets and Liabilities (b) Production concept and Marketing concept (c) Needs and Wants (d) Design functions and Operational control functions in operations **(4)**

Teaching Plan

Sl.No	TOPIC	SESSION
	Module I	
1.1	Introduction to management	1
1.2	Levels of managers and skill required	2
1.3	Classical management theories	3
1.4	neo-classical management theories	4
1.5	modern management theories	5
1.6	System approaches to Management,	6
1.7	Task and Responsibilities of a professional Manager	7
	Module 2	
2.1	Management process – planning	8
2.2	Mission – objectives – goals – strategy – policies – programmes – procedures	9
2.3	Organizing, principles of organizing, organization structures	10
2.4	Directing, Leadership	11
2.5	Motivation, Controlling	12
	Module III	
3.1	Concept of productivity and its measurement Competitiveness	13
3.2	Decision making process;	14
3.3	Models in decision making	15
3.4	Decision making under certainty and risk	16
3.5	Decision making under uncertainty	17
3.6	Decision trees	18
3.7	Models of decision making.	19
	Module IV	
4.1	Project Management	20

Sl.No	TOPIC	SESSION
	Module I	
4.2	Network construction	21
4.3	Arrow diagram, Redundancy	22
4.4	CPM and PERT Networks	23
4.5	Scheduling computations	24
4.6	PERT time estimates	25
4.7	Probability of completion of project	26
4.8	Introduction to crashing	
	Module V	
5.1	Introduction to functional areas of management,	28
5.2	Operations management	29
5.3	Human resources management ,	30
5.4	Marketing management	31
5.5	Financial management	32
5.6	Entrepreneurship,	33
5.7	Business plans	34
5.8	Corporate social responsibility, Patents and Intellectual property rights	35

CORE COURSES S5 & S6

SEMESTER V

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
MET301	MECHANICS OF MACHINERY	PCC	3	1	0	4

Preamble:

This course aims to introduce the students to the fundamentals of the kinematics of various mechanisms and also its analysis for its displacement, velocity, and acceleration. The course will also cover the design of cams, theory and analysis of gears, gear trains and synthesis of mechanisms. The static force analysis of planar mechanisms and concept of gyroscopic couple along with its effect has also been included. This course also aids students in estimating unbalance in rotating and reciprocating masses and suggesting methods to overcome it.

Prerequisite: Engineering Mechanics (EST 100)

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

CO 1	Explain the fundamentals of kinematics, various planar mechanisms and interpret the basic principles of mechanisms and machines
CO 2	Perform analysis and synthesis of mechanisms
CO 3	Solve the problem on cams and gear drives, including selection depending on requirement.
CO 4	Calculate the gyroscopic effect in various situations
CO 5	Analyse rotating and reciprocating masses for its unbalance

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 12
CO 1	2										
CO 2	3	3	3	2	2						
CO 3	3	3	2	2	2						
CO 4	3	2	1	1	1						
CO 5	3	2	2	1	2						

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): Explain the fundamentals of kinematics, various planar mechanisms and their components

1. Define the terms Link, Kinematic chain, Mechanism & Machine.

2. Explain Grashof's law.

3 Apply Kutzbach criterion to find the mobility of mechanisms.

4.Sketch and explain the various inversions of slider crank chain/fourbar chain

Course Outcome 2 (CO2) : Perform analysis and synthesis of mechanisms

1. Find out the velocity and acceleration of links of various planar mechanisms

2. State and prove the Arnold Kennedy's three centre theorem

2. Derive an expression for the magnitude and direction of Coriolis component of acceleration

3. Design a four bar mechanism to generate a given function accurate upto 3 positions

4. Do the static force analysis of four bar/slider crank mechanisms with different loading conditions

Course Outcome 3 (CO3): Solve the problem on cams and gear drives, including selection depending on requirement

1. Why is a roller follower preferred over knife edge follower
2. Design a cam profile to suit the situations for the follower such as SHM, dwell, constant velocity, uniform acceleration cycloidal motion etc
3. What do you understand by the term “interference” as applied to gears
4. Find out the gear train values of simple ,compound and epicyclic gear trains

Course Outcome 4 (CO4): Calculate the gyroscopic effect in various situations

1. What do you understand by Gyroscopic couple? Derive its formula for its magnitude.
2. Explain the effect of the gyroscopic couple on the reaction of the four wheels of a vehicle negotiating a curve.
3. Describe the working of a gyroscope.
4. How does gyroscopes help in guidance?

Course Outcome 5 (CO5): Analyse rotating and reciprocating masses for its unbalance

1. Distinguish between static balancing and dynamic balancing
2. Find out the magnitude and position of balancing masses required to balance unbalanced masses rotating in different planes.
3. What do you mean by primary and secondary unbalanced forces?
4. Find out the value of unbalanced primary force, primary couple, secondary force and secondary couple.

MODEL QUESTION PAPER

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIFTH SEMESTER B. TECH DEGREE EXAMINATION

Course Code: MET301

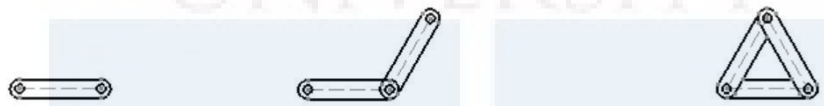
Course Name: MECHANICS OF MACHINERY

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

PART – A

(ANSWER ALL QUESTIONS, EACH QUESTION CARRIES 3 MARKS)

1. Find out the degree of freedom in the following cases.



a) A planar link b) Two planar links joined by a revolute joint c) Three Planar links joined by three revolute joints

2. Describe the motion of the following items as pure rotation, pure translation or complex planar motion.
   a) The hand of a clock **b)** The pen in an XY plotter **c)** connecting rod of an IC engine

3. A rod of length 1m with its one end fixed at origin is oriented in the positive X direction. It rotates in the XY plane with an angular velocity of 10rad/s clockwise direction and angular acceleration of 10rad/s^2 in the counter clock wise direction at a particular instant. Find out the total acceleration experienced at the free end.

4. Obtain the expression for velocity when the cam follower motion is cycloidal in nature.

5. How do we bring interchangeability of gears?

6. What do you mean by type synthesis?

7. Define the term 'friction circle'

8. How does a gyroscope help in guidance of aircrafts?

9. Does a rotor which is statically balanced require dynamic balancing?

10. Why do we go for partial balancing in the case of balancing of reciprocating masses?

Part B

(ANSWER ONE FULL QUESTION FROM EACH MODULE)

MODULE – I

11. **a)** Draw the inversions of the mechanism shown in Figure 1 which leads to double crank,

double rocker and crank rocker mechanisms. Describe the nature of motion of each link in each case also **(9 marks)**

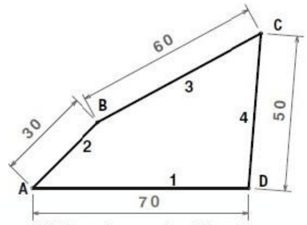


Figure-1

b) What are binary, ternary and quaternary links? **(5 marks)**

12. In the figure 2 given below the angular velocity of the crank OA is 600 r.p.m. Determine the linear velocity of the slider and angular velocity of all other links. The dimensions of various links are: OA=28 mm; AB = 44 mm; BC = 49 mm and BD = 46 mm. The centre distance between centres of rotation O and C is 65mm.The path of travel of slider is 11 mm below the fixed-point C **(14 marks)**

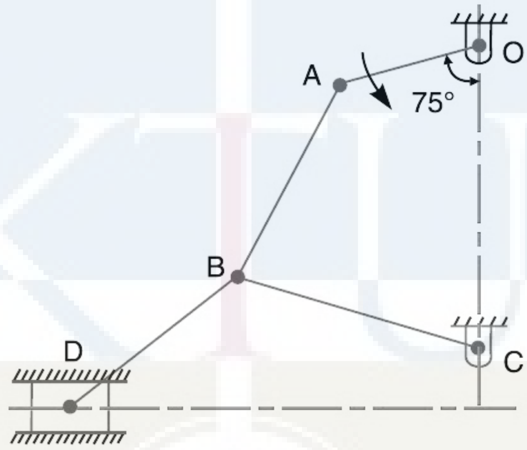


Figure-2

MODULE – II

13. a) What is meant by Coriolis component of acceleration. In which case does it occur? How is its direction determined? **(9 marks)**

b) A link OB rotating with a constant angular velocity of 2 rad/s in the counter clockwise direction and a block is sliding radially outwards on it with a uniform velocity of 0.75 m/s with respect to the rod as shown in the figure 3 below. Given OA =1 m and link OB is inclined to the positive X axis by 45°.Find out the absolute acceleration of block at A in magnitude and direction. **(5 marks)**

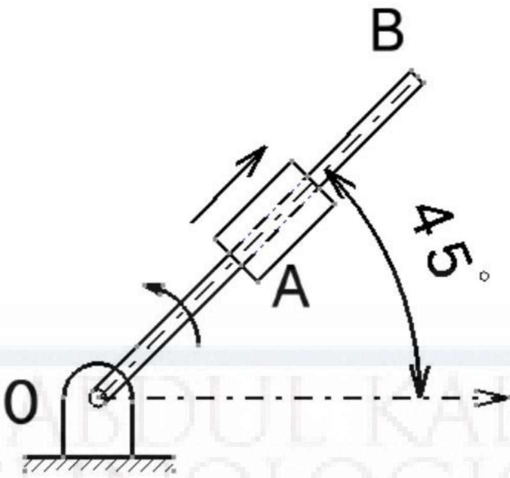


Figure-3

14. A cam rotating at 150 rpm operates a reciprocating follower of radius 2.5 cm. The follower axis is offset by 2.5 cm to the right. The least radius of the cam is 5 cm and the stroke of the follower is 5 cm. ascent and descent with take place by uniform acceleration and retardation. Ascent take place during 75° and descent during 90° of cam rotation. Dwell between ascent and descent is 60°. Draw the cam profile. Also sketch velocity and acceleration diagrams and mark salient values. **(14 marks)**

MODULE – III

15. In an epicyclic gear train as shown in Figure 4 the internal wheels A and B and the compound wheels C & D rotate independently about axis O. The wheels E and F rotate on pins fixed to the arm G.E gears with A and C and F gears with B and D. All wheels have the same module and the number of teeth are:
Tc = 28, T_D = 26, T_E = T_F = 18

i) Sketch the arrangement

ii) Find the number of teeth on A and B

iii) If the arm G makes 100 r.p.m clockwise and A is fixed, find the speed B

iv) If the arm G makes 100 r.p.m clockwise and wheel A makes 10 r.p.m counter clockwise, find the speed of wheel B **(14 marks)**

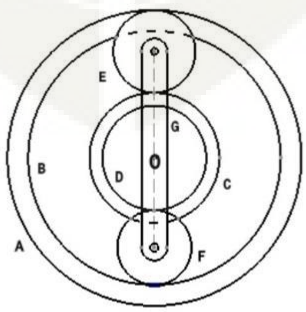


Figure-4

16. **a)** Design a four bar crank rocker to give 45° of rocker motion with a time ratio of 1:1.25 with 45° output rocker motion. **(9 marks)**

b) Design a slider crank mechanism to coordinate two positions of the input link and the slider for the following angular and linear displacement of the input link and slider respectively.

θ_{12} = 30° & S_{12}= 100 mm **(5 marks)**

MODULE – IV

17. The applied load on the piston of an offset slider-crank linkage shown in Fig. is 100 N, and the coefficient of friction between the slider and the guide is 0.27, using any method ,determine the magnitude and sense of torque T_2 applied on OA for the static equilibrium of the linkage. (**14 marks)**

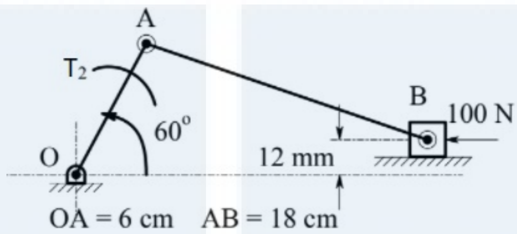


Figure-5

18 a) The wheels of a motor cycle have a moment of inertia of 5 kg m^2 and the engine parts, a moment of inertia of 0.35 kgm^2. The wheel axles and the crank shaft of the engine are all parallel to each other. If the ratio of reduction gears is 4:1, the wheel diameter is 700 mm, determine the magnitude and direction of the gyroscopic couple when the motor cycle negotiates a curve of 50 m radius at a speed of 50 km/hr. If the mass of the motor cycle with rider is 250 kg with centre of gravity at 65 cm above the ground in vertical position, determine the speed of the motor cycle rounding a curve of 60 m if the road condition permits an angle of heel of 45°. **(10 marks)**

b) Explain spin vector, precession vector, gyroscopic applied torque vector and gyroscopic reactive torque vector. **(4 marks)**

MODULE – V

19. A shaft carries four masses A, B, C and D which are placed in parallel planes perpendicular to the longitudinal axis. Th unbalanced masses at planes B and C are 3.6 kg and 2.6kg respectively and both are assumed to be concentrated at a radius of 25mm while the masses in planed A and D are both at a radius of 40mm.The angle between the planes B and C is 100° and that between B and A is 190°, both angles being measured in counter clock wise direction from the plane B .The planes containing A and B are 250mm apart and those containing B and C are 500mm.If the shaft is to be completely balanced ,determine

i) Masses at the planes A and D

ii) the distance between the planes C and D

iii) the angular position of the mass D **(14 marks)**

20. A five cylinder in-line engine running at 750 r.p.m. has successive cranks 144° apart, the distance between the cylinder centre lines being 375 mm. The piston stroke is 225mm and the ratio of the connecting rod to the crank is 4. Examine the engine for balance of primary and secondary forces and couples. Find the maximum values of these and the position of the central crank at which these maximum values occur. The reciprocating mass for each cylinder is 15 kg. **(14 marks)**

Syllabus

Module 1

Introduction to kinematics and mechanisms - various mechanisms, kinematic diagrams, degree of freedom- Grashof's criterion, inversions, coupler curves mechanical advantage, transmission angle. straight line mechanisms exact, approximate. Displacement, velocity analysis– relative motion - relative velocity. Instantaneous centre -Kennedy's theorem.

Module 2

Acceleration analysis- Relative acceleration - Coriolis acceleration - graphical and analytical methods.
Cams - classification of cam and followers - displacement diagrams, velocity and acceleration analysis of SHM, uniform velocity, uniform acceleration, cycloidal motion
Graphical cam profile synthesis, pressure angle.

Module 3

Gears – Classification- terminology of spur gears – law of gearing -tooth profiles- involute spur gears- contact ratio - interference - backlash - gear standardization – interchangeability. Gear trains - simple and compound gear trains - planetary gear trains.

Kinematic synthesis (planar mechanisms) - type, number and dimensional synthesis – precision points. Graphical synthesis for motion - path and prescribed timing - function generator. 2 position and 3 position synthesis – overlay Method. Freudenstein's equation.

Module 4

Static force analysis- Analysis of four bar linkages and slider crank mechanism, graphical method, Matrix method, principle of virtual work. Analysis of four bar and slider crank mechanisms with sliding and pin friction.

Gyroscopic couples-spin, precession and applied gyroscopic couple vectors-effects on the stability of two wheelers, four wheelers, sea vessels and air crafts, application of gyroscopes

Module 5

Static balancing-dynamic balancing-balancing of several masses in the same plane-several masses in different planes-graphical and analytical method-force and couple polygons.

Balancing of reciprocating masses -Single cylinder engine-multi cylinder engine -V-engine

Text Books

1. Ballaney P. L., Theory of Machines and Mechanisms, Khanna Publishers,2005
2. S. S. Rattan, Theory of Machines, Tata Mc Graw Hill,2009

Reference Books

1. C. E. Wilson, P. Sadler, Kinematics and Dynamics of Machinery, Pearson Education,2005.
2. D.H. Myskza, Machines and Mechanisms Applied Kinematic Analysis, Pearson Education,2013
3. G. Erdman, G. N. Sandor, Mechanism Design: Analysis and synthesis Vol I & II, Prentice Hall of India,1984.
4. Ghosh, A. K. Malik, Theory of Mechanisms and Machines, Affiliated East West Press,1988
5. J. E. Shigley, J. J. Uicker, Theory of Machines and Mechanisms, McGraw Hill,2010
6. Norton, Kinematics and Dynamics of Machinery, Tata McGraw Hill,2009

Course Contents and Lecture Schedule

No	Topic	No. of lectures
1	**Module-1-**	**10 Hours**
1.1	Introduction to kinematics and mechanisms	1 Hr
1.2	Various mechanisms	2 Hr
1.3	Kinematic diagrams, degree of freedom, Grashof’s criterion	2 Hr
1.4	Inversions	1 Hr
1.5	Coupler curves mechanical advantage, transmission angle.	1 Hr
1.6	Straight line mechanisms exact, approximate	1 Hr
1.7	Displacement, velocity analysis, Kennedy’s theorem.	2 Hr
2	**Module 2-**	**10 Hours**
2.1	Acceleration analysis- Relative acceleration - Coriolis acceleration -	1 Hr
2.2	Graphical and analytical methods. .	2Hr

2.3	Cams - classification of cam and followers	1 Hr
2.4	Displacement diagrams, velocity and acceleration analysis of SHM,	2 Hr
2.5	Uniform velocity,uniform acceleration and cycloidal motion	1 Hr
2.5	Graphical cam profile synthesis, pressure angle.	2 Hr
2.6	Analysis of tangent cam with roller follower and circular cam with flat follower	1 Hr
3	**Module-3**	**9 Hours**
3.1	Gears – terminology of spur gears – law of Gearing	1 Hr
3.2	involute spur gears - contact ratio- interference - backlash - gear standardization-interchangeability	1 Hr
3.3	Gear trains - simple and compound gear trains - planetary gear trains	2 Hr
3.4	Kinematic synthesis (planar mechanisms) - type, number and dimensional synthesis – precision points.	2 Hr
3.5	Graphical synthesis for motion - path and prescribed timing - function generator. 2 position and 3 position synthesis	2 Hr
3.6	Overlay Method. Freudenstein's equation	1 Hr
4	**Module-4-**	**8 Hours**
4.1	Static force analysis- Analysis of four bar linkages and slider crank mechanism	2 Hr
4.2	Graphical method, Matrix method	1 Hr
4.3	principle of virtual work	1 Hr
4.4	Analysis of four bar and slider crank mechanisms with sliding and pin friction.	1 Hr
4.4	Gyroscopic couples-spin, precession and applied gyroscopic couple vectors	2 Hr
4.5	Effects on the stability of two wheelers **,** Four wheelers, sea vessals and air crafts	1 Hr
5	**Module-5- Kinematics-synthesis**	**8 Hours**
5.1	Static balancing-dynamic balancing-	2 Hr

5.2	balancing of several masses in the same plane	1 Hr
5.3	several masses in different planes-graphical and analytical method	1 Hr
5.4	force and couple polygons	1 Hr
5.5	Balancing of reciprocating masses -Single cylinder engine	1 Hr
5.6	multi cylinder engine-v engine-inline engine	2 Hr

MRT303	LINEAR CONTROL SYSTEMS	CATEGORY	L	T	P	CREDIT
		PCC	3	1	0	4

Preamble: This course enables students to systematically study the principles of system modelling, analysis and feedback control, and use them to design and evaluate feedback control systems.

Prerequisite: Linear Differential Equations, Laplace Transform

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

CO 1	Understand control systems in the design of dynamic systems.
CO 2	Identify a set of equations for representing and modelling physical systems.
CO 3	Perform analysis of control systems in time and frequency domains
CO 4	Analyse the stability of control systems.
CO 5	Identify different controllers and compensation techniques
CO 6	Apply the knowledge of control systems in real time control applications

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	2		2								
CO 2	3	2	2	2								2
CO 3	3	3										
CO 4	3	3	2	2								2
CO 5	3	2										2
CO 6	3	2		2								2

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	10
Understand	20	20	20
Apply	10	10	30
Analyse	10	10	40
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. Differentiate between open loop and closed loop control systems with examples.

2. What do you mean by transfer function of a system?

3. What is Mason's Gain Formula?

Course Outcome 2 (CO2)

1. Obtain the value of current in an RC circuit excited with a constant voltage source.

2. Obtain the transfer function of an armature controlled DC motor.

3. What do you mean by analogous systems?

Course Outcome 3(CO3):

1. What are the standard test signals?

2. Obtain the step response of a second order system.

3. Obtain the polar plot of the system $\frac{10(s+1)}{(s+2)(s+5)}$.

Course Outcome 4 (CO4):

1. Determine the RH stability of given characteristic equation, $s^4+8s^3+18s^2+16s+5=0$.

2. Determine the limiting value of 'K' for stability $G(s)H(s) = \frac{K(s+4)}{s(s-2)}$

3. Sketch the root locus of the unity feedback system with $G(s) = \frac{K}{s^2+2s+2}$ for positive values of K.

Course Outcome 5 (CO5):

1. What is a Phase Lag compensator and why is it used?

2. What is the need of PID controller?

3. Describe the design procedure for a lag compensator.

Course Outcome 6 (CO6):

1. Describe the role of control system in mechatronics.

2. Illustrate an Automatic temperature control system suitable for automation.

3. Describe the working of an automatic traffic light control system.

Model Question paper

Course Code: MRT303

Course Name: LINEAR CONTROL SYSTEMS

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

PART A

Answer all Questions. Each question carries 3 Marks

1. What is the difference between type and order of a system?
2. What do you mean by transfer function?
3. A unity feedback system has an open loop transfer function $\frac{20(S+5)}{S^2(S+0.1)(S+3)}$. Determine steady state error for unit parabolic input?
4. Explain the effect of adding poles and zeros on root locus?
5. Derive an expression for resonant frequency and resonant peak of a second order system.
6. Determine the phase cross over frequency of a system with open loop transfer function $G(s) = \frac{1}{(1+2s)(1+s)}$.
7. Give two examples of non-minimum phase transfer function. Explain why they are called non-minimum phase system?
8. Give a physical example of transportation lag. How can it be represented?
9. What is the need for cascade compensation?
10. With an example explain the role of control systems in Mechatronics.

PART B

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

Module 1

11. (a) Differentiate between open loop control system & closed loop control system. (6)

    (b) Obtain the transfer function of a series RLC circuit. (8)

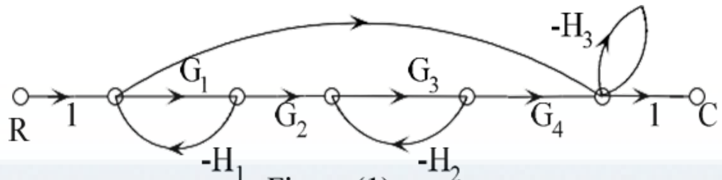


Figure (1)

12. (a) Find the overall transfer function of the signal flow graph shown in Figure (1) using Mason's gain formula (7)

    (b) Obtain the value of current in an RC circuit excited with a constant voltage source(7)

Module 2

13. (a)Obtain the force voltage analogy of a general mechanical translation system (4)

    (b) Obtain the transfer function of a field controlled DC Motor (8)

14. (a) Obtain the transfer function of an armature controlled DC Motor. (10)

    (b) Explain the force-current analogy. (4)

Module 3

15. (a) The forward path transfer function of a unity feedback control system is given by $G(s) = \frac{2}{s(s+3)}$. Obtain an expression for unit step response of the system.(10)

    (b) What do you mean by PID control? (4)

16. (a) Evaluate the static error coefficients and steady state error for a unity feedback system having a forward path transfer function$G(s) = \frac{50}{s(s+10)}$for the input $r(t) = 1 + 2t + t^2$. (10)

    (b) What are the standard test signals? (4)

Module 4

17. The open loop transfer function of a unity feedback system is $\frac{10K}{s(s^2+2s+2)}$. Find the open loop poles.Draw the root locus. Find the range of values of K for which the system is stable. Find all the closed loop poles corresponding to a damping ratio of 0.7. (14)

18. (a) Ascertain stability of the system whose characteristic equation is

    $s^6 + 3s^5 + 5s^4 + 9s^3 + 8s^2 + 6s + 4 = 0.$ (5)

    (b) The open loop transfer function of a unity feedback system is $\frac{10}{s(s+2)(s+5)}$. Draw the Bode plot and find Gain margin and phase margin (9)

Module 5

19. Illustrate an Automatic temperature control system suitable for automation. (14)

20. Describe the working of an automatic traffic light control system. (14)

Syllabus

Module 1 (10 Hours)

Introduction: Principle of Automatic control- Open loop and closed loop systems – examples System modelling & approximations -modelling of electrical systems – dynamic equations using KCL & KVL of RL, RC and RLC circuits – Transfer functions- development of block diagrams of simple electrical networks - block diagram reduction -signal flow graphs - Mason's gain formula.

Module 2 (9 Hours)

Modelling and analogy of other physical systems: Modelling of translational and rotational mechanical systems –differential equations for mass, spring, and dashpot elements -D'Alembert's principle – dynamic equations & transfer function for typical mechanical systems - analogous systems –force voltage & force-current analogy - toque-voltage & torque-current analogy – electromechanical systems - transfer function of armature controlled dc motor & field controlled dc motor

Module 3 (9 Hours)

Time domain analysis: Continuous systems -standard test signals - step, ramp, parabolic, impulse - transient and steady state response –first order systems - unit impulse, step responses of first order systems and second order systems - under damped and over damped systems - time domain specifications - steady state error – static position, velocity & acceleration error constants. Control structures: PID control, feed forward, ratio control and predictive control.

Module 4 (9 Hours)

Stability of control systems and Frequency Domain Analysis: Concept of stability - stability & location of the poles in S-plane - Routh-Hurwitz stability criterion-Root Locus Method, Construction of root locus- Effect of poles and zeros and their location on the root locus. Frequency Response representation- Polar Plot- Logarithmic Plots-Frequency Domain Specifications - Non-Minimum Phase Systems

Module 5 (8 Hours)

Compensation techniques and Case studies in Mechatronics: Need for Cascade compensation- Cascade Compensation- PI, PD and PID controllers – tuning of PID Controller- Lead, Lag and Lead- Lag compensation- Role of control system in mechatronics-case studies Automatic temperature control, automatic traffic light control-Automatic street light control

Text Books

1. I. J. Nagrath and M. Gopal, "Control Systems Engineering", New Age International Pvt Ltd, 6/e.

2. Katsuhiko Ogata, "Modern Control Engineering", Pearson Education India, 5/e.

3. A. Nagoorkani, "Control Systems", RBA Publications.

Reference Books

1.Kuo, "Automatic Control Systems", Prentice Hall.

2. Norman S. Nise, "Control Systems Engineering", Wiley India Pvt. Ltd.

3. K. Ogata, "Discrete- Time Control Systems", Pearson Education .

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Introduction**	
1.1	Principle of Automatic control- Open loop and closed loop systems – examples System modelling & approximations	2 Hours
1.2	Modelling of electrical systems – dynamic equations using KCL & KVL of RL, RC and RLC circuits	4 Hours
1.3	Transfer functions- development of block diagrams of simple electrical networks - block diagram reduction -signal flow graphs - Mason's gain formula	4 Hours
2	**Modelling and analogy of other physical systems**	
2.1	Modelling of translational and rotational mechanical systems – differential equations for mass, spring, and dashpot elements - D'Alembert's principle – dynamic equations & transfer function for typical mechanical systems	3 Hours
2.2	Analogous systems –force voltage & force-current analogy - toque-voltage & torque-current analogy	3 Hours
2.3	Electromechanical systems - transfer function of armature controlled dc motor & field controlled dc motor	3 Hours
3	**Time domain analysis**	
3.1	Continuous systems -standard test signals - step, ramp, parabolic, impulse.	2 Hours
3.2	Transient and steady state response –first order systems - unit impulse, step responses of first order systems and second order systems	3 Hours
3.3	Under damped and over damped systems - time domain specifications - steady state error – static position, velocity & acceleration error constants	2 Hours
3.4	Control structures: PID control, feed forward, ratio control and predictive control	2 Hours
4	**Stability of control systems and Frequency Domain Analysis**	
4.1	Concept of stability - stability & location of the poles in S-plane -	2 Hours

	Routh-Hurwitz stability criterion	
4.2	Root Locus Method, Construction of root locus- Effect of poles and zeros and their location on the root locus.	4 Hours
4.3	Frequency Response representation- Polar Plot- Logarithmic Plots- Frequency Domain Specifications - Non-Minimum Phase Systems	3 Hours
5	**Compensation techniques and Case studies in Mechatronics**	
5.1	Need for Cascade compensation-Cascade Compensation- PI, PD and PID controllers	2 Hours
5.2	Tuning of PID Controller- Lead, Lag and Lead- Lag compensation-	3 Hours
5.3	Role of control system in mechatronics-case studies Automatic temperature control, automatic traffic light control-Automatic street light control	3 Hours

MRT305	PLC & DATA ACQUISITION SYSTEMS	CATEGORY	L	T	P	CREDIT
		PCC	3	1	0	4

Preamble: In simple terms PLC is a solid-state industrial control device which receives signals from user supplied controlled devices, such as sensors and switches, implements them in a precise pattern determined by ladder-diagram based application progress stored in user memory, and provides outputs for control of processes or user supplied devices, such as relays or motor starters. Industry needs less manpower, more and accurate throughput. Accuracy enhances by exact reading of data from sources which further uses to control the whole system.

Prerequisite: Nil

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

CO 1	Study the evolution and advantages of PLC.
CO 2	Understand the various PLC instructions.
CO 3	Design specific applications using PLC
CO 4	Understand the need of computer control in automation.
CO 5	Study data acquisition 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	3	1	2	-	-	2	-	-	-	3	-	3
CO 2	3	3	2	-	-	2	-	-	-	3	-	3
CO 3	3	3	3	3	3	2	-	-	3	3	-	3
CO 4	3	2	2	-	3	2	-	-	3	3	-	3
CO 5	3	2	2	-	-	2	-	-	-	3	-	3

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. State the functionality of Programmable Logic Controllers.

2. List the different configurations used.

3. Define the different capabilities & advantages of PLCs.

Course Outcome 2 (CO2)

1. Demonstrate the different programs using PLCs

2. Give example for real time programming using PLCs

3. Describe the functionality of the different instructions.

Course Outcome 3(CO3):

1. Demonstrate different applications of PLC.

2. Give example for different control using PLC

3. Describe the functionality of automation.

Course Outcome 4 (CO4):

1. State the functionality of the data acquisition system.

2. List the functionality of a digital control interfacing.

3. Define the functionality of SCADA systems.

Course Outcome 5 (CO5):

1. State the signal conversions.

2. List the Practical implementation of sampling and digitizing.

3. Develop the ADC and DAC interfacing with microprocessors.

Model Question Paper

Course Code: MRT305

Course Name: PLC & DATA ACQUISITION SYSTEMS

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

PARTA

Answer all Questions. Each question carries 3 Marks

1. Explain opto isolator in PLC input output module
2. Explain ladder logic in PLC
3. What are various arithmetic functions used in PLC?
4. Explain the functions of retentive timer
5. Brief out the data handling functions in PLC
6. List out any three program control instructions in PLC
7. Explain the need of computer in control system
8. Explain data logger in computer control
9. The analog input signal ranges from -5v to +5v for a 9 bit ADC
   (a) How many step intervals are available within an ADC
   (b) What is the resolution in volt/increment
10. Explain the term aliasing

PART B

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

Module 1

11. (a) Explain the architecture of a PLC system with neat diagrams

    (b)Define PLC and explain how it is helpful in automated process.

12. a)Draw a ladder diagram for liquid level controller

    (b) State and explain advantages and disadvantages of PLC in detail.

Module 2

13. Develop a PLC adder diagram from the following sequence . Start the motor with push switch, and then after delay of 90 sec , start the pump. When the motor is switched off, the pump will get switched off after a delay of 5 sec. Mention the logic used for each rung in the program to substantiate the answer

14. Timers and counters in the PLC with suitable example

Module 3

15. Design a ladder logic for the bottle filling systems for the following sequence
    i. Start the program by processing the start push button
    ii. Once the start push button is pressed the conveyor belt should be start moving.
    iii. If the proximity sensor senses the bottle in the conveyor belt. The belts have to stop moving.
16. Enumerate data transfer and program control instruction used in PLC

Module 4

17. (a) Draw and explain SCADA architecture in detail.

    (b) State applications of SCADA.

18. (a) Explain advantages and disadvantages of SCADA systems.

    (b) Explain first, second and third generations of SCADA architecture.

Module 5

19. Discuss in detail about analog to digital conversion procedure
20. How a DAC is interfaced to microprocessor.Explain the procedure with necessary block diagram

Syllabus

Module 1. BASICS OF PLC (9hrs)

Definition and History of PLC-PLC advantage and disadvantages- Over all PLC systems-CPU and Programmer/Monitors-PLC input and output models – Architecture- PLC Programming language – Relay logic – Ladder logic – Programming of Gates – Flow charting as a programming method – connecting PLC to computer - PLC Troubleshooting and Maintenance.

Module 2. PLC PROGRAMMING (9hrs)

Programming of Timers – Introduction - ON delay, OFF delay, Retentive Timers – PLC Timer functions – Examples of timer function Industrial application. Programming Counters –up/down counter – Combining counter - Examples of counter function Industrial application. PLC Arithmetic Functions – PLC number Comparison function

Module 3. PLC DATA HANDLING FUNCTIONS (9hrs)

PLC Program Control Instructions: Master Control Reset - Skip – Jump and Move Instruction. Sequencer instructions - Types of PLC Analog modules and systems, PLC analog signal processing – BCD or multi bit data processing – Case study of Tank level control system, bottle filling system and Sequential switching of motors

Module 4. COMPUTER CONTROL – INTRODUCTION (9hrs)

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. DATA ACQUISITION SYSTEMS (9hrs)

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] D.Roy Choudhury and Shail B.Jain, " Linear Integrated Circuits", New age International Pvt. Ltd,

REFERENCES:

[1] Hughes .T, "Programmable Logic Controllers", ISA Press, 1989.

[2] G.B.Clayton," Data Converters", The Mac Millian Press Ltd., 1982.

[3] John w.Webb & Ronald A.Reis., "Programmable logic controllers- principles and applications", 5th Edition – PHI Learning Pvt. LTd, New Delhi -2010.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Basics of PLC**	
1.1	Definition and History of PLC	1
1.2	PLC advantage and disadvantages	1
1.3	Over all PLC systems-CPU and Programmer/Monitors-PLC input and output models	1
1.4	Architecture	1
1.5	PLC Programming language	1
1.6	Relay logic – Ladder logic – Programming of Gates	1
1.7	Flow charting as a programming method	1
1.8	connecting PLC to computer	1
1.9	PLC Troubleshooting and Maintenance.	1
2	**PLC Programming**	
2.1	Programming of Timers – Introduction - ON delay, OFF delay	1
2.2	Retentive Timers	1
2.3	PLC Timer functions	1
2.4	Examples of timer function Industrial application.	1
2.5	Programming Counters –up/down counter	1

2.6	Combining counter	1
2.7	Examples of counter function Industrial application.	1
2.8	PLC Arithmetic Functions	1
2.9	PLC number Comparison function	1
3	**PLC Data Handling Functions**	
3.1	PLC Program Control Instructions: Master Control Reset	2
3.2	Skip – Jump and Move Instruction	1
3.3	Sequencer instructions -	1
3.4	Types of PLC Analog modules and systems	1
3.5	PLC analog signal processing	1
3.6	BCD or multi bit data processing	1
3.7	Case study of Tank level control system, bottle filling system and Sequential switching of motors	2
4	**Computer Control – Introduction**	
4.1	Need of computer in a control system	1
4.2	Functional block diagram of a computer control system-	1
4.3	Data loggers-	2
4.4	Supervisory computer control	1
4.5	Direct digital control	1
4.6	Digital control interfacing.	2
4.7	SCADA	2
5	**Data Acquisition Systems**	
5.1	Sampling theorem – Sampling and digitizing	2
5.2	Aliasing – Sample and hold circuit.	1
5.3	Practical implementation of sampling and digitizing –	1
5.4	Definition, design and need for data acquisition systems –	1
5.5	Interfacing ADC and DAC with Microprocessor / Multiplexer - Multiplexed channel operation –	2
5.6	Microprocessor/PC based acquisition systems	2

MRT307	SOFT COMPUTING TECHNIQUES	CATEGORY	L	T	P	CREDIT
		PCC	3	1	0	4

Preamble: This course aims the students to learn about the introduction of all basics soft computing and basic concept of geneticalgorithms

Prerequisite: EST-102PROGRAMMING IN C

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

CO 1	Explain the basic concept of Fuzzy set theory
CO 2	Be familiar with concepts of fuzzy inference model
CO 3	Understand the basic concepts of geneticalgorithms and simulated annealing
CO 4	Understand basic concept of Competitive Learning Networks
CO 5	Understand the basic concept of Adaptive Networks and various application of soft computing

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	3	-	-	-	-	-	-	-	-	-
CO2	3	3	3	-	-	-	-	-	-	-	-	-
CO3	3	3	3	3	-	-	-	-	-	-	-	-
CO4	3	-	3	3	-	-	-	-	-	-	-	-
CO5	3	-	2	-	3	-	3	-	-	-	-	-

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. What do you mean by FIS?
2. What is the advantage of fuzzy systems over conventional methods?
3. How do you customize a membership function?

Course Outcome 2 (CO2)

1. What is a fuzzy inference model?
2. Explain about Mamdani Fuzzy Model.
3. Write a note on Sugeno Fuzzy Model.

Course Outcome 3(CO3):

1. What do you mean by Simulated Annealing?
2. Explain concept of genetic algorithm.
3. Explain Random Search.

Course Outcome 4 (CO4):

1. Discuss about Neural networks as solution provider.

2. Explain about RBF.

3. Briefly explain about Supervised Learning.

Course Outcome 5 (CO5):

1. Explain the steps in Hybrid Learning Algorithm.

2. Give an application of adaptive networks?

3. Explain how adaptive networks function.

Model Question paper

Course code: MRT307

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

SOFT COMPUTING TECHNIQUES (2019- Scheme)

PART A

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

1 .Define Soft Computing and list out its constituents.

2. Explain fuzzy set theory with example.

3. Illustrate with diagram the working of fuzzy inference system.

4. Explain Mamdani model with neat diagram.

5. Draw the diagram which represents various units of perceptron network?

6. Differentiate between supervised and unsupervised learning?

7. Write applications for adaptive systems?

8. Draw a flow diagram which depicts ANFIS procedure?

9. Write a short note on character recognition using neural network?

10. What is the difference between forward and inverse kinematics problem?

PART B

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

Module 1

11. (a) Write a note on characteristics of Soft computing. (10 marks)

(b) Explain the term: a) Fuzzy number b) open-right. (4 marks)

12. (a) Explain the set theoretic operations . (10 marks)

(b) Analyse the importance of neural networking. (4 marks)

Module 2

13. (a) Explain the mamdani fuzzy model with example. (10 marks)

(b) Define the term inference model. (4 marks)

14. Explain the sugeno model and tsukamoto model . (14 marks)

Module 3

15. (a) Explain concept of genetic algorithm. . (10 marks)

(b) Define the term perceptron's. (4 marks)

16. Narrate the steps for supervised Learning neural networks. (14 marks)

Module 4

17. Explain radial basis function networks. (14 marks)

18. (a)Explain the kohonen self-learning networks. (10 marks)

(b) Explain the basic concept of Hebbian learning. (4 marks)

Module 5

19. Explain with the term Hybrid learning algorithms. (14 marks)

20. Explain in detail about ANFIS and RBFN. (14 marks)

Syllabus

SOFT COMPUTING TECHNIQUES

Module 1 (9 Hours)

Introduction to Neuro – Fuzzy and Soft Computing – Fuzzy Sets – Basic Definition and Terminology – Set-theoretic Operations – Member Function Formulation and Parameterization – Fuzzy Rules and Fuzzy Reasoning –Extension Principle and Fuzzy Relations

Module 2 (9 Hours)

Fuzzy Inference Systems – Mamdani Fuzzy Models – Sugeno Fuzzy Models – Tsukamoto Fuzzy Models. Derivative-based Optimization

Module 3 (9 Hours)

Genetic Algorithms – Simulated Annealing – Random Search – Downhill Simplex Search. Supervised Learning Neural Networks – Perceptrons - Adaline – Back propagation Mutilayer Perceptrons

Module 4 (9 Hours)

Radial Basis Function Networks – Unsupervised Learning Neural Networks – Competitive Learning Networks – Kohonen Self-Organizing Networks – Learning Vector Quantization –Hebbian learning.

Module 5 (9 Hours)

Adaptive Neuro-Fuzzy Inference Systems – Architecture – Hybrid Learning Algorithm – Learning Methods that Cross- fertilize ANFIS and RBFN – Coactive Neuro Fuzzy Modeling–– Printed Character Recognition – Inverse Kinematics Problems– Automobile Fuel Efficiency Prediction – Soft Computing for Color Recipe Prediction

Text Books

1. J.S.R.Jang, C.T.Sun and E.Mizutani, “Neuro-Fuzzy and Soft Computing”, PHI, 2004, Pearson Education 2004.
2. S.N.Sivanandam&S.N.Deepa “Principles of Soft Computing” Wiley India Pvt. Ltd., 2007

Reference Books

1. Timothy J.Ross, “Fuzzy Logic with Engineering Applications”, McGraw-Hill, 1997.
2. Davis E.Goldberg, “Genetic Algorithms: Search, Optimization and Machine Learning”, Addison Wesley, N.Y., 1989.
3. S. Rajasekaran and G.A.V.Pai, “Neural Networks, Fuzzy Logic and Genetic Algorithms”, PHI, 2003.
4. R.Eberhart, P.Simpson and R.Dobbins, “Computational Intelligence - PC Tools”, AP Professional, Boston, 1996.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Introduction to Neuro**	
1.1	Fuzzy and Soft Computing	1 Hour
1.2	Fuzzy Sets ,Basic Definition and Terminology	1 Hour
1.3	Set-theoretic Operations	1 Hour
1.4	Member Function Formulation and Parameterization	2 Hours
1.5	Fuzzy Rules and Fuzzy Reasoning	2 Hours
1.6	Extension Principle and Fuzzy Relations	2 Hours
2	**Fuzzy Inference Systems**	
2.1	Mamdani Fuzzy Models	2 Hours
2.2	Sugeno Fuzzy Models	2 Hours
2.3	Tsukamoto Fuzzy Models	2 Hours

2.4	Derivative-based Optimization	3 Hours
3	**Genetic Algorithms**	
3.1	Genetic Algorithms	1 Hour
3.2	Simulated Annealing	1 Hour
3.3	Random Search ,Downhill Simplex Search	2 Hours
3.4	Learning Neural Networks , Perceptrons	2 Hours
3.5	Adaline	1 Hour
3.6	Back propagation MutilayerPerceptrons	2 Hours
4	**Radial Basis Function Network**	
4.1	Unsupervised Learning Neural Networks	2 Hours
4.2	Competitive Learning Networks	2 Hours
4.3	Kohonen Self-Organizing Networks	1 Hour
4.4	Learning Vector Quantization	2 Hours
4.5	Hebbian learning	2 Hours
5	**Adaptive Neuro-Fuzzy Inference Systems**	
5.1	Architecture	1 Hour
5.2	Hybrid Learning Algorithm ,Learning Methods	1 Hour
5.3	fertilize ANFIS and RBFN	2 Hours
5.4	Coactive Neuro Fuzzy Modeling	1 Hour
5.5	Printed Character Recognition – Inverse Kinematics Problems	1 Hour
5.6	Automobile Fuel Efficiency Prediction	1 Hour
5.7	Soft Computing for Color Recipe Prediction	2 Hours

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
MRL331	PLC AND DATA ACQUISITION LAB	PCC	0	0	3	2

Preamble: This course enables students to students to practice the applications of data acquisition and PLC systems experimentally.

Prerequisite: MRT 305 PLC AND DATA ACQUISITION SYSTEMS

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

CO 1	Experimentally test and familiarize the characteristics of strain gauge , load cell, LVDT, thermocouple, thermostat and LDR using measurements kits
CO 2	Understand about basics of PLC
CO 3	Implement the PLC program for logic gates and flipflops and apply in hardware and simulation
CO 4	Simulate and implement various control operations using PLC hardware and software

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	-	-	2
CO 2	3	-	2	-	-	-	-	-	3	-	-	2
CO 3	3	2	3	2	3	-	-	-	3	-	-	3
CO 4	3	3	3	3	3	-	-	-	3	-	-	3

Assessment Pattern

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	75	75	2.5 hours

Continuous Internal Evaluation Pattern:

Attendance : 15 marks
Continuous Assessment : 30 marks
Internal Test (Immediately before the second series test) : 30 marks

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 equipments and trouble shooting) : 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.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. What is the role of LVDT in data acquisition? What are its characteristics?
2. What do you infer from the strain gauge characteristics?
3. How can you make use of thermocouple in data acquisition?

Course Outcome 2 (CO2)
1. Draw and explain a ladder diagram.
2. What are the commercially available PLCs?
3. Explain the working of a PLC.

Course Outcome 3(CO3):
1. Implement a universal gate using PLC.
2. Implement a counter using PLC.
3. Implement the SR flip flop using PLC.

Course Outcome 4 (CO4):
1. Implement a timer circuit for traffic signal control using PLC.
2. Implement a level control circuit for an overhead tank using PLC.
3. Develop a controller for stepper motor control using PLC.

LIST OF EXPERIMENTS :(Minimum 12 experiments is mandatory)

1. Strain gauge characteristics
2. Load cell characteristics
3. LVDT characteristics
4. Characteristics of thermocouples
5. Characteristics of RTD
6. Characteristics of thermostats

7. LDR and opto coupler characteristics
8. AD590 Characteristics
9. Capacitive transducer characteristics
10. Study of PLC
11. Implementation of logic gates using PLC
12. Implementation of Flip flops using PLC
13. Implementation of timers and counters using PLC
14. Tank level control using PLC – simulation
15. Sequential switching of motors using PLC simulation
16. To construct sequencer using bit logic instruction only

Text Books

1. Hughes . T, "Programmable Logic Controllers" , ISA press, 1989
2. Petrezeulla, "Programmable Logic Controllers", McGraw Hill, 1989.
3. Curtis D. Johnson," Process Control Instrumentation Technology", 8th edition Prentice Hall June 2005

CODE	INSRTUMENTATION LAB	CATEGORY	L	T	P	CREDIT
MRL333		PCC	0	0	3	2

Preamble: This course enables students to students to familiarize various instruments and practice them for applications in automation.

Prerequisite: Nil

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

CO 1	Understand the calibration and use of different measuring instruments
CO 2	Evaluate the uncertainties involved in any measurement
CO 3	Understand and analyze construction and operational aspects of different electro-mechanical measuring instruments along with their application domains
CO 4	Explain the need of various modern measuring instruments and precision measurement techniques
CO 5	Develop knowledge on the fundamental concepts and principles of metrology
CO 6	Study the operating principle and analyse the output characteristics of different electronics instruments

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	2							2			2
CO 3	3	2							2			
CO 4	3	2	2									2
CO 5	3	2							2			
CO 6	3		2						2			2

Assessment Pattern

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	75	75	2.5 hours

Continuous Internal Evaluation Pattern:

Attendance	:	15 marks
Continuous Assessment	:	30 marks
Internal Test (Immediately before the second series test)	:	30 marks

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 trouble shooting)	: 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.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Mention some of the transducers.

2. The temperature coefficient of material should be high or low?

3. What is the value of excitationvoltage?

Course Outcome 2 (CO2)

1. Define Skin effect?

2. what are errors in this instrument?

3. Define self heating property of thermistor?

Course Outcome 3(CO3):

1. Give commonly used pressure sensitive devices?

2. What is the working principle of mercury in glass thermometer?

3. What is the nature of EMF induced in thermocouple?

Course Outcome 4 (CO4):

1. Why calibration is essential and how it is performed for a strain gauge?

2. What is Torque?

3. Are RTDs and thermocouples intrinsically safe?

Course Outcome 5 (CO5):

1. What is the relation between variation due to observation, manufacturing process and measuring process of a product?

2. What is the least count of clinometer which is used to check reading of column rotation used for setting of helix angles in universal micro meter?

3.What is the difference unilateral and bilateral system of tolerance? Discuss the least count of a verniercalliper?

Course Outcome 6 (CO6):

1.What do you meant by Basic size?

2. What is the sensitivity of Wheatstone bridge

3. The characteristics of thermistor in linear or non-linear?

LIST OF EXPERIMENTS (Minimum 12 experiments is mandatory)

1) Calibration of Bourdon tube pressure gauge using dead weight pressure gauge tester.

2) Calibration of strain gauge pressure cell

3) Measurement of temperature using Radiation pyrometer and infrared pyrometer

4] Time constant of temperature measuring device

5) Measurement of vibration using Piezoelectric Accelerometers

6) Measurement of vibration using vibrometers

7) Measurement of torque and force

Measurement of cutting force during turning, drilling and milling using tool force dynamometer

8) Acoustic measurement using Sound level meter and octave band filter

9) Preparation of noise Contours

10) Calibration of tachometers

11) Measurement of rotation speed using tachometer, tacho generator and stroboscopic tachometer

12) Metrology

Measurement of surface finish using stylus type surface roughness measuring device

13) Measurement of tool wear using tool makers microscope

14) Study and use of linear and angular measuring devices-verniercaliper, outside and inside micrometer, vernier depth gauge, vernier height gauge, feeler gauge, screw pitch gauge, sine bar, slip gauge- bevel protractor- profile projector

15) Measurements of gears and screw threads

16) Analysis of exhaust gases and flue gases with the help of orsats apparatus, Gas chromatograph, paramagnetic oxygen analyser, smoke meter etc.

Reference Books

1.Advanced laboratory manual of parasitology and immunopharmacology by MANNA

2. Electrical Measurements in the Laboratory Practice ByBartiromo, Rosario**,** De Vincenzi**,** Mario

3. Basic Theory and Laboratory Experiments in Measurement and Instrumentation:by Cataldo, A., Giaquinto, N., De Benedetto, E., Masciullo, A., Cannazza, G., Lorenzo, I., Nicolazzo, J., Meo, M.T., Monte, A.D., Parisi, G., Gaetani, F.

SEMESTER V

MINOR

MRT381	EMBEDDEED SYSTEMS	CATEGORY	L	T	P	CREDIT
		VAC	3	1	0	4

Preamble:

To mould students into high calibre embedded real time application designers by enhancing their knowledge and skills in various system design aspects of embedded real time system.

Prerequisite:

Strong Electronics fundamentals, C/C++ programming, Microcontroller/Microprocessor programming, Communication Engineering

Course Outcomes:

After the completion of the course the student will be able to

CO 1	Explain Embedded System, its challenges, technologies.
CO 2	Optimize the processor design.
CO 3	Design systems with a microprocessor having a superscalar architecture.
CO 4	Program a PIC microcontroller, CCP modules.
CO 5	Explain various protocols associated with an Embedded 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
CO 2	3											3
CO 3	3		3									3
CO 4	3				3							3
CO 5	2											2

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	3		3
Understand	47	45	92
Apply		5	5
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 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 any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. State Embedded system.
2. List the IC technologies.
3. Describe the design challenges.

Course Outcome 2 (CO2):

1. State the custom single purpose processor design.
2. List the RT level combinational components.
3. Describe optimizing custom single purpose processors.

Course Outcome 3 (CO3):

1. Demonstrate pipelining, superscalar and VLIW architecture.
2. Give example for ASIP.
3. Describe the features of the microcontroller, and DSP.

Course Outcome 4 (CO4):

1. Demonstrate the addressing mode of PIC Microcontroller.

2. Give example for Timers, Interrupt logic.

3. Describe about CCP modules and ADC circuitry.

Course Outcome 5 (CO5):

1. Illustrate about parallel, serial and wireless communication.

2. Describe about serial protocols.

3. Explain parallel and wireless protocol.

Model Question paper

Course Code: MRT 381

Course Name: EMBEDDED SYSTEMS

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

PARTA

Answer all Questions. Each question carries 3 Marks

1. Define an Embedded System with an example.
2. Distinguish between the IC technologies.
3. Write a short note on RT level sequential components.
4. Define optimization in FSMD.
5. Explain about pipelining.
6. Write short note on superscalar architecture in an Embedded System.
7. Explain Timers in PIC microcontrollers.
8. Compare the different addressing modes in a PIC microcontroller.
9. Write short note on AMBA Bus.
10. Explain with specific reason the relevance of IrDA bus.

PART B

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

Module 1

11. (a) Describe briefly the IC technologies. (10)
    (b) State the design challenges associated in Embedded System. (4)
12. Describe PLDs and its trends associated with a system.

Module 2

13. (a) Explain the formation of custom single purpose processors. (10)
    (b) How a custom single purpose processor is optimized? Explain. (4)
14. Compare the optimization process involved in FSMD and FSM.

Module 3

15. (a) Describe the architecture of general purpose processors. (10)

    (b) Illustrate VLIW and superscalar architecture with an application. (4)

16. Classify ASIP with an example program and how a microprocessor selected accordingly.

Module 4

17. Briefly explain the architecture of PIC microcontroller with a neat diagram.
18. (a) State interrupt logic associated in an Embedded System. (4)

    (b) With a neat diagram, explain the CCP modules in PIC microcontrollers. (10)

Module 5

19. (a) Show how a data or information is transmitted in a different manner in a communication system with few examples and list down the standards associated with it. (10)

    (b) Write a short note on communication protocols in an Embedded System. (4)
20. (a) Differentiate I2C bus and CAN bus with neat sketches. (10)

    (b) Explain IEEE802.11 standard and its relevance in a communication system. (4)

Syllabus

EMBEDDED SYSTEM DESIGN

Module 1 (8 Hours)

Introduction

Embedded system overview- Design challenges: optimizing design metrics, IC technology: Full-custom/VLSI, Semi-custom ASIC, PLD, Trends, Design technology.

Module 2 (9 Hours)

Custom Single purpose processors

RT- level combinational components, RT level sequential components, custom single purpose processor design, RT level custom single purpose processor design

Optimizing custom single purpose processors, the original program, FSMD, Datapath and FSM.

Module 3 (9 Hours)

General purpose processors

Basic architecture, Datapath, control unit, memory, pipelining, superscalar and VLIW architecture, Application-Specific Instruction Set Processor(ASIP), Microcontrollers, DSP, selecting a microprocessor/general purpose processor design.

Module 4 (9 Hours)

PIC Microcontroller

Basic concept of PIC microcontroller and architecture, Instruction Set, Addressing mode, Timers, Interrupt logic, CCP modules, ADC.

Module 5 (10 Hours)

Advanced communication principles

Parallel, serial, wireless communication; serial protocols: I2C Bus, CAN Bus, firewire Bus, USB; Parallel protocols: PCI Bus, AMBA Bus; wireless protocols: IrDA, Bluetooth, and IEEE802.11.

Text Books

1. Frank Vahid And Tony Givargis, "Embedded System Design - A Unified Hardware/Software Introduction", John Wiley & Sons, 2002
2. Rajkamal, "Embedded System- Architecture, programming, Design", Tata McGraw Hill, 2011.
3. John B. Peatman, "Design with PIC Microcontroller", Prentice Hall, 2003.

Reference Books

1. Steve Health, "Embedded System Design", Butteworth Heinemann.
2. Gajski and Vahid, "Specification and Design of Embedded System", Prentice Hall.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Introduction(8 Hours)**	
1.1	Embedded system overview- Design challenges.	1 Hour
1.2	Optimizing design metrics.	2 Hour
1.3	IC technology: Full-custom/VLSI, Semi-custom ASIC.	2 Hours
1.4	PLD, Trends, Design technology.	3 Hours
2	**Custom Single Purpose Processors (9 Hours)**	
2.1	RT- level combinational components, RT level sequential components.	2 Hour
2.2	Custom single purpose processor design, RT level custom single purpose processor design.	2 Hours
2.3	Optimizing custom single purpose processors, optimizing the original program.	2 Hours
2.4	Optimizing FSMD, optimizing data path, optimizing FSM.	3 Hours
3	**General Purpose Processors (9 Hours)**	

3.1	Basic architecture, data path, control unit, memory.	2 Hours
3.2	Pipelining, superscalar and VLIW architecture.	2 Hours
3.3	Application-Specific Instruction Set Processor (ASIP), Microcontrollers, DSP.	2 Hours
3.4	Selecting a microprocessor/general purpose processor design.	3 Hours
4	**PIC Microcontroller (9 Hours)**	
4.1	Architecture, Instruction Set.	2 Hours
4.2	Addressing mode, Timers, Interrupt logic.	3 Hours
4.3	CCP modules.	2 Hour
4.4	ADC.	2 Hour
5	**Advanced Communication Principles (10 Hours)**	
5.1	Parallel, serial, wireless communication.	2 Hour
5.2	Serial protocols: I2C Bus, CAN Bus, fire wire Bus, USB.	2 Hours
5.3	Parallel protocols: PCI Bus, AMBA Bus.	3 Hours
5.4	Wireless protocols: IrDA, Bluetooth, and IEEE802.11.	3 Hours

MRT383	DATA AQUISTION & PLC SYSTEMS	CATEGORY	L	T	P	CREDIT
		VAC	3	1	0	4

Preamble:

In simple terms PLC is a solid-state industrial control device which receives signals from user supplied controlled devices, such as sensors and switches, implements them in a precise pattern determined by ladder-diagram based application progress stored in user memory, and provides outputs for control of processes or user supplied devices, such as relays or motor starters. . Industry needs less manpower, more and accurate throughput. Accuracy enhances by exact reading of data from sources which further uses to control the whole system.

Prerequisite: NIL

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

CO 1	Study the evolution and advantages of PLC.
CO 2	Understand the various PLC instructions.
CO 3	Design specific applications using PLC
CO 4	Understand the need of computer control in automation.
CO 5	Study data acquisition 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	3	1	2	-	-	2	-	-	-	3	-	3
CO 2	3	3	2	-	-	2	-	-	-	3	-	3
CO 3	3	3	3	3	3	2	-	-	3	3	-	3
CO 4	3	2	2	-	3	2	-	-	3	3	-	3
CO 5	3	2	2	-	-	2	-	-	-	3	-	3

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. State the functionality of Programmable Logic Controllers.

2. List the different configurations used.

3. Define the different capabilities & advantages of PLCs.

Course Outcome 2 (CO2)

1.Demonstrate the different programs using PLCs

2. Give example for real time programming using PLCs

3. Describe the functionality of the different instructions.

Course Outcome 3(CO3):

1. Demonstrate different applications of PLC.

2. Give example for different control using PLC

3. Describe the functionality of automation.

Course Outcome 4 (CO4):

1. State the functionality of the data acquisition system.

2. List the functionality of a digital control interfacing.

3. Define the functionality of SCADA systems.

Course Outcome 5 (CO5):

1. State the signal conversions.

2. List the Practical implementation of sampling and digitizing.

3. Develop the ADC and DAC interfacing with microprocessors.

Model Question Paper

Course Code: MRT383

Course Name: DATA ACQUISITION & PLC SYSTEMS

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

PARTA

Answer all Questions. Each question carries 3 Marks

1. Explain opto isolator in PLC input output module
2. Explain ladder logic in PLC
3. What are various arithmetic functions used in PLC?
4. Explain the functions of retentive timer
5. Brief out the data handling functions in PLC
6. List out any three program control instructions in PLC
7. Explain the need of computer in control system
8. Explain data logger in computer control
9. The analog input signal ranges from -5v to +5v for a 9 bit ADC
   (a) How many step intervals are available within an ADC
   (b) What is the resolution in volt/increment
10. Explain the term aliasing

PART B

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

Module 1

11. (a) Explain the architecture of a PLC system with neat diagrams

    (b)Define PLC and explain how it is helpful in automated process.

12. a)Draw a ladder diagram for liquid level controller

    (b) State and explain advantages and disadvantages of PLC in detail.

Module 2

13. Develop a PLC adder diagram from the following sequence . Start the motor with push switch, and then after delay of 90 sec , start the pump. When the motor is switched off, the

pump will get switched off after a delay of 5 sec. Mention the logic used for each rung in the program to substantiate the answer

14. Timers and counters in the PLC with suitable example

Module 3

15. Design a ladder logic for the bottle filling systems for the following sequence
    i. Start the program by processing the start push button
    ii. Once the start push button is pressed the conveyor belt should be start moving.
    iii. If the proximity sensor senses the bottle in the conveyor belt. The belts have to stop moving.
16. Enumerate data transfer and program control instruction used in PLC

Module 4

17. (a) Draw and explain SCADA architecture in detail.

    (b) State applications of SCADA.

18. (a) Explain advantages and disadvantages of SCADA systems.

    (b) Explain first, second and third generations of SCADA architecture.

Module 5

19. Discuss in detail about analog to digital conversion procedure
20. How a DAC is interfaced to microprocessor. Explain the procedure with necessary block diagram

Syllabus

Module 1. BASICS OF PLC (9hrs)

Definition and History of PLC-PLC advantage and disadvantages- Over all PLC systems-CPU and Programmer/Monitors-PLC input and output models – Architecture- PLC Programming language – Relay logic – Ladder logic – Programming of Gates – Flow charting as a programming method – connecting PLC to computer - PLC Troubleshooting and Maintenance.

Module 2. PLC PROGRAMMING (9hrs)

Programming of Timers – Introduction - ON delay, OFF delay, Retentive Timers – PLC Timer functions – Examples of timer function Industrial application. Programming Counters –up/down counter – Combining counter - Examples of counter function Industrial application. PLC Arithmetic Functions – PLC number Comparison function

Module 3. PLC DATA HANDLING FUNCTIONS (9hrs)

PLC Program Control Instructions: Master Control Reset - Skip – Jump and Move Instruction. Sequencer instructions - Types of PLC Analog modules and systems, PLC analog signal processing –

BCD or multi bit data processing – Case study of Tank level control system, bottle filling system and Sequential switching of motors

Module 4. COMPUTER CONTROL – INTRODUCTION (9hrs)

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. DATA ACQUISITION SYSTEMS (9hrs)

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] D.Roy Choudhury and Shail B.Jain, " Linear Integrated Circuits", New age International Pvt. Ltd,

REFERENCES:

[1] Hughes .T, "Programmable Logic Controllers", ISA Press, 1989.

[2] G.B.Clayton," Data Converters", The Mac Millian Press Ltd., 1982.

[3] John w.Webb & Ronald A.Reis., "Programmable logic controllers- principles and applications", 5th Edition – PHI Learning Pvt. LTd, New Delhi -2010.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Basics of PLC**	
1.1	Definition and History of PLC	1
1.2	PLC advantage and disadvantages	1
1.3	Over all PLC systems-CPU and Programmer/Monitors-PLC input and output models	1
1.4	Architecture	1
1.5	PLC Programming language	1
1.6	Relay logic – Ladder logic – Programming of Gates	1
1.7	Flow charting as a programming method	1
1.8	connecting PLC to computer	1
1.9	PLC Troubleshooting and Maintenance.	1
2	**PLC Programming**	
2.1	Programming of Timers – Introduction - ON delay, OFF delay	1
2.2	Retentive Timers	1
2.3	PLC Timer functions	1
2.4	Examples of timer function Industrial application.	1
2.5	Programming Counters –up/down counter	1
2.6	Combining counter	1

2.7	Examples of counter function Industrial application.	1
2.8	PLC Arithmetic Functions	1
2.9	PLC number Comparison function	1
3	**PLC Data Handling Functions**	
3.1	PLC Program Control Instructions: Master Control Reset	2
3.2	Skip – Jump and Move Instruction	1
3.3	Sequencer instructions -	1
3.4	Types of PLC Analog modules and systems	1
3.5	PLC analog signal processing	1
3.6	BCD or multi bit data processing	1
3.7	Case study of Tank level control system, bottle filling system and Sequential switching of motors	2
4	**Computer Control – Introduction**	
4.1	Need of computer in a control system	1
4.2	Functional block diagram of a computer control system-	1
4.3	Data loggers-	2
4.4	Supervisory computer control	1
4.5	Direct digital control	1
4.6	Digital control interfacing.	2
4.7	SCADA	2
5	**Data Acquisition Systems**	
5.1	Sampling theorem – Sampling and digitizing	2
5.2	Aliasing – Sample and hold circuit.	1
5.3	Practical implementation of sampling and digitizing –	1
5.4	Definition, design and need for data acquisition systems –	1
5.5	Interfacing ADC and DAC with Microprocessor / Multiplexer - Multiplexed channel operation –	2
5.6	Microprocessor/PC based acquisition systems	2

SEMESTER V

HONOURS

MRT 393	DRIVES & CONTROL SYSTEM FOR AUTOMATION	CATEGORY	L	T	P	CREDIT
		VAC	4	1	0	4

Preamble: To introduce to the students the different types of drives, and their control in automation.

Prerequisite: Knowledge of drives and linear control theory

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

CO 1	Understand working principles of various types of motors, their characteristics and selection criteria for various industrial applications.
CO 2	Explain control methods of special drives.
CO 3	Elucidate various linear and rotary motion principles and methods and apply them for industrial automation.
CO 4	Carry out programming of PLC and use them for automation in industries.
CO 5	Discuss supervisory control and data acquisition method and use the same in complex automation applications.
CO 6	Understand and use logical elements and use of Human Machine Interfacing (HMI) devices to enhance control & communication aspects of automation.

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			
CO 2	3	2							2			
CO 3	3	2							2			
CO 4	3	2							2			
CO 5	3	2							2			
CO 6	3	2							2			

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. Explain with diagram the working of a multi stack variable reluctance stepper motor
2. What is micro stepping? Determine the step angle of a variable reluctance stepper motor with 12 teeth in stator and 8 rotor teeth.
3. A 3-phase, 400 V, 50 Hz induction motor has a rotor resistance of 0.1 Ω and standstill reactance of 0.9 Ω per phase. The full load slip is 4%, Calculate (i) Full load torque as a percentage of maximum torque and the value of extra resistance to be added in the rotor circuit to have 80% of maximum torque at start.

Course Outcome 2 (CO2)

1. With suitable block diagrams explain the control of stepper motors.
2. A microprocessor based control scheme is required to be implemented with DC separately excited motor to keep the speed of the motor at desired speed. Give the scheme and outline the steps in software design.
3. Explain the principle of speed control of a 3-phase induction motor by V/F method and draw the corresponding torque-speed characteristics and discuss the applications and limitations of these methods.

Course Outcome 3(CO3):

1.Under what circumstances chain drives are preferred over V belt drives.

2.With the help of a sketch, indicate the normal pitch and axial pitch in a helical gear.Name two important modes of failure in gear.

3. Write notes on chordal action in chain drives. What do you understand by simplex, duplex and triplex chains?

Course Outcome 4 (CO4):

1. Develop a ladder diagram of OR and EX-OR Logic gates.
2. What is the importance of PLC scanning? Explain PLC scanning with the help of necessary figures.

3.What is the use of interrupt instructions in PLC? Explain anyone instruction.

Course Outcome 5 (CO5):

1. With a neat diagram, explain signal sources and O/P loads of SCADA.

2. What do you mean by off-line configuration in DCS? What is software wiring in context of DCS?
3. Briefly explain PROFIBUS, its BUS access method, features & acceptance.

Course Outcome 6 (CO6):
1. Explain working of HMI with sketch.
2. What is RTU? Explain various types of RTUs in the context of SCADA.
3. Explain in short: (i) Relay Instruction (ii) Data Handling Instruction.

Model Question Paper

Course Code: MRT 393

Course Name: DRIVES & CONTROL SYSTEM FOR AUTOMATION

Max. Marks: 100Duration: 3 Hours

	PART A **Answer all the questions. Each question carries 3 Marks**	
1.	Discuss briefly any two assumptions made in Potier method.	
2.	Define synchronizing power coefficient and also mention its units.	
3.	Explain, why the speed of 3-phase induction motor cannot be equal to synchronous speed?	
4.	Show that a Synchronous motor has no net starting torque? Explain different methods of starting synchronous motor?	
5.	What are the effects of centrifugal tension on flat belt.	
6.	Express the following equation in ladder logic program: (i)4 to 1 line multiplexer (ii)F (a,b,c) = Σ (2,4,6,7)	
7.	Describe various move instructions: BIT,BYTE,WORD,DOUBLEWORD, REAL.	
8.	How will you implements communication network for PLC? Explain with industrial communication.	
9.	List the shift Register in PLC. Explain Shift Register function with suitable application.	
10.	Name the three forms of PLC counter instructions, and explain the basic operation of each.	

	PART B **Answer any one full question from each module. Each question carries 14 Marks**	
	Module 1	
11	(a) The frequency of the e.m.f in the stator of a 4 pole induction motor is 50Hz, and that in the rotor is 1.5 Hz. What is the slip, and at what speed is the motor running? (b) Explain the procedure of drawing the circle diagram of an induction motor. What information can be drawn from the circle diagram? (c) A 4-pole, 50 Hz, 3-phase induction motor develops a maximum torque of 120 Nmat1460r.p.m.Theresistanceofthestarconnectedrotoris0.35Ω/phase.	3 4 7

	Determine the value of resistance that must be inserted in series, with each rotor phase to produce a starting torque equal to half the maximum torque.	
12	(a)Compare voltage source inverter and current source inverter as applied to their use in speed control of induction motor (b) Explain with a neat circuit diagram rheostatic braking of DC shunt motor. Sketch also the braking characteristics. (c) Draw the circle diagram from no-load and short circuit test on a 3-phase, 14.92 kW, 440V, 6-pole induction motor from the following results: No-load: 400V, 11A, PF=0.2 Short-circuit test : 100V, 25A, PF=0.4 Rotor Cu losses at stand still is half the total Cu losses from the circle diagram ,find (i) Line current, slip, efficiency and PF at full load (ii) Maximum torque.	4 3 7
	Module2	
13	(a)Draw the V and inverted V curves and explain the effect of excitation on armature current and power factor of synchronous motor. (b) What are the conditions for regenerative braking of an induction motor to be possible ? (c) A 50 KW motor with a heating time constant of 100 minutes has a final temperature rise of 50°C on continuous rating. Find the half-an hour rating of the motor for this temperature rise assuming that it cools down completely between each load period. the motor has maximum efficiency of 80% at full load.	4 3 7
14	(a) Describe the operation of dynamic braking for a 3 phase squirrel cage induction motor. (b)A three phase induction motor has 2 poles and is connected to 400 V, 50 Hz supply. Calculate the actual rotor speed and rotor frequency when slip is 4%. (c)A 1000 kVA, 11,000 V, 3-Phase star connected synchronous motor has an armature resistance and reactance per phase of 3 Ω and 40 Ω respectively. Determine the induced emf and angular retardation of the motor when fully loaded at (i) unity PF (ii) 0.9 PF lead Discuss how the dynamic braking can be made in a single phase induction motor.	4 3 7
	Module 3	
15	(a) What are the effects of increasing or decreasing the pressure angle in gear design? (b) Draw a block diagram of a PLC showing the main functional items and how buses link them, explaining the functions of each block. (c) Write a PLC ladder logic equivalent for NAND and NOR as universal gates.	3 4 7
16	(a) Write notes on chordal action in chain drives. What do you understand by simplex, duplex and triplex chains? (b) Draw and explain the three phase motor control in forward and reverse direction with PLC. (c) Describe PID function of PLC in detail.	3 4 7

	Module 4	
17	(a) Describe how each of the five common types of PLC registers is used in PLC operation. (b) Describe the networking in PLC (c) Explain the following functions in PLC with examples of each. (i) ADDITION (ii) SQUARE ROOT (iii) Conversion of INTEGER TO DOUBLE INTEGER (iv) SET & RESET BIT (iv) MOV_W	3 3 8
18	(a) Why Latch and Unlatch Instruction required in PLC Programming? How it is close to retentive timer operation. (b) Setup a PLC program to obtain an output, P, in registerOR0055. The output is to give a value based on two inputs, M and N. P equals the square of M plus the square root of N. (c) There are 30 bit patterns of 27 bits each to be moved sequentially into or 0011 one every 7 seconds. Design a double tr function program with a timer to accomplish the data transfer. Two tr functions are required because there are more than 16 bits (the amount available in one register) to be transferred.	3 5 6
	Module 5	
19	(a) What is sub-commutation and super-commutation in context of Multiplexer system? (b) Explain in detail MODBUS bus access methods, transmission modes, application services and acceptance (c) Explain about Integration of PLCs and DCS with Direct I/O.	4 3 7
20	(a) What is controller function configuration in context of DCS? Discuss SAMA symbology and ISA symbology. (b) What is Profibus? Explain its access methods, application services and acceptance (c) Describe the system architecture of a SCADA system. Explain and justify how it is an open ended system architecture comprising of the system hardware, the system software and the human machine interface (HMI), HCI (Human-Computer Interface).	4 4 6

Syllabus

Module 1 (8 Hours)

Working principle of synchronous, asynchronous & stepper motors: difference between induction and servo motors, torque v/s speed characteristics, power v/s. speed characteristics, vector duty induction motors, concepts of linear and frameless motors, selection of feedback system, duty cycle, V/F control, flux vector control, sensor less vector control, digital technique in speed control, advantages and limitations, microprocessor based control of drives.

Module 2 (7 Hours)

Industrial drives:DC and AC motors operation and selection, method of control and application of brushless DC motor, Permanent Magnet Synchronous Motor (PMSM), stepper motor, AC servomotor, selection criteria for servo motor and servo amplifier, universal motor, electric drive, types of industrial drives, the characteristics of drive, advantages of drives over other prime movers, motor rating, heating effects, electric braking, rheostatic and regenerative braking principles in power converters, hydraulic motor.

Module 3 (10 Hours)

Motion laws for rotary and linear systems, converting rotary to linear system, concepts and principles of ball screws, rack and pinion, belt and pulley, chain drives, gear drives, selection of converting systems, dynamic response, gearing, and control approaches of robots, control loops using current amplifier, control loops using voltage amplifier.

Introduction to Programmable Logic Controllers (PLC):Definitions of PLC, basic structure of PLC, working principles, conventional Ladder v/s PLC ladder, instructions & application of PLC, series and parallel function of OR, AND, NOT logic, EXOR logic, analysis of rung, timer and counter Instructions; on delay and off delay and retentive timer instructions, PLC counter up and down instructions, combining counters and timers.

Module 4 (10 Hours)

Methods of PLC programming (LD, ST, FBD & SFC), function blocks logical/ mathematical operators & data types, array & data structure, data storage methods, inputs/ outputs flag processing, types of variables, definition of firmware, software, programming software tool and interfacing with PC (RS232 & TCP-IP), PID, types of tasks and configuration, selection of PLC controller (case study), centralized concept, types of field bus systems, comparison and data handling instructions, sequencer instruction, visualization systems, types of visualization system, PC based controller, applications of HMI's, and interfacing of HMI with controllers, programming of HMI and its implementation.

Module 5 (11 Hours)

Introduction to supervisory control & data acquisitions: Distributed Control System (DCS):computer networks and communication in DCS, different BUS configurations used for industrial automation, GPIB, HART and OLE protocol, industrial field bus, Factory Instrumentation Protocol (FIP), PROFIBUS (Process field bus), bit bus. interfacing of SCADA with controllers, basic programming of SCADA, SCADA in PC based controller/ HMI.

Text Books

1. G. K. Dubey, Fundamentals of Electrical Drives, CRC Press, 2002.
2. R. Krishnan, Electric Motor Drives Modeling, Analysis, and Control, 2nd Ed., Prentice Hall, 2012.
3. W. Leonhard, Control of Electric Drive, Springer Science & Business Media, 2001.
4. V. Subramaniam, Electric Drives: Concepts and Applications, Tata McGraw Hill, 2011.
5. B. K. Bose, Modern Power Electronics and AC Drive, Pearson Education, 2002.
6. N. K. De, P. K. Sen, Electric Drives, PHI, New Delhi 2001.
7. S. K. Bhattacharya, Electrical Machines, Tata McGraw-Hill, 2nd Ed., 1999.
8. J. Nagrath, D. P. Kothari, Electric machines, 3rd Ed., Tata McGraw Hill, 2011.
9. W. Bolton, Programmable Logic Controllers
10. V. B. Bhandari, Design of Machine Elements, 2nd Ed., Tata McGraw-Hill, 2007.
11. R. L. Norton Machine Design - An Integrated Approach, 2nd Ed., Prentice Hall, 2004.

12. R. C. Juvenile, K. M. Marshek, Fundamentals of Machine Component Design, 3rd Ed., John Wiley, 2000.

Reference Books:

1. J. D. Edwards, Electrical Machines and Drives, Macmillan publications, 3rd Ed., 1991.
2. G. Dunning, Introduction to Programmable Logic Controllers, 3rd Ed., Delmar Cengage, 2005.
3. A. Parr, Industrial drives, Butterworth-Heineamann.
4. A. E. Fitzerald, C. Kingsley, S. D. Umans, Electric Machinery, McGraw Hill
5. S. K. Pillai, A First course on electric drives, Wiley Eastern, 1990.
6. P. C. Sen, Principles of Electrical Machines and Power Electronics, 2nd Ed., John Wiley & Sons.
7. B. R. Gupta, V. Singhal, Fundamentals of Electrical Machines, New Age International, 2001.
8. M. G. Say, Alternating Current Machines, 5th Ed., Pitman.
9. T. Wildi, Electrical Machines, Drives and Power Systems, 6th Ed., Pearson Education.
10. H. Jack, Programmable Logic Controllers.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
	Module 1	
1.1	Working principle of synchronous, asynchronous & stepper motors	1
1.2	difference between Induction and servo motors, torque v/s speed characteristics, power v/s. speed characteristics	1
1.3	Vector duty induction motors, concepts of linear and frameless motors	2
1.4	selection of feedback system, duty cycle, V/F control, flux vector control, sensor less vector control	2
1.5	Digital technique in speed control, Advantages and limitations, Microprocessor based control of drives	2
2	**Module 2**	
2.1	Industrial drives, DC and AC motors operation and selection	1
2.2	method of control and application of brushless DC motor, PMSM, stepper motor	1
2.3	AC servomotor, selection criteria for servo motor and servo amplifier, universal motor	2
2.4	electric drive, types of industrial drives, the characteristics of drive, advantages of drives over other prime movers, motor rating, heating effects	1
2.5	electric braking, rheostatic and regenerative braking principles in power converters, hydraulic motor	2
3	**Module 3**	
3.1	Motion laws for rotary and linear systems, converting rotary to linear system, concepts and principles of ball screws, rack and pinion, belt and pulley, chain drives, gear drives, selection of converting systems,	1

3.2	dynamic response, gearing and control approaches of Robots, control loops using current amplifier, control loops using voltage amplifier.	2
3.3	Introduction to Programmable Logic Controllers (PLC), Definitions of PLC, basic structure of PLC, working principles, Conventional Ladder v/s PLC ladder	1
3.4	instructions & application of PLC, series and parallel function of OR, AND, NOT logic, EXOR logic, analysis of rung, timer and counter Instructions	3
3.5	on delay and off delay and retentive timer instructions, PLC counter up and down instructions, combining counters and timers	3
4	**Module 4**	
4.1	Methods of PLC programming (LD, ST, FBD & SFC), function blocks logical/ mathematical operators & data types, array & data structure, data storage methods, inputs/ outputs flag processing, types of variables,	3
4.2	definition of firmware, software, programming software tool and interfacing with PC (RS232 & TCP-IP), PID, types of tasks and configuration	2
4.3	selection of PLC controller (case study), centralized concept, types of field bus systems, comparison and data handling instructions, sequencer instruction	2
4.4	visualization systems, types of visualization system, PC based controller, applications of HMI's, and interfacing of HMI with controllers, programming of HMI and its implementation.	3
5	**Module 5**	
5.1	Introduction to supervisory control & data acquisitions, Distributed Control System (DCS): computer networks and communication in DCS	2
5.2	different BUS configurations used for industrial automation, GPIB, HART and OLE protocol, industrial field bus	2
5.3	Factory Instrumentation Protocol (FIP), PROFIBUS (Process field bus), bit bus.	3
5.4	interfacing of SCADA with controllers, basic programming of SCADA, SCADA in PC based controller/ HMI.	3

*****

MRT395	ADVANCED CONTROL SYSTEMS	CATEGORY	L	T	P	CREDIT
		VAC	3	1	0	4

Preamble: This course aims the student to analyse stability of linear and non-linear control systems.

Prerequisite: LINEAR CONTROL SYSTEMS

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

CO 1	Design a compensator.
CO 2	Analyse a linear system using state space analysis technique.
CO 3	Design feedback controllers and observers, analyse sampled data systems.
CO 4	The basic concept of nonlinearities.
CO 5	Analyse a nonlinear system and basic concept of stability of nonlinear 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	3	2	3			2	2	2				3
CO 2	3	2	3			2	2	2				3
CO 3	3	2	3			2	2	2				3
CO 4	3	2	3			2	2	2				3
CO 5	3	2	3			2	2	2				2

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. State the functions of a compensator.

2. Design of various compensators.

3. Explain types of controllers.

Course Outcome 2 (CO2)

1. Define state transition matrix.

2. Obtain state model.

3. Transformation from canonical form to phase variable form.

Course Outcome 3(CO3):

1. Define controllability and observability

2. Design state feedback controllers and observers.

3. Check stability of sampled data systems.

Course Outcome 4 (CO4):

1. List different types of nonlinearities.

2. Determine the describing function of nonlinear system.

3. Analyse nonlinear systems.

Course Outcome 5 (CO5):

1. Classify singular points.

2. Concept of stability in the sense of Liapunov.

3.Analyse the stability using Liapunov.

Model Question paper

Course code: MRT 395

ADVANCED CONTROL SYSTEMS

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

(2019- Scheme)

PART A

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

1. What are the effects of Lag, Lead, Lag-Lead compensator?
2. Compare the effects and performance of P, PI, PID controllers in a closed loop system.
3. Define a) state b) state variables c) state vectors d) state model e) state space.
4. What are the advantages of state space analysis?
5. State and explain sampling theorem.
6. The characteristic polynomial of certain sampled data system is given by P (z) = z4- 1.2z3+ 0.07z2+ 0.3z - 0.08 = 0, test the stability of the system using Jury's stability test.
7. Mention any two characteristics of Nonlinear systems. What are limit cycles?
8. What is the difference between describing function and phase plane method of stability analysis?
9. Define Singular point. Explain the nature of Eigen values of system matrix for any five types of singular points.
10. Explain Liapunov direct method of stability for nonlinear systems.

PART B

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

Module 1

11. (a) The open loop transfer function of a unity feedback control system is given by G(S) = K/[S(1+0.5S)(1+0.2S)]. It is desired that (i) the steady state error to unit ramp input is less than 0.125 (ii) Phase margin≥300 (iii) Gain margin≥10 db. Design a suitable compensator. (10)

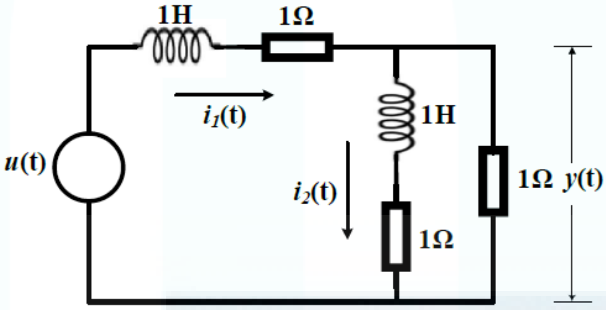
    (b) What is a lead compensator? Obtain its frequency response characteristics? (4)

12. (a) Explain the Ziegler-Nichols method of tuning a PID controller when (a) dynamic model is known (b) dynamic model is not known. (10)

    (b) Explain the effects of adding PID controller to a system. (4)

Module 2

13. (a) Selecting i1(t) =x1(t) and i2(t) =x2(t) as state variables, obtain state equation and output equation of the network shown in Fig. below.



(7)

(b) Obtain the state model of the system whose transfer function is given by

Y(s)/U(s)= 10/[s3+4s2+2s+1] (7)

14. (a)A discrete time system is described by the difference equation y(k+2)+5y(k+1)+6y(k)=u(k) y(0)=y(1)=0; T=1 sec. (a) Determine state model in a canonical form (b) Find the state transition matrix . (10)

(b) Derive the state model of an R-L-C series circuit (4)

Module 3

15. (a) Derive the transfer function of a ZOH circuit. (4)

(b) Transform the system in to controllable canonical form

$$\dot{x} = \begin{bmatrix} -1 & 1 \\ 0 & 2 \end{bmatrix} x + \begin{bmatrix} 2 \\ 1 \end{bmatrix} u \text{ and } y = \begin{bmatrix} 1 & 2 \end{bmatrix} x$$

(10)

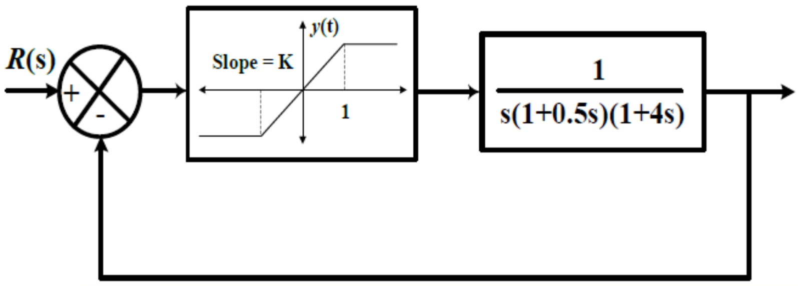
16. (a)Consider a linear system described by the transfer function Y(s)/U(s) =10/[S(S+1)(S+2)]. Design a feedback controller with a state feedback so that the closed loop poles are placed at -2, -1±j1. (10)

(b) Define controllability and observability. Explain any method to check controllability and observability. (4)

Module 4

17. (a) Derive the Describing function of saturation with relay. (7)

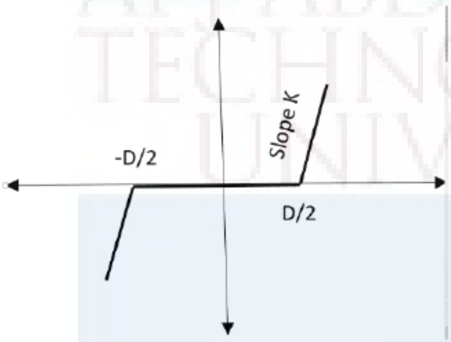
(b) A common form of an electronic oscillator is represented as shown in Fig. . For what value of *K,* the possibility of limit cycle predicted? If *K*=3, determine amplitude and frequency of limit cycle. Also find the maximum value of *K* for the system is stable.



(7)

18. (a) Derive the Describing function of saturation with deadzone. (7)

(b)Identify the following non linearity and derive a describing function for the same



(7)

Module 5

19. (a) A linear second order system is described by the equation $\ddot{e} + 2\delta\omega n\dot{e} + \omega n2e=0$ Where $\delta = 0.15$, ωn = 1rad/sec, e(0)=1.5, and $\dot{e}(0) = 0$ .Determine the singular point and state the stability by constructing the phase trajectory using the method of isoclines. (10)

(b) What is the difference between describing function and phase plane method of stability analysis? (4)

20. (a) Explain Liapunov direct method of stability for nonlinear systems. (4)

(b)Test the stability of the system using Lyapunov stability theorem

(a) $\dot{x_1} = -x_1 + 2x_1^2x_2$, $\dot{x_2} = -x_2$

(b) $\dot{x_1} = x_2, \dot{x_2} = -sin(x_1) - x_2$ (10)

****

Syllabus

Module 1 (9 Hours)

Compensator design:
Realization of compensators – lag, lead and lag-lead -Design of compensator using bode plot.
Design of compensator using rootlocus.
Types of controller- Feedforward-feedback-cascade-P, PI and PID .Design of P, PI and PID controller using Ziegler-Nichols tuning method.

Module 2 (11 Hours)

State space analysis of systems:
Introduction to state concept-definition-state ,state variables ,state vectors, state model - state equation of linear continuous time systems, matrix representation of state equations. Phase variable and canonical forms of state representation-controllable, observable, diagonal and Jordan canonical forms- solution of time invariant autonomous systems, forced system-state transition matrix-relationship between state equations and transfer function. Properties of state transition matrix-Computation of state transition matrix using Laplace transform-Cayley-Hamilton method. Conversion from canonical form to phase variable form.

Module 3 (8 Hours)

State feedback controller design:
Controllability & observability. State feed-back design via pole placement technique. State observers.
Sampled data control system:
Pulse Transfer function-sampler circuits with ZOH and FOH. Analysis of sampled data systems using Z-transform. Stability of sampled data system -Routh Hurwitz criterion and Jury's test. Introduction to state-space representation of sampled data systems.

Module 4 (8 Hours)

Nonlinear systems:
Introduction - characteristics of nonlinear systems. Types of nonlinearities. Analysis through harmonic linearisation - Determination of describing function of nonlinearities (relay, dead zone and saturation only) - application of describing function for stability analysis of autonomous system with single nonlinearity.

Module 5 (9 Hours)

Phase Plane Analysis:
Concepts- Construction of phase trajectories for nonlinear systems and linear systems with static nonlinearities - Singular points – Classification of singular points. Definition of stability- asymptotic stability and instability Liapunov methods to stability of linear and nonlinear, continuous time systems.

Stability of Nonlinear Systems - Liapunov stability - local stability - local linearization and stability in the small- Direct method of Liapunov - generation of Liapunov function for linear and nonlinear systems – variable gradient method.

Text Books

1. Nise N. S., Control Systems Engineering, 6/e, Wiley Eastern, 2010.
2. Nagarath I. J. and Gopal M., Control System Engineering, Wiley Eastern, 2008.
3. Hassan K Khalil, Nonlinear Systems, Prentice - Hall International (UK), 2002.
4. Ogata K., Modern Control Engineering, Prentice Hall of India, New Delhi, 2010.
5. Kuo B.C, Analysis and Synthesis of Sampled Data Systems, Prentice Hall Publications.

Reference Books

1. Alberto Isidori, Nonlinear Control Systems, Springer Verlag, 1995.
2. Gibson J. E., F.B. Tuteur and J. R. Ragazzini, Control System Components, Tata McGraw Hill, 2013
3. Gopal M., Control Systems Principles and Design, Tata McGraw Hill, 2008.
4. Jean-Jacques E. Slotine & Weiping Li, Applied Nonlinear Control, Prentice-Hall., NJ, 1991.
5. Shankar Sastry, “Nonlinear System Analysis, Stability and Control”, Springer, 1999.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Compensator design:**	
1.1	Realization of compensators – lag, lead and lag-lead -Design of compensator using bode plot.	3
1.2	Design of compensator using rootlocus.	3
1.3	Types of controller- Feedforward-feedback-cascade-P, PI and PID .	1
1.4	Design of P, PI and PID controller using Ziegler-Nichols tuning method.	2
2	**State space analysis of systems:**	
2.1	Introduction to state concept - state equation of linear continuous time systems, matrix representation of state equations.	2
2.2	Phase variable and canonical forms of state representation-controllable, observable, diagonal and Jordan canonical forms-	3
2.3	solution of time invariant autonomous systems, forced system-	2
2.4	state transition matrix-relationship between state equations and transfer function. Properties of state transition matrix-Computation of state transition matrix using Laplace transform-Cayley-Hamilton method	3
2.5	Conversion from canonical form to phase variable form.	1
3	**State feedback controller design:**	
3.1	Controllability & observability. State feed-back design via pole placement technique.	2
3.2	State observers.	1
	Sampled data control system:	

3.3	Pulse Transfer function-sampler circuits with ZOH and FOH.	2
3.4	Analysis of sampled data systems using Z-transform	1
3.5	Stability of sampled data system -Routh Hurwitz criterion and Jury's test	1
3.6	Introduction to state-space representation of sampled data systems	1
4	**Nonlinear systems:**	
4.1	Introduction - characteristics of nonlinear systems. Types of nonlinearities.	2
4.2	Analysis through harmonic linearisation	1
4.3	Determination of describing function of nonlinearities (relay, dead zone and saturation only) -	3
4.4	Application of describing function for stability analysis of autonomous system with single nonlinearity.	2
5	**Phase Plane Analysis:**	
5.1	Concepts- Construction of phase trajectories for nonlinear systems and linear systems with static nonlinearities - Singular points – Classification of singular points.	3
5.2	Definition of stability- asymptotic stability and instability Liapunov methods to stability of linear and nonlinear, continuous time systems.	2
	Stability of Nonlinear Systems	
5.3	Liapunov stability - local stability - local linearization and stability in the small-	1
5.4	Direct method of Liapunov - generation of Liapunov function for linear and nonlinear systems	2
5.5	variable gradient method.	1

SEMESTER VI

MRT302	ROBOTICS & AUTOMATION	CATEGORY	L	T	P	CREDIT
		PCC	3	1	0	4

Preamble: This course aims at imparting knowledge about the robotics as well as automation. This will include basics of robots, sensors, kinematics as well as control and industrial automation.

Prerequisite: NIL

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

CO 1	Understand the robot actuators and controls
CO 2	Get knowledge on robot sensors for robotic application
CO 3	Understand the kinematics of robots and adaptive control
CO 4	Understand the basics of Programming Logic Circuits
CO 5	Acquire proficiency in programming Programmable Logic Circuits

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								
CO 2	3	2	2	2								2
CO 3	3	3										
CO 4	3	3	2	2								2
CO 5	3	2										2

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. How do you classify robotic structures?
2. Define roll, pitch and yaw.
3. Which are the drives used in Robotics?

Course Outcome 2 (CO2):

1. What is the necessity of sensors in robotics?
2. Why is machine vision a superior sensor in robotics?
3. Mention few sensors used in robotics.

Course Outcome 3 (CO3):

1. What do you mean by forward kinematics?
2. Explain the inverse kinematics of robots.
3. What is the advantage of adaptive control structures?

Course Outcome 4 (CO4):

1. What is a PLC?
2. What is a ladder program? What are its components?
3. Explain the architecture of PLC.

Course Outcome 5 (CO5):

1. What are the advantages and capabilities of a PLC
2. Explain a PLC based system for automation
3. Explain alarms an interlocks.

Model Question paper

QP CODE:

Reg. No: _____________________

Name: _______________________

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

COURSE CODE: MRT 302 **Duration: 3 hours**

ROBOTICS & AUTOMATION

Mechatronics Branch

PART A

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

1. What are the advantages of PLC over electromechanical relay control? (3 marks)
2. With suitable example explain latching in PLC Ladder logic? (3 mark)
3. What is the scope of industrial automation? (3 mark)
4. What are the applications of Motion Actuators? (3 mark)
5. Differentiate between a serial and parallel robot (3 marks)
6. Write a short note on encoders. (3 marks)
7. Write a short note on Force-Torque sensors. (3 marks)
8. Draw and explain the components and structure of robotic arm? (3 marks)
9. When will hydraulic drive be preferred in robot? (3 marks)
10. Explain the common kinematic arrangements of robots based on various coordinate System? (3 marks)

PART B

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

Module 1

11. Explain different types of stepper motor (14 marks)
12. With illustrations, explain the basic robotic configurations. (14 marks)

Module 2

13 Explain different types of robot End effectors?(14 marks)

14 Illustrate the working principle of various position sensors used in a robotic system? (14 marks)

Module 3

15 Explain the structure of robot programming language (14 marks)

16 Explain about joint angle, joint distance, link length and link twist with the help of D-H representation. (14 marks)

Module 4

17 (a) Illustrate the architecture of PLC? (8 marks)
(b)What are the different types of PLC? (6 marks)

18 What are the advantages and capabilities of a PLC? (14 marks)

Module 5

19 Explain a PLC based system for automation. Explain its ladder diagram. (14 marks)

20 (a) Explain the requirement of communication system in a PLC? (4 marks)
(b) Illustrate the importance of Alarms and Interlocks in a PLC program? (10 marks)

SYLLABUS

Module 1 (8 Marks)

Robotics –Introduction –Basic Structure-Classification of Robot and Robotic System-Law of Robotics-Robot Motion-Wrist Configuration-Motion – Roll –Pitch-Yaw-Drives-Hydraulic Motors-DC Motor-Stepper Motor-Power Transmission Systems

Module 2 (9 Marks)

Sensors in Robotics: Position Sensor-Potentiometer-Encoders-LVDT-Velocity Sensor-Acceleration Sensor-Force-Pressure and Torque Sensor-Touch and Tactile Sensor-Proximity –Range and Sniff Sensor-Robot End Effectors-Types of End Effectors- Mechanical Gripper –Types of Gripper Mechanism

Module 3 (12 Marks)

Position Orientation-Frames-Mapping-Changing Description from Frames to Frames. Transformation arithmetic's -Translation-rotation-transformation- transforms equations- transformation of the vectors-.Introduction to manipulations Forward Kinematics and inverse Kinematics- D-H representation-Method of Robotic Programming (Qualitative Treatment Only).

Module 4 (7 Marks)

Basics of PLC-Advantage- Capabilities of PLC-Architecture of PLC- Scan Cycle-Types of PLC-Types of I/O modules-Configuring of PLC –PLC wiring

Module 5 (9 Marks)

Simple process control programme using ladder logic- PLC arithmetic functions- Timer and Counters-Data transfer-comparison and manipulation instructions-Interlocks and Alarms-Requirement of communication networks in PLC –connecting PLC to computer.

Text Books

1. M.P Groover, "Industrial Robotics-Technology, Programming and Applications", McGraw-Hill USA, 1986

2.John Craig, “Introduction to Robotics”,Macmillan, 1985
3. Curtis Johnson,“Process Control Instrumentation Tech” 8 TH Edition Prentice Hall June 2005
4. Petrezeulla, “Programmable Controllers”, McGraw Hills, 1989

Reference Books

1. D Roy Choudhury and shaail B. jain, “Linear Integrated circuits”, New age international Pvt.Ltd 2003
2.Boltans w. ”Mechatronics” Pearson Education , 2009

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Robotics: Introduction**	
1.1	Basic Structure- Law of Robotics	1
1.2	Classification of Robot and Robotic System	1
1.3	Robot Motion	1
1.4	Wrist Configuration-Motion – Roll –Pitch-Yaw	1
1.5	Drives-Hydraulic Motors	1
1.6	DC Motor	1
1.7	Stepper Motor	1
1.8	Power Transmission Systems	1
2	**Sensors in Robotics**	
2.1	Position Sensor-Potentiometer-Encoders-LVDT-	1
2.2	Velocity Sensor	1
2.3	Acceleration Sensor	1
2.4	Force-Pressure and Torque Sensor	1
2.5	Touch and Tactile Sensor	1
2.6	Proximity –Range and Sniff Sensor	1
2.7	Robot End Effectors	1
2.8	Types of End Effectors	1
2.9	Mechanical Gripper –Types of Gripper Mechanism	1
3	**Robotics Kinematics**	
3.1	Description-Position	1
3.2	Orientation-Frames- Mapping	1
3.3	Changing Description from Frames to Frames.	1
3.4	Translation-rotation-transformation	1
3.5	Transformation arithmetic’s- transforms equations	1
3.6	transformation of the vectors	1
3.7	Introduction to manipulations Forward Kinematics and inverse Kinematics	2
3.8	D-H representation	2
3.9	Method of Robotic Programming (Qualitative Treatment Only).	2
4	**Basics of PLC**	
4.1	Advantage of PLC	1

4.2	Architecture of PLC	2
4.3	Scan Cycle-Types of PLC	1
4.4	Types of I/O modules	1
4.5	Configuring of PLC	1
4.6	PLC wiring	1
5	**PLC programming**	
5.1	Simple process control programme using ladder logic	1
5.2	PLC arithmetic functions- Timer and Counters	2
5.3	Data transfer	1
5.4	comparison and manipulation instructions	1
5.5	Interlocks and Alarms	2
5.6	Requirement of communication networks in PLC	1
5.7	connecting PLC to computer	1

MRT304	DIGITAL IMAGE PROCESSING &MACHINE VISION	CATEGORY	L	T	P	CREDIT
		PCC	3	1	0	4

Preamble:

This course enables the students to systematically study the image processing techniques and familiarises them with enhancement, restoration, compression and segmentation techniques. Students also study the concept of machine vision, an advanced sensor for robotics and automation.

Prerequisite: A knowledge of different transforms

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

CO 1	Explainthe basic concepts of image processing and various transforms used.
CO 2	Summarize image enhancement techniques.
CO 3	Perform image restoration procedures.
CO 4	Apply image compression and segmentation techniques.
CO 5	Apply image representation techniques
CO 6	Identify machine vision as an advanced sensor for automation.

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	1		1								
CO 2	3	2	1	2								2
CO 3	3	3										
CO 4	3	3	2	2								2
CO 5	3	2										2
CO 6	3	1		1								2

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1	**2**	
Remember	10	10	10
Understand	20	20	20
Apply	10	10	30
Analyse	10	10	40
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. Write short notes on selective filtering.

2. What is the need for image transform? Explain.

3. What are the advantages and disadvantages of local histogram processing when compared to global histogram processing?

Course Outcome 2 (CO2)

1. What is meant by image restoration?

2. Write the difference between image restoration and image enhancement.

3. Write the drawback of inverse filtering

Course Outcome 3(CO3):

1. Explain the different types of blurs.

2. List out different noises in images.

3. Explain about periodic noise reduction using frequency domain filtering.

Course Outcome 4 (CO4):

1. What is the need of compression?

2. Prove that erosion and dilation are dual to each other.

3. Define image segmentation. Give classification.

Course Outcome 5 (CO5):

1. What is the advantage of machine vision?

2. What is meant by visual servoing?

3. Explain an industrial application utilising machine vision.

Course Outcome 6 (CO6):

1. Describe the role of control system in mechatronics.

2. Illustrate an Automatic temperature control system suitable for automation.

3. Describe the working of an automatic traffic light control system.

Model Question paper

Course Code: MRT 304

Course Name: DIGITAL IMAGE PROCESSING AND MACHINE VISION

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

PART A

Answer all Questions. Each question carries 3 Marks

1. Explain different level processes in image processing.
2. Define neighbours of a pixel.
3. Write short notes on selective filtering.
4. Write the difference between image restoration and image enhancement.
5. What is meant by digital image water marking?
6. Write the drawback of inverse filtering.
7. Define gradient of an image.
8. Compare orthogonal and bi-orthogonal wavelets.
9. What is the advantage of machine vision?
10. How does a bar code reader work?

PART B

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

Module 1

11. (a) Explain the theory of sampling of an image. (8)

    (b) Explain convolution and correlation. (6)

12. (a)Define histogram equalization. Explain the procedure for histogram equalization(7)

(b) Derive the basis function of Walsh transform.(7)

Module 2

13. (a)What are the advantages of adaptive filters? Explain about adaptive median filter.(8)

    (b) What is constrained least mean square filtering (6)

14. (a) Define blur of an image. Explain the different types of blurs. (8)

    (b) Explain inverse filtering method. (6)

Module 3

15. (a) Define compression and explain the general compression system model (8).

    (b) Explain watermarking in Frequency domain (6).

16. (a)What are the different image compression standards? Explain. (8)

    (b) Explain the application of wavelet in image processing. (6)

Module 4

17. (a) Explain about Boundary Extraction and Region Filling Algorithm.(10)

    (b) Discuss about region based segmentation (4)

18. (a) What o you mean by texture? (4)

    (b) Explain boundary extraction and hole filling (10)

Module 5

19. Illustrate an Industrial automation system employing machine vision. (14)

20. (a) How do you classify vision systems based on their level of complexity? (6)

    (b) Which are the different cameras used in machine vision systems? (8).

Syllabus

Module 1 (10 Hours)

Introduction to image processing : Fundamentals of image processing – Image sampling and quantization- Basic relationship between pixels – Basicgeometric transformations-Introduction to Fourier Transform-Properties of 2D Fourier Transform – Separable Image Transforms –Walsh – Discrete Cosine Transform- Haar Transform-Spatial Domain methods: Basic grey level transformation – Histogram equalization – Image subtraction – Image averaging

Module 2 (8 Hours)

Image enhancement: Spatial filtering: Smoothing- sharpening filters –Frequency domain filters: Smoothing – Sharpening filters – Homomorphic filtering

Model of Image Degradation/restoration process – Noise models – Inverse filtering –Least mean square filtering – Constrained least mean square filtering – Blind image restoration – Pseudo inverse

Module 3 (9 Hours)

Image compression: Lossless compression: Variable length coding – LZW coding – Bit plane coding-predictive coding-DPCM. Lossy Compression: Wavelet coding-Digital Image Watermarking. – Basics of Image compression standards: JPEG- MPEG.

Module 4 (9 Hours)

Representation and description : Edge detection – Thresholding - Region Based segmentation – Boundary representation: chain codes– Boundary segments – boundary descriptors: Simple descriptors-Fourier descriptors - Regional descriptors –Simple descriptors- Texture

Module 5 (9 Hours)

Machine Vision: Machine Vision as a sensor - low and higher level vision- 1D and 3D vision-image acquisition and digitization- cameras- CCD- CID- CPD illumination and types- image processing and analysis- feature extraction- Applications of vision in industrial automation – Control systems using vision for decision making and feedback-Visual Servoing

Text Books

1..RafelC.Gonzalez and Richard E.Woods. Digital Image Processing, Addison Wesley, 1993.

2. Anil K. Jain, Fundamentals of Digital Image Processing, Prentice Hall of India, 1997

3. Vernon D, Machine Vision – Automated Visual Inspection and Robot Vision, Prentice Hall, International Ltd., 1991

4. Ramesh Jain, RangacharKasturi, Brain G. Schunk, Machine Vision, McGraw Hill International Editions, Computer Science Series.

Reference Books

1. William K. Pratt, Digital Image Processing, John Wiley, NY, 1987.

2. Sid Ahmed M.A., Image Processing Theory, Algorithms and Architectures, McGraw Hill, 1995

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Introduction to image processing**	
1.1	Fundamentals of image processing – Image sampling and quantization- Basic relationship between pixels	2
1.2	Basicgeometric transformations-Introduction to Fourier Transform Properties of 2D Fourier Transform – Separable Image Transforms – Walsh – Discrete Cosine Transform- Haar Transform-	4
1.3	Spatial Domain methods: Basic grey level transformation – Histogram equalization – Image subtraction – Image averaging	4
2	**Image enhancement**	
2.1	Spatial filtering: Smoothing- sharpening filters –Frequency domain filters: Smoothing – Sharpening filters – Homomorphic filtering	2
2.2	Model of Image Degradation/restoration process – Noise models	3
2.3	Inverse filtering –Least mean square filtering – Constrained least mean square filtering – Blind image restoration – Pseudo inverse	3
3	**Image compression**	
3.1	Lossless compression: Variable length coding – LZW coding – Bit plane coding- predictive coding-DPCM.	3
3.2	Lossy Compression: Wavelet coding	2
3.3	Digital Image Watermarking	2
3.4	Basics of Image compression standards: JPEG- MPEG	2
4	**Representation and description**	
4.1	Edge detection – Thresholding - Region Based segmentation –	2
4.2	Boundary representation: chain codes– Boundary segments	2
4.3	Boundary descriptors: Simple descriptors-Fourier descriptors - Regional descriptors –Simple descriptors- Texture	5
5	**Machine Vision**	
5.1	Machine Vision as a sensor - low and higher level vision- 1D and 3D vision-image acquisition and digitization- cameras- CCD- CID- CPD illumination and types	3
5.2	image processing and analysis- feature extraction	2
5.3	Applications of vision in industrial automation	2
5.4	Control systems using vision for decision making and feedback-Visual Servoing	2

MRT306	INDUSTRIAL HYDRAULICS & PNEUMATICS	CATEGORY	L	T	P	CREDIT
		PCC	3	1	0	4

Preamble: The course aims at giving adequate exposure to hydraulic and pneumatic systems and designs them. The course also demonstrates relay control systems and PLC systems and their programming.

Prerequisite: Nil

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

CO 1	Understand various components of fluid power systems,their advantages and select them for various applications.
CO 2	Differentiate the merits between the hydraulic and pneumatic power systems.
CO 3	Design and simulate fluidpowersystems for automation of machine tools and other equipments.
CO 4	Select the appropriate control system like electrical, electronics, and PLC to control the fluid power system.
CO 5	Applythefundamentalconceptsoffluidpowerandtoobtainsolutiontoengineering problems.
CO 6	Troubleshoot and identify maintenance problems associated with fluid power 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	3	2										
CO 2	3	2										
CO 3	3	3	2						2			
CO 4	3	2							2			
CO 5	3	3	2									
CO 6	3	2										

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.

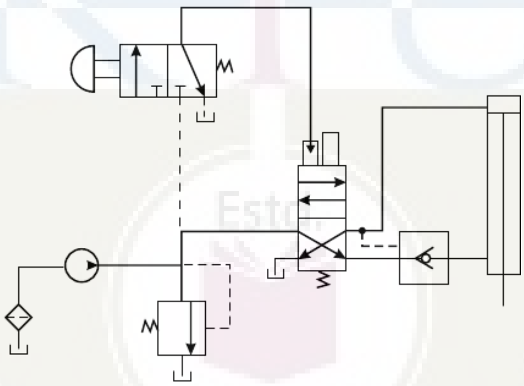
Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Brief the various components of pneumatic system and its fluid power symbol.
2. Write short notes on direction control valve and its types with neat sketches.
3. With a neat sketch, describe the construction and working of pressure compensated flow control valve.

Course Outcome 2 (CO2)

1. Analyze the circuit shown in Fig



2. Explain 4-way spool valve.
3. Explain following functions generated in Pneumatic systems,
   (i) OR gate
   (ii) AND gate
   (iii) NOT gate.

Course Outcome 3(CO3):

1. Draw and explain the working principle of a fail-safe circuit with overload protection.

2. A hydraulic motor has a displacement of 130 cm , operates with a pressure of 10^5 bar and has a speed of 2000 rpm. Ifthe actual flow rate consumed by the motor is 0.05 m^3/s and the actual torque delivered by the motor is 200 N-m, Estimate:

(i) Volumetric efficiency

(ii) Mechanical efficiency

(iii) Overall efficiency

(iv) Power developed by motor in kW

3. A hydraulic cylinder is used to operate a machine. The load during the forward stroke is 20 kN and that during the return stroke is approx. 10 kN. The forward and return speeds are about 3.5 m/min. and 5.5 m/min respectively. Total stroke of the cylinder is 300 mm. Provision is required to hold the cylinder anywhere between the end positions. Develop a suitable hydraulic circuit and select different components from the data given. Specify the ratings of the components in case it is not available in the given data.

Course Outcome 4 (CO4):

1. Discuss the applications of Programmable Logic Controllers in fluid power control.
2. State and explain Open loop and Closed loop control systems. Also, compare their merits and demerits.
2. What is the advantage of using sequencing circuit?
3. Construct a ladder logic for the following Boolean equations and explain

(i) $Y = (X_l+X_2).X_3$

(ii) $Y = (X_l+X_2).(X_3+X_4)$

(iii) $Y = (X_l.X_2)+X_3$

(iv) $Y = (X_l+X_2+X_3)+X_4$

Course Outcome 5 (CO5):

1. What is an actuator? Draw hydraulic system operating double acting actuator with 3/2 DCV
2. Explain electropneumatic control of double acting cylinder with a neat sketch
3. A hydraulic motor has a 100 cm^3 volumetric displacement. If it has a pressure rating of 140 bar and receives oil from a 0.001 m^3/sec theoretical flow rate pump, find the motor:

(i) Speed

(ii) Theoretical torque

(iii) Theoretical KW power

Course Outcome 6 (CO6):

1. List the electric devices used in the control of fluid power system.
2. What could be the reasons for failure in fluid power systems?
3. Discuss the applications of Programmable logic controllers in fluid power control.

Model Question Paper

Course Code: MRT 306

Course Name: INDUSTRIAL HYDRAULICS AND PNEUMATICS

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

PART A

Answer all the questions. Each question carries 3 Marks

1. Write symbols for:
   (i) Pressure relief valve.
   (ii) Pressure reducing valve.
   (iii) Counter balance valve.
2. With neat sketches, explain the advantages of 'Tandem center' over a 'Closed center' design in a DCV.
3. Explain the working principle of 4-way spool valve with a neat schematic.
4. Draw the ISO symbols of any 4 DCV's.
5. Write the PID controller equation.
6. Define: Gain Margin
7. Explain the basic structure of a PLC.
8. What is the function of Karnaugh map?
9. Define the terms "Lap" and "Null" with respect to servo valves
10. Define underlap and overlap in the context of servo valve spools.

PART B

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

Module 1

11 (a)What is the function of pressure reducing valve? sketch & explain with neat 3
sketch the working of pressure reducing valve. 4
(b)Draw and explain the internal architecture of a 4-way DCV with its symbol. 7
(c) How an electro-hydraulic servo valve works?

12 (a)Using two-way, two-position DCV, show how the following logic-functions can 3
be achieved in pneumatics? (i) AND (ii) OR. 4
(b)A gear pump has a 75 mm outside diameter a 50 mm inside diameter and a 25 7
mm width. If the volumetric efficiency is 90% at rated pressure, what is the corresponding actual flow rate? The pump speed is 1000 rpm.
(c)What are the different types of Servo valves? Explain in detail.

Module 2

13 (a)How do servo valves differ from proportional control valves? 4
(b) State the use of twin pressure valve and shuttle valve 4
(c) With a neat sketch describe the construction and operation of a pressure 6
compensated flow control valve.

14 (a) Explain the working of a pilot operated pressure relief valve with neat sketch. 3
(b)Explain the working of metering in hydraulic circuit with a suitable sketch. 4
(c) Explain the regenerative circuit and its application. 7

Module 3

15 (a) What are advantages of frequency response analysis? 4

(b) Explain the block diagram and components of closed loop electro-hydraulic servo system. 4

(c) Explain the reaction curve technique for tuning of controller. What are its limitations? 6

16 (a)State the advantages of frequency domain analysis. 3

(b)How is phase margin determined from Bode plots? 7

(c)State and explain open loop and closed loop control systems. Also comparetheir merits and demerits.

Module 4

17 (a)Explain the principle of cascade control systems. 4

(b) Differentiate between relays and solenoids. 3

(c)Draw a ladder logic program for generating the activation sequence $A^+B^-A^-B^+$ for the 2 cylinders A and B. Four limit switches a–, a+, b–, and b+ are connected to the cylinders A and B. Assume a starting switch “START” to start operation and that initially switch b– is active. After all 4 sequences one alarm should ring for 5 seconds. 7

18 (a)Illustrate the use of sequence valve with a simple hydraulic circuit. 3

(b) Explain with neat sketch coordinated sequence motion of two cylinders. 4

(c)Develop an electro pneumatic circuit by cascade method for the following sequence: $A^+B^+B^-A$ where A and B stands for cylinders, (+) indicates extension and (–) retraction of cylinders. 7

Module 5

19 (a)What is the advantage of using servo systems? 3

(b) Explain the working of a 2-stage servo valve. 4

(c) Design and draw a hydraulic circuit to achieve following objectives 7

(i) piston advances with uniform speed in the first half of forward stroke,

(ii) with reduced speed in the next half of forward stroke and

(iii) return quickly

20 (a) Explain the working of a pilot operated sequence valve. 3

(b) How speed control is done with the help of meter-in, meter-out and bleed-off circuits. 4

(c)Explain in detail about the control of a hydraulic cylinder using limit switch with neat sketches and explain about different electrical components used in the system with its symbols. Draw the ladder logic for the same. 7

Syllabus

Module 1 (9 Hours)

Fluid power generating/ utilizing elements: Hydraulic pumps and motor gears, vane, piston pumps-motors-selection and specification-drive characteristics-Linear actuator- types, mounting details, cushioning-power packs-construction, reservoir capacity, heat dissipation, accumulators-standard circuit symbols, circuit (flow) analysis.

Control and regulation elements: Direction flow and pressure control valves- method of actuation, types, sizing of ports-pressure and temperature compensation, overlapped and under lapped spool valves- operating characteristics-electro-hydraulic systems, electro-hydraulic servo valves- different types characteristics and performance.

Module 2 (9 Hours)

Comparison of hydraulics and pneumatics: Need for automation, hydraulic and pneumatic comparison-ISO symbols for fluid power elements, hydraulic, pneumatics-selection criteria and examples related to selection criteria.

Advanced Hydraulics:Types of proportional control devices-pressure relief, flow control, directional control, hydraulic symbols, spool configurations, electrical operation, basic electrical circuit and operation, solenoid design, comparison between conventional and proportional valves.

Module 3 (9 Hours)

Method of control : Comparison between analogue and digital control, proportional attributes, ramp, gain, dead band, dither, pulse width modulation, amplifier cards, principles of operation, design and application, analogue and digital, closed loop, internal and external feedback devices, operation and application of closed loop system, integrated electronics option frequency response, principles of operation, Bode diagrams and their use in manufacturer’s data,PID control, practical exercises, commissioning and set up procedures, open loop circuits, closed loop circuits, interface to the control.

Module 4 (9 Hours)

Electrical control of fluid power: Electrical control of hydraulics and pneumatics, use of relays, timers, counters, PLC ladder diagram for various circuits, motion controllers, use of field busses incircuits,Electronic circuits for various open loop control and closed loop(servo) control of hydraulics and pneumatics.

Circuit Design: Typical industrial hydraulic circuit design methodology- ladder diagram-cascade, method- truth table- Karnaugh map method-sequencing circuits- combinational and logic circuit.

Module 5 (9 Hours)

Servo systems: Hydro mechanical servo systems, electro hydraulic servo systems and proportional valves, velocity control, position control and directional control and applications (process industry, printing, extrusionpress,continuouscasting,foodand packaging, injection moulding, solar energy, automobile etc.).

Pneumatic PID circuits: PLC applications in fluid power control, ladder diagrams, timers and counters. Low cost automation using pneumatics and flexible manufacturing system. fluid power circuits; failure and troubleshooting

Text Books

1.S.R.Majumdar, "Pneumatic System-Principles and Maintenance", McGraw Hill, 2017.
2.A. Esposito, "Fluid Power with Applications", 7thEd., Pearson Hall, 2008.
3.R.Srinivasan, "Hydraulic and Pneumatics control", McGraw Hill, 2008.
4.A. Parr, "Hydraulic and Pneumatics", Jaico Publishing House, 1993.

Reference Books

1.H. E. Merritt,"Hydraulic control systems", John Wiley& Sons, NewYork,1967.
2.D. A. Peace, "Basic fluid power", Prentice Hall Inc,1987.
3.P. Rohner, "Fluid Power logic circuit design", Macmillan,1979.
4.S. R. Majumdar, "Oil hydraulic Systems", McGraw-Hill, 2002.
5. H. L. Stewart, "Practical Guide to Fluid Power", 2ndEd., Audel, 1968
6. M. J. Pinches, J. G. Ashby, "Power Hydraulics", Longman, 1988.
7. D. A. Pease, J.J. Pippenger, "Basic Fluid Power", 2nd Ed., Pearson, 1986.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
	Module 1	
1.1	Fluid power generating/utilizing elements: Hydraulic pumps and motor gears, vane, piston pumps-motors- selection and specification- drive characteristics	3
1.2	Linear actuator- types, mounting details, cushioning- power packs- construction, reservoir capacity, heat dissipation, accumulators- standard circuit symbols, circuit (flow) analysis	2
1.3	Control and regulation elements: Direction flow and pressure control valves- method of actuation, types, sizing of ports- pressure and temperature compensation, overlapped and under lapped spool valves-	3
1.4	operating characteristics- electro hydraulic systems, electro hydraulic servo valves- different typescharacteristics and performance	1
	Module 2	
2.1	Comparison of hydraulics and pneumatics: Need for automation, hydraulic and pneumatic comparison	2
2.2	ISO symbols for fluid power elements, hydraulic, pneumatics- selection criteria and examples related to selection criteria	2
2.3	Advanced Hydraulics: Types of proportional control devices- pressure relief, flow control, directional control, hydraulic symbols, spool configurations	3
2.4	Electrical operation, basic electrical circuit and operation, solenoid design, comparison between conventional and proportional valves	2
	Module 3	
3.1	Method of control : Comparison between analogue and digital control, proportional attributes, ramp, gain, dead band, dither, pulse width modulation, amplifier cards	3
3.2	principles of operation, design and application, analogue and digital, closed loop, Internal and external feedback devices, operation and application of	3

	closed loop system, integrated electronics option frequency response, principles of operation, Bode diagrams and their use in manufacturer's data	
3.3	PID control, practical exercises, commissioning and set up procedures, open loop circuits, closed loop circuits, interface to the control	3
	Module 4	
4.1	Electrical control of fluid power: Electrical control of hydraulics and pneumatics, use of relays, timers, counters, PLC ladder diagram for various circuits,	3
4.2	motion controllers, use of field busses in circuits, Electronic circuits for various open loop control and closed loop (servo) control of hydraulics and pneumatics.	2
4.3	Circuit Design: Typical industrial hydraulic circuit design methodology- ladder diagram- cascade, method- truth table- Karnaugh map method- sequencing circuits- combinational and logic circuit.	4
	Module 5	
5.1	Servo systems: Hydro mechanical servo systems, electro hydraulic servo systems and proportional valves	2
5.2	velocity control, position control and directional control and applications (process industry, printing, extrusion press, continuous casting, food and packaging, injection moulding, solar energy, automobile etc.)	3
5.3	Pneumatic PID circuits: PLC applications in fluid power control, ladder diagrams, timers and counters.	2
5.4	Low cost automation using pneumatics and flexible manufacturing system. fluid power circuits; failure and troubleshooting	2

*****

MRT308	COMPREHENSIVE COURSE WORK	CATEGORY	L	T	P	CREDIT
		PCC	1	0	0	1

Preamble: The course is designed to ensure that the students have firmly grasped the fundamental knowledge in Mechatronics Engineering familiar enough with the technological concepts. It provides an opportunity for the students to demonstrate their knowledge in various Instrumentation and Control Engineering subjects.

Pre-requisite: Nil

Course outcomes: After the course, the student will able to:

CO1	Learn to prepare for a competitive examination
CO2	Comprehend the questions in Mechatronics Engineering field and answer them with confidence
CO3	Communicate effectively with faculty in scholarly environments
CO4	Analyze the comprehensive knowledge gained in basic courses in the field of Mechatronics Engineering

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	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	1	1			2										
CO2	3	1				2				3			1	1	1	1
CO3	3	1			1	2				3						
CO4	3	3			1	2							1	1	1	1

Assessment pattern

Bloom's Category	End Semester Examination (Marks)
Understand	15
Apply	5
Analyze	5
Evaluate	
Create	

End Semester Examination Pattern:

A written examination will be conducted by the University at the end of the sixth semester. The written examination will be of objective type similar to the GATE examination. Syllabus for the comprehensive examination is based on following five Mechatronics Engineering core courses.

MRT 201- ELECTRICAL MACHINES & DRIVES

MRT 203- ANALOG AND DIGITAL ELECTRONICS

MRT 204- SENSORS AND ACTUATORS

MRT 206- MICROPROCESSOR & EMBEDDED SYSTEMS

MRT 303–LINEAR CONTROL SYSTEMS

The written test will be of 50 marks with 50 multiple choice questions (10 questions from each module) with 4 choices of 1 mark each covering all the five core courses. There will be no negative marking. 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 above.

Written examination	:	50marks
Total	:	50 marks

Course Level Assessment and Sample Questions:

1) No-load speed of which of the following motor is highest?
   a. Differentially compound motor
   b. Cumulative compound motor
   c. Series Motor
   d. Shunt Motor
2) A three-point starter is suitable for
   a. Shunt Motor
   b. Series Motor
   c. Shunt & Compound Motor
   d. Shunt, Series, and compound motor
3) The speed of a dc shunt motor is required be more than full load speed. This may be achieved by
   a. Increasing the armature current
   b. Decreasing the armature current
   c. Increasing the excitation current
   d. Reducing the field current
4) The output impedance of an ideal op-amp is
   a. Zero
   b. Low
   c. High
   d. infinite

5) A 2-bit binary multiplier can be implemented using
   a. 2 input AND gates only.
   b. 2 number of 2 input XOR gates and 6 number of 2 input AND gates.
   c. Two 2-input NOR gates and one XNOR gate.
   d. XOR gates and shift registers.
6) 11001, 1001 and 111001 correspond to the 2's complement representation of which one of the following sets of numbers
   a. 25, 9 and 57 respectively
   b. -6, -6 and -6 respectively
   c. -7, -7 and -7 respectively
   d. -25, -9 and -57 respectively
7) A stable linear time invariant (LTI) system has a transfer function H(s)=1/s2+s−6. To make this system causal it needs to be cascaded with another LTI system having a transfer function H1(s). A correct choice for H1(s) among the following options is
   a. s+3
   b. s-2
   c. s-6
   d. s+1

10) What will be the nature of time response if the roots of the characteristic equation are located on the s-plane imaginary axis?

   a. Oscillations
   b. Damped oscillations
   c. No oscillations
   d. Under damped oscillations

11) Consider a system with transfer function G(s) = s+6/Ks2+s+6. Its damping ratio will be 0.5 when the values of k is:

   a. 2/6
   b. 3
   c. 1/6
   d. 6

12) The unit step response of a second order system is = 1-e-5t-5te-5t . Consider the following statements:
1. The under damped natural frequency is 5 rad/s.
2. The damping ratio is 1.
3. The impulse response is 25te-5t.
Which of the statements given above are correct?

   a. Only 1 and 2
   b. Only 2 and 3
   c. Only 1 and 3

d. 1,2 and 3

13) An 8-bit microprocessor can process _____ data at a time.

a. 4-bit
b. 8-bit
c. 16-bit
d. All of the above

14) The external system bus architecture is created using from?

a. Pascal
b. Dennis Ritchie
c. Charles Babbage
d. Von Neumann

15) Single-bit indicators that may be set or cleared to show the results of logical or arithmetic operations are the

a. Flags
b. Monitors
c. Registers
d. Decisions

Course Code: MRT 308

Comprehensive Course Work

MODULE 1: ELECTRICAL MACHINES & DRIVES

DC generator - Working principle – EMF equation – types of dc generators –DC motor - Working principle - back emf – types of dc motor - equations for torque - power starters- Transformers-Working principle - emf equation – voltage transformation ratio– losses-3-pahse induction motors types – operation – concept of rotating magnetic field – slip - torque equation– starting -1-phase induction motors- Working principle –types-Aletrnators - working principle - emf equation –voltage regulation-Synchronous motor- special electrical machines- Basic concepts of Rectifier and inverter-Electrical Drives - Parts of electrical drives - Choice of electric drives- 3-pahse induction motors speed control

MODULE 2: ANALOG AND DIGITAL ELECTRONICS

BJT -FET- JFET & MOSFET-. Power amplifiers-class A, B, AB & C amplifiers.Oscillators-Barkhausen criteria-Classification- RC phase shift oscillators- Hartley and Colpitts Oscillator. Op-amp characteristics –offset voltage & offset current –frequency response- Integrator, Differentiator- Comparator, S/H, Isolation amplifier, V/I & I/V Converter.Active Filters- Analysis of first order LPF & HPF filter- Band Pass & Band stop Filters- Timer IC 555 – Astable and Monostable modes. Phase Locked Loops-Principles- building blocks of PLL-VCO- Logic gates-De-Morgan’s theorem –K-Map and Quine Mc Cluskey method. Combinational Circuits- Adder, Subtractor, Code converters Encoders, Decoders, Multiplexers, De-multiplexers .Flip Flop –SR,D,JK,T and master slave flip flop- Shift Registers- Counters –Synchronous and asynchronous- Counter, Sequence detector.

MODULE 3:SENSORS AND ACTUATORS

Sensors and Actuators - Magnetic Sensors - Linear and Latching Solenoid Actuators - Stepper Motors - Special Magnetic Devices - Rotary and Linear Actuators - Magnetic Materials - Magnetic Sensors - VR Sensors - Solid-State Sensors - Magnetic Sensor Applications - Magnetic Speed Sensor Requirements - Applications - Magnetic Position Sensor -VR Sensor NoiseLinear Actuators - Fast-Acting Actuators - Solenoids –types and applications - Long Stroke Solenoid Fuel Pump –Fuel Injectors - Solenoids- Disk Rotary Actuators , Claw Pole Rotary Actuators , Cylindrical Rotary Actuators - Theory and applications- Controls in NC Machines and fluidic control- stepping motors- feedback devices- encoders - resolvers – Tacho-generators - fluid logic control -Coanda effect - basic fluidic devices - fluidic logic gates - bistable flipflop - OR and NOR gates - exclusive OR gates - fluidic sensors - backpressure sensor –jet sensors

MODULE 4: MICROPROCESSOR & EMBEDDED SYSTEMS

8085 Microprocessor - Addressing modes- Instruction set- Interrupts-Timing and control–Machine cycles, instruction cycle and T states–fetch and execute cycles–IO and memory interfacing –Address decoding–I/O ports – Programmable peripheral interface PPI 8255 -Modes of operation. Microprocessor Vs Microcontroller, Tool Chain System, Assemblers, Compilers, linkers, Loaders, Debuggers Profilers & Test Coverage Tools-8051 Microcontroller - Architecture-Memory organization –Special function registers –Addressing modes – Instruction set –Interrupts -Embedded C Programming -Peripheral Programming- A/D and D/A converters.

MODULE 5: LINEAR CONTROL SYSTEMS

Feedback principles, signal flow graphs, transient response, time domain analysis of first and second order systems, steady-state-errors, Bode plot, phase and gain margins, Routh and Nyquist criteria, root loci, design of lead, lag and lead-lag compensators, state-space representation of systems; time-delay systems

CODE: MRL332	MECHATRONIC SYSTEMS LAB	CATEGORY	L	T	P	CREDIT
		PCC	0	0	3	2

Preamble: Mechatronic Systems lab aims at giving hands on experience to students in the practical aspects of hydraulic kits, and operation of robots as well as sensors. System modelling using dedicated software like MATLAB and LABVIEW provides simulation studies. PLC programming gives introduction to automation.

Prerequisite:NIL

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

CO 1	Acquire the basic knowledge in using electro- pneumatic kits and assemble them
CO 2	Operate a robot for applications like pick and place
CO 3	Experimentally apply the virtual instrumentation technique using LABVIEW
CO 4	Develop automation modules using PLC
CO 5	Use platforms like MATLAB or Python for data processing
CO 6	Acquire the basic knowledge in various sensors used inautomotive.

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**	**PSO 13**	**PSO 14**
CO 1	3	2	2	2					2			2	2	2
CO 2	2					2							2	3
CO 3	3	2	2		3				2			3	3	3
CO4	3	2	2	2					2			2	2	2
CO5	3	2	2	2	2				2			2	3	3
CO6	3	2	2	2					2			2	2	2

Assessment Pattern

Mark distribution

Total Marks	**CIE**	**ESE**	**ESE Duration**
150	75	75	2.5 hours

Continuous Internal Evaluation Pattern:

Attendance : 15 marks
Continuous Assessment : 30 marks
Internal Test (Immediately before the second series test) : 30 marks

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.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. What are various components of a pneumatic systems?
2. Draw a circuit representing a pneumatic system with a double acting cylinder and a 3/2 solenoid valve?
3. Explain about different types of control valves and cylinders used in a pneumatic System?

Course Outcome 2 (CO2)

1. How do you program a robot?
2. What are the end effectors used in robots?
3. Perform pick and place operation using the given manipulator

Course Outcome 3 (CO3):

1. What are the applications of LABVIEW?
2. Develop virtual instrumentation panel for the control of a servomotor.
3. Develop virtual instrumentation panel for signal monitoring

Course Outcome 4 (CO4):

1. What are the inputs and Outputs required for an automatic door opening and closing system using PLC?
2. Draw the ladder diagram for an automatic door opening and closing system using PLC?
3. What is a ladder program?

Course Outcome 5(CO5):

1. Use MATLAB for image recognition.
2. Use Python application for image rotation and enhancing
3. What is the use of filters in image processing?

Course Outcome 6 (CO6)

1. Enlist various sensors used in automotive
2. Validate the significance of Electronic control unit in a vehicle.

3. Explain the working of an Exhaust Oxygen Sensor?

LIST OF EXPERIMENTS (Minimum 12 experiments is mandatory)

1	Design and assembly of pneumatic/hydraulic kit
2	Study of different type of pneumatic and hydraulic valve.
3	Study of reciprocating movement of double acting cylinder using pneumatic direction control valve.
4	Programming Robot (Pick and place robot)
5	Sensors for automotive
6	PID Controller
7	Automatic door opening and closing
8	Data acquisition for Virtual Instrumentation
9	Image acquisition techniques
10	Control of stepper motor
11	Control of servomotor
12	Signal conditioning of strain gauge. LVDT, Thermocouple, pressure transducer
13	A/D and D/A conversion
14	Machine Vision system
15	Study of robot end effectors
16	Image Processing Examples using Python
17	Image Processing Examples using MATLAB

Text Books

1. R.K. Jain ,Engineering Metrology, Khanna Publishers, 1994
2. Andrew Parr, “Hydraulics and Pneumatics” (Third Edition),Butterworth-Heinemann,2011,
3. Roy Choudhary,’ Linear Integrated Circuits.‘ Publisher, New Age International (P) Limited, 2007
4. Devadas Shetty, Richard A.Kolkm, “Mechatronics system design, PWS publishing company,2009.
5. Bolton, “Mechatronics – Electronic control systems in mechanical and electrical engineering,2nd edition, Addison Wesley Longman Ltd., 2009.
6. D. Patranabis, “Principles of Industrial Instrumentation”, Tata McGraw-Hill, eleventh reprint(2004).

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
MRD334	MINIPROJECT	PWS	0	0	3	2

Preamble: This course is designed for enabling the students to apply the knowledge to address the real-world situations/problems and find solutions. The course is also intended to estimate the ability of the students in transformingtheoretical knowledge studied as part of the curriculum so far in to a working model. The students are expected to design and develop a software/hardware project to innovatively solve a real-world problem.

Prerequisites: Subjects studied up to sixth semester.

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

CO No.	Course Outcome (CO)	Bloom's Category Level
CO 1	Make use of acquired knowledge within the selected area of technology for project development.	Level 3: Apply
CO 2	Identify, discuss and justify the technical aspects and design aspects of the project with a systematic approach.	Level 3: Apply
CO 3	Interpret, improve and refine technical aspects for engineering projects.	Level 3: Apply
CO 4	To exercise their creative and innovative qualities in a group project environment	Level 3: Apply
CO 5	Report effectively theproject related activities and findings.	Level2: Understand

Mapping of course outcomes with program outcomes

POs / COs	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	3	3	3	3	-	-	-	3
CO 2	3	3	3	3	3	-	2	3	-	3	2	3
CO 3	3	3	3	3	3	2	3	3	-	2	3	3
CO 4	3	3	2	2	-	-	-	3	3	3	3	3
CO 5	3	-	-	-	2	-	-	3	2	3	2	3

Assessment Pattern

The End Semester Evaluation (ESE) will be conducted as an internal evaluation based on the product/project, 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 and project guide/coordinator. The Committee will be evaluating the level of completion and demonstration of functionality/specifications, presentation, oral examination, working knowledge and involvement.

The Continuous Internal Evaluation (CIE) is conducted by evaluating the progress of the miniproject through minimum of TWO reviews. At the time of the 1st review, students are supposed to propose a new system/design/idea, after a thorough literature study of the existing systems underthe chosen area. In the 2nd review students are expected to highlight the implementation details of the proposed solution. The review committee should assess the extent to which the implementation reflects the proposed design. The final CIE mark is the average of 1st and 2nd review marks.

A zeroth review may be conducted before the beginning of the project to give a chance for the students to present their area of interest or problem domain or conduct open brain storming sessions for innovative ideas.Zeroth review will not be apart of the CIE evaluation process.

In the final review students are expected to demonstrate the product with its full specification along with a final report. A well coded, assembled and completely functional product is the expected output during the end of the semester.

Marks Distribution

Total Marks	**CIE**	**ESE**
150	75	75

Continuous Internal Evaluation Pattern:
Attendance : 10 marks
Marks awarded by Guide : 15 marks
Project Report: 10 marks
Evaluation by the Committee : 40 Marks

End Semester Examination Pattern: The following guidelines should be followed regarding award of marks.
(a) Demonstration : 50 Marks
(b) Project report: 10 Marks
(d) Viva voce : 15marks

Course Plan

In this course, each group consisting of three/four members is expected to design and develop a moderately complex software/hardware system with practical applications. This should be a working model. The basic concept of product design may be taken into consideration.

Students should identify a topic of interest in consultation with Faculty-in-charge of miniproject/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.

SEMESTER VI

PROGRAM ELECTIVE I

MRT312	OBJECT ORIENTED PROGRAMMING	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

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:

EST 102- Programming in C

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

CO 1	Familiarize the concepts of Object-Oriented Programming
CO 2	Understand the components of Java for better programming skills
CO 3	Understand file management with java
CO 4	Design java applet and execute jar file
CO 5	Familiarize the database with java application

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	3				2			3
CO 2	3	3	3	3	3				2			3
CO 3	3	2	2	2	2				2			3
CO 4	3	3	3	3	3				2			3
CO 5	3	3	3	3	3				2			3

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. Develop a program to read the student's detail and print the result
2. What do you mean by access specifier?

Course Outcome 2 (CO2)

1. Develop a java program to demonstrate multilevel inheritance.
2. What o you mean by inner class?

Course Outcome 3(CO3):

1. Write a program to demonstrate the start, run, sleep and join methods in Thread class.
2. What are the aspects of file management in Java?

Course Outcome 4 (CO4):

1. 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.
2. What is an applet?

Course Outcome 5 (CO5):

1. Design a java application to take students marks of a class, store it and display the result.
2. What do you mean by data base management?

Model Question paper

Course Code: MRT312

Course Name: OBJECT ORIENTED PROGRAMMING

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

PARTA

Answer all Questions. Each question carries 3 Marks

1. Compare data hiding and data abstraction in Java.
2. Define method overloading
3. Define the use of final key word
4. How a single inheritance is differ from multilevel inheritance
5. What is a package? How is it created, imported and used in Java?
6. Distinguish between InputStream and Reader classes and OutputStream
7. What is thread synchronisation?
8. How thread priority is set in Java?
9. Give the syntax of SELECT and UPDATE SQL commands with examples.
10. What is JDBC? List out three interfaces/ classes in JDBC API.

PART B

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

Module 1

11. (a) Describe the concepts of object and class with a suitable Java program

    (b) Compare and contrast object-oriented paradigm with procedure-oriented paradigm.

12. (a) Why is Java considered to be platform independent? What is the role of Bytecode in making Java platform independent?

    (b) Illustrate how protected members in a class can be accessed in Java.

Module 2

13. (a) What is inheritance? Explain the advantages of inheritance.

    (b) What is the importance of abstract class

14. (a) Discuss any two type of inheritance with real time example

(b) Compare method overloading and method overriding

Module 3

15. (a) What is a stream? Illustrate how the concept of streams is used in java.

(b) What is a thread explain its properties

16. (a) Explain object streams in Java. Explain the role of Serializable interface with a suitable code sample.

(b) Write a program that creates two threads. Fist thread prints the numbers from 1 to 100 and the other thread prints the numbers from 100 to 1.

Module 4

17. (a) Write an applet program that displays an image in the applet panel

(b) Compare Application and Applet.

18. (a) Design a simple calculator to run in applet panel

(b) Explain the applet life cycle.

Module 5

19. (a) Write a Java Program to create a student table and to add student details to it using JDBC.

(b) Differentiate between yield() and sleep() methods.

20. What is a JDBC Connection? Explain steps to get database connection in a java program.

(b) Explain the JDBC architecture.

Syllabus

Module	Topics	Hr
1	Object Oriented Programming using Java –Objects, classes, methods, access specifiers-static methods– constructors, Arrays – Strings -Packages	**7**
2	Inheritance – class hierarchy – polymorphism – dynamic binding – final keyword – abstract classes – the Object class – Reflection – interfaces – inner classes	**7**
3	Streams and Files -Use of Streams, Object Streams, File Management Multithreaded programming– Thread properties – Creating a thread - Interrupting threads –Thread priority- thread synchronization – Synchronized method -Inter thread communication	**7**
4	Applet Basics-The Applet HTML Tags and Attributes, Multimedia, The Applet Context, JAR Files.	**7**

5	Database Programming -The Design of JDBC, The Structured Query Language, JDBC Installation, Basic JDBC Programming Concepts, Query Execution	**7**

Text Books

1. Cay S. Horstmann and Gary Cornell, "Core Java: Volume I & II– Fundamentals",Pearson Education, 2008.
2. Herbert Schildt , The Complete Reference Java2, Eighth Edition, Tata McGraw Hill

Reference Books

1. Balagurusamy E., Programming JAVA a Primer, 5/e, McGraw Hill, 2014.
2. Doug Lea, Concurrent programming in Java Design Principles and Patterns, Pearson Education.
3. K. Arnold and J. Gosling, "The JAVA programming language", Pearson Education.
4. Timothy Budd, "Understanding Object-oriented programming with Java", Pearson Education.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Principles of Object-Oriented Programming**	
1.1	Object Oriented Programming using Java	1
1.2	Objects, classes, methods,	1
1.3	access specifiers	1
1.4	static methods	1
1.5	constructors, Arrays	1
1.6	Strings	1
1.7	Packages	1
2	**Inheritance**	
2.1	Inheritance - class hierarchy	1
2.2	polymorphism	1
2.3	dynamic binding	1
2.4	final keyword - abstract classes	1
2.5	the Object class – Reflection	1
2.6	Interfaces	1
2.7	inner classes	1
3	**Streams and Files**	
3.1	Use of Streams, Object Streams	1
3.2	File Management Multithreaded programming	1
3.3	Thread properties – Creating a thread	1
3.4	Interrupting threads	1
3.5	Thread priority- thread synchronization	1

3.6	Synchronized method	1
3.7	Inter thread communication	1
4	**Applet Basics**	
4.1	The Applet HTML Tags and Attributes	2
4.2	Multimedia	2
4.3	The Applet Context	2
4.4	JAR Files.	1
5	**Database Programming**	
5.1	The Design of JDBC,	1
5.2	The Structured Query Language	2
5.3	JDBC Installation,	1
5.4	Basic JDBC Programming Concepts,	2
5.5	Query Execution	1

CODE MRT322	BIOMEDICAL INSTRUMENTATION	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble:

To give a brief introduction to human physiology and various instrumentations system for measurement and analysis of physiological parameters

Prerequisite: Nil

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

CO 1	List different biopotential and its propagation.
CO 2	Explain the physiology of biological system
CO 3	Measure biomedical and physiological information
CO 4	Explain the different electrode placement for various physiological recording
CO 5	Discuss the application of Electronics in diagnostics and therapeutic area

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											
CO 2	3	2										
CO 3	2					2					2	
CO 4	2	2	2									
CO 5						2					2	

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 full question carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. What do you mean by bio potential?

2. What are the different components of a biomedical systems?

3. How is bio potential propagated in human body?

Course Outcome 2 (CO2)

1. What is the role of neurons in nervous system?

2. Explain the nervous system functioning.

3. What are the basic components of a biomedical system?

Course Outcome 3(CO3):

1. List the types of electrodes in biomedical systems.

2. What is the role of amplifiers in biomedical systems?

3. Explain EEG and ECG.

Course Outcome 4 (CO4):

1. Explain the importance of electrode placement for various physiological recording

2. Explain a method for measurements and recording of cardiac output.

Course Outcome 5 (CO5):

1. Discuss in detail the application of Electronics in diagnostics and therapeutic area.

2. What is radiation therapy?

3. Discuss about the electrical safety in medical environment.

Model Question paper

QP CODE:

Reg. No:------------------- **Name: ---------------------**

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

Course code: MRT322 **Duration: 3hours**

BIOMEDICAL INSTRUMENTATION (2019- Scheme)

Mechatronics Branch

PART A (Answer all the questions, each question carries 3 marks)

1. What are the different components of a biomedical systems?

2. Give a brief note on fiber optic temperature sensor.

3. List the types of electrodes in biomedical systems

4. Draw the typical wave forms of a normal ECG

5. Differentiate systolic and diastolic pressure.

6. Give a short note on respiration rate and pulse ate

7. Write the uses of X-rays in biomedical.

8. What is the basic principle of computed tomography?

9. Write a short note about the shock hazards in biomedical systems

10. What are the instruments used for checking safety parameters of biomedical equipment?

PART B (Answer one full question from each module .each question carries 14 marks)

Module 1

11. (a) Explain with neat sketch the human nervous system, neurons and synapse . (10 marks)

    (b) Give a brief note on a ultrasonic transducer. (4 marks)

12. (a) What is bio-potential and its propagation .(7 marks)

    (b) Give brief note on cardio vascular system. (7 marks)

Module 2

13. (a) Explain detailed about chopper amplifier and isolation amplifier. (10 marks)

    (b) Give a short note on limb electrode. (4 marks)

14. (a) Explain with neat sketch the lead systems and various recording methods. (14 marks)

Module 3

15. (a) Explain how ultra sound blood flow measurements works. (10 marks)

(b) What are the different dilution methods? (4 marks)

16. Explain the direct and indirect methods for measuring blood pressure with neat diagrams. (14 marks)

Module 4

17. Give a brief note on angiography and endoscopy. (14 marks)

18. (a) List the advantages and disadvantages of radiation therapy.(8 marks)

(b) What is the need for infant incubators.(6 marks)

Module 5

19. Explain the important of tele-medicine in the modern medical era . (14 marks)

20. Write a detailed study of electrical safety in medical environment. (14 marks)

Syllabus

Module 1 (7 Hours)

Physiology and transducers –Cell and its structure, Resting and Action Potential, Origin of bio potential and its propagation , Nervous system – Functional organization of the nervous system, Structure of nervous system, neurons, synapse, transmitters and neural communication, Cardio vascular system, respiratory system, Basic components of a biomedical system, Transducers, selection criteria, Piezo-electric, ultrasonic transducers- Fiber optic temperature sensors.

Module 2 (7 Hours)

Electro–Physiological measurements- Electrodes, Types of electrodes , Limb electrodes, floating electrodes, pre-gelled disposable electrodes, Micro, needle and surface electrodes. Amplifiers: Preamplifiers, differential amplifiers, chopper amplifiers, Isolation amplifier. ECG,EEG,EMG,Lead systems and recording methods, Typical waveforms.

Module 3 (7 Hours)

Measurement of Non-Electrical parameters-Temperature, respiration rate and pulse rate measurements. Blood Pressure: indirect methods - Auscultatory method, direct methods: electronic manometer, Systolic, diastolic pressure, Blood flow and cardiac output measurement: Indicator dilution and dye dilution method, ultrasound blood flow measurement

Module 4 (7 Hours)

Assisting and the rapeutic equipments -Ventilators, heart lung machine, hemodialysis, lithotripsy, infant incubators X-rays- principles of generation, uses of X-rays- diagnostic still picture, fluoroscopy, angiography, endoscopy, diathermy. Basic principle of computed tomography, magnetic resonance imaging system and nuclear medicine system – radiation therapy.

Module 5 (7 Hours)

Instruments For Clinical Laboratory- test on blood cells – chemical tests - Electrical safety in medical environment: shock hazards, leakage current-Instruments for checking safety parameters of biomedical equipment– method of accident prevention, introduction to tele-medicine.

Text Books

1. J. G. Webster, "Medical Instrumentation, Application and Design", John Wiley and Sons

2. L. Cromwell, F. J. Weibell and L. A. Pfeiffer, "Biomedical Instrumentation Measurements", Pearson education, Delhi, 1990.

Reference Books

1. R. S. Khandpur, "Handbook of Biomedical Instrumentation", Tata Mc Graw Hill

2. J. J. Carr and J. M. Brown, "Introduction to Biomedical Equipment Technology", Pearson Education

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Physiology and transducers**	
1.1	Cell and its structure, Resting and Action Potential,	1
1.2	Nervous system , Functional organization of the nervous system, Structure of nervous system, neurons, synapse, transmitters and neural communication,	3
1.3	Cardio vascular system, respiratory system, Basic components of a biomedical system, Transducers, selection criteria, Piezo-electric, ultrasonic transducers.	2
1.4	Fiber optic temperature sensors	1
2	**Electro–Physiological measurements**	
2.1	Electrodes, Origin of bio potential and its propagation. Types of electrodes , Limbelectrodes,floatingelectrodes,pre-gelleddisposableelectrodes, Micro, needle and surface electrodes.	2
2.2	Amplifiers:Preamplifiers,differentialamplifiers,chopperamplifiers,Isolationamplifier	2
2.3	ECG,EEG,EMG, Lead systems and recording methods, Typical waveforms.	3
3	**Measurement Of Non-Electrical parameters**	
3.1	Temperature, respiration rate and pulse rate measurements	1
3.2	Blood Pressure: indirect methods - Auscultatory method, direct methods: electronic manometer, Systolic, diastolic pressure	3
3.3	Blood flow and cardiac output measurement: Indicator dilution and dye dilution	2

	method	
3.4	ultrasound blood flow measurement	1
4	**Assisting and therapeutic equipments**	
4.1	Ventilators, heart lung machine, hemodialysis, lithotripsy, infant incubators X-rays- principles of generation, uses of X-rays- diagnostic still picture, fluoroscopy, angiography, endoscopy, diathermy	4
4.2	Basic principle of computed tomography, magnetic resonance imaging system and nuclear medicine system – radiation therapy.	3
5	**Instruments for clinical laboratory**	
5.1	test on blood cells – chemical tests	1
5.2	Electrical safety in medical environment: shock hazards, leakage current	2
5.3	Instruments for checking safety parameters of biomedical equipment– method of accident prevention,	3
5.4	Introduction to tele- medicine.	1

CODE	COURSE NAME	CATEGORY	L	T	P	CREDITS
MRT332	POWER ELECTRONICS	PEC	2	1	0	3

Preamble:

To impart knowledge about the power semiconductor devices, the operation of various power converters and its applications.

Prerequisite:

Basics of Electrical Engineering / Introduction to Electrical Engineering/ Basics of Electronics Engineering

Course Outcomes:

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

CO 1	Explain the operation of modern power semiconductor devices and its characteristics.
CO 2	Analyse the working of controlled rectifiers.
CO 3	Explain the working of AC voltage controllers, inverters and PWM techniques.
CO 4	Compare the performance of different dc-dc converters.
CO 5	Describe basic drive schemes for ac and dc motors.

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								
CO 2	3	2	2	2								2
CO 3	3	3										
CO 4	3	3	2	2								2
CO 5	3	2										2

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	20
Understand	20	20	30
Apply	10	10	30
Analyse	10	10	20
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 full question carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Explain the working and switching characteristics of SCR, MOSFET, IGBT
2. Give a brief description on wide band-gap power devices
3. Draw and explain the switching characteristics of SCR

Course Outcome 2 (CO2):

1. Describe the working with waveforms of single phase half wave rectifiers for different firing angles.
2. Describe the working with waveforms of single phase fully controlled rectifiers for different firing angles and loads.
3. Describe the working with waveforms of single phase half controlled rectifiers for different firing angles and loads.

Course Outcome 3 (CO3):

1. Explain single phase inverter for R and RL loads, problems in finding the output voltage, THD of inverter.
2. Explain 3 phase mode 120° and 180° conduction modes.
3. Explain single phase current source inverter PWM Inverter.

Course Outcome 4 (CO4):

1. Problems related to step up and step down converters.
2. Analyse the working of Buck, Boost & Buck Boost regulators.
3. Design the value of filter inductor & capacitance in regulators.

Course Outcome 5 (CO5):

1. Explain the block diagram of an electric drive

2. Explain the working of single phase rectifier fed DC drive
3. Explain the chopper controller DC drive

Model Question paper

QP CODE:

PAGES:2

Reg.No:______________
Name:______________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
SIXTH SEMESTER B.TECH DEGREE EXAMINATION,
MONTH & YEAR
Course Code: MRT 332

Course Name: POWER ELECTRONICS

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

PART A (3 x 10 = 30 Marks)

Answer all Questions. Each question carries 3 Marks

1. What are the different turn on methods of SCR?
2. Describe the reverse recovery characteristics of a power diode.
3. Draw the input and output voltage waveforms of single phase half controlled rectifier feeding RL load in continuous conduction mode.
4. Explain with neat sketches, the input and output voltage waveforms of 3ø half controlled rectifier with R load for a firing angle of 300.
5. What is the difference between voltage source and current source inverters?
6. What do you mean by pulse width modulation?
7. Explain time ratio control method to vary the output voltage in choppers.
8. Derive the expression for output voltage of a Buck Converter.
9. What are the advantages of electric drives?
10. Explain regenerative braking control in drives.

PART B (14 x 5 = 70 Marks)
Answer any one full question from each module. Each question carries 14 Marks

Module 1

11. a) Explain the two transistor analogy of SCR. (6)

b) Explain the switching characteristics of IGBT. (8)

12. a) Explain the structural details of MOSFET. (8)

b) Write short note on wideband gap devices. (6)

Module 2

13. a) Explain the operation of single phase full wave controlled rectifier without freewheeling diode, when feeding RL load. (14)

14. a)The full-wave controlled bridge rectifier has an AC input of 220 V rms at 50 Hz and a 20 ohmload resistor. The delay angle is 400. Determine the average current in the load, the power absorbed by the load, and the source volt-amperes. (7)

b) Draw the circuit of 3 phase fully controlled rectifier with RLE load and explain the working for α=600 with necessary waveforms. Derive the expression for output voltage. (7)

Module 3

15. a) Explain the 120° conduction mode of a three-phase bridge inverter with output voltage waveforms, indicating the devices conducting in each state. (14)

16. a) Explain the PWM technique for varying the magnitude of output voltage in a single-phase inverter. (6)

b) Briefly explain current source inverter (8)

Module 4

17. a) Explain the working of a Buck-Boost regulator, showing relevant waveforms and derive the expression for its output voltage. (8)

b) Design a DC-DC Converter with 12 V input and 200 V output at upto 50 W. The ripple in the output voltage and input current should not exceed +- 5% and +- 20% respectively. Select suitable device and switching frequency. (6)

18. a) Describe the working of four quadrant chopper in all the four quadrants with relevant circuit diagrams. (14)

Module 5

19. a) Explain the working of a single phase full converter drive (8)
b) Explain the working of a chopper drive (6)

20. a) Explain the stator voltage control for Induction motor drive (8)
b) Explain the working of v/f control of Induction motor drive (6)

Syllabus

Module 1 (7 Hours)

Introduction to Power Electronics-Scope and applications-power electronics vs signal electronics - Structure and principle of operation ofpower devices- Power diode, Power MOSFET & IGBT – switching characteristics - comparison. SCR- Structure, Static characteristics & Switching (turn-on & turn-off) characteristics - di/dt& dv/dt protection – Turn-on methods of SCR - Two transistor analogy Gate triggering circuits – Requirements of isolation and synchronization in gate drive circuits

Module 2 (7 Hours)

Controlled Rectifiers- Single Phase Controlled Rectifiers – Half-wave controlled rectifier with R load– Fully controlled and half controlled bridge rectifier with R, RL and RLE loads (continuous & discontinuous conduction) – Output voltage equation 3-phase half-wave controlled rectifier with R load – Fully controlled & half-controlled bridge converter with RLE load (continuous conduction, ripple free) (detailed mathematical analysis not required)

Module 3 (7 Hours)

AC Voltage Controllers and **Inverters**- AC voltage controllers (ACVC) – 1-phase full-wave ACVC with R load Inverters – Voltage Source Inverters– 1-phase half-bridge & full bridge inverter with R and RL loads –3-phase bridge inverter with R load – 120° and 180° conduction modes Current Source Inverters-1-phase capacitor commutated CSI.Voltage control in 1-phase inverters – Pulse width modulation- Modulation Index - Frequency modulation ratio.

Module 4 (7 Hours)

DC-DC converters – Step down and Step up choppers – Single-quadrant and Two-quadrant chopper – control schemes Switching regulators – Buck, Boost & Buck-boost –Operation with continuous conduction mode – Waveforms

Module 5 (7 Hours)

Electric Drive: Introduction to electric drives – Block diagram – advantages of electric drives- types of load – classification of load torque DC Drives: Single phase semi converter and single phase fully controlled converter drives. Dual Converters for Speed control of DC motor- Chopper controlled DC drives AC Drives: Three phase induction motor speed control. Stator voltage control – stator frequency control - Stator voltage and frequency control

Text Books

1. Muhammad H. Rashid, “Power Electronics Circuits, Devices and Applications”, Pearson Education
2. Daniel W. Hart, “Power Electronics”, Tata McGraw-Hill Education
3. P.S. Bimbhra, “Power Electronics”, Khanna Publishers, New Delhi

References:

1. Mohan N., T. M. Undeland and W. P. Robbins., Power Electronics, Converters, Applications & Design, Wiley-India
2. Fundamentals of Power Electronics, Erickson, Robert W., and Maksimovic, Dragan.
3. Krein P. T., Elements of Power Electronics, Oxford University Press, 1998.

4. L. Umanand, Power Electronics – Essentials & Applications, Wiley-India
5. Singh M. D. and K. B. Khanchandani, Power Electronics, Tata McGraw Hill, New Delhi, 2008.
6. Joseph Vithayathil, Power Electronics: Principles and Applications, McGraw-Hill College; International edition ,1995
7. Application notes on SiC and GaN, www.infineon.com. [online]
8. Evolution of wide Band-gap Semi-conductors for power devices expanding field of applications. Technical review, Vol 4, Toshiba Corporation, 2018
9. Milligan, J. W., Sheppard, S., Pribble, W., Wu, Y.-F., Muller, G., &Palmour, J. W. (2007). SiC and GaN Wide Bandgap Device Technology Overview, 2007 IEEE Radar Conference. doi:10.1109/radar.2007.374395.
10. VedamSubramaniam "Electric drives (concepts and applications)", Tata McGraw-Hill, 2001.
11. G. K. Dubey, Fundamentals of Electric Drives, Narosa publishers, second edition, 2010.

Course Contents and Lecture Schedule:

No.	Topic	No. of Lectures
1	**Power Devices (7 hours)**	
1.1	Introduction to Power Electronics: Scope and applications-power electronics vs signal electronics.	1
1.2	Structure, principle of operation, switching characteristicsof Power Devices-Power Diode, Power MOSFET & IGBT – Comparison	2
1.3	Basic principles of wideband gap devices-SiC, GaN	1
1.4	SCR- Structure, Static characteristics & Switching (turn-on & turn-off) characteristics - di/dt& dv/dt protection – Turn-on methods of SCR - Two transistor analogy	2
1.5	Requirements of isolation and synchronization in gate drive circuits- Opto and pulse transformer based isolation	1
2	**Single phase and three phase controlled rectifiers (7 hours)**	
2.1	Half-wave controlled rectifier with R load	1
2.2	1-phase fully controlled bridge rectifier with R, RL and RLE loads (continuous & discontinuous conduction) – Output voltage equation	1
2.3	1-phase half controlled bridge rectifier with R, RL and RLE loads	1
2.4	3-phase half-wave controlled rectifier with R load	2
2.5	3-phase fully controlled & half-controlled converter with RLE load (continuous conduction, ripple free)	2
3	**Inverters and Voltage control in single phase inverters (7 Hours)**	
3.1	Applications of AC-AC converters – Single phase full-wave AC voltage controllers with R, & RL loads- Waveforms	1
3.2	RMS output voltage, Input power factor with R load	1

3.3	Voltage Source Inverters– 1-phase Half-bridge & Full bridge inverter with R and RL loads– THD in output voltage	1
3.4	3-phase bridge inverter with R load – 120° and 180° conduction modes	1
3.5	Current Source Inverters-1-phase capacitor commutated CSI.	1
3.6	Pulse Width Modulation – Single pulse width, Multiple pulse width and Sine-triangle PWM (bipolar modulation) – Modulation Index - Frequency modulation ratio.	2
4	**DC-DC converters (7 Hours)**	
4.1	Step down and Step up choppers – Single-quadrant chopper	2
4.2	Two-quadrant and Four-quadrant chopper – Pulse width modulation &current limit control in dc-dc converters.	2
4.3	Buck, Boost & Buck-boost –Operation with continuous conduction mode – Waveforms	2
4.4	Design of Power circuits (switch selection, filter inductance and capacitance)	1
5	**Electric drives (7 Hours)**	
5.1	Electric Drive: Introduction to electric drives – Block diagram – advantages of electric drives- types of load – classification of load torque	1
5.2	DC Drives: Single phase semi converter and single phase fully controlled converter drives. Dual Converters for Speed control of DC motor-1-phase and 3-phase configurations; Simultaneous and Non-simultaneous operation.	2
5.3	Chopper controlled DC drives. Single quadrant chopper drives. Two quadrant chopper drives.	2
5.4	AC Drives: Three phase induction motor speed control. Stator voltage control – stator frequency control - Stator voltage and frequency control (v/f) (3 hrs)	2

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
MRT342	AUTOMOBILE ENGINEERING	PEC	2	1	0	3

Preamble:

The objective of this course is

- To know the anatomy of automobile in general
- To understand the working of different automotive systems and subsystems
- To update the latest developments in automobiles

Prerequisite: Basics of Mechanical Engineering

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

CO 1	Explain different automotive systems and subsystems.
CO 2	Illustrate the principles of transmission, suspension, steering and braking systems of an automobile.
CO 3	Build a basic knowledge about the technology in electric vehicles.
CO 4	Summarize the concept of aerodynamics in automobiles.

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
CO 2	3											3
CO 3	3											3
CO 4	3											3

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. What are the different types of frames?
2. What are the different types of chassis?
3. What is the need of gear box?

Course Outcome 2 (CO2)

1. Explain the automatic transmission system.
2. What do you mean by braking efficiency?
3. How does a height correction suspension work?

Course Outcome 3(CO3):

1. What is ABS in vehicles?
2. What is the advantage of regenerative braking system?
3. What is a hybrid vehicle?

Course Outcome 4 (CO4):

1. Explain a method of reducing aerodynamic drag in vehicles
2. What is hatch back drag?
3. What is aerodynamic lift? How do you control it?

Max. Marks: 100 **Model Question paper** Duration: 3 Hours

PART A ***(30 marks)***

Answer all questions, each carries 3 marks.

1. List the three types of chassis construction.
2. Explain the loads coming on a chassis frame.
3. Differentiate body roll couple and body overturning couple.
4. Explain the features of Double Wish Bone suspension system.
5. Describe any type of a regenerative brake system.
6. Illustrate the desirable properties of brake pad materials.
7. Define the terms under steer and over steer in automobiles.
8. Explain the advantages of power assisted steering system.
9. Explain the functions of negative lift aerofoil wings.
10. List out the advantages of rear end spoiler in a vehicle.

PART B ***(70 marks)***

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

Module 1

11. a) Explain the working of worm and roller steering gearbox system with the help of a neat sketch. (7)

b) Explain the common troubles encountered in gear boxes and suggest suitable remedies. (7)

12. Compare hydraulic, mechanical, electrical and vacuum methods of operating clutches. Describe a hydraulic operated clutch in detail with help of simple diagram. (14)

Module 2

13. a) Explain the features of McPherson strut suspension system with a neat sketch. (8)

b) Explain the function of an antiroll bar in a four wheeled vehicle. (6)

14. a) Illustrate the working of swing arm rear wheel drive independent suspension. (8)

b) Explain the features of De Dion axle rear wheel suspension. (6)

Module 3

15. a) Explain how the braking efficiency of a vehicle is evaluated? Also detail the parameters that affect the braking efficiency. (7)

b) Derive an expression for the brakes applied on front and rear wheels. (7)

16. a) Discuss the working and advantages of ABS over conventional systems. (8)

b) Explain the working of a brake caliper with a neat sketch. (6)

Module 4

17. a) Explain the working and advantages of turbocharger with a neat sketch. (8)

b) Explain how oil control ring helps in piston lubrication. (6)

18. a) Explain the basic principle of a hydrogen fuel cell and its efficiency. (8)

b) Explain the technology of high speed electric trains. (6)

Module 5

19. a) Differentiate between fast back drag and hatch back drag. (7)

b) Explain the methods to control the aerodynamic lift in vehicles. (7)

20. a) Illustrate the influence of shape of vehicles on drag coefficients. (7)

b) Explain how profile edge chamfering improves drag in vehicles. (7)

Syllabus

Module 1 (7 hours)

Components of an automobile. General classification. Conventional Chassis construction- Types of frames- Frameless constructions.

Friction clutch: Principle, dry friction clutches- Pull type diaphragm clutch, multiple diaphragm clutch, multi-plate hydraulically operated automatic transmission clutch, semi centrifugal clutch, fully automatic centrifugal clutch, and integral single plate diaphragm clutch. Electromagnetic clutch operation. wet clutch.

Manual transmission- Need of gear box, power to weight ratio, speed operating range-, constant mesh, and synchromesh gear boxes. Automatic transmission- Epicyclic gear box - torque convertor – Over drives. Automated manual transmission.

Module 2 (8hours)

Suspension: - suspension geometry, terminology- Macpherson strut friction and spring offset - suspension roll centers: -roll centers, roll axis, roll centre height, short swing arm suspension, transverse double wishbone, Macpherson strut suspension, body roll stability analysis: - body roll couple, body roll stiffness, body over turning couple.

Rear suspension: - live rigid axle suspension, non-drive rear suspension- swing arm rear wheel drive independent suspension. Low pivot split axle coil spring wheel drive independent suspension, trailing and semi trailing arm rear wheel drive independent suspension. Transverse double link arm rear wheel drive independent suspension, De Dion axle rear wheel suspension - hydro-pneumatic automatic height correction suspension.

Module 3 (6 hours)

Brakes: mechanical and hydraulic brakes (review only) – properties of friction lining and pad materials, theory of internal shoe brake, equations –effect of expanding mechanism of shoes on total braking torque, equations.

Anti-Lock Braking system (ABS):- hydro-mechanical ABS - hydro-electric ABS - air-electric ABS. Brake servos: - direct acting suspended vacuum assisted brake servo unit operation - hydraulic servo assisted brake systems. Pneumatic operated disc brakes – electronic-pneumatic brakes. Regenerative braking system.

Module 4 (7 hours)

Steering: -basic principle of a steering system– Ackermann –over steer and under steer – slip angle, camber, king pin inclination, caster, toe-in and toe-out .Steering gear box:-worm and roller type steering gear box – Re-circulating ball nut and rocker lever– need of power assisted steering. External direct coupled - rack and pinion - integrated -steering power cylinder

Fuel injection systems: multiport fuel injection (MPFI) and common rail direct injection (CRDI) systems.

Module 5 (7 hours)

Electric Vehicle Technology (EVT): EV Architecture, types of batteries, battery parameters, super capacitors. Fuel cells and its efficiency. EV Chassis – requirements, suspension for EVs. Recent Electric vehicles- Electric mobility aids. Future of electric vehicles –Tesla S, Maglev trains, Electric rail road systems.

Aerodynamic drag: pressure drag, air resistance, opposing motion of a vehicle, equations, after flow wake, drag coefficients, various body shapes, base drag, vortices, trailing vortex drag, attached transverse vortices. Aerodynamic lift: -lift coefficients, vehicle lift, underbody floor height versus aerodynamic lift and drag, aerofoil lift and drag, front end nose shape. Car body drag reduction, Aerodynamic lift control, After body drag.

Text Books

1. Heinz Heisler, Vehicle and engine technology, Butterworth-Heinemann, 2nd edition,1998.

2. R.B. Gupta., Auto design, Satya Prakashan Publishers, New Delhi, 2016.

3. James Larminie and John Lowry, Electric vehicle technology explained, Wiley publications, 2nd edition, 2015.

4. Kirpal Singh, Automobile Engineering Vol.1 & Vol.2, Standard Publishers, 13th edition, 2020.

Reference Books

1. V.A.W. Hillier, Fundamentals of modern vehicle technology, Butterworth-Heinemann, 2nd edition,1998.
2. Tom Denton, Electric and Hybrid Vehicles, Routledge Publishers, 2nd edition, 2020.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Clutch and transmission**	
1.1	Introduction, Chassis construction- Types of frames, Frameless construction	1
1.2	Principle of dry friction clutches- Single plate, Multi plate.	1
1.3	Semi centrifugal clutch, fully automatic centrifugal clutch, and Integral single plate diaphragm clutch.	1
1.4	Electromagnetic clutch operation.wet clutches.	1
1.5	Sliding mesh, constant mesh, synchromesh gear boxes,	1
1.6	Epicyclic gear box, Torque convertor	1
1.7	Over drives, Automated manual transmission.	1
2	**Suspension**	
2.1	Suspension: - suspension geometry, terminology. Macpherson strut friction and spring offset.	1
2.2	Suspension roll centers:-roll centers, roll axis, roll centre height, short swing arm suspension.	1
2.3	Transverse double wishbone, Macpherson strut suspension	1
2.4	Body roll stability analysis: - body roll couple, body roll stiffness, body over turning couple.	1

2.5	Rear suspension: - live rigid axle suspension, non-drive rear suspension-swing arm rear wheel drive independent suspension.	1
2.6	Low pivot split axle coil spring wheel drive independent suspension, trailing and semi trailing arm rear wheel drive independent suspension.	1
2.7	Transverse double link arm rear wheel drive independent suspension, De Dion axle rear wheel suspension.	1
2.9	hydro-pneumatic automatic height correction suspension.	1
3	**Brakes**	
3.1	Types of Brakes, Properties of friction lining and pad materials.	1
3.2	Theory of internal shoe brake, equations	1
3.3	Effect of expanding mechanism of shoes on total braking torque, equations.	1
3.4	Hydro-mechanical ABS - hydro-electric ABS	1
3.5	Air-electric ABS. Brake servos: -direct acting suspended vacuum assisted brake servo unit operation - Hydraulic servo assisted brake systems.	1
3.6	Pneumatic operated disc brakes – electronic-pneumatic brakes. Regenerative braking systems.	1
4	**Steering, Engine**	
4.1	Ackermann steering mechanism, over steer and under steer.	1
	slip angle, camber, , king pin inclination, caster, toe-in and toe-out	1
4.2	Steering gear box:-Worm and roller type steering gear box,	1
4.3	Re-circulating ball nut and rocker lever, power assisted steering.	1
4.4	External direct coupled - rack and pinion - integrated -steering power	1
4.5	Fuel injection systems multiport fuel injection (MPFI) and common rail direct injection (CRDI) systems.	2
5	**EVT & Aerodynamics**	
5.1	EV Architecture, types of batteries, battery parameters, super capacitors. Fuel cells and its efficiency.	1
5.2	EV Chassis – requirements, suspension for EVs. Recent Electric vehicles-Electric mobility aids.	1
5.3	Future of electric vehicles –Tesla S, Maglev trains, Electric rail road	1

	systems.	
5.4	Aerodynamic drag: pressure drag, air resistance, opposing motion of a vehicle. Flow wake, drag coefficients, various body shapes, base drag, vortices, trailing vortex drag, attached transverse vortices.	2
5.5	Aerodynamic lift: -lift coefficients, vehicle lift. Under body floor height versus aerodynamic lift and drag. Aerofoil lift and drag, front end nose shape.	1
5.6	Car body drag reduction, Aerodynamic lift control, After body drag	1

MRT352	INDUSTRIAL ENGINEERING	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble: This course helps an engineering student to understand the functions and techniques of Industrial Engineering. It addresses economic aspects of the business decision and the concepts of human factors in design. The course involves productivity improvement methods, Work study, Method study and Time study. Industrial Engineering Tools and Techniques for Plant management including Plant layout and Material handling are also covered in this course. The students also will able understand Production Planning and Control process, and procedures. The other focus areas of Industrial Engineering, Quality practices, Project Management and Replacement technique are also part of this course.

Prerequisite: NIL

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

CO 1	Understand the functions of Industrial Engineering, Economic aspects of business and Human factors in design
CO 2	Apply Principles of Work study, Method study and Work measurement techniques.
CO 3	Develop layout for a manufacturing/service system and apply plant management and Material handling techniques.
CO 4	Evaluate Production Planning and Control techniques and Inventory control
CO 5	Analyse Quality practices, and Apply Project Management and Replacement techniques.

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			3	3				3	
CO 2		3	3			3						
CO 3		3	3		3							
CO 4		3	3	3	3						3	
CO 5		3	3	3		3	3				3	

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. State functions of an Industrial Engineer which will lead to improvement in productivity?

2. How the productivity of s system can be improved? List factors affecting productivity that can be controlled.

3. Asian industries specialize in the manufacture of small capacity motors. The cost structure of the motor is as under

Material Rs 50/-

Labour Rs 80/-

Variable overhead 75% of labour cost

Fixed cost of the company amount 2,40,000 Rs/annum

The sales price of the motor is Rs 230/- each

Determine the number of motors to be manufactured to break even
How many motors are to be sold to make a profit of Rs 1 Lakh

If the sale price is reduced by Rs. 15/- how many motors are to sold to break even

Course Outcome 2 (CO2)

1. What is the concept of work content? What are reasons for excess of work content?

2. Differentiate between Two hand process chart and Multiple Activity chart.

3. The following data refers to the study conducted for an operation. The table shows the actual time for elements in minutes.

Cycle elements	1	2	3	4	5
1	2.5	2.6	2.4	2.5	2.5
2	6.0	6.2	6.1	5.9	6.0
3	2.3	2.1	2.4	2.2	2.3
4	2.4	2.5	2.6	2.8	2.5

i) Element 3 is machine elements

ii)Take performance rating as 110

Take following personal allowance of 30 minutes in shift of 8 hours, fatigue allowance 15%, contingency allowance 2%. Estimate the standard time for the operation and production per 8 hour shift.

Course Outcome 3(CO3):

1. List the different types of layout. Differentiate between Product and process layout based any five parameters.

2. Consider the following assembly network relationships of a product. The number of shifts per day is two and the number of working hours per shift is 8. The company aims to produce 80 units of the product per day. Group the activities into work stations using Ranking Positional Weight method and compute balancing efficiency.

Operation Number	Immediate predecessor	Duration (Min)
1	-	7
2	1	2
3	1	2
4	1	5
5	2,3	8
6	3,4	3
7	5	4
8	5,6	7
9	4,6	9
10	7,8,9	8

3. The initial cost of an equipment is Rs 21000/- expected salvage value Rs 1000 and expected useful life of 10 years. Calculate the depreciation and book value after 1 year and 9 years using sinking fund method and straight line method. Take interest rate as 6%

Course Outcome 4 (CO4):

1. Explain the steps of Production planning Process,

2. Describe the importance Product Life cycle in Product development and Management.

3. A manufacturer has to supply his customer a 2400 units of his products per year. Shortages are not permitted. Inventory carrying cost amounts to Rs. 0.8/- per unit per annum. The setup cost per run is Rs 60/- . Find

i. EOQ
ii. Optimum number of order per annum
iii. Average annual inventory cost(min)
iv. Optimum period of supply per order

Course Outcome 5 (CO5):

1. Explain the Procedure of X and R chart .

2. The mortality rate are given in the table below for certain type of electric bulb. There are 2000 bulb in use and it costs Rs 12/- to replace an individual bulb that has burnt. If all the bulbs are replaced simultaneously, it would cost Rs. 4/- per bulb. It is proposed to replace all the bulbs in fixed intervals, whether or not they have burnt out and to continue replacing burnt bulbs out bulbs if they fail. At what intervals should all the bulbs be replaced?

Week	1	2	3	4	5	6
Probability of failure	0.05	0.2	0.25	0.3	0.15	0.05

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
SIXTH SEMESTER B.TECH DEGREE EXAMINATION
Course Code : **MRT352**

Course Name : **INDUSTRIAL ENGINEERING**

Max. Marks : 100 Duration : 3 Hours

Part A

(**ANSWER ALL QUESTIONS, EACH QUESTION CARRIES 3 MARKS**)

1. What are the factors influencing productivity?
2. Explain the role ergonomics plays in environmental man-machine interface
3. What is micro motion study? What are the steps involved?
4. Explain flow diagram with example
5. Explain REL Chart
6. Explain the criteria for selecting Material handling equipment
7. How order promising is done during Production planning
8. Briefly explain any three selective inventory control techniques
9. Explain the significance of Bathtub curve
10. Briefly explain the stages of TQM implementation

Part B

(ANSWER ONE FULL QUESTION FROM EACH MODULE)

Module 1

11. a) Explain the factors affecting make or buy decisions. (7marks)

b) ABC company plans to sell an article at local market. The articles are purchased at Rs 5 on the condition that all unsold items shall be returned. The rent for the space Rs 2000. The article will be sold at Rs 9 . Determine the number of articles which must be sold to i) to break even ii) to earn Rs 400 profit iii)if the company sells 750 articles . Calculate the margin of Safety (7 marks)

12. a) Explain the principles in the application of Anthropometric data. How it can be used in work place design? (8 marks)

b) Explain the functions of Industrial Engineering (6 Marks)

Module 2

13. a) Explain the use recording techniques in method study. Differentiate between Operations Process chart and Flow process chart. (7 Marks)

b) The observed time and the performance rating for five elements are given. Compute the standard time assuming rest and personal allowance as 15% and contingency as 2% of basic time.

Element	**1**	**2**	**3**	**4**	**5**
Observed time	0.2	0.08	0.50	0.12	0.10
Performance rating	85	80	90	85	80

(7 Marks)

14 a) Explain the different techniques used for work measurement. (7 Marks)

b) The following data refers to the study conducted for an operation. The table shows the actual time for elements in minutes.

Cycle elements	1	2	3	4	5
1	2.5	2.6	2.4	2.5	2.5
2	6.0	6.2	6.1	5.9	6.0
3	2.3	2.1	2.4	2.2	2.3
4	2.4	2.5	2.6	2.8	2.5

i) Element 3 is machine elements

ii)Take performance rating as 110

Take following personal allowance of 30 minutes in shift of 8 hours, fatigue allowance 15%, contingency allowance 2%. Estimate the standard time for the operation and production per 8 hour shift.

(7 Marks)

Module 3

15. a) Explain Systematic Layout planning with the help of block diagram. (6 Marks)

b) Consider the following assembly network relationship of a product. The number of shifts per day is two and the number of working hours per shift is 12. The company aims to produce 100 units of the product per day. Group the activities into work stations using Rank Positional Weight Method and compute balancing efficiency.

Operation number	Immediate preceding Tasks	Duration (Min)
1	-	7
2	1	2
3	1	2
4	1	5

5	2,3	8
6	3,4	3
7	5	4
8	5,6	7
9	4,6	9
10	7,8,9	8

(8 Marks)

16 a) The initial cost of an equipment is Rs 21000/- expected salvage value Rs 1000 and expected useful life of 10 years. Calculate the depreciation and book value after 1 year and 9 years using sinking fund method and straight line method. Take interest rate as 6%. (6 Marks)

b)The price of an office equipment is Rs 2.5 lakhs the salvage value at the end of 10 years is Rs 25,000/ Calculate the amortised value after 5 years by using i) sinking fund method ii) declining balance method. (8 Marks)

Module 4

17 a) What are the different types of Production system, explain (7 Marks)

b)Consider the following 3 machine and 5 jobs flow shop problem. Check whether Johnson's can be extended to this problem. What is the optimal schedule for this problem and corresponding makespan? Draw the Gantt chart.

Job	**Machine 1**	**Machine 2**	**Machine 3**
1	11	10	12
2	13	8	20
3	15	6	15
4	12	7	19
5	20	9	7

(7 Marks)

18 a) Explain the Product Life cycle and its importance in Product management. (7 Marks)

b) ABC industry needs 15,000 units/year of a bought out component which will be used in its main product. The ordering cost is Rs. 125 per order and holding cost per unit per year is 20% of the purchase price per unit which is Rs. 75.

i. Find economic order quantity
ii. Number of order per year
iii. Time between successive orders

The activities involved in ABC manufacturing company are listed below with their time estimates. Draw the network for the given activities and carry out critical path calculations.

(7 Marks)

Module 5

19 a) Differentiate between PERT and CPM, Specify the difference in application (6 Marks)

b) Consider the following data of the project

Activity	Predecessor	Duration (Weeks)		
		a	m	b
A	_	3	5	8
B	_	6	7	9
C	A	4	5	9
D	B	3	5	8
E	A	4	6	9
F	C,D	5	8	11
G	C,D,E	3	6	9
H	F	1	2	9

i. Construct the project network

ii. Find expected duration and variance of each activity

iii. What is the probability of completing the project in 30 weeks?

(8 Marks)

20 a) What is Process Capability? Explain the significance Process capability Index

(7 Marks)

b)The cost of a machine is Rs. 60,000/-. The salvage value and the running costs of a machine are shown in the table. Depreciation is cumulative. Find the most economical replacement age of the machine. (7 marks)

Year	**1**	**2**	**3**	**4**	**5**	**6**
Running cost in Rs.	12050	14100	16375	18875	20500	24550
Resale value in Rs	40000	30000	25000	15000	10500	7000

Syllabus

Module 1

Introduction to Industrial Engineering - Evolution of modern Concepts in Industrial Engineering - Functions of Industrial Engineering.
Production costs concepts – Manufacturing Vs Purchase- problems- Economic aspects- C-V-P analysis – simple problems.
Ergonomics Man-Machine Systems-Anthropometry Work place design and ergonomics - Value Engineering.

Module 2

Work study-procedure-concept of work content- techniques to reduce work content.
Method Study-steps-recording techniques-operation process chart-flow process chart-two hand process chart-multiple activity chart. Diagrams- Flow diagrams -String diagrams. Micro-motion study-SIMO chart-critical examination. Principle of motion economy.
Work measurement- techniques of work measurement - Time Study- - Steps in time study- calculation of standard time (problems)- allowances.

Module 3

Plant location, plant layout and material handling- Type of layouts–Tools and techniques for plant layout- travel chart – REL chart- Computer algorithms for layout design CRAFT-ALDEP (methods only)- Systematic layout planning -Line balancing–RPW (problem).
Principles of material handling- Unit load concept- Automated Material Handling Systems- AGVs.
Depreciation -Method of providing for depreciation- straight line method- Declining balance method- Sinking fund methods (Problems)

Module 4

Production Planning and control **-** Types of Production systems.
Demand forecasting- Forecasting methods, Gantt charts. Introduction and need for a new product-product life cycle. Inventory Control, Inventory models – Basic model -price discounts -problems – determination of safety stock - Selective inventory control techniques

Module 5

Quality control - Statistical quality control –causes of variation in quality- control charts for X and R. Process Capability- process capability index- Reliability-causes of failures- Bath tub curve. -System reliability. Introduction to concepts of, TQM, ISO, Six Sigma and Quality circles.
Project management- Critical Path Method, PERT. Determination of economic life -Replacement policy-- Methods of replacement analysis. (simple Problems)

Text Books

1. Martand Telsang, Industrial Engineering & Production Management, S. Chand, Third revised edition 2018.
2. B. Kumar, Industrial Engineering Khanna Publishers, Tenth Edition 2015

3. Thomas E Vollmann , William L Berry , D Clay Whybark, F Robert Jacobs, Manufacturing Planning and Control for Supply Chain Management, McGraw Hill Education (India) Private Limited, Fifth Edition 2017

4. M Mahajan, Industrial Engineering & Production Management, Dhanpat Rai, 2015

5. O. P. Khanna, Industrial Engineering and Management, Dhanpat Rai, 2018

Reference Books

1. E. S. Buffa, Modern Production management, John Wiley, 1983

2. Grant and Ieven Worth, Statistical Quality Control, McGraw Hill, 2000

3. Ralph M Barnes, Motion and Time Study, Wiley, 1980

4. Richard L. Francis, F. McGinnis Jr., John A. White, Facility Layout and Location: An Analytical Approach, 2nd Edition,1991

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	Introduction to Industrial Engineering - Evolution of modern Concepts in Industrial Engineering - Functions of Industrial Engineering. Production costs concepts – Manufacturing Vs Purchase- problems- Economic aspects- C-V-P analysis – simple problems. Ergonomics Man-Machine Systems-Anthropometry Work place design and ergonomics - Value Engineering	6-1-0
2	Work study-procedure-concept of work content- techniques to reduce work content. Method Study-steps-recording techniques-operation process chart-flow process chart-two hand process chart-multiple activity chart. Diagrams- Flow Diagrams-String diagrams. Micro-motion study-SIMO chart- critical examination. Principle of motion economy. Work measurement- techniques of work measurement - Time Study- - Steps in time study- calculation of standard time (problems)- allowances	6-1-0
3	Plant location, plant layout and material handling- Type of layouts–Tools and techniques for plant layout- travel chart – REL chart- Computer algorithms for layout design CRAFT-ALDEP (methods only)- Systematic layout planning -Line balancing–RPW (problem). Principles of material handling- Unit load concept- Automated Material Handling Systems- AGVs. Depreciation -Method of providing for depreciation- straight line method- Declining balance method- Sinking fund methods (Problems)	6-1-0
4	Production Planning and control- Types of Production systems. Demand forecasting- Forecasting methods, Gantt charts. Introduction and need for a new product-product life cycle. Inventory Control, Inventory models – Basic model -	6-1-0

	price discounts -problems – determination of safety stock - Selective inventory control techniques	
5	Quality control - Statistical quality control –causes of variation in quality- control charts for X and R. Process Capability- process capability index- Reliability-causes of failures-Bath tub curve.System reliability. Introduction to concepts of, TQM, ISO, Six Sigma and Quality circles. Project management- Critical Path Method, PERT. Determination of economic life -Replacement policy-- Methods of replacement analysis (Simple Problems).	6-1-0

MRT362	DESIGN FOR MANUFACTURING	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	4

Preamble:

General design principles for manufacturability- Factors Influencing form Design-Process capability-Design for castings-Design for welding-Design for machining-Design for the environment.

Prerequisite: Knowledge of Manufacturing Process, Machine tool technology

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

CO 1	Apply the knowledge of General design principles for manufacturability
CO 2	Identify Factors Influencing form Design, improve process capability and use Selective and Interchangeable assembly to simplify designs.
CO 3	Identify uneconomical design of casting and welding, Modify the design, and design better castings, welded joints and brazing and soldering joints.
CO 4	Simplify Design features to facilitate simplicity in different machining processes and apply design principles for machinability, assembly and disassembly.
CO 5	Apply the knowledge of Design for energy efficiency and less environmental impact.

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									
CO 2	3		3									
CO 3	2		2									
CO 4	2		3				2					
CO 5	3	2				2						

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1	**2**	
Remember	20	20	20
Understand	10	10	10
Apply	30	30	40
Analyse	20	20	20
Evaluate	10	10	10
Create	10	10	

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 Outcome 1 (CO1):

List out and explain the general design rules for manufacturability

Course Outcome 2 (CO2)

Discuss the rules for selective and interchangeable assembly

Course Outcome 3(CO3):

Discuss the general design considerations for casting process

Course Outcome 4 (CO4):

What are the design recommendations that you can suggest for machining
non- rotational parts?

Course Outcome 5 (CO5):

Discuss the design principles for energy efficiency

.

MODEL QUESTION PAPER

DESIGN FOR MANUFACTURING

Time: 3 hours **Max Marks: 100**

PART A

Answer all Questions 10 x 3= 30 Marks

1. Differentiate between DFM, DFA and DFMS.
2. What is the effect of blow hole in design for casting?
3. What is manufacturability?
4. List out general design for machining rules.
5. What are the good design practices for joining?
6. Explain the behaviour of cast iron during solidification.
7. List 3 design features to facilitate machining using drills.
8. List 3 Design rules for assembly.
9. What do you mean by Environmentally responsible product assessment?
10. What do you mean by Lifecycle assessment?

Part B - Answer any one full question from each module (14 X 5 = 70 marks)

Module 1

11 (a)List out and explain the general design rules for manufacturability **(7 marks)**
.

(b) Explain the selection of materials for economical production. **(7 marks)**

12 (a) Explain the order in which one should progress with a design. **(7 marks)**

(b) Discuss briefly the basic principles of designing for economical production. **(7 marks)**

Module 2

13(a) Discuss the factors Influencing form Design **(7 marks)**

(b) What are the design recommendations that you can suggest for machining non- rotational parts? **(7 marks)**

14 (a) Discuss the rules for selective and interchangeable assembly **(7 marks)**

(b). Explain Process capability analysis **(7 marks)**

Module-3

15(a) Discuss the general design considerations for casting process. **(7 marks)**

(b). Briefly explain the design guidelines for brazed joints. **(7marks)**

16 (a) Explain briefly the design rules for welding **(7 marks)**

(b). Why pre and post treatment of welds are done? Explain **(7 marks)**

.

Module-4

17 (a). Explain the concept of redesign of components for machining ease. **(7 marks)**

(b)**.**What are the general problems we come across while designing for machining operations? Explain how one can overcome those problems **(7 marks)**

18 (a) Design features to facilitate machining using milling cutters **(7 marks)**

(b). Discuss the rules for Design for clampability **.** **(7 marks)**

Module 5

19(a) List the Design principles to minimize material usage **(7 marks)**

(b) Discuss the design principles for energy efficiency **(7 marks)**

20(a) Explain Techniques to reduce environmental impact in design process **(7 marks)**

(b) Design for recyclability **(7 marks)**

Syllabus

Module 1

Engineering design: Concept – Kinds of design – Design process steps – Factors influencing design – Concurrent Engineering – Material selection process – Evaluation methods for material selection. General design principles for manufacturability: strength and mechanical factors, mechanisms selection, evaluation method.

Module 2

Factors Influencing form Design: Working principle, Material, Manufacture, Design- Possible solutions, Materials choice, Influence of materials on form design.

Process capability: Feature tolerances, Geometric tolerances, Assembly limits, Datum features, and Tolerance stacks. Process capability analysis – Centrality analysis – Compound assembly – Selective and Interchangeable assembly – Grouped Datum systems.

Module 3

Design for castings: Redesign of castings based on parting line considerations, Minimizing core requirements. Identification of uneconomical design.

Design for recommendation for welding process, Design recommendations for solder and brazed assembly, Design recommendations for adhesive joint

Module 4

Design for machining: Design features to facilitate machining using drills, milling cutters, keyways, Doweling procedures, Reduction of machined area, simplification by separation, simplification by amalgamation, Design for machinability, Design for economy, Design for accessibility, Design for assembly, Design for disassembly.

Module 5

Design for the Environment: Introduction, Basic DFE methods, Design guide lines, Example application, Lifecycle assessment, Basic method, Environmentally responsible product assessment, Weighted sum assessment method, Lifecycle assessment method, Techniques to reduce environmental impact, Design to minimize material usage, Design for recyclability, Design for remanufacture, Design for energy efficiency.

Text Books

Dieter, G.E., Engineering Design: A Materials and processing Approach, McGraw Hill Co. Ltd, 2000.

Boothroyd, G., Assembly, Automation and product design, CRC press, 2005.

Kevien Otto and Kristin Wood, Product Design. Pearson Publication, 2004.

Ulrich, K.T. and Eppinger, S.D., Product design and development, Tata McGraw Hill

James G. Bralla (1998) Design for Manufacturability Handbook, Second Edition, McGraw-Hill companies, New York, USA

Fixel, J., Design for the Environment McGraw Hill., 1996.

Reference books

Boothroyd, G, Heartz and Nike, Product Design for Manufacture, Marcel Dekker, 1994.

Dickson, John. R, and Corroda Poly, Engineering Design and Design for Manufacture and Structural Approach, Field Stone Publisher, USA, 1995.

Graedel T. Allen By. B, Design for the Environment Angle Wood Cliff, Prentice Hall. Reason Pub.1996.

Eggert, R.J., Engineering Design, Pearson Education, Inc. New Jersey, 2005.

KalandarSaheb, S.D and Prabhakar, O., Engineering Design for Manufacture, ISPE 1999.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Module I (7)**	
1.1	Engineering design: Concept – Kinds of design	1
1.2	Design process steps – Factors influencing design	1
1.3	Concurrent Engineering	1
1.4	Material selection process	1
1.5	Evaluation methods for material selection.	1
1.6	General design principles for manufacturability	1
1.7	strength and mechanical factors, mechanisms selection, evaluation method	1
2	**Module II (8)**	
2.1	Factors Influencing form Design	1
2.2	Working principle, Material, Manufacture	1
2.3	Design- Possible solutions, Materials choice	1
2.4	Influence of materials on form design	1
2.5	Process capability: Feature tolerances, Geometric tolerances	1
2.6	Assembly limits, Datum features, and Tolerance stacks.	1
2.7	Process capability analysis – Centrality analysis – Compound assembly	1
2.8	Selective and Interchangeable assembly – Grouped Datum systems	1
3	**Module III (6)**	
3.1	Design for castings: Redesign of castings based on parting line considerations	1
3.2	Minimizing core requirements, Identification of uneconomical design,	2
3.3	Design for recommendation for welding process	1
3.4	Design recommendations for solder and brazed assembly, Design recommendations for adhesive joint.	2

4	**Module IV(7)**	
4.1	Design for machining: Design features to facilitate machining using drills, milling cutters, keyways	1
4.2	Doweling procedures. Reduction of machined area,	1
4.3	simplification by separation, simplification by amalgamation	2
4.4	Design for machinability, Design for economy	1
4.5	Design for accessibility, Design for assembly	1
4.8	Design for disassembly	1
5	**Module V (7)**	
5.1	Design for the Environment: Introduction, Basic DFE methods, Design guide lines, Example application	2
5.2	Lifecycle assessment, Basic method, environmentally responsible product assessment	1
5.3	Weighted sum assessment method, Lifecycle assessment method,	2
5.4	Techniques to reduce environmental impact, Design to minimize material usage	1
5.5	Design for recyclability, Design for remanufacture, Design for energy efficiency.	1

MRT372	OPERATIONS RESEARCH	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble:

Introduction to linear programming problem, Simplex Method. Big M method-Two phase Method. Dual of Linear programming problems, Transportation problem:- North west corner method - Least cost Method - Vogel's Approximation Method. Assignment Problem, Queuing Theory-Sequencing-Project management technique:-Critical path method (CPM), Project evaluation and review technique (PERT), Game Teory-Simulation

Prerequisite: NIL

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

CO1	Solve different type of LPP
CO2	Apply the concept of O.R in real life problems
CO3	Solve different type of queuing and sequencing type problems
CO4	Understand design and analysis of algorithms in network techniques and project management.

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3			2	2			3					3
CO2	2	2	1					2							1
CO3	3	3	3	3							3				2
CO4	3	2	3							3					2

3- Strong Correlation, 2 – Moderate Correlation, 1 – Weak Correlation, Blank – No correlation

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1	**2**	
Remember	20	20	20
Understand	10	10	10
Apply	30	30	40
Analyse	20	20	20
Evaluate	10	10	10
Create	10	10	

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. Solve the following problem by Simplex method and comment on the result.
   Max. $Z=40x+60y$

   Subjected to the constraints

   $3x+3y \leq 36$
   $5x+2y \leq 60$
   $2x+6y \leq 60$
   $x, y \geq 0$

Course Outcome 2 (CO2)

1. A student has to select one elective in each semester and the same should not be selected in different semesters. The expected grade in each subject in different semester varies as given below. The grade points are S=10, A=9, B=8, C=7, D=6, E=5, F=4. Solve the Assignment problem.

	Elective 1	Elective 2	Elective 3	Elective 4
Sem 1	F	E	D	C
Sem 2	E	E	C	C
Sem 3	C	D	C	A
Sem 4	B	A	S	S

Course Outcome 3(CO3):

Arrivals at a telephone booth are considered to be Poisson with an average time of 10 minutes between one arrival and next. The length of the phone call is assumed to be distributed exponentially with mean three minutes i) What is the probability that a person arriving at booth will have to wait ii) What is the average length of the queue iii) The telephone department will install a second booth when convinced that an arrival would have to wait at least 3 minutes for the phone. By how much time must be the flow of arrivals be increased in order to justify for a second booth

Course Outcome 4 (CO4):

The following refers to a project network

Activity	A	B	C	D	E	F	G	H	I	J
Immediate Predecessor	-	A	A	A	A	E	D	G,F	C,H	B
Duration in days	1	4	2	3	2	3	2	1	3	2

i) Draw the network

ii) Find the total float, free float and independent float of each activity

iii) Determine the critical path and project completion time

MODEL QUESTION PAPER

MRT 372 OPERATIONS RESEARCH

Time: 3 hours **Max Marks: 100**

PART A

Answer all Questions 10x 3= 30 Marks

1. Write down the applications of OR with examples.
2. Explain the concept of duality as applied to LPP.
3. Discuss how an unbalanced assignment problem can be solved.
4. Explain the differences between transportation and assignment problems
5. Explain Kendall's Notation.
6. List the assumptions of sequencing problems.
7. Give the important differences between PERT and CPM.
8. Explain the terms: i) Critical activity ii) Total Float iii)Free Float
9. Mention the properties of a two-person zerosum game.
10. List the application areas of simulation

PART B

Answer any one question from each module (14x5=70 marks)

Module 1

11 . Solve the following problem by Simplex method and comment on the result. (14)

Max. Z=40x+60y, subjected to the constraints

$3x+3y \leq 36$, $5x+2y \leq 60$, $2x+6y \leq 60$ and $x, y \geq 0$

12. Use 2 Phase method to solve. Maximize Z= 5x-4y+3z Subject to $2x+y-6z=20$; $6x+5y+10z\leq 76$; $8x-3y+6z\leq 50$; $x, y, z\geq 0$ (14)

Module 2

13. Use the concept of Vogel's Approximation method and North west corner method to solve the following transportation problem and find the optimum distribution pattern and the optimum cost. (14)

	Warehouse 1	Warehouse 2	Warehouse 3	Warehouse 4	**Supply**
Plant A	10	22	10	20	**8**
Plant B	15	20	12	8	**13**
Plant C	20	12	10	15	**11**
Demand	**7**	**10**	**6**	**9**	

14. A student has to select one elective in each semester and the same should not be selected in different semesters. The expected grade in each subject in different semester varies as given below. The grade points are S=10, A=9, B=8, C=7, D=6, E=5, F=4. Solve the Assignment problem.

	Elective 1	Elective 2	Elective 3	Elective 4
Sem 1	F	E	D	C
Sem 2	E	E	C	C
Sem 3	C	D	C	A
Sem 4	B	A	S	S

(14)

Module-3

15. a) The time to repair electronic equipment is distributed exponentially with mean 30 minutes. The equipment arrives for repair at an average rate of ten per eight hour day. Determine the average time the repairman is idle in each day? What is the average number of items in the repair shop? (7)

b) Arrivals at a telephone booth are considered to be Poisson wth an average time of 10 minutes between one arrival and next. The length of the phone call is assumed to be distributed exponentially with mean three minutes i) What is the probability that a person arriving at booth will have to wait ii) What is the average length of the queue iii) The telephone department will install a second booth when convinced that an arrival would have to wait at least 3 minutes for the phone. By how much time must be the flow of arrivals be increased in order to justify for a second booth (7)

16.A machine operator has to perform three operations, turning, threading and knurling on a number of different jobs. The time required to perform these operations (in minutes) on each job is known. Find the order in which the jobs should be processed in order to minimize the total time. Find minimal elapsed time and idle time for each machine. (14)

Job	1	2	3	4	5	6
Turning	3	12	5	2	9	11
Threading	8	6	4	6	3	1
Knurling	13	14	9	12	8	13

Module-4

17. The following refers to a project network

Activity	A	B	C	D	E	F	G	H	I	J

Immediate Predecessor	-	A	A	A	A	E	D	G,F	C,H	B
Duration in days	1	4	2	3	2	3	2	1	3	2

i) Draw the network
ii) Find the total float, free float and independent float of each activity
iii) Determine the critical path and project completion time

(14)

18. Construct the PERT network-Determine the critical path. Find the project duration at 95 percent probability. What is the probability deviation of the project if the project is completed in i) 3 weeks earlier than the expected time ii) 3 weeks later than the expected time.

Activity	Optimistic Time ,a (Weeks)	Most Likely Time, m (Weeks)	Pessimistic Time, b (Weeks)
1-2	1	3	5
2-3	3	4.5	9
2-4	2	3	4
3-5	2	4	6
4-5	4	7	16
4-6	1	1.5	5
5-7	2.5	3.5	7.5
6-7	1	2	3
7-8	4	5	6
7-9	1.5	3	4.5
8-9	1	3.5	3

(14)

Module 5

19. a) Explain maximin and minimax principle applied to games (4)

b) Explain the terms 1) Saddle point 2) Value for a game (4)

c) Solve the following 2x2 game. (6)

$$A = \begin{bmatrix} 2 & -3 \\ -3 & 4 \end{bmatrix}$$

20. a) Explain the steps involved in the development of a simulation model
(6)

b) Mention the advantages and disadvantages of simulation (4)

c) Discuss any four advantages and disadvantages of using decision trees in

decision making situations. (4)

Syllabus

Module 1

Basics of operations research–OR models–applications. Linear programming-Problem Formulation-Graphical Method-Simplex Method-Big-M Method -Dual of Linear programming problems- Duality principle-Degeneracy

Module 2

Transportation problem – Balanced and Unbalanced transportation problems - Initial basic solution - North west corner method - Least cost Method - Vogel's Approximation Method - Test for optimality – Modi Method.

Assignment Problem-Formation-Optimal Solution -Hungarian Assignment Method. Travelling Salesman problem.

Module 3

Introduction to queuing theory–terminologies– Kendall's Notation -classification of queuing models-Single server problems.

Sequencing problem– terminology and notations – assumptions – – problems with *n* jobs through one machine - problems with *n* jobs through two machines -Problems with *n* jobs through m machines.

Module 4

Project management: Network analysis – basic terms – network construction – time analysis Critical path method (CPM) Programme evaluation and review technique (PERT)- Concepts and uses of PERT-Probability of completion Cost considerations in network analysis – crashing. Differences between PERT and CPM

Module 5

Game theory –Introduction-Classification of games – games with saddle points. Games without saddle points – 2 x 2 games

Simulation modeling (Basic concepts only), types of simulation – phases of simulation –applications– advantages and disadvantages. Decision theory – steps in decision theory approach – decision making conditions-Decision tree analysis (Description only)

Text Books

1. G Hadley, Linear programming, Narosa Publishing House, New Delhi, 2002
2. Kanti Swarup, P.K.Guptha, Man Mohan, Operations Research, Sultan Chand & Sons, New Delhi, 2010.
3. Taha.H.A, OperationResearch, Pearson, 2004

References:

1. Francis & White, Facility Layout & Location, Prentice Hall Inc., 1974
2. Hillier & Lieberman, Introduction to Operations Research, Holden Day Inc., 1996
3. R Panneerselvam, Operation Research. PHI, 2006
4. Samuel Eilon, Elements of Production Planning & Control, Universal Book, 1991. Corporation
5. D.S.Hira, Operations Research, S Chand,2014

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Module I**	
1.1	Basics of operations research–OR models–applications	1
1.2	Linear programming-Problem Formulation	1
1.3	Graphical Method-	1
1.4	Simplex Method-	2
1.5	Big-M Method -	1
1.6	Dual of Linear programming problems- Duality principle-Degeneracy	1
2	**Module II**	
2.1	Transportation problem – Balanced and Unbalanced transportation problems	1
2.2	Initial basic solution - North west corner method - Least cost Method	2
2.3	Vogel's Approximation Method -	1
2.4	Test for optimality – Modi Method	1
2.5	Assignment Problem-Formation-Optimal Solution -Hungarian Assignment Method	1
2.6	Travelling Salesman problem	1
3	**Module III**	
3.1	Introduction to queuing theory–terminologies- Kendall's Notation	1

3.2	Classification of queuing models-Single server problems (Derivations not required).	2
3.3	Sequencing problem– terminology and notations – assumptions	1
3.4	Problems with *n* jobs through 1 machine -	1
3.5	Problems with *n* jobs through two machines	1
3.6	Problems with *n* jobs through m machines	1
4	**Module IV**	
4.1	Project management: Network analysis – basic terms – network construction – time analysis	2
4.2	Critical path method (CPM)	1
4.3	Programme evaluation and review technique (PERT)- Concepts and uses of PERT-Probability of completion	2
4.4	Cost considerations in network analysis – crashing.	1
4.5	Differences between PERT and CPM	1
5	**Module V**	
5.1	Game theory – games with saddle points.	2
5.2	Games without saddle points – 2 x 2 games	1
5.3	Simulation modeling (Basic concepts only),	1
5.4	Types of simulation – phases of simulation – Applications– advantages and disadvantages	1
5.5	Decision theory – steps in decision theory approach –	1
5.6	Decision making conditions-Decision Tree Analysis	1

SEMESTER VI

MINOR

MRT382	INTRODUCTION TO ROBOTICS & AUTOMATION	CATEGORY	L	T	P	CREDIT
		VAC	3	1	0	4

Preamble: This course aims at imparting knowledge about the robotics as well as automation. This will include basics of robots, sensors, kinematics as well as control and industrial automation.

Prerequisite: NIL

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

CO 1	Understand the robot actuators and controls
CO 2	Get knowledge on robot sensors for robotic application
CO 3	Understand the kinematics of robots and adaptive control
CO 4	Understand the basics of Programming Logic Circuits
CO 5	Acquire proficiency in programming Programmable Logic Circuits

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								
CO 2	3	2	2	2								2
CO 3	3	3										
CO 4	3	3	2	2								2
CO 5	3	2										2

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. How do you classify robotic structures?
2. Define roll, pitch and yaw.
3. Which are the drives used in Robotics?

Course Outcome 2 (CO2):

1. What is the necessity of sensors in robotics?
2. Why is machine vision a superior sensor in robotics?
3. Mention few sensors used in robotics.

Course Outcome 3 (CO3):

1. What do you mean by forward kinematics?
2. Explain the inverse kinematics of robots.
3. What is the advantage of adaptive control structures?

Course Outcome 4 (CO4):

1. What is a PLC?
2. What is a ladder program? What are its components?
3. Explain the architecture of PLC.

Course Outcome 5 (CO5):

1. What are the advantages and capabilities of a PLC
2. Explain a PLC based system for automation
3. Explain alarms an interlocks.

Model Question paper

QP CODE:

Reg. No: ____________________

Name: ______________________

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

COURSE CODE: MRT 382 **Duration: 3 hours**

ROBOTICS & AUTOMATION

Mechatronics Branch

PART A

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

1. What are the advantages of PLC over electromechanical relay control? (3 marks)
2. With suitable example explain latching in PLC Ladder logic? (3 mark)
3. What is the scope of industrial automation? (3 mark)
4. What are the applications of Motion Actuators? (3 mark)
5. Differentiate between a serial and parallel robot (3 marks)
6. Write a short note on encoders. (3 marks)
7. Write a short note on Force-Torque sensors. (3 marks)
8. Draw and explain the components and structure of robotic arm? (3 marks)
9. When will hydraulic drive be preferred in robot? (3 marks)
10. Explain the common kinematic arrangements of robots based on various coordinate System? (3 marks)

PART B

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

Module 1

11. Explain different types of stepper motor (14 marks)
12. With illustrations, explain the basic robotic configurations. (14 marks)

Module 2

13 Explain different types of robot End effectors?(14 marks)

14 Illustrate the working principle of various position sensors used in a robotic system? (14 marks)

Module 3

15 Explain the structure of robot programming language (14 marks)

16 Explain about joint angle, joint distance, link length and link twist with the help of

D-H representation. (14 marks)

Module 4

17 (a) Illustrate the architecture of PLC? (8 marks)
(b)What are the different types of PLC? (6 marks)

18 What are the advantages and capabilities of a PLC? (14 marks)

Module 5

19 Explain a PLC based system for automation. Explain its ladder diagram. (14 marks)

20 (a) Explain the requirement of communication system in a PLC? (4 marks)
(b) Illustrate the importance of Alarms and Interlocks in a PLC program? (10 marks)

SYLLABUS

Module 1 (9 Marks)

Robotics –Introduction –Basic Structure-Classification of Robot and Robotic System-Law of Robotics-Robot Motion-Wrist Configuration-Motion – Roll –Pitch-Yaw-Drives-Hydraulic Motors-DC Motor-Stepper Motor-Power Transmission Systems

Module 2 (9 Marks)

Sensors in Robotics: Position Sensor-Potentiometer-Encoders-LVDT-Velocity Sensor-Acceleration Sensor-Force-Pressure and Torque Sensor-Touch and Tactile Sensor-Proximity –Range and Sniff Sensor-Robot End Effectors-Types of End Effectors- Mechanical Gripper –Types of Gripper Mechanism

Module 3 (11 Marks)

Position Orientation-Frames-Mapping-Changing Description from Frames to Frames. Transformation arithmetic's -Translation-rotation-transformation- transforms equations- transformation of the vectors-.Introduction to manipulations Forward Kinematics and inverse Kinematics- D-H representation-Method of Robotic Programming (Qualitative Treatment Only).

Module 4 (7 Marks)

Basics of PLC-Advantage- Capabilities of PLC-Architecture of PLC- Scan Cycle-Types of PLC-Types of I/O modules-Configuring of PLC –PLC wiring

Module 5 (9 Marks)

Simple process control programme using ladder logic- PLC arithmetic functions- Timer and Counters-Data transfer-comparison and manipulation instructions-Interlocks and Alarms-Requirement of communication networks in PLC –connecting PLC to computer.

Text Books

1. M.P Groover, Industrial Robotics-Technology, Programming and Applications, McGraw-Hill USA, 1986
2. John Craig, "Introduction to Robotics",Macmillan, 1985
3. Curtis Johnson Process Control Instrumentation Tech 8 TH Edition Prentice Hall June 2005
4. Petrezeulla, Programmable Controllers, McGraw Hills, 1989

Reference Books

1. D Roy Choudhury and shaail B. jain, Linear Integrated circuits New age international Pvt.Ltd 2003
2. Boltans w. "Mechatronics" Pearson Education , 2009

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Robotics: Introduction**	
1.1	Basic Structure- Law of Robotics	1
1.2	Classification of Robot and Robotic System	1
1.3	Robot Motion	1
1.4	Wrist Configuration-Motion – Roll –Pitch-Yaw	1
1.5	Drives-Hydraulic Motors	1
1.6	DC Motor	1
1.7	Stepper Motor	1
1.8	Power Transmission Systems	2
2	**Sensors in Robotics**	
2.1	Position Sensor-Potentiometer-Encoders-LVDT-	1
2.2	Velocity Sensor	1
2.3	Acceleration Sensor	1
2.4	Force-Pressure and Torque Sensor	1
2.5	Touch and Tactile Sensor	1
2.6	Proximity –Range and Sniff Sensor	1
2.7	Robot End Effectors	1
2.8	Types of End Effectors	1
2.9	Mechanical Gripper –Types of Gripper Mechanism	1
3	**Robotics Kinematics**	
3.1	Description-Position	1
3.2	Orientation-Frames- Mapping	1
3.3	Changing Description from Frames to Frames.	1
3.4	Translation-rotation-transformation	1
3.5	Transformation arithmetic's- transforms equations	1
3.6	transformation of the vectors	1
3.7	Introduction to manipulations Forward Kinematics and inverse Kinematics	1
3.8	D-H representation	2
3.9	Method of Robotic Programming (Qualitative Treatment Only).	2

4	**Basics of PLC**	
4.1	Advantage of PLC	1
4.2	Architecture of PLC	2
4.3	Scan Cycle-Types of PLC	1
4.4	Types of I/O modules	1
4.5	Configuring of PLC	1
4.6	PLC wiring	1
5	**PLC programming**	
5.1	Simple process control programme using ladder logic	1
5.2	PLC arithmetic functions- Timer and Counters	2
5.3	Data transfer	1
5.4	comparison and manipulation instructions	1
5.5	Interlocks and Alarms	2
5.6	Requirement of communication networks in PLC	1
5.7	connecting PLC to computer	1

MRT384	ADVANCED AUTOMATION SYSTEMS	CATEGORY	L	T	P	CREDIT
		VAC	3	1	0	4

Preamble:

To make students familiar with automation and control technologies in modern manufacturing

To provide knowledge on the elements of modern manufacturing systems

Examine the mechanisms of CMM and FMS

To determine the modern application of automation systems in manufacturing industry

Prerequisite: Nil

Course Outcomes - At the end of the course students will be able to

CO1: Understand the principles of automation systems and to determine the relationship between product and production.

CO2: Analyze the different elements of automation system and to find the importance of control systems in automation.

CO3: Classify the manufacturing systems and what are the components of manufacturing systems.

CO4: Define Group technology and understand about CMM

CO5: Explain about Machine vision in manufacturing system and FMS

Mapping of course outcomes with program outcomes (Minimum requirements)

	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	-	-	-	-	-	-	-	-		-	-
CO 2	2	-	2	-	-	-	-	-	-	-	-	-
CO 3	2	-	-	-	-	-	-	-	-	-	-	-
CO 4	2	-	2	-	-	-	-	-	-	-	-	-
CO 5	3	-	-	2	-	-	-	-	-	-	-	-

ASSESSMENT PATTERN

Bloom's taxonomy	Continuous Assessment Tests		End Semester Examination (Marks)
	Test 1 (Marks)	Test 11 (Marks)	
Remember	25	25	25
Understand	15	15	45
Apply	10	10	30
Analyze			
Evaluate			
Create			

Mark distribution

Total Marks	CIE marks	ESE marks	ESE duration
150	50	100	3 Hours

Continuous Internal Evaluation (CIE) Pattern:

Attendance	10 marks
Regular class work/tutorials/assignments	15 marks
Continuous Assessment Test(Minimum 2 numbers)	25 marks

End semester 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):

1. Explain different types of production system facilities?
2. What do you mean by USA principle?
3. Describe product/production relationship with an example?
4. Manual labor is unavoidable in manufacturing? Justify
5. What are the limitation and capabilities of manufacturing plant?

Course Outcome 2 (CO2):

1. Describe about advanced automation function in manufacturing system
2. What are the elements of automated systems?
3. Explain about different types of control systems in manufacturing system?
4. Define levels of automation? Explain in detail?

Course Outcome 3 (CO3)

1. What are the components of manufacturing system?
2. Explain about learning curve?
3. How we can classify manufacturing systems?

Course Outcome 4 (CO4):

1. Define group technology? Explain how it's done?
2. Explain about contact and non-contact inspection techniques?
3. With neat sketch explain about CMM construction? Explain its application?

Course Outcome 5 (CO5):

1. With neat sketch explain in detail about machine vision? Explain its importance in manufacturing system?
2. What is meant by FMS? Explain its components and application?
3. Differentiate between lean and agile manufacturing?

SYLLABUS

MODULE – 1 (9 Hours)

Production system facilities-Manufacturing support systems-Automation in production systems-manual labor in production systems-automaton principles and strategies-USA principle-ten strategies of Automation and Production Systems-Automation Migration strategy-manufacturing industries and products-manufacturing operations-processing and assembly operations-product /production relationships- production quantity and product variety-limitations and capabilities of a manufacturing plant

MODULE – II (9 Hours)

Elements of an automated system- power to accomplish the Automated process-program of Instructions- control systems-advanced automation functions-safety monitoring-maintenance and repair diagnostics- Error detection and Recovery-levels of automation, variables and parameters in process industries and discrete manufacturing industries-continuous and discrete control systems-computer process control- control requirements-capabilities of computer control and levels of industrial process control-computer process monitoring-direct digital control-numerical control and robotics-PLC

MODULE – III (9 Hours)

Components of a manufacturing system-production machines-material handling system-computer control system-human resources-classification of manufacturing systems-types of operations performed-number of work stations-automation levels-part or product variety-Type I type II and type III manufacturing systems-manufacturing progress functions-learning curves

MODULE – IV (9 Hours)

Part families-parts classification and coding-features and examples of part classification and coding systems-production flow analysis-cellular manufacturing-application of group technology. Inspection metrology-contact and non-contact inspection techniques-conventional measuring and gauging techniques-coordinate measuring machines-CMM construction-CMM operation and planning-CMM softwares-CMM applications and benefits.

MODULE – V(9 Hours)

Machine vision-image acquisition and digitizing-image processing, digitizing analysis and interpretation- machine vision applications. Flexible manufacturing systems-types of FMS-FMS components-workstations-material handling and storage systems-computer control systems-human resources-FMS applications and benefits-FMS planning and implementation issues-FMS planning and design issues-FMS operational issues. Comparison of lean and agile manufacturing.

Text Books

1. Mikell P Groover, Automation, Production Systems and Computer –Integrated Manufacturing, PearsonEducation

Reference

1. Groover , Automation , Production systems and CIM , Prentice Hall ofIndia
2. Radhakrishnan, P Subramanian S,CAD/CAM and CIM ,WileyEastern
3. HMT Mechatronics, TATA Mc GrawHill

MODEL QUESTION PAPER

ADVANCED AUTOMATION SYSTEMS – MRT384

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

Part – A

Answer all questions.

Answer all questions, each question carries 3 marks

1. Explain the ten strategies of automation systems?
2. What are the limitation and capabilities of manufacturing plant?
3. Explain how safety monitoring is done in manufacturing systems?
4. Differentiate between continuous and discrete control systems?
5. Describe about the objectives of material handling systems?
6. Classify FMS workstations and give its feature?
7. List down the advantages of cellular manufacturing?
8. Differentiate between contact and non-contact inspection technique with the help of examples?
9. What are the applications of machine vision?
10. Explain material handling system?

PART -B

Answer one full question from each module.

MODULE – 1

11. **a.** Write short note on manual labor in production system? (4 marks)

b. Explain in detail about the ten strategies of automation systems? (10 marks)

OR

12. a. Explain about automation migration strategy? (5 marks).

b. Discuss the factors that are determining how the products are being manufactured? (9 marks)

MODULE – 2

13. **a**. Write short note on error detection and recovery in an automated system? (8 marks).

b. Differentiate between different modes of control systems with the help of diagrams? (6 marks).

OR

14. a. Explain in detail about the elements of an automated systems? (10 marks).

b. Explain why advanced automation functions are implemented in manufacturing systems? (4 marks)

MODULE – 3

15. What are the components of manufacturing systems? Explain the role of human resources in manufacturing systems? (14 marks)

OR

16. a. Briefly explain classification of manufacturing systems? (8marks).

b. Define learning curves? Explain its importance in manufacturing systems? (6marks)

MODULE – 4

17. a. Explain group technology? List the application of group technology? (10marks).

b. List any four CMM softwares? (4marks)

OR

18. a. Define CMM? (4 marks).

b. Describe about six types of mechanical structure of CMM? (

MODULE – 5

19. a Describe about image acquisition and digitalization, image processing and analysis and interpretation (10 marks)

b. Explain the importance of machine vision in manufacturing? (4 marks).

OR

20. a. Define FMS (5marks).

b. Describe about the types of flexible manufacturing systems and mentioned its features(10 marks)

COURSE CONTENT AND LECTURE SCHEDULES.

Module	TOPIC	No. of hours	Course outcomes
1.1	Production system facilities-Manufacturing support systems-Automation in production systems	2	CO1
1.2	Manual labor in production systems-automaton principles and strategies-USA principle-ten strategies of Automation and Production Systems.	2	CO1
1.3	Automation Migration strategy-manufacturing industries and products	1	CO1
1.4	manufacturing operations-processing and assembly operations	1	CO1
1.5	product /production relationships-production quantity and product variety	2	CO1 C
CO1CC 1.6	Limitations and capabilities of manufacturing plant	1	CO1
2.1	Elements of an automated system- power to accomplish the Automated process-program of Instructions-control systems	1	CO2
2.2	advanced automation functions-safety monitoring-maintenance and repair diagnostics-Error detection and Recovery	2	
2.3	levels of automation, variables and parameters in process industries and discrete manufacturing industries	1	CO2
2.4	continuous and discrete control systems-computer process control-control requirements	1 1	
2.5	capabilities of computer control and levels of industrial process control- computer process monitoring-direct digital control	2	CO2
2.6	direct digital control-numerical control and robotics-PLC	2	

3.1	Components of a manufacturing system-production machines-material handling system-computer control system-human resources	2	CO3
3.2	classification of manufacturing systems-types of operations performed-number of work stations	3	
3.3	automation levels-part or product variety-Type I type II and type III manufacturing systems	2	CO3
3.4	manufacturing progress functions-learning curves	2	
4.1	Part families-parts classification and coding-features and examples of part classification and coding systems	3	CO4
4.2	production flow analysis-cellular manufacturing-application of group technology	1	CO4
4.3	Inspection metrology-contact and non-contact inspection techniques-conventional measuring and gauging techniques	2	CO4
4.4	Coordinate measuring machines-CMM construction-CMM operation and planning-CMM softwares-CMM applications and benefits.	3	CO4
5.1	Machine vision-image acquisition and digitizing-image processing, digitizing analysis and interpretation- machine vision applications	3	CO5
5.2	Flexible manufacturing systems-types of FMS-FMS components-workstations	1	CO5
5.3	material handling and storage systems-computer control systems-human resources-FMS applications and benefits	2	CO5
5.4	FMS planning and implementation issues-FMS planning and design issues- FMS operational issues	2	CO5
5.5	Comparison of lean and agile manufacturing.	1	CO5

SEMESTER VI

HONOURS

MRT394	ARTIFICIAL INTELLIGENCE & EXPERT SYSTEM IN AUTOMATION	CATEGORY	L	T	P	CREDIT
		VAC	3	1	0	4

Preamble:

Artificial intelligence (AI) refers to the simulation of human intelligence in machines that are programmed to think like humans and mimic their actions. Expert systems in Artificial Intelligence are a prominent domain for research in AI. The main purpose of offering this course is to elaborate the theoretical and practical aspects of Artificial intelligence (AI)& expert system in day to day life.

Prerequisite: Nil

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

CO 1	Get an exposure to the basics of Artificial intelligence
CO 2	Understand the concepts of Searching algorithms
CO 3	Interpret about Prediction logic
CO 4	Identify various learning methods of AI
CO 5	Acquire knowledge on expert 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	3		2	2	3							3
CO 2	3		2	2	3							3
CO 3	3		2	2	3							3
CO 4	3		2	2	3							3
CO 5	3		2	2	3							3

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. What are the various AI techniques?
2. Compare Supervised and Unsupervised learning
3. Explain various Mathematical foundations of machine learning.

Course Outcome 2 (CO2)

1. Distinguish between breadth first search & depth first search.
2. Explain about A* & AO* Algorithms
3. Write a short note on Alpha-Beta pruning.

Course Outcome 3(CO3):

1. What are the various knowledge representation issues
2. Write a short note on Baye’s probabilistic interferences.
3. Define Dempster-Shafer theory

Course Outcome 4 (CO4):

1. Discuss about Inference in first order logic.
2. Explain about Statistical Learning methods.
3. Briefly explain about Reinforcement Learning.

Course Outcome 5 (CO5):

1. Explain the structure of expert systems.

2. How can we select an appropriate knowledge acquisition method?
3. Explain how expert system works.

Model Question paper

Course Code: MRT 394

Course Name: ARTIFICIAL INTELLIGENCE & EXPERT SYSTEM IN AUTOMATION

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

PART A

Answer all Questions. Each question carries 3 Marks

1. Write a short note on various AI techniques.
2. Distinguish between Supervised and Unsupervised learning.
3. Give a brief description about uniformed search strategies.
4. What do you meant by Alpha-Beta pruning.
5. What are the various knowledge representation issues?
6. Define Dempster-Shafer theory.
7. Summarize about first order logic.
8. What do you meant by forward chaining?
9. Explain the basic concept of expert systems.
10. List out the problem areas addressed by expert systems.

PART B

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

Module 1

11. Explain about Regression and its classification
12. Differentiate between Supervised and Unsupervised learning.

Module 2

13. Explain about Breadth first search & depth first Search algorithms.
14. Explain about A* & AO* Algorithms.

Module 3

15. How can werepresent knowledge using rules and explain rules based deduction systems.
16. Describe in detail aboutBaye’s probabilistic interferences.

Module 4

17. Explain in detail about Reinforcement Learning.

18. Identify the various Statistical Learning methods. Explain in detail.

Module 5

19. Explain aboutscope of knowledge and difficulties in knowledge acquisition methods.

20. Distinguish between model based reasoning & case based reasoning.

Syllabus

Module 1 (9 Hours)

Defining Artificial Intelligence, Defining AI techniques, Using Predicate Logic and Representing Knowledge as Rules, Representing simple facts in logic, Computable functions and predicates, Procedural vs Declarative knowledge, Logic Programming, Mathematical foundations: Matrix Theory and Statistics for Machine Learning, Idea of Machines learning from data, Classification of problem – Regression and Classification, Supervised and Unsupervised learning

Module 2(9 Hours)

Searching- Searching for solutions, uniformed search strategies – Breadth first search, depth first Search. Search with partial information (Heuristic search) Hill climbing, A* ,AO* Algorithms, Problem reduction, Game Playing-Adversial search, Games, mini-max algorithm, optimal decisions in multiplayer games, Problem in Game playing, Alpha-Beta pruning, Evaluation functions.

Module 3 (9 Hours)

Knowledge representation issues, predicate logic- logic programming, semantic nets- frames and inheritance, constraint propagation, representing knowledge using rules, rules based deduction systems. Reasoning under uncertainty, review of probability, Baye's probabilistic interferences and Dempster-Shafer theory.

Module 4 (9 Hours)

First order logic. Inference in first order logic, propositional vs. first order inference, unification & lifts forward chaining, Backward chaining, Resolution, Learning from observation Inductive learning, decision trees, Explanation based learning, Statistical Learning methods, Reinforcement Learning.

Module 5 (9 Hours)

Expert systems:- Introduction, basic concepts, structure of expert systems, the human element in expert systems how expert systems works, problem areas addressed by expert systems, expert systems success factors, types of expert systems, expert systems and the internet interacts web, knowledge engineering, scope of knowledge, difficulties, in knowledge acquisition methods of knowledge acquisition, machine learning, intelligent agents, selecting an appropriate knowledge acquisition method, societal impacts reasoning in artificial intelligence, inference with rules, with frames: model based reasoning, case based reasoning, explanation & meta knowledge inference with uncertainty representing uncertainty.

Test book:

1. S. Russel and P. Norvig, "Artificial Intelligence – A Modern Approach", Second Edition, Pearson Education
2. Anindita Das Bhattacharjee, "Practical Workbook Artificial Intelligence and Soft Computing for beginners, Shroff Publisher-X team Publisher.
3. Saroj Kaushik, Artificial Intelligence, Cengage Learning, 1st Edition 2011

Reference Books:-

1. David Poole, Alan Mackworth, Randy Goebel, "Computational Intelligence : a logical approach", Oxford University Press.
2. G. Luger, "Artificial Intelligence: Structures and Strategies for complex problem-solving", Fourth Edition, Pearson Education.
3. J. Nilsson, "Artificial Intelligence: A new Synthesis", Elsevier Publishers.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Introduction to Artificial intelligence**	
1.1	Defining Artificial Intelligence, Defining AI techniques	1
1.2	Using Predicate Logic and Representing Knowledge as Rules, Representing simple facts in logic	1
1.3	Computable functions and predicates, Procedural vs Declarative knowledge, Logic Programming	2
1.4	Mathematical foundations: Matrix Theory and Statistics for Machine Learning	2
1.5	Idea of Machines learning from data	1
1.6	Classification of problem –Regression and its classification	1
1.7	Supervised and Unsupervised learning	1
2	**Searching algorithms**	
2.1	Searching for solutions	1
2.2	Uniformed search strategies – Breadth first search, depth first Search	2
2.3	Search with partial information (Heuristic search) Hill climbing	1
2.4	A* ,AO* Algorithms, Problem reduction	2
2.5	Game Playing-Adversial search, Games, mini-max algorithm	1
2.6	Optimal decisions in multiplayer games	1
2.7	Problem in Game playing, Alpha-Beta pruning, Evaluation functions	1
3	**Prediction logic**	
3.1	Knowledge representation issues, predicate logic	1
3.2	Logic programming, semantic nets	1
3.3	Frames and inheritance, constraint propagation	1
3.4	Representing knowledge using rules, rules based deduction systems	2
3.5	Reasoning under uncertainty	1
3.6	Review of probability	1
3.7	Baye's probabilistic interferences and Dempster-Shafer theory.	2
4	Learning methods of AI	
4.1	First order logic. Inference in first order logic, propositional vs first order inference,	2
4.2	Unification & lifts, forward chaining, Backward chaining	2
4.3	Resolution, Learning from observation Inductive learning, decision	3

	trees, Explanation based learning	
4.4	Statistical Learning methods, Reinforcement Learning	2
5	**Expert systems**	
5.1	Expert systems:- Introduction, basic concepts, structure of expert systems, the human element in expert systems	1
5.2	How expert systems works, problem areas addressed by expert systems, expert systems success factors	2
5.3	Types of expert systems, expert systems and the internet interacts web	1
5.4	Knowledge engineering, scope of knowledge, difficulties, in knowledge acquisition methods of knowledge acquisition	2
5.5	Machine learning, intelligent agents, selecting an appropriate knowledge acquisition method, societal impacts, reasoning in artificial intelligence	1
5.6	Inference with rules, with frames: model based reasoning, case based reasoning	1
5.7	Explanation & meta knowledge inference with uncertainty representing uncertainty	1

MRT 396	ADVANCED COMPUTER CONCEPT FOR AUTOMATION	CATEGORY	L	T	P	CREDIT
		VAC	3	1	0	4

Preamble: Introduction of automated machines into production systems helped them to achieve improved efficiency and productivity. Computer controlled systems and automated machines took over manual production systems and became common in almost all types of production systems. Hence it is a necessity to learn about automated systems and application of computers in automation.

Prerequisite: Basic knowledge about computers and programming languages

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

CO 1	Understand the principles and types of automated production systems
CO 2	Learn about object-oriented concepts of programming language
CO 3	Acquire the knowledge of object-oriented programming and JAVA and their application in automation
CO 4	Understand principles and designing of database management system
CO 5	Develop awareness about basic operating system principles and 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	**3**	2	2						2			
CO 2	**3**	2	2						2			
CO 3	**3**	2	2						2			
CO 4	**3**	2	2						2			
CO 5	**3**	2	2						2			

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. What is the function of a display adaptor?
2. What are the different types of Automations?
3. Explain about – Open loop and Closed group systems?

Course Outcome 2 (CO2)

1. What is the use of creating an Object?
2. Compare procedural and object oriented approach.
3. Explain a brief on OOPS concepts.

Course Outcome 3(CO3):

1. Explain C++ input and output concepts?
2. Explain the working of exception handling in C++.
3. Discuss the application of oops in automation.

Course Outcome 4 (CO4):

1. Enlist and explain characteristic Features of Database Management Systems?
2. Briefly explain about the Relational Database system.
3. Compare File System and Database Management System-.

Course Outcome 5 (CO5):

1. Write a short note on the components of an operating system
2. Compare Distributed system and Real Time systems.
3. Write short notes on the following: i) FTP ii) TCP/IP

Model Question paper

Course Code: MRT 236

Course Name: ADVANCED COMPUTER COMMUNICATION SYSTEM FOR AUTOMATION

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

PARTA

Answer all Questions. Each question carries 3 Marks

3. What is the function of a display adaptor?
4. What are the different types of Automations?
5. What is the use of creating an Object?
6. What do you mean modularity in terms of OOPS?
7. What are the functions of JVM?
8. Define the term template.
9. What do you mean by a Data Warehouse?
10. Explain how authorisation helps in providing security for a database?
11. Define Time sharing system.
12. Write a short note on the components of an operating system.

PART B

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

Module 1

13. Explain about – Open loop and Closed group systems
14. Differentiate VGA and XGA.

Module 2

15. Compare procedural and object oriented approach.
16. Explain a brief on OOPS concepts.

Module 3

17. Explain the working of exception handling in C++.
18. Discuss the OOPS features that makes JAVA a purely object-oriented language.

Module 4

19. Compare File System and Database Management System-.

20. Explain briefly about the Relational Database system.

Module 5

21. Compare Distributed system and Real Time systems.

22. Write short notes on the following: i) FTP ii) TCP/IP

Syllabus

Module 1 (9 Hours)

Introduction to computer Automation-Elements of Automation and Types of Automation-Importance of Computers in Automation-Computer Networks and Topology Types. Computer Graphics-Display Adapters-Video Display Modes.

Module 2 (9 Hours)

Object Oriented Programming Introduction: Necessity of Object-Oriented Programming-Procedural Language and Object Oriented Approach-Characteristics of Object Oriented Languages. OOP's Concepts: Objects, Classes, Inheritance, Overloading, Virtual Functions, and Polymorphism.

Module 3 (9 Hours)

OOP's features for Automation: Templates and Exceptions-C++ Input and output concepts,-OOPSfor Automation. Introduction to JAVA -Features of JAVA-OOPS through JAVA

Module 4 (9 Hours)

Database Management System Introduction: Comparison of File System-Database Management System-Characteristic Features of Database Management Systems. Database Design: Relational Database- Logical Database Design-Data Base Models-DBMS Languages and Interfaces. Data Base Security and Authorization. Data Ware House

Module 5 (9 Hours)

Operating Systems and Protocols: Basic Concepts of batch Systems-Multi Programming, Time Sharing-Distributed and Real Time Systems. Operating System Structures: Operating System Components and Services & brief discussion about protocols-FTP, TCP/IP & HTTP.

Text Books

1. Object Oriented Programming with C++ - E. Balaguruswamy, TMH
2. C++ Programming-BjarneStroustrup, Addison Wesley.
3. Operating System Concepts – Silberschatz, Galvin, Gagne, Sixth edition, John Wiley.

Reference Books

1. Fundamentals of DBMS – RamezElmasri and Navathe, Addison Wesley.

2. Computer Graphics, C version – Donald Hearn, M. Pauline Baker, Pearson Education.
3. Object Oriented Programming with C++ - Robert Lafore, PHI
4. Operating Systems-A concept based approach”, D M Dhamdhere, TMH
5. Internet Working with TCP/IP – Douglas, PHI 9. Introduction to DBMS – Date C.J. Addison Wesley

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	Introduction to computer Automation-	
1.1	Elements of Automation	1
1.2	Types of Automation	1
1.3	Importance of Computers in Automation	1
1.4	Computer Networks	1
1.5	Topology Types	2
1.6	Computer Graphics	2
1.7	Display Adapters and Video Display Modes	1
2	**Object Oriented Programming Introduction**	
2.1	Necessity of Object Oriented Programming	1
2.2	Procedural Language and Object Oriented Approach	2
2.3	Characteristics of Object Oriented Languages	1
2.4	OOP’s Concepts: Objects, Classes	1
2.5	Inheritance, Overloading	2
2.6	Virtual Functions	1
2.7	Polymorphism	1
3	**OOP’s features for Automation**	
3.1	Templates and Exceptions	1
3.2	C++ Input and output concepts	2
3.3	OOPS for Automation.	1
3.4	Introduction to JAVA	2
3.5	Features of JAVA	1
3.6	OOPS through JAVA	2
4	**Database Management System Introduction**	
4.1	Comparison of File System-Database Management System	2
4.2	Characteristic Features of Database Management Systems	2
4.3	Database Design: Relational Database- Logical Database Design	2
4.4	Logical Database Design-Data Base Models-DBMS Languages and Interfaces	2
4.5	Data Base Security and Authorization. Data Ware House	1
5	**Operating Systems and Protocols**	
5.1	Basic Concepts of batch Systems-Multi Programming, Time Sharing-Distributed and Real Time Systems	3
5.2	Operating System Structures: Operating System Components and Services	3
5.3	Brief discussion about protocols-FTP, TCP/IP & HTTP.	3