ANNA UNIVERSITY : : CHENNAI 600 025

UNIVERSITY DEPARTMENTS

M.E. MECHATRONICS (FT)

REGULATIONS – 2019

CHOICE BASED CREDIT SYSTEM

VISION OF THE DEPARTMENT

To develop disciplined, socially committed and technically competent Production Engineers with Creativity, Comprehension and Managerial skills to design and manufacture innovative cost effective quality products for the benefit of mankind.

MISSION OF THE DEPARTMENT

1. Train the students who will be able to design and manufacture Innovative, Environment Friendly, Ergonomic and Cost Effective Quality Products and Services.
2. Improve the technical quality of the students to meet the challenges, competitions and opportunities in production engineering.
3. Prepare the students who will be able to solve socially relevant engineering problems and other complex problems by means of inculcating Managerial Skills.
4. Enhance the department industry / research centre interaction by means of training, internship and student projects to solve industrial problems.

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

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UNIVERSITY DEPARTMENTS

M.E. MECHATRONICS (FT)

REGULATIONS – 2019

CHOICE BASED CREDIT SYSTEM

PROGRAM EDUCATIONAL OBJECTIVES (PEO)

I. Find gainful employment in industry and academia.
II. Achieve the scientific / managerial position and became a successful entrepreneur on their career paths by applying multi-disciplinary approach.
III. Ability to design, develop and analyze the mechatronic system and provide optimal solutions with basic and advanced technology for industrial and societal problems.
IV. Become an ethically responsible person with practice of life-long learning and effective communication to work as an individual and part of team for societal cause.

PROGRAM OUTCOMES (POs)

After going through post graduate in mechatronics, the graduates will exhibit ability to:

PO. No.	Graduate Attribute	Programme Outcome
1	Engineering knowledge	Apply the fundamental knowledge of mechanics, electronics, sensors, actuators, control systems, microcontrollers, mechatronic system design, industrial automation and other engineering science serves the integrated solutions for various types of engineering problems.
2	Problem analysis	Identify and formulate problem statements and analyze engineering solutions to arrive at substantiated conclusions using principles of engineering sciences and mathematical models.
3	Design/ development of solutions	Design, model, integrate and develop the solution for the engineering problems to meet the direct and indirect requirements of human and other living being in various levels of fundamental need search in socio-economical context.
4	Conduct investigations of complex problems	Evaluate the design, analyze and optimize the integrated functionalities of systems and its parameters to create additional intelligence for valid decision making.
5	Modern tool usage	Create, select, and use an appropriate modern devices and technologies for engineering problem with understanding the limitations of socio-economical context.
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 teams, and in multidisciplinary settings.
10	Communication	Communicate effectively with the engineering community and with society at large. Be able to comprehend and write effective reports documentation. Make effective presentations, and give and receive clear instructions.

11	Project management	Demonstrate the understanding of multi-disciplinary engineering concepts and apply these to one's individual work, as a member and leader in a team.
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 (PSOs)

By completion of post graduate in mechatronics, the graduates will have following program specific outcomes:

I. Familiarization of conventional and modern mechatronic systems and its integrated functionalities.

II. Able to model, design, develop, analyze and implement automation solution to meet social and industrial demands with environmental considerations.

III. Knowledgeable to acquire employment in industry, academic profession, scientific position, managerial position and entrepreneur on their career paths with ethical values.

MAPPING OF PEOS WITH POS

Programme Educational Objectives PEOs	Programme Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
I	√	√	√	√	√	√	√	√	√	√	√	√
II	√	√	√	√	√	√	√	√	√	√	√	√
III	√	√	√	√	√	√	√				√	
IV							√	√	√	√	√	√

PROGRAM CORE COURSES (PCC)

		COURSE	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
YEAR 1	SEM 1	Concepts in Electronics Engineering	√	√	√		√	√					√	√
		Concepts of Machines and Mechanisms	√	√	√				√				√	√
		Sensors and Signal Conditioning	√	√	√	√	√	√	√				√	√
		Control System Design	√	√	√	√	√		√				√	√
		Drives and Actuators for Automation	√	√	√	√	√		√				√	√
		Research Methodology and IPR	√	√	√	√	√	√	√	√	√	√	√	√
		Program Elective – I												
		Audit Course – I												
		Computer Aided Modelling and Control Systems Design Laboratory	√	√	√	√	√	√	√				√	√
		Sensors and Signal Conditioning Laboratory	√	√	√	√	√	√					√	√
	SEM 2	Design of Machine Elements and Product Development	√	√	√	√	√	√	√				√	√
		Mechatronics System Design	√	√	√	√	√	√	√				√	√
		Industrial Automation	√	√	√	√	√	√	√				√	√
		Embedded Systems	√	√	√	√	√	√	√				√	√
		Program Elective – II												
		Program Elective – III												
		Audit Course – II												
		Embedded Systems Laboratory	√	√	√	√	√	√	√				√	√
		Simulation, Programming and Automated Inspection Laboratory	√	√	√	√	√	√	√				√	√
YEAR 2	SEM 3	Program Elective – IV												
		Program Elective – V												
		Open Elective – I												
		Dissertation -I	√	√	√	√	√	√	√		√	√	√	√
		Industrial Training/ Internships/ Certified Training Courses	√	√	√	√	√				√	√	√	√
	SEM 4	Dissertation - II	√	√	√	√	√	√	√		√	√	√	√

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PROGRAM ELECTIVE COURSES (PEC)

		COURSE	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
YEAR 1	SEM 1	Computer Aided Inspection	√	√		√	√						√	√
		Digital Manufacturing	√	√			√						√	√
		Single Board Computers and Programming	√	√	√	√	√	√	√				√	√
		Micro and Nano Systems	√	√	√	√	√	√	√				√	√
		Green Concepts						√	√				√	√
	SEM 2	Industrial Robotics	√	√	√	√	√	√					√	√
		Multi-Body Dynamics	√	√	√	√							√	√
		Modelling and Finite Element Analysis of Electromechanical Systems	√	√	√	√	√	√					√	√
		Biomechatronics	√	√	√	√	√	√					√	√
		Applied Signal Processing	√	√	√	√	√	√					√	√
		Advanced Control System	√	√	√	√	√	√					√	√
		Haptics and Mixed Reality	√	√	√	√	√	√					√	√
		Human Machine Interface	√	√	√	√	√	√	√				√	√
		Computer Vision and Deep Learning	√	√	√	√	√	√					√	√
		Quality and Reliability Engineering	√	√	√	√	√	√	√		√		√	√
YEAR 2	SEM3	Machine Vision	√	√	√	√	√	√					√	√
		Vetronics	√	√	√	√	√	√					√	√
		Mobile Robotics	√	√	√	√	√	√					√	√
		System Design and Programming Of FPGA	√	√	√	√	√						√	√
		Analytical Robotics	√	√	√	√	√						√	√
		Machine Learning	√	√	√	√	√						√	√
		Medical Mechatronics	√	√	√	√	√	√					√	√
		Communication Protocols	√	√	√	√	√		√				√	√
		Industry 4.0 and Internet of Things	√	√	√	√	√		√				√	√
		Computer Aided Production and Automation of Plants	√	√	√	√	√	√					√	√
		Instrumentation in Non-Destructive Evaluation	√	√	√	√	√		√				√	√
		Mechatronics in Advanced Manufacturing Systems	√	√	√	√	√		√				√	√
		Industrial Solid State Drives	√	√	√		√		√				√	√

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ANNA UNIVERSITY : : CHENNAI 600 025
UNIVERSITY DEPARTMENTS
REGULATIONS - 2019
M.E. MECHATRONICS (FULL – TIME)
CURRICULA AND SYLLABI FOR I TO IV SEMESTERS

Sl. No	Course Code	Course Title	Category	Periods per week			Total Contact Periods	Credits
				L	T	P		
THEORY								
1.	MR5101	Concepts in Electronics Engineering	PCC	2	1	0	3	3
	MR5102	Concepts of Machines and Mechanisms	PCC					
2.	MR5103	Sensors and Signal Conditioning	PCC	3	0	0	3	3
3.	MR5104	Control System Design	PCC	3	1	0	4	4
4.	MR5151	Drives and Actuators for Automation	PCC	3	0	2	5	4
5.	RM5151	Research Methodology and IPR	MC	2	0	0	2	2
6.		Program Elective – I	PEC	3	0	0	3	3
7.		Audit Course – I*	AC	2	0	0	2	0
PRACTICALS								
8.	MR5111	Computer Aided Modelling and Control Systems Design Laboratory	PCC	0	0	4	4	2
9.	MR5112	Sensors and Signal Conditioning Laboratory	PCC	0	0	4	4	2
			TOTAL	**18**	**2**	**10**	**30**	**23**

* Audit Course is optional.

SEMESTER II

Sl. No	Course Code	Course Title	Category	Periods per week			Total contact periods	Credits
				L	T	P		
THEORY								
1.	MR5201	Design of Machine Elements and Product Development	PCC	3	0	0	3	3
2.	MR5251	Mechatronics System Design	PCC	3	0	2	5	4
3.	MR5202	Industrial Automation	PCC	3	0	2	5	4
4.	MR5203	Embedded Systems	PCC	3	0	0	3	3
5.		Program Elective – II	PEC	3	0	0	3	3
6.		Program Elective – III	PEC	3	0	0	3	3
7.		Audit Course – II*	AC	2	0	0	2	0
PRACTICALS								
8.	MR5211	Embedded Systems Laboratory	PCC	0	0	4	4	2
9.	MR5212	Simulation, Programming and Automated Inspection Laboratory	PCC	0	0	4	4	2
			TOTAL	**20**	**0**	**12**	**32**	**24**

* Audit Course is optional.

SEMESTER III

Sl. No	Course Code	Course Title	Category	Periods per week			Total Contact Periods	Credits
				L	T	P		
THEORY								
1.		Program Elective – IV	PEC	3	0	0	3	3
2.		Program Elective – V	PEC	3	0	0	3	3
3.		Open Elective	OE	3	0	0	3	3
PRACTICALS								
4.	MR5311	Dissertation - I	EEC	0	0	12	12	6
5.	MR5312	Industrial Training* / Internships*/ Certified Training Courses#	EEC	0	0	2	2	1
			TOTAL	**9**	**0**	**14**	**23**	**16**

***** Minimum 14 Days during Vacation, # - Subject to the Prior Approval Head of the Department during Any Period before 3rd Semester (Minimum of 30 Hrs) and Maximum of Two Certificate Courses.

SEMESTER IV

SI. NO	COURSE CODE	COURSE TITLE	CATEGORY	Periods per week			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1	MR5411	Dissertation - II	EEC	0	0	24	24	12
			TOTAL	**0**	**0**	**24**	**24**	**12**

TOTAL CREDITS TO BE EARNED FOR THE AWARD OF THE DEGREE = 75

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PROGRAM CORE COURSES (PCC)

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	MR5101	Concepts in Electronics Engineering	PCC	3	2	1	0	3
	MR5102	Concepts of Machines and Mechanisms	PCC					
2.	MR5103	Sensors and Signal Conditioning	PCC	3	3	0	0	3
3.	MR5104	Control System Design	PCC	4	3	1	0	4
4.	MR5151	Drives and Actuators for Automation	PCC	5	3	0	2	4
5.	MR5111	Computer Aided Modelling and Control Systems Design Laboratory	PCC	4	0	0	4	2
6.	MR5112	Sensors and Signal Conditioning Laboratory	PCC	4	0	0	4	2
7.	MR5201	Design of Machine Elements and Product Development	PCC	3	3	0	0	3
8.	MR5251	Mechatronics System Design	PCC	5	3	0	2	4
9.	MR5202	Industrial Automation	PCC	5	3	0	2	4
10.	MR5203	Embedded Systems	PCC	3	3	0	0	3
11.	MR5211	Embedded Systems Laboratory	PCC	4	0	0	4	2
12.	MR5212	Simulation, Programming and Automated Inspection Laboratory	PCC	4	0	0	4	2

PROGRAM ELECTIVE COURSES (PEC)

SEMESTER I (ELECTIVE I)

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	Periods per week			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	MR5001	Computer Aided Inspection	PEC	3	0	0	3	3
2.	MR5002	Digital Manufacturing	PEC	3	0	0	3	3
3.	MR5003	Single Board Computers and Programming	PEC	3	0	0	3	3
4.	MR5004	Micro and Nano Systems	PEC	3	0	0	3	3
5.	MN5072	Green Concepts	PEC	3	0	0	3	3

SEMESTER II (ELECTIVE II & III)

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	Periods per week			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	MR5071	Industrial Robotics	PEC	3	0	0	3	3
2.	MR5005	Multi-Body Dynamics	PEC	3	0	0		3
3.	MR5006	Modelling and Finite Element Analysis of Electromechanical Systems	PEC	3	0	0	3	3
4.	MR5007	Biomechatronics	PEC	3	0	0	3	3
5.	MR5008	Applied Signal Processing	PEC	3	0	0	3	3
6.	MR5009	Advanced Control Systems	PEC	3	0	0	3	3
7.	MR5010	Haptics and Mixed Reality	PEC	3	0	0	3	3
8.	MR5011	Human Machine Interface	PEC	3	0	0	3	3
9.	MR5012	Computer Vision and Deep Learning	PEC	3	0	0	3	3
10.	MN5074	Quality and Reliability Engineering	PEC	3	0	0	3	3

SEMESTER III (ELECTIVE IV & V)

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	Periods per week			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	MR5013	Machine Vision	PEC	3	0	0	3	3
2.	MR5014	Vetronics	PEC	3	0	0	3	3
3.	MR5015	Mobile Robotics	PEC	3	0	0	3	3
4.	MR5016	Field Programmable Gate Arrays for Embedded Systems	PEC	3	0	0	3	3
5.	MR5017	Analytical Robotics	PEC	3	0	0	3	3
6.	MR5018	Machine Learning	PEC	3	0	0	3	3
7.	MR5019	Medical Mechatronics	PEC	3	0	0	3	3
8.	MR5020	Communication Protocols	PEC	3	0	0	3	3
9.	MR5072	Industry 4.0 and Internet of Things	PEC	3	0	0	3	3
10.	MR5021	Computer Aided Production and Automation of Plants	PEC	3	0	0	3	3
11.	MR5022	Instrumentation in Non-Destructive Evaluation	PEC	3	0	0	3	3

12.	MR5023	Mechatronics in Advanced Manufacturing Systems	PEC	3	0	0	3	3
13.	MR5024	Industrial Solid State Drives	PEC	3	0	0	3	3

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	MR5311	Dissertation – I	EEC	12	0	0	12	6
2.	MR5411	Dissertation – II	EEC	24	0	0	24	12
3.	MR5312	Industrial Training* / Internships*/ Certified Training Courses#	EEC	2	0	0	2	1

RESEARCH METHODOLOGY AND IPR COURSES (RMC)

SL. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
			L	T	P		
1.	RM5151	Research Methodology and IPR	2	0	0	2	2

OPEN ELECTIVE COURSES [OEC]

(Out of 6 Courses one Course must be selected)

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	OE5091	Business Data Analytics	OEC	3	0	0	3	3
2.	OE5092	Industrial Safety	OEC	3	0	0	3	3
3.	OE5093	Operations Research	OEC	3	0	0	3	3
4.	OE5094	Cost Management of Engineering Projects	OEC	3	0	0	3	3
5.	OE5095	Composite Materials	OEC	3	0	0	3	3
6.	OE5096	Waste to Energy	OEC	3	0	0	3	3

AUDIT COURSES (AC)

Registration for any of these courses is optional to students

SL. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
			L	T	P	
1.	AX5091	English for Research Paper Writing	2	0	0	0
2.	AX5092	Disaster Management	2	0	0	0
3.	AX5093	Sanskrit for Technical Knowledge	2	0	0	0
4.	AX5094	Value Education	2	0	0	0
5.	AX5095	Constitution of India	2	0	0	0
6.	AX5096	Pedagogy Studies	2	0	0	0
7.	AX5097	Stress Management by Yoga	2	0	0	0
8.	AX5098	Personality Development Through Life Enlightenment Skills	2	0	0	0
9.	AX5099	Unnat Bharat Abhiyan	2	0	0	0

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SI. NO.	M.E MECHATRONICS (FULL TIME)					
	SUBJECT AREA	CREDITS PER SEMESTER				CREDITS TOTAL
		I	II	III	IV	
1.	PCC	18	18	00	00	36
2.	PEC	03	06	06	00	15
3.	MC	02	00	00	00	02
4.	OE	00	00	03	00	03
5.	EEC	00	00	07	12	19
6.	Non Credit/ Audit Courses	✓	✓	00	00	00
	TOTAL CREDITS	**23**	**24**	**16**	**12**	**75**

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MR5101 **CONCEPTS IN ELECTRONICS ENGINEERING**

L	T	P	C
2	1	0	3

COURSE OBJECTIVES

- To recall the functionality of fundamental electronic components.
- To understand the functions of operational amplifier and its applications.
- To review and use the logic gates for various digital circuit development.
- To understand the functions and uses in measurement.
- To learn the power management on various electronic units.

UNIT- I ELECTRONIC COMPONENTS AND DEVICES 6+3

Resistors, Capacitors, Inductors, Transformers – Types and Properties - PN Junction Diodes, Zener Diodes, Transistors, Thyristors – Types - Operating Mechanism -Characteristics and Applications. LED Construction and Working – Applications, Types of Displays and its Construction – Applications.

UNIT- II OPERATIONAL AMPLIFIERS AND APPLICATIONS 6+3

Operational Amplifiers – Principles, Specifications, Characteristics and Applications - Arithmetic Operations, Integrator, Differentiator, Comparator, Schmitt Trigger, Instrumentation Amplifier, Active Filters, Linear Rectifiers, Waveform Generators, Sample and Hold Circuits, D/A Converters, Feedback and Power Amplifiers , Sine Wave Oscillators,

UNIT - III DIGITAL ELECTRONICS 6+3

Number Systems – Logic Gates – Boolean Algebra – Simplification of Boolean Functions – Study of Combinational Logic Circuits - Full Adder, Code Converters, Multiplexers, Decoders, Study of Sequential Logic Circuits - Flip-Flops, Counters, Shift Registers – Memory - Types - Solid State Memory – A/D Converters.

UNIT- IV MEASURING INSTRUMENTS 6+3

Regulated Power Supply - Rectifiers and Filters – Switching Power Supplies - Thermal Considerations. Measurement of Voltage, Current, Frequency and Power Using Multi Meters, Oscilloscopes, Recorders, Data Loggers, Signal Sources, Counters, Analyzers and Printers.

UNIT- V POWER MANAGEMENT 6+3

Energy Estimation – Power Estimation and Optimization of Electrical and Electronics Elements, Integrated System - Sensors, Data Acquisition System - Drives, Switching Devices, Actuators and Controllers - Batteries - Types, Specification - Power Conversion Methods.

LECTURE = 30, TUTORIAL = 15, TOTAL = 45 PERIODS

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO1: Apply the fundamental electronic components in various circuits.
CO2: Create the basic electronic circuits using op-amp for various applications.
CO3: Develop the digital electronic circuits using logic gate ICs'.
CO4: Use the power supply and measurement system appropriately for various applications.
CO5: Measure, estimate and monitor the power for various applications to use battery or electrical power sources.

COURSE OUTCOMES COs	Programme Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	√										√	√
2	√	√	√		√	√					√	√
3	√	√	√		√	√					√	√
4	√	√	√		√	√					√	√
5	√	√	√		√	√					√	√

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REFERENCES

1. Helfrick A.D and Cooper .W. D. “Modern Electronic Instrumentation and Measurements Techniques”, Prentice Hall, 2008.
2. Jacob Millman, “Microelectronics Digital and Analog Circuits and Systems”, McGraw-Hill, 2014.
3. Malvino & Leach, “Digital Principles and Application”, Tata McGraw-Hill Education, 2002.
4. Millman and Halkias, “Electronic Devices and Circuits”, McGraw Higher Ed., 2015.
5. Roy Choudhury, “Linear Integrated Circuits”, New Age, 2006.

		L	T	P	C
MR5102	**CONCEPTS OF MACHINES AND MECHANISMS**	**2**	**1**	**0**	**3**

COURSE OBJECTIVES

- To understand the functionality of basic mechanism and to determine the position, velocity and acceleration profiles of these mechanisms.
- To recognize the effect of friction in joints and to know the various types of mechanical power transmission using belt drives.
- To identify the nomenclature of gear and to understand the functions and typical uses of various types of gears and Cams.
- To understand the behaviors of the vibration in various machines.
- To make use of various conventional machine tools for component development.

UNIT- I MECHANISMS 6+3

Definition – Machine and Structure – Kinematic Link, Pair and Chain – Classification of Kinematic Pairs – Constraints & Motions - Degrees of Freedom – Slider Crank – Single and Double – Crank Rocker Mechanisms – Inversions – Applications. Kinematic Analysis and Synthesis of Simple Mechanisms – Determination of Velocity and Acceleration of Simple Mechanisms.

UNIT - II FRICTION AND MECHANICAL DRIVES 6+3

Types of Friction – Friction in Screw and Nuts – Pivot and Collar – Thrust Bearings – Collar Bearing – Plate and Disc Clutches – Belt (Flat &Vee) and Rope Drives – Creep in Belts – Open and Cross Belt Drives – Ratio of Tensions – Effect of Centrifugal and Initial Tension – Condition for Maximum Power Transmission

UNIT- III GEARING AND CAMS 6+3

Gear Profile and Geometry - Nomenclature of Spur and Helical Gears – Law of Gearing – Interference - Requirement of Minimum Number of Teeth in Gears - Gear Trains - Simple and Compound Gear Trains - Determination of Speed and Torque in Epicyclic Gear Trains - Cam Profile - Different Types of Followers.

UNIT - IV VIBRATION 6+3

Free, Forced and Damped Vibrations of Single Degree of Freedom Systems – Force Transmitted to Supports – Vibration Isolation – Vibration Absorption – Torsional Vibration of Shafts – Single and Multirotor Systems – Geared Shafts – Critical Speed of Shafts.

UNIT - V MACHINE TOOLS 6+3

Machine Tool Construction - Features – Operations of Lathe, Milling Machine, Drilling Machine – Drive System for Machine Tools – Mechanical, Hydraulic and Electric Stepped and Variable Speeds – Spindle Speeds and Feed Drives - Linear and Reciprocation Motion Generation - CNC Machines - Basics and Types.

LECTURE = 30, TUTORIAL =15, TOTAL = 45 PERIODS

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO1: Apply the fundamental mechanism in machinery development.

CO2: Consider the functions of friction in joints and select of appropriate belt drives for the typical applications.

CO3: Select and use of appropriate gears and cams for system development.

CO4: Evaluate the possibility of vibration generation in the system design.

CO5: Demonstrate the various conventional machine tools and CNC Machines.

COURSE OUTCOMES COs	Programme Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	√	√	√								√	√
2	√	√	√								√	√
3	√	√	√								√	√
4	√	√	√								√	√
5	√	√	√								√	√

REFERENCES

1. Bansal R.K,"Theory of Machines", Laxmi Publications (P) ltd., 2011.
2. Joseph Edward Shigley, Charles R.Mischke, "Mechanical Engineering Design" Mcgraw Hill, 2008.
3. Khurmi .R.S and Gupta, "Theory of Machines", Eurasia Publishing House Pvt. Ltd., 2012.
4. Malhotra .D.R. and Gupta .H.C. "The Theory of Machines" Satya Prakasam, Tech. India Publications, 1989.
5. Sen.G.C and Bhattacharya. A, "Principles of Machine Tools", New Central book Agency, 1999.

MR5103 SENSORS AND SIGNAL CONDITIONING

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

- To learn the various types of sensors, transducers, sensor output signal types, calibration techniques, formulation of system equation and its characteristics.
- To understand basic working principle, construction, Application and characteristics of displacement, speed and ranging sensors.
- To understand and analyze the working principle, construction, application and characteristics of force, magnetic and heading sensors.
- To learn and analyze the working principle, construction, application and characteristics of optical, pressure, temperature and other sensors.
- To familiarize students with different signal conditioning circuits design and data acquisition system.

UNIT – I SENSOR CLASSIFICATION, CHARACTERISTICS AND SIGNAL TYPES 8

Basics of Measurement – Classification of Errors – Error Analysis – Static and Dynamic Characteristics of Transducers – Performance Measures of Sensors – Classification of Sensors – Sensor Calibration Techniques – Sensor Outputs - Signal Types - Analog and Digital Signals, PWM and PPM.

UNIT - II DISPLACEMENT, PROXIMITY AND RANGING SENSORS 9

Displacement Sensors – Brush Encoders - Potentiometers, Resolver, Encoders – Optical, Magnetic, Inductive, Capacitive, LVDT – RVDT – Synchro – Microsyn, Accelerometer – Range Sensors - Ultrasonic Ranging - Reflective Beacons - Laser Range Sensor (LIDAR) – GPS - RF Beacons.

UNIT – III FORCE, MAGNETIC AND HEADING SENSORS 9

Strain Gage – Types, Working, Advantage, Limitation, and Applications: Load Measurement – Force and Torque Measurement - Magnetic Sensors – Types, Principle, Advantage, Limitation, and Applications - Magneto Resistive – Hall Effect, Eddy Current Sensor - Heading Sensors – Compass, Gyroscope and Inclinometers.

UNIT - IV OPTICAL, PRESSURE, TEMPERATURE AND OTHER SENSORS 9

Photo Conductive Cell, Photo Voltaic, Photo Resistive, LDR – Fiber Optic Sensors – Pressure – Diaphragm – Bellows - Piezoelectric - Piezo-resistive - Acoustic, Temperature – IC, Thermistor, RTD, Thermocouple – Non Contact Sensor - Chemical Sensors - MEMS Sensors - Smart Sensors.

UNIT - V SIGNAL CONDITIONING 10

Need for Signal Conditioning – Resistive, Inductive and Capacitive Bridges for Measurement - DC and AC Signal Conditioning - Voltage, Current, Power and Instrumentation Amplifiers – Filter and Isolation Circuits – Fundamentals of Data Acquisition System.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon the completion of this course, the students will able to;

CO1: Understand various sensor effects, sensor characteristics, signal types, calibration methods and obtain transfer function and empirical relation of sensors. They can also analyze the densor response.

CO2: Analyze and select suitable sensor for displacement, proximity and range measurement.

CO3: Analyze and select suitable sensor for force, magnetic field, speed, position and direction measurement.

CO4: Analyze and Select suitable sensor for light detection, pressure and temperature measurement and also familiar with other miniaturized smart sensors.

CO5: Select and design suitable signal conditioning circuit with proper compensation and linearizing element based on sensor output signal.

COURSE OUTCOMES Cos	Programme Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	√	√	√									√
2	√	√	√	√	√	√					√	√
3	√	√	√	√	√	√					√	√
4	√	√	√	√	√	√					√	√
5	√	√	√	√	√	√					√	√

REFERENCES

1. Ernest O. Doeblin, “Measurement system, Application and Design”, Tata McGraw Hill Publishing Company Ltd., 2004.
2. Jacob Fraden, “Handbook of Modern Sensors, Physics, Design and Applications”, Springer, 2016.
3. John P. Bentley., “Principle of Measurement systems”, Pearson Prentice Hall, 2005.
4. Patranabis D., “Sensor and Actuators”, Prentice Hall of India (Pvt) Ltd., 2005.
5. Renganathan S., “Transducer Engineering”, Allied Publishers (P) Ltd., 2003

Attested

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MR5104 **CONTROL SYSTEM DESIGN** **L T P C**
3 1 0 4

COURSE OBJECTIVES

- To represent and simplify the mathematical models for various types of physical systems.
- To recognize the time domain specifications and to analyze of various types of system and its characteristics in time domain.
- To know the frequency domain specifications and to analyze of various types of system and its characteristics in frequency domain methods.
- To design compensator and controller using time and frequency domain.
- To evaluate, analyze and design a control system of servomotors for motion control.

UNIT - I SYSTEM REPRESENTATION AND MODELLING 9+3

Introduction and Need for Control Systems with Examples – Open loop and Closed loop Systems – Transfer Function Model – System Representation - Mathematical Modelling of Mechanical, Electrical, Thermal, Fluid Transportation, and Fluid Powered Systems – Block Diagram Reduction – Signal Flow Graph.

UNIT - II TIME DOMAIN ANALYSIS 9+3

Feedback Systems – Block Diagram – Definition of Process Variable, Set-Point, Manipulated Variable and Final Control Element with Examples. Inputs Signals and its Models - Time Domain Response of First & Second Order Systems – Time Domain Specifications - Steady State Errors and Error Constants – Routh Hurwitz Criterion – Root Locus – Root Locus Approach for Control System Design. Impulse Responses of Various Types of System and its Stability.

UNIT - III FREQUENCY DOMAIN ANALYSIS 9+3

Performance Measures in Frequency Domain - Bode Plot – Polar Plot – Nyquist Stability Criterion – Stability Analysis – Experimental Determination of Transfer Functions – Control System Design using Frequency Domain Analysis.

UNIT - IV DESIGN OF COMPENSATORS AND CONTROLLERS 9+3

Lead, Lag, Lag-Lead Compensation in Time Domain and Frequency Domain. Introduction - Characteristics of Analog ON-OFF, P, PI, PD and PID Controllers – Implementation Issues of PID Controller – Tuning of Controllers - Practical PID Control –Two DOF PID Controllers.

UNIT - V CONTROL AND ANALYSIS OF SERVO MOTOR 9+3

Servo Motor – Mathematical Modelling of Servo Motor – Analysis of Servo Motor System Using Routh Hurwitz Criterion, Root Locus, Bode Plot, Polar Plot and Stability Analysis – Implementation of P, PI , PD and PID Controllers for Servo Motor and Analysis - Bumpless Control Transfer Between Manual and PID Control - Anti-Windup Control Using a PID Controller – Motion Control System and its Design Challenges.

LECTURE = 45, TUTORIAL = 15, TOTAL = 60 PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

CO1: Develop the mathematical model of physical systems.
CO2: Characterize the responses and evaluate the range of stability for the physical systems using time domain techniques.
CO3: Describe and assess the range of stability for the physical systems using frequency domain technique.
CO4: Design an appropriate control system and compensator for system dynamics.
CO5: Evaluate and demonstrate the motion control of motors.

COURSE OUTCOMES Cos	Programme Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	√	√										
2		√	√	√		√						
3		√	√	√		√						
4		√	√	√		√						
5	√	√	√	√	√	√					√	√

REFERENCES

1. Asif Sabanovic and Kouhei Oshnishi, “Motion Control Systems” Willey, 2011.
2. Farid Golnaraghi, Benjamin C. Kuo, “Automatic Control Systems”, Willey, 2009.
3. Nagrath.I.J and Gopal, “Control System Engineering”, New Age international (P) Ltd., 2006.
4. Nise Norman S., “Control Systems Engineering”, John Wiley & Sons Inc., 2012.
5. Ogata.K, “Modern Controls Engineering“, Prentice Hall of India Pvt. Ltd., New Delhi, 2005.
6. William.S Levine, “Control System Fundamentals”, CRC Press, 2011.

MR5151 DRIVES AND ACTUATORS FOR AUTOMATION

L	T	P	C
3	0	2	4

COURSE OBJECTIVES

- To recognize the standard symbols and to understand the functions of basic fluid power generation and actuation elements.
- To realize the functions of fluid regulation and control elements and its typical uses in fluid power circuit and to acquire the practice on assembling the various types of pneumatic circuits.
- To familiar and exercise the design procedure of various types of pneumatic and hydraulic fluid power circuits and to provide a training to create the various types of hydraulic circuits.
- To understand the typical functions and selections of various types electrical actuators and to provide the hands on training to the use of various electrical motors for automatic control.
- To apprehend the utilities of mechanical and power electronic drives for various functional requirements of actuators and control valves.

UNIT - I FLUID POWER SYSTEM GENERATION AND ACTUATORS 9

Need For Automation, Classification of Drives - Hydraulic, Pneumatic and Electric –Comparison – ISO Symbols for their Elements, Selection Criteria. Generating Elements- Hydraulic Pumps and Motor Gears, Vane, Piston Pumps – Motors - Selection and Specification - Drive Characteristics – Utilizing Elements - Linear Actuator – Types, Mounting Details, Cushioning – Power Packs – Accumulators.

UNIT - II CONTROL AND REGULATIING ELEMENTS 8

Control and Regulating Elements — Direction, Flow and Pressure Control Valves -Methods of Actuation, Types, Sizing of Ports. Spool Valves - Operating Characteristics -Electro Hydraulic Servo Valves - Types - Characteristics and Performance.

UNIT - III CIRCUIT DESIGN FOR HYDRAULIC AND PNEUMATICS 10

Typical Design Methods – Sequencing Circuits Design - Combinational Logic Circuit Design - Cascade Method – KV Mapping - Electrical Control of Pneumatic and Hydraulic Circuits - Use of Relays, Timers, Counters, Programmable Logic Control of Hydraulics - Pneumatics Circuits - PLC Ladder Programming

UNIT- IV ELECTRICAL ACTUATORS 9

DC Motors – Construction, Working Principle, Classification, Characteristics, Applications – Single Phase and Three Phase AC Motors – Construction, Working Principle, Classification, Characteristics and Applications, Special Electrical Motors - Servomotors - Stepper Motors, Principle, Classification, Construction and Working - BLDC Motor and its Operating Modes - Piezo Electric Actuators – Linear Electrical Actuators - Hybrid Actuators.

UNIT - V ELECTRICAL DRIVE CIRCUITS 9

Drives for Motion Control - DC Motors - Speed, Torque, Direction and Position Control - H-Bridge under PWM Mode**.** Control of AC Motor Drives – VFD Drives – Energy Saving AC Drives - AC Servo Drives - Speed, Breaking, Direction, Position and Torque Control – Stepper Motor Drive Circuits for Speed and Position Control - Drives for BLDC Motor - Selection of Drives – Protection and Switchgears.

LECTURE = 45 PERIODS

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO1: Use the appropriate fluid power generation and actuation elements and fluid power symbols to design and integrate the pneumatic and hydraulic systems.

CO2: Select and design the basic fluid power circuits using control valves and regulating elements for various types' of actuation and breaking**.**

CO3: Analyze and design the complex sequences of cylinders using advanced techniques for manual and automatic control.

CO4: Identify and select the appropriate electrical actuators for typical applications of system development.

CO5: Analyze the need of appropriate drive and its functions for various actuator and valve control in mechatronic system development.

COURSE OUTCOMES COs	Programme Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	√										√	√
2	√	√	√	√	√	√					√	√
3		√	√	√	√	√					√	√
4		√	√	√	√	√					√	√
5	√	√	√	√	√	√					√	√

REFERENCES

1. Antony Esposito, "Fluid Power Systems and Control", Prentice-Hall, 2006.
2. Austin Hughes, "Electric Motors and Drives Fundamentals, Types and Applications", Fourth Edition, Elsevier, 2013
3. Gopal K.Dubey, "Fundamentals of Electrical Drives", Narosa Publications, 2001.
4. Peter Rohner, "Fluid Power Logic Circuit Design", the Macmillan Press Ltd., London, 1979.
5. Singh.M.D, Khanchandani.K.B, "Power Electronics", Second Edition, McGraw-Hill, 2008.

LABORATORY

LIST OF EXPERIMENTS

FLUID POWER DRIVES

1. Experimental Verification of Speed Control Circuits in Pneumatic and Hydraulic Trainer.
2. Experimental Verification of Single and Double Acting Cylinder Circuits Using Different Directional Control Values.
3. Experimental Verification of Electro-Pneumatic Circuits.
4. Experimental Verification of Pneumatic Sequencing Circuits.
5. Experimental Verification of Logic, Metre-in and Metre-out Pneumatic Circuits.
6. Experimental Verification of Electro Pneumatic Sequencing Circuits.
7. Experiments on Control of PLC Based Electro Pneumatic Sequencing Circuits.
8. Experiments on Control of PLC Based Electro Hydraulic Sequencing Circuits.

ELECTRICAL DRIVES

1. Experiments on Position, Speed and Direction Control of AC and DC Motors.
2. Experiments on Position, Speed and Direction Control of Stepper Motor.
3. Experiments on Various Types of Switching and Protection Devices.

PRACTICAL = 30 PERIODS

TOTAL = 75 PERIODS

RM5151 RESEARCH METHODOLOGY AND IPR L T P C
2 0 0 2

COURSE OBJECTIVES:

To impart knowledge and skills required for research and IPR:

- Problem formulation, analysis and solutions.
- Technical paper writing / presentation without violating professional ethics
- Patent drafting and filing patents.

UNIT I RESEARCH PROBLEM FORMULATION 6

Meaning of research problem- Sources of research problem, criteria characteristics of a good research problem, errors in selecting a research problem, scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, necessary instrumentations

UNIT II LITERATURE REVIEW 6

Effective literature studies approaches, analysis, plagiarism, and research ethics.

UNIT III TECHNICALWRITING /PRESENTATION 6

Effective technical writing, how to write report, paper, developing a research proposal, format of research proposal, a presentation and assessment by a review committee.

UNIT IV INTRODUCTION TO INTELLECTUAL PROPERTY RIGHTS (IPR) 6

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT V INTELLECTUAL PROPERTY RIGHTS (IPR) 6

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System, IPR of Biological Systems, Computer Software etc.
Traditional knowledge Case Studies, IPR and IITs.

TOTAL: 30 PERIODS

COURCE OUTCOMES:

1. Ability to formulate research problem
2. Ability to carry out research analysis
3. Ability to follow research ethics
4. Ability to understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity
5. Ability to understand about IPR and filing patents in R & D.

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

REFERENCES:

1. Asimov, “Introduction to Design”, Prentice Hall, 1962.
2. Halbert, “Resisting Intellectual Property”, Taylor & Francis Ltd ,2007.
3. Mayall, “Industrial Design”, McGraw Hill, 1992.
4. Niebel, “Product Design”, McGraw Hill, 1974.
5. Ranjit Kumar, 2nd Edition, “Research Methodology: A Step by Step Guide for beginners” 2010

MR5111	COMPUTER AIDED MODELLING AND CONTROL SYSTEM DESIGN LABORATORY	L T P C 0 0 4 2

COURSE OBJECTIVES

- To familiarize the commands and procedure for 2D drawing and 3D models in computer oriented Modelling environment.
- To assemble the parts and generate the motion simulation of 3D models.
- To familiarize and practice the computer oriented design, analysis and verification of control systems.
- To verify the effect of system dynamics with and without the control systems.

COMPUTER AIDED MODELLING AND SIMULATION

1. 2D and 3D Modelling of Components;
   - Bearing and Couplings.
   - Ball Screw and Gears
   - Sheet Metal Components
   - Jigs, Fixtures and Die Assemblies.

2. 3D Modelling of Machine Components using 3D Printer.
   - Gears
   - Links

3. Assembly and Simulation of Parts
   - Serial Robots

4. Modelling and Simulation of Mechanism
   - 4 Bar Chain
   - Slider Crank
   - Quick Return and Elliptical Trammel.

5. Analysis of Mechanical Components
   - Introduction to FEA Packages.
   - Machine Elements under Static Loads and Dynamic Loads.

CONTROL SYSTEM DESIGN

1. a) Mathematical Modelling and Simulation of a Physical Systems.
   b) Simulation and Reduction of Cascade and Parallel, and Closed Loop Sub-System
2. a) Simulation and Analysis of First and Second Order System Equations in Time and Frequency Domain.
   b) Simulation and Analysis of Root-Locus and Bode Plot.
3. Simulation and Implementation of PID Combination for First and Second Order Systems.
4. Stabilisation and Control of Linear and Rotary Inverted Pendulum.
5. Stabilisation and Control of Vision Based Ball Balancing System.
6. Realization of Motion Control in Pan and Tilt Axis Stabilization.
7. Realization of Control in Active Suspension System.

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO1: Draw 2D drawing and 3D models for part design and model developments.
CO2: Assemble the parts and capable to simulate motion functionality of the model virtually.
CO3: Analyze, verify and develop the control systems for various system dynamics.
CO4: Practice and demonstrate control systems for typical applications.

COURSE OUTCOMES Cos	Programme Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	√	√	√	√	√	√					√	√
2	√	√	√	√	√	√					√	√
3	√	√	√	√	√	√					√	√
4	√	√	√	√	√	√					√	√

TOTAL: 60 PERIODS

MR5112 SENSORS AND SIGNAL CONDITIONING LABORATORY

L	T	P	C
0	0	4	2

COURSE OBJECTIVES

- To learn and gather the practical experience on sensors and its measurements for mechatronics system development.
- To have hands on experience on various sensors to understand the working principle and its characteristics.
- To do experiments on designing of signal conditioning circuit based on sensor output signal.

LIST OF EXPERIMENTS

1. Experiments Using Strain Gauge Sensor: Load Measurement, Torque Measurement and Force Measurement.
2. Determine the characteristics of Pressure Sensor and Piezoelectric Force Sensor.
3. Displacement Measurement using LVDT and Hall Effect Sensor.
4. Thickness Measurement using Eddy Current Sensor.
5. Determine the Characteristics of Various Temperature Sensors.
6. Determine the Characteristics of Various Light Detectors (Optical Sensors).
7. Distance Measurement using Ultrasonic and Laser Sensor.
8. Determine angular velocity using Gyroscope, Vibration measurement using Accelerometer and Direction measurement using Magnetometer.
9. Speed and Position Measurement Using Encoders.
10. Design and realize inverting, Non-Inverting and Instrumentation amplifier using Op-Amp.
11. Design and Study the frequency response of Active Filters.
12. Design and realize circuit to convert change in resistance, inductance and capacitance to voltage.

TOTAL: 60 PERIODS

COURSE OUTCOMES

Upon the completion of this course, the students will be able to;

CO1: Demonstrate the ability to understand and compare the characteristics of sensors.
CO2: Design and develop signal conditioning circuits for sensors.
CO3: Select suitable sensor for the application.

COURSE OUTCOMES Cos	Programme Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	√	√	√	√	√	√					√	√
2	√	√	√	√	√	√					√	√
3	√	√	√	√	√	√					√	√

MR5201 **DESIGN OF MACHINE ELEMENTS AND PRODUCT DEVELOPMENT**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

- To familiarize the fundamentals of symbols, dimensions, material, safety consideration in design
- To understand the effect of static and dynamic stresses of rotating elements and to learn the detailed design of spring and couplings
- To acquire the design skills of transmission elements of mechanical systems.
- To understand the consideration of various factors in product design and development.
- To acquaint with the finite elemental modelling of stress analysis of mechanical system elements.

UNIT- I INTRODUCTION TO MACHINE DESIGN 9

Introduction to National and International Symbols - Engineering Materials - Physical Properties and their Applications in Design - Selection of Materials - Selection for Newer Design and Material Considerations - Factors of Safety in Design - Dimensioning and Detailing - Fits and Tolerances - Surface Finish and Machining Symbols.

UNIT- II STATIC AND VARIABLE STRESSES 9

Static and Variable Loading in Machine Elements - Stress Concentration - Goodman and Soderberg Method of Design - Design of Power Transmission Shafts - Subjected to Torsion, Bending and Axial Loads - Design of Closed Coiled Helical Spring - Design of Couplings - Muff, Flange, Bushed and Pin Types.

UNIT- III DESIGN OF TRANSMISSION ELEMENTS 9

Design of Gears - Selection and Specification - Design of Journal Bearings – Selection and Specification of Anti-Friction Bearings – Roller Bearings – Ball Screw - Belt Drive - Chain Drive.

UNIT- IV PRODUCT DESIGN AND DEVELOPMENT 9

Quality Function Development (QFD) - Product Design and Specification, Design for Manufacturability (DFM), Design for Assembly and Disassembly, Human Factors in Design Ergonomics, Creativity in Design, TRIZ - Axiomatic Design.

UNIT- V FINITE ELEMENT ANALYSIS 9

Basic Concept of FEA - Finite Element Analysis of One Dimensional and Two Dimensional Problems - Variational Formulation of B.V.P. – Ritz Method - Examples Related to One - Dimensional and Two-Dimensional Problems.

TOTAL = 45 PERIODS

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO1: Use various symbols, dimensions, materials and safety considerations for design.
CO2: Evaluate static and dynamic stresses of rotating elements and familiar with design of springs and couplings.
CO3: Design transmission elements for mechanical systems.
CO4: Remember the salient features of product design and development.
CO5: Evaluate effect of various parameters due to its elemental interactions using FEA.

COURSE OUTCOMES COS	Programme Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	√					√					√	√
2	√	√	√	√	√	√					√	√
3			√								√	√
4	√	√	√	√	√	√					√	√
5		√	√	√	√						√	√

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1. George E.Dieter, Linda C.Schmidt, “Engineering Design”, McGraw-Hill International, 2009.
2. Jain R.K., “Machine design”, Khanna Publishers, 2008.
3. Khurmi R.S and Gupta J.K, “A Text Book of Machine Design”, Eurasia Publishing House (P) Ltd, 2008.
4. Ramamurthi, V., “Finite Element Method in Machine Design”, Narosa Publishing House, 2009.
5. Shigley J.E. “Mechanical Engineering Design”, McGraw-Hill International. 2011.
6. Spotts N.F. “Design of Machine Elements”, Prentice-Hall of India, 2004.

MR5251 MECHATRONICS SYSTEM DESIGN

L	T	P	C
3	0	2	4

COURSE OBJECTIVES

- To enlist the various elements required to design and integrate the mechatronic systems.
- To acquire the Modelling skill to capture the system dynamics of hybrid systems and to familiar the system identification techniques and to practice the design and assembly of mechanical system in software environment for integrating various system sub-elements.
- To familiar the standard simulation procedure for algorithm and controller development and to practice simulate and verify interactions and functions of integrated systems and its elements for fine tuning the design and control for real time system development.
- To apply the optimization procedure for the appropriate selection of mechatronic system elements and process parameter optimization.
- To understand, apply, analyze and evaluate the functions of systems models for integrating the virtual elements of mechatronics.

UNIT - I ELEMENTS OF MECHATRONICS 8

Comparison of Conventional System vs. Mechatronic System – Identification of Mechatronic System Requirements in Real World Problems - Mechatronics System Overview – Key Elements – Identification of Key Elements in Various Systems - Application Overview – Mechatronics System Design Process - Recent Advancements in Mechatronics System for Modern Automation.

UNIT - II MODELLING & SYSTEM IDENTIFICATION 9

Need for Modelling – Systems Overview – Representation of Systems in State Space –Analogue Approach – Parametric and Non-Parametric Modelling - Bond Graph Approach for Modelling of Electrical, Mechanical, Thermal, Fluid and Hybrid Systems – System Identification – White, Grey and Block Box Modelling - Overview – Types - Least Square Method.

UNIT - III SIMULATION 8

Simulation Fundamentals – Simulation Life Cycle – Monte Carlo Simulation – Solution for Model Equations and their Interpretations – Hardware-In-Loop Simulation (HIL) - Controller Prototyping – Software’s for Simulation and Integration.

UNIT - IV DESIGN OPTIMIZATION 9

Optimization – Problem Formulation - Constraints – Overview of Linear and Nonlinear Programming Techniques – Other Optimization Techniques - Optimal Design of Mechatronics System with Case Studies.

UNIT - V CASE STUDIES ON MODELING OF MECHATRONIC SYSTEMS 11

Modelling and Simulation of Automotive System - Power Window, Engine Timing, Building Clutch Look-Up, Antilock Braking System and Automatic Transmission Controller – Modelling of Manufacturing Systems, Inspection System, Transportation System, Industrial Manipulator, Light Motor Vehicle, Aerial Vehicle, Underwater Vehicle.

Attested

LECTURE: 45 PERIODS

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COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO1: Identify the list of elements required integrate the entire mechatronic systems developments.

CO2: Model the system dynamics of hybrid systems and to trial the system identification techniques and to practice the design, integration and simulation in virtual systems that are closer to the real time systems' functionalities and its parameters.

CO3: Follow standard simulation procedure for algorithm and controller development.

CO4: Use the optimization concepts mechatronics elements selection and process parameter optimization.

CO5: Integrate and analyze the mechatronics system design virtually and able to fine tune the system design and control algorithms in the software-in-loops before real time development.

COURSE OUTCOMES COs	Programme Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	√										√	√
2	√	√	√	√	√	√					√	√
3		√	√	√	√	√					√	√
4			√	√	√						√	√
5	√	√	√	√	√	√					√	√

REFERENCES

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3. Brian Morriss, "Automated Manufacturing Systems – Actuators Controls, Sensors and Robotics", McGraw Hill International Edition, 2000.
4. Devadas Shetty, Richard A.Kolkm, "Mechatronics System Design", PWS Publishing Company, 2009.
5. Ogata.K, "Modern Controls Engineering", Prentice Hall of India Pvt. Ltd., 2005.

LABORATORY

LIST OF EXPERIMENTS

1. Modelling and Simulation of Vehicle and its Automotive Sub System.
2. Modelling and Simulation of 6 DOF Serial Manipulators.
3. Modelling and Simulation of Parallel Manipulator.
4. Modelling and Simulation of Aerial Vehicle.
5. Modelling and Simulation of Mobile Robot.

PRACTICAL: 30 PERIODS
TOTAL: 75 PERIODS

Attested

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MR5202	INDUSTRIAL AUTOMATION	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES

- To understand the importance of automation in industry and various industrial standard sensors and process parameters to control the production process.
- To learn PLC hardware, and practice the PLC programming and simulation in real systems.
- To get knowledge on industrial standard data communication protocols, SCADA, centralized and decentralized control.
- To get introduced to factory layout, Total Integrated Automation on factory and Industry 4.0.
- To get exposure on building automation using sensors, controllers and actuators.

UNIT - I INDUSTRIAL INSTRUMENTATION AND CONTROL 9

Introduction and Need for Automation - Instrumentation System for Measurement of Process Parameters – Overview on Flow, Level, Pressure, Temperature, Speed, Current and Voltage Measurements – Proximity and Vision Based Inspection Systems – Process Control Systems – Continuous and Batch Process – Feedback Control System Overview.

UNIT - II PROGRAMMABLE LOGIC CONTROLLER 9

Fundamentals of Programmable Logic Controller - Functions of PLCs - Features of PLC - Selection of PLC - Architecture – Basics of PLC Programming - Logic Ladder Diagrams – Communication in PLC – Programming Timers and Counters – Data Handling - PLC modules - Advanced PLC.

UNIT - III DATA COMMUNICATION AND SUPERVISORY CONTROL SYSTEMS 9

Industrial Data Communications - Fiber Optics – Modbus – HART – DeviceNet – Profibus – Fieldbus – Introduction to Supervisory Control Systems – SCADA - Distributed Control System (DCS) – Safety Systems – Man-Machine Interfaces - Total Integrated Automation (TIA) – Industry 4.0.

UNIT - IV FACTORY AUTOMATION 9

Factory Layout - Tools and Software Based Factory Modelling - Case Study on Automated Manufacturing Units, Assembly Unit, Inspection Systems and PLC Based Automated Systems - Introduction to Factory Automation Monitoring Software.

UNIT - V BUILDING AUTOMATION 9

Building Layout and its 3D Model - Power Distribution System in Buildings - HVAC Systems - Systems Design and Operation - PLC in Building Services - Building Automation Systems – Control Panel - Introduction to Building Automation Software.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon the completion of this course, the students will be able to;

CO1: Understand the need of process parameter measurement and control.

CO2: Select, configure and program the PLC by interfacing the sensors and actuators and other input and output devices for automation.

CO3: Understand and compare various data communication protocols. Able to compare centralized, decentralized and smart control system.

CO4: Select and apply suitable sensor, control and actuation for factory automation. Also they can simulate the same using software.

CO5: Select appropriate sensor, controller and actuation unit for building automation.

Attested

COURSE OUTCOMES COs	Programme Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	√										√	√
2		√	√		√	√					√	√
3	√	√	√		√	√					√	√
4	√	√	√	√	√	√					√	√
5	√	√	√	√	√	√					√	√

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1. Frank D, Petruzella, “Programmable Logic Controller” McGraw – Hill Publications, 2016.
2. Lucas, M.P., “Distributed Control System”, Van Nastrand Reinhold Company, 1986.
3. Mackay S., Wrijut E., Reynders D. and Park J., “Practical Industrial Data Networks Design, Installation and Troubleshooting”, Newnes Publication - Elsevier, 2004.
4. Patranabis. D, “Principles of Industrial Instrumentation”, Tata McGraw-Hill Publishing Ltd., 1999.
5. Shengwei Wang, “Intelligent Buildings and Building Automation”, Routledge Publishers, 2009.

LABORATORY

1. Experiments on Ladder Logic Program for Various Logic Gates AND, OR, NOT, NOR, NAND, EX-OR and EX-NOR.
2. Implement Various Mathematical Functions in PLC Using Ladder Diagram Programming Language.
3. Develop Ladder Diagram Programming to set Timer and Counter in PLC.
4. Develop PLC Program to Control Traffic Light.
5. Develop PLC Program to Maintain the Pressure and Level in a Bottle Filling System.
6. Develop Ladder Diagram Program in PLC For Material Filling, Object Shorting, Orientation Check and Material Property Check.
7. Develop the Ladder Diagram Program in PLC for Material Handling, Delaying Conveyor, Feeding, Pick and Place Operation.
8. Experiments on Sensor and Actuator Interfacing and PLC to PLC. Communication.

PRACTICAL: 30 PERIODS

TOTAL: 75 PERIODS

MR5203 **EMBEDDED SYSTEMS** **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To familiarize the architecture and fundamental units of microcontroller.
- To know the microcontroller programming methodology and to acquire the interfacing skills and data exchange methods using various communication protocols.
- To design the interface circuit and programming of I/O devices, sensors and actuators.
- To understand ARM processor architecture and its functions to meet out the computational and interface needs of growing mechatronic systems.
- To acquaint the knowledge of real time embedded operating system for advanced system developments.

UNIT- I MICROCONTROLLER 9

Fundamentals Functions of ALU - Microprocessor - Microcontrollers – CISC and RISC – Types Microcontroller - 8051 Family - Architecture - Features and Specifications - Memory Organization - Instruction Sets – Addressing Modes.

UNIT- II PROGRAMMING AND COMMUNICATION 9

Fundamentals of Assembly Language Programming – Instruction to Assembler – Compiler and IDE - C Programming for 8051 Microcontroller – Basic Arithmetic and Logical Programming - Timer and Counter - Interrupts – Interfacing and Programming of Serial Communication, I^2C, SPI and CAN of 8051 Microcontroller – Bluetooth and WI-FI interfacing of 8051 Microcontroller.

UNIT- III PERIPHERAL INTERFACING 9

I/O Programming – Interfacing of Memory, Key Board and Displays – Alphanumeric and Graphic, RTC, interfacing of ADC and DAC, Sensors - Relays - Solenoid Valve and Heater - Stepper Motors, DC Motors - PWM Programming – Closed Loop Control Programming of Servomotor – Overview of Advanced Microcontrollers.

UNIT- IV INTRODUCTION TO ARM 7 CORE 8

Introduction ARM 7 Processor - Internal Architecture – Modes of Operations – Register Set – Instruction Sets – ARM Thumb - Thumb State Registers – Pipelining – basic programming of ARM 7 - Applications.

UNIT- V REAL TIME MODELS, LANGUAGES AND OPERATING SYSTEMS 10

Models and Languages – State Machine and State Tables in Embedded Design – High Level Language Descriptions – Real Time Kernel - OS Tasks - Task Scheduling - Kernel Services – Real Time Embedded Operating Systems - Real Time Programming Languages - GPIO Programming – Comparative Overview of C and Python for Embedded Systems.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO1: Select the microcontroller based on the features and specifications.
CO2: Setup the programming platform and establish the various communications.
CO3: Design the microcontroller based interfacing of sensors, actuators and other I/O's for controller development.
CO4: Use and program the ARM processor growing needs of mechatronic systems.
CO5: Establish and use the real time embedded operating systems and programming languages for peripheral interfacing and control.

COURSE OUTCOMES COs	Programme Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	√										√	√
2		√	√		√	√					√	√
3		√	√	√	√	√					√	√
4		√	√	√	√	√					√	√
5	√	√	√	√	√	√					√	√

REFERENCES

1. Ball S.R., "Embedded Microprocessor Systems – Real World Design", Prentice Hall, 2006
2. Frank Vahid and Tony Givagis, "Embedded System Design", 2011, Wiley.
3. James W. Stewart, "The 8051 Microcontroller Hardware, Software and Interfacing", Regents Prentice Hall, 2003.
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5. Kenneth J. Aylala, "The 8051 Microcontroller, the Architecture and Programming Applications", 2003
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MR5211 EMBEDDED SYSTEMS LABORATORY

COURSE OBJECTIVES

L	T	P	C
0	0	4	2

- To give the hands on experience on designing a microcontroller based I/O interface circuits.
- To acquire the practice on programming the interfaces of keyboards, sensors, actuators, timers and counters, display devices and communication protocols using 8051 microcontroller and ARM processor.

LIST OF EXPERIMENTS

1. Assembly Language Programming and Simulation of 8051.
2. Alphanumeric and Graphic LCD Interfacing using 8051 Microcontroller.
3. Input switches and keyboard interfacing of 8051.
4. Sensor Interfacing with ADC to 8051 and DAC & RTC Interfacing with 8051. .
5. Timer, Counter and Interrupt Program Application for 8051.
6. Step Motor (Unipolar & Bipolar Motor) and PWM Servo Motor Control to Interfacing with 8051.
7. UART Serial and Parallel Port Programming of 8051.
8. I^2C, SPI and CAN Programming of 8051.
9. Interfacing and Programming of Bluetooth and Wi-Fi with 8051
10. Programming of ARM Processor for Sensor Interface.
11. Stepper Motor and Servo Motor Control Using ARM Processor.
12. Serial Communication of ARM Processor with Computation Platform.
13. Wireless Communication of ARM Processor with Computation Platform.
14. GPIO Programming of Real Time Embedded Operating Systems.

TOTAL = 60 PERIODS

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO1: Design and use a microcontroller based system control with I/O interface circuit.

CO2: Program the interfaces of keyboards, sensors, actuators, timers and counters, display devices and communication protocols using 8051 microcontroller and ARM processor.

COURSE OUTCOMES COs	Programme Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	√	√	√	√	√	√					√	√
2	√	√	√	√	√	√					√	√
3	√	√	√	√	√	√					√	√

MR5212 SIMULATION, PROGRAMMING AND AUTOMATED INSPECTION LABORATORY

L	T	P	C
0	0	4	2

COURSE OBJECTIVES

- To Model, Simulate and verify the forward and inverse kinematics of serial manipulators for trajectory generation and to attain the exposure on robot programming.
- To realize the integrated operation of mechatronics system thorough CNC Programming methods for part manufacturing.
- To observe, practice and analyze the function of automated quality inspection and classifications system for dimensional and non-dimensional features.

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SIMULATION AND PROGRAMMING OF ROBOTS

1. Simulation of Forward and Inverse Kinematics of Planar Manipulators.
2. Simulation of Forward and Inverse Kinematics of Spatial Manipulators.
3. Trajectory Planning of Planer Manipulators.
4. Trajectory Planning of Spatial Manipulators.
5. Experiments on Programming of Serial Manipulators.
    - Articulated Robot.
    - Cartesian Robot.

PROGRAMMING OF CNC MACHINES

1. NC Programming on CNC Routers, Vertical Machining Centre and Turning Centre
2. Programming of EDM and Water Jet Cutting.
3. Programming of Rapid Prototyping.

AUTOMATED MEASUREMENT AND INSPECTION

1. Conveyor Based Object Sorting using Sensors.
2. Conveyor with Vision Based Object Classification.
3. Vision Based Measurements of Various Profiles.
4. Automated Measurement using CMM Simple Profiles.

TOTAL = 60 PERIODS

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO1: Simulate and validate the kinematics and trajectory of various configurations and qualified on programming the industrial serial manipulator for the desired applications.

CO2: Formulate the programming of part manufacturing using CNC based machines according to the nature of the part and materials.

CO3: Use the automated dimensions measurement system and give the design suggestion for vision based quality inspection and classification system for manufactured products.

COURSE OUTCOMES COs	Programme Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	√	√	√	√	√	√					√	√
2	√	√	√	√	√	√					√	√
3	√	√	√	√	√	√					√	√

MR5311 **DISSERTATION - I** **L T P C**
0 0 12 6

OBJECTIVES:

- To enable students to select and define a problem/need for analysis in the field of mechatronic and its interdisciplinary area based on the complexity of the problem.
- To review and analyse literature/ data of selected problem for study and propose objective and scope of dissertation work.
- To develop hypothesis and identify methodology based on ethical, scientific and systematic application of knowledge in the proposed field of dissertation work.
- To design, model and experiment/develop optimal solution for problem being investigated
- To analysis and interpretation of system and its performance, data, and synthesis of the information to provide valid conclusions and submit dissertation.

EVALUATION:

- A project topic may be selected based on the literature survey and the creative ideas of the students themselves in consultation with their project supervisor. The topic should be so chosen that it will improve and develop the skills in design, modelling, simulation, developing algorithms, fabrication and integration of system elements for automation and research. Literature survey and a part of the project work be carried out in dissertation-I.
- The progress of the project is evaluated based on a minimum of three reviews and review committee may be constituted by the Head of the Department.
- The project work is evaluated jointly by external and internal examiners constituted by the Head of the Department based on oral presentation and the project report.
- A project report for dissertation-I is to be submitted at the end.
- Project work evaluation is based on the Regulations of the Credit system for the Post graduate programmes of Anna University

TOTAL = 180 PERIODS

OUTCOMES:

CO1: The students would apply the knowledge gained from theoretical and practical courses in solving problems, so as to give confidence to the students to be creative and get trained in planning, organizing and coordination various components of dissertation work.

COURSE OUTCOMES Cos	Programme Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	√	√	√	√	√	√	√	√	√	√	√	√

MR5312 **INDUSTRIAL TRAINING/ INTERNSHIPS/ CERTIFIED TRAINING COURSES** **L T P C 0 0 2 1**

COURSE OBJECTIVES

INTERNSHIPS

- To asses defined problems in the industry and to provide the feasible solutions based on the skills of the graduate through internship.

INDUSTRIAL TRAINING

- To asses and acquire the training by observing and analyzing the functioning of various machineries and its elements in the industrial training.

CERTIFIED TRAINING COURSES

- To acquire certified training on various design and automation systems and its technologies offered by state / central approved institution.

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

INTERNSHIPS

CO1: Give feasible solutions to the industrial problem using systematic approach.

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INDUSTRIAL TRAINING

CO2: Get qualified and practiced to work in the industrial environment.

CERTIFIED TRAINING COURSES

CO3: Work in the industrial technologies on the certified platform.

COURSE OUTCOMES COs	Programme Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	√	√	√	√	√	√					√	√
2	√	√	√	√	√	√					√	√
3	√	√	√	√	√	√					√	√

TOTAL = 30 PERIODS

MR5411 **DISSERTATION - II**

L	T	P	C
0	0	24	12

OBJECTIVES:

- The students will be able to propose and define a problem/need for development and analysis in the field of mechatronic and its interdisciplinary area and it may be a continuation dissertation -I or newly formulated problem for dissertation - I.
- To comprehensively review and analyse literature/ data to develop hypothesis and identify methodology based on ethical, scientific and systematic application of knowledge in the field of problem.
- To design, modelling, simulation, developing algorithms, fabrication and integration of system elements for automation for development of sustainable and economical solution for problem being investigated.
- To analyse and interpretation of system and its performance, data, and synthesize of the factual information's to arrive at valid conclusions
- To enable students to communicate technical information in form of oral presentation and technical report in form of dissertation

EVALUATION:

- The progress of the project is evaluated based on a minimum of three 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 project work is evaluated jointly by external and internal examiners constituted by the Head of the Department based on oral presentation and the project report.
- Project work evaluation is based on the Regulations of the Credit system for Post graduate programmes of Anna University.

OUTCOMES:

CO1: The students' would apply the knowledge gained from theoretical and practical courses in solving problems, so as to give confidence to the students to be creative, well planned, organized, coordinated project outcome of the aimed work.

COURSE OUTCOMES COs	Programme Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	√	√	√	√	√	√	√	√	√	√	√	√

TOTAL = 360 PERIODS

MR5001 **COMPUTER AIDED INSPECTION**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

To familiar the measurement standards and to know the instruments used and various errors in measurements

- To recognize the use of basic and advanced instruments for measurements.
- To learn the applications of opto-electronics device for measurements.
- To observe the machine vision based inspections.
- To acquire the measurement strategies in inspection using CMM.

UNIT – I FUNDAMENTALS AND CONCEPTS IN METROLOGY 9

Standards of Measurement – Analog and Digital Measuring Instruments - Comparators – Limits, Fits and Tolerances – Gauge Design –Surface Roughness – Form Errors and Measurements.

UNIT – II INSPECTION AND GENERAL MEASUREMENTS 10

Linear Measuring Instruments – Evolution – Types – Classification – Limit Gauges – Gauge Design – Terminology – Procedure – Concepts of Interchange Ability and Selective Assembly – Angular Measuring Instruments – Types – Bevel Protractor Clinometers Angle Gauges, Spirit Levels Sine Bar – Angle Alignment Telescope – Autocollimator – Applications - Inspection of Gears And Threads – Tool Makers' Microscope – Universal Measuring Machine – Use of Laser Interferometer in Machine Tool Inspection – Uses of Laser in On-Line Inspection – Laser Micrometer – Laser Alignment Telescope.

UNIT – III OPTO ELECTRONICS IN ENGINEERING INSPECTION 8

Use of Optoelectronics in Tool Wear Measurements – Microhole Measurement and Surface Roughness – Applications in In-Process Measurement and On-Line Inspection.

UNIT – IV MACHINE VISION 9

Fundamentals of Image Processing – Steps Involved in Image Processing – Machine Vision Applications in Manufacturing and Metrology.

UNIT – V COORDINATE METROLOGY AND QUALITY CONTROL 9

Architecture of Coordinate Measuring Machines - Cycle Time Estimation for Measurement – Applications and Case Studies of CMM in Inspection – Use of Computers in Quality Control – Control Charts – Reliability.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO1: Practice the standards in measurements and to avoid the various forms of errors in measurements.
CO2: Use of basic and advanced metrology instruments for measurements.
CO3: Acquire the knowledge on non-contact opto-electronics device for measurements.
CO4: Apply machine vision based inspections.
CO5: Plan the measurement strategies in inspection using CMM

COURSE OUTCOMES COs	Programme Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	√										√	√
2	√				√	√					√	√
3	√				√	√					√	√
4	√				√	√					√	√
5	√	√	√	√	√	√					√	√

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1. Anil. K. Jain, “Fundamentals of Digital Image Processing”, Prentice Hall of India Pvt. Ltd., 2004.
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7. Robert J. Hocken, Paulo H. “Coordinate Measuring Machines and Systems”, Second Edition, 2016.

MR5002 DIGITAL MANUFACTURING

L	T	P	C
3	0	0	3

COURSE OBJECTIVES
- To interprete the classification of conventional machine tools and differences of NC, CNC and DNC**.**
- To understand the architecture of CNC and to identify the mechatronic elements and its functions in CNC machine reliable performance.
- To know the function various instrumentation system for parameter measurement and interface
- To understand standards and programing techniques in CNC machine.
- To learn the testing and maintance of various sub systems of CNC.

UNIT – I NC, CNC, AND DNC **9**

Classification of Machine Tools – Types, Functions and Processes - Fundamentals of NC and CNC Technologies Adaptive Control - Types, Application and Benefits - General Configuration of Adaptive Control and Function – Reasons for Process Change - Practical Problems with Adaptive Control - Example for Feedback and Adaptive Control.

UNIT – II MECHATRONIC ELEMENTS IN CNC MACHINE TOOLS **9**

CNC Systems - Configuration of the CNC System – Interfacing – Monitoring – Diagnostics - Machine Data - Compensations for Machine Accuracies - PLC in CNC – PLC Programming for CNC, Steps in Programming and Case Studies - Machine Structure -Types of Loads on CNC Machine - Guide Ways and Types - Mechanical Transmission Elements - Elements for Rotary Motion to Linear Motion - Ball Screw and Types - Roller Screw and Types - Rack and Pinion - Various Torque Transmission Elements - Requirements of Feed Drives and Spindle Drive.

UNIT – III INSTRUMENTATION SYSTEM AND AUTO TOOLING **9**

Measuring Systems - Feedback Devices - Velocity Feedback - Analog and Digital - Position Feedback - Rotary and Linear. Tooling - Requirement and Planning - Preset, Qualified and Semi Qualified Tools. Fixtures – Requirement - Unified and Modular Fixtures - Tool Identification - Touch Trigger Probe- Tool Coding - Tool Condition Monitoring - Various Indirect and Direct Methods. Identification and Gauging of Work Piece. Tool Locking System - Ball Lock Mechanism and Contact Pressure Monitoring. Automatic Tool Changing System - Types and Benefits - Tool Magazine – Sensors in CNC.

UNIT – IV CNC PROGRAMMING **10**

ISO 6983 Standards - Machine Axes Identification - Primary, Secondary and Tertiary - Manual CNC Programming - Milling Programming Fundamentals - Compensation and Offset in Milling - Fixed Cycles in Milling - Repetitive Programming - Loops, Sub Programs and Macros. Turning Programming Fundamentals - Compensation and Offset in Turning - Fixed Cycles in Turning. Computer Assisted Programming in APT - Basic Geometry Definition - Cutter Motion Definition - Postprocessor Statements - Generation and Execution of APT Programs

UNIT – V TESTING AND MAINTENANCE OF CNC MACHINES 8

Verification of Technical Specification And Functional Aspects, Verification During Idle Running & Machine Tool and the Work Piece Accuracy - Installation of CNC Machines - Maintenance of CNC Machines - Machine Elements – Hydraulic Elements - Electrical and Electronic Elements – Maintenance Schedules.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO1: Aware the differences of NC, CNC and DNC**.**

CO2: Analyze architecture of CNC and to identify the mechatronic elements and its functions in CNC machine reliable performance.

CO3: Realize the functions of instrumentation systems

CO4: Write the part programing in CNC machine.

CO5: Perform the testing and maintenance of various sub systems of CNC.

COURSE OUTCOMES Cos	Programme Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	√										√	√
2	√				√	√					√	√
3	√				√	√					√	√
4	√	√	√	√	√	√					√	√
5	√	√	√	√	√	√					√	√

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MR5003 SINGLE BOARD COMPUTERS AND PROGRAMMING

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

- To know the architecture Single board computers
- To understand the function and uses of Real time operating system
- To familiar the python programming
- To develop the embedded based python programming
- To experiment the application development in SBC using python programming.

UNIT- I INTRODUCTION TO SINGLE BOARD COMPUTERS 9

On-Board System Architecture - Processor- Architecture – Features - SPI-I2C- UART- USB - Ethernet- CAN Protocol - Wi-Fi – Bluetooth - HDMI- GPIO- Memory- Input Devices – Camera Interfacing.

UNIT- II REAL TIME OPERATING SYSTEM 8

Operating System Architecture – File Systems- Resource Management – Process Scheduling – Applications.

UNIT- III PYTHON PROGRAMMING 10

Python Language – Using the Interpreter – Python Data Types And Functions – Working With Data – List, Dictionary And Set – Processing Primitives – List Comprehensions – File Handling – Object Model Including Variables, Reference Counting, Copying, and Type Checking – Error Handling Iterative Statement- Conditional Statement – Operators – Arrays Libraries- Library - GUI Development.

UNIT- IV EMBEDDED PYTHON PROGRAMMING 9

GPIO Programming – Numerical Library- Communication Library- Image Processing – Machine Learning.

UNIT- V APPLICATIONS 9

Automotive – Mobile Robotics - IOT- Factory Automation - Home Automation.

TOTAL = 45 PERIODS

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO1: Select the Single board computers for mechatronics system development
CO2: Access the library and functions for Real time operating system
CO3: Write the python programming for various applications
CO4: Use the GPIO and peripherals using embedded based python programming
CO5: Develop the application in SBC using python programming.

COURSE OUTCOMES COs	Programme Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	√										√	√
2	√	√	√	√	√	√					√	√
3	√	√	√	√	√	√					√	√
4	√	√	√	√	√	√					√	√
5	√	√	√	√	√	√					√	√

REFERENCES

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2. Gabriele Manduchi and Ivan Cibrario Bertolotti, “Real-Time Embedded Systems: Open-Source Operating Systems”, CRC Press, 2012.
3. Guttag, John. “Introduction to Computation and Programming Using Python”, MIT Press, 2013.
4. Ninad Sathaye, “Learning Python Application Development”, Packt Publishing, 2016
5. Sai Yamanoor, Srihari Yamanoor, “Raspberry-Pi Mechatronics Projects”, Packt Publishing, 2016.
6. Warren Gay, “Mastering the Raspberry Pi”, Apress, 2014.

MR5004 MICRO AND NANO SYSTEMS L T P C
3 0 0 3

COURSE OBJECTIVES

- To introduce to microsystem of MEMS, material and fabrication technique
- To provide overview of characterization tools for MEMS
- To create awareness about principles and applications of various sensors
- To impart knowledge on different kind of Micro-Nano actuators
- To introduce Bio MEMS, Microfluidic and Nano position system

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UNIT- I INTRODUCTION TO MICRO AND NANO TECHNOLOGY 9

Overview of Nanotechnology and MEMS - Nano Structuring - Nano Particles and Nano Layers - Properties - Science and Synthesis of Nano Materials – Lithography - Micromachining - Photolithography, Deposition Methods, DIRE, LIGA and Laser-Assisted Processing - Overview of Materials for MEMS – Si Wafer, Si Based Products, Polymers.

UNIT- II CHARACTERIZATION OF MATERIALS 9

Principles and Applications of Nano Measuring Systems – Microscopy Techniques, Confocal LASER Scanning Microscopy - Scanning Electron Microscopy - Transmission Electron Microscopy, Scanning Tunnelling Microscopy, Atomic Force Microscopy, Diffraction Techniques – Auger Electron Spectroscopy (AES), X-Ray Photoelectron Spectroscopy (XPS), Electron Probe Micro-Analyser (EPMA) - Application.

UNIT- III MICRO AND NANO SENSORS 9

Si Active Tactile Sensor - Fabric Tactile Sensor and its application – Accelerometer- Capacitive Silicon – Wall in-Tube Flow Sensor and its application- Inertial Sensors – Accelerometer – Gyroscope – Pressure Sensors – Piezoresistive – Capacitive - Micro Channel Heat Sinks – Optical MEMS – Visual Display– Optical Data Switching – RF MEMS – MEMS Variable Capacitors – MEMS Switches – Resonators - Pressure Sensor - Nano Tweezers.

UNIT- IV MICRO AND NANO ACTUATORS 9

Requirement for Micro Actuators - Nano Positioners, Micro Mechanical Testing Apparatus - Classification of Micro Actuator - Electrostatic Distributed Actuator- Force Distance various Actuators– Inch Worm, Zipper and Scratch Drive. Thermal Actuation-Bimorph-Buckle Beam - Frequency and Force Characteristics and Advantages -Electro thermal Actuator - Electro Thermal Relay with Mechanical Latch – Force vs Displacement Curve - Piezoelectric Actuation Advantages - MEMS Switch -Thin Film Bulk Acoustic Resonator (FBAR) - Magnetic Actuation - External Magnetic Field Actuators & Issues - Variable Reluctance Actuators - Shape Memory Actuators - Micro Pump and Micro Fluidics.

UNIT- IV MICRO AND NANO SYSTEM 9

Micro Fluidic Systems - Micro Engine Driven by Electrostatically Actuated Comb Drive – Micro Robots and Nano Robots – Micro Insects, Night Vision System, BioMEMS- Principle and Application of Micro and Nano position Systems.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO1: Understand material and fabrication involved in Microsystem

CO2: Explain techniques to visualize and measure geometrical features of MEMS system and chemical composition.

CO3: Select a type of sensors based on application with working knowledge and principles.

CO4: Select a type of factor based on application with knowledge of working principle.

CO5: Discuss on Micro fluidic, Bio MEMS and Nano position systems.

COURSE OUTCOMES COs	Programme Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	√										√	√
2	√	√	√	√	√	√					√	√
3	√	√	√	√	√	√					√	√
4	√	√	√	√	√	√					√	√
5	√	√	√	√	√	√					√	√

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REFERENCES:

1. Mahalik N P, “MEMS”, McGraw Hill (India), 2009
2. Marc Madou, “Fundamentals of Micro Fabrication”, CRC Press, 2011.
3. Mohamed Gad-el-Hak, “MEMS Handbook”, CRC Press, 2006,
4. Sami Franssila, Introduction to Micro Fabrication, John Wiley & Sons Ltd, 2010.
5. Tai – Ran Hsu, “MEMS and Microsystems Design and Manufacture”, Tata-McGraw Hill, New Delhi, 2007.
6. Waqar Ahmed and Mark J. Jackson, “Emerging Nanotechnologies for Manufacturing”, Elsevier Inc., 2014.

MN5072 GREEN CONCEPTS L T P C
3 0 0 3

OBJECTIVES

- To impart knowledge about air pollution and its effects on the environment.
- To enlighten the students with knowledge about noise and its effects on the environment.
- To enlighten the students with knowledge about water pollution and its effects on the environment.
- To impart the knowledge of fire safety and its production.
- To impart the knowledge about the need, procedure and benefits of Green-Co rating.

UNIT I AIR POLLUTION SAMPLING AND MEASUREMENT 9

Primary and Secondary Pollutants, Automobile Pollutants, Industrial Pollution, Ambient air quality Standards, Metrological aspects of air Pollution, Temperature lapse Rates and Stability-wind velocity and turbulence-Pump behaviour dispersion of air Pollutants-solution to the atmosphere dispersion equation-the Gaussian Plume Model, Air pollution sampling-collection of gaseous air pollutants collection of particulate pollutants-stock sampling, analysis of air pollutants-sulphur dioxide-nitrogen dioxide, carbon monoxide, oxidants and ozone

UNIT II NOISE POLLUTION AND CONTROL 9

Frequency and Sound Levels, Units of Noise based power radio, contours of Loudness. Effect of human, Environment and properties, Natural and Anthrogenic Noise Sources, Measuring Instruments for frequency and Noise levels, Masking of sound, Types, Kinetics, Selection of different reactors used for waste treatment, Treatment of noise at source, Path and Reception, Sources of noise, Effects of noise-Occupational Health hazards, thermal Comforts, Heat Island Effects, Radiation Effects.

UNIT III WATER DEMAND AND WATER QUALITY 9

Factors affecting consumption, Variation, Contaminants in water, Nitrates, Fluorides, Detergents, taste and odour, Radio activity in water, Criteria, for different impurities in water for portable and non portable use, Point and non-point Source of pollution, Major pollutants of Water, Water Quality Requirement for different uses, Global water crisis issues.

UNIT IV FIRE SAFETY 9

Basic Elements, Causes, Industrial Fires, Explosions, Effects on Environmental, Property and Human Loss, Prevention technique, Building Design, Fire Protection System, contingency plan, Emergency preparedness, Evacuation.

UNIT V GREEN CO-RATING 9

Ecological footprint, Need for Green Co-rating systems, Intent, System approach, Weightage, Assessment Process, types of ratings, Green Co-Benefits, Case studies of Green Co-Rating.

TOTAL: 45 PERIODS

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OUTCOMES:

Students will be able to

CO1 : Understand manufacturing processes towards minimization or prevention of air pollution.

CO2 : Understand manufacturing processes towards minimization or prevention of noise pollution.

CO3 : Understand manufacturing processes towards minimization or prevention of water pollution.

CO4 : Presenting the knowledge of fire safety and its production.

CO5 : Predicting green co-rating and its benefits.

REFERENCES:

1. Dornfield David, Green Manufacturing, Springer, 2013
2. Davim J Paulo, Green Manufacturing Processes and Systems, Springer, 2013
3. Cairncrss and Francis – Costing the earth – Harvard Business School Press – 2009
4. World Commission on Environment and Development (WCED), Our Common Future, Oxford University Press 2005.
5. Green Co Case Study Booklet, CII – Sohrabji Godrej Green Business Centre, 2015.

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

MR5071 INDUSTRIAL ROBOTICS

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

- To know the basic terminologies, classification of robot and configurations of serial manipulator.
- To understand the mechanical design and kinematics of serial manipulator.
- To learn the robot programing and safety consideration of industrial manipulator.
- To understand the concepts and stabilization of legged and wheeled mobile robots.
- To demonstrate the robots in various applications.

UNIT - I INTRODUCTION TO SERIAL MANIPULATORS 9

Types of Industrial Robots, Definitions – Classifications Based on Work Envelope – Generations Configurations and Control Loops - Co-Ordinate System – Need for Robot – Basic Parts and Functions – Specifications – Robotic Sensor - Position and Proximity's Sensing – Tactile Sensing – Sensing Joint Forces.

UNIT - II MECHANICAL DESIGN OF ROBOT SYSTEM 11

Robot Motion – Linkages and Joints – Mechanism – Method for Location and Orientation of Objects - Kinematics of Robot Motion – Direct and Indirect Kinematics Homogeneous Transformations – D-H Transformation – Drive Systems – End Effectors – Types, Selection, Classification and Design of Grippers – Gripper Force Analysis.

UNIT- III ROBOT PROGRAMMING & ROBOTIC WORK CELLS 9

Types of Programming – Teach Pendant Programming – Basic Concepts in AI Techniques – Concept of Knowledge Representations – Expert System and its Components Robotic Cell Layouts – Inter Locks.

UNIT- IV MOBILE ROBOTICS 8

Wheeled Robot and Legged Robot – Architecture - Configurations and Stability - Design Space and Mobility Issues - Teleportation and Control – Localization – Navigation - AGV

UNIT - V APPLICATIONS OF ROBOTS 8

Robotic Surgery - Manufacturing Industries - Material Handling, Assembly, Inspection - Space – Underwater – Nuclear industry – Humanoid Robots.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO1: Classify the various configurations of serial manipulators.
CO2: Develop the kinematics solution of serial manipulator.
CO3: Find the differences of robot programing languages and safety consideration of industrial manipulator.
CO4: Develop the legged and wheeled mobile robots.
CO5: Demonstrate the robots in various applications.

COURSE OUTCOMES COs	Programme Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	√										√	√
2		√	√	√							√	√
3	√	√	√	√	√	√					√	√
4	√	√	√	√	√	√					√	√
5	√	√	√	√	√	√					√	√

REFERENCES:

1. Fu.K.S, Gonzalac R.C, Lee C.S.G, “Robotics Control, Sensing, Vision and Intelligence”, Mc-Graw Hill book co 2011.
2. Groover.M.P. “Industrial Robotics, Technology, Programming and Application”, Mc-Graw Hill book and co. 2012
3. John J Craig, “Introduction to Robotics”, Pearson, 2005.
4. Saeed B.Niku, “Introduction to Robotics, Analyses, Systems, Applications”, Prentice Hall Pvt Ltd., 2005.
5. Yoram Koren, “Robotics”, McGraw Hill 2006.

MR5005 MULTI-BODY DYNAMICS

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

- To understand the important concepts of multi-body dynamics.
- To familiar the various computational methods multi-body dynamics.
- To characterize the nonlinear concepts of multi-body dynamics.
- To recognize the need of control in nonlinear dynamics multi body interactions.
- To interpret the nonlinear dynamics of multi body systems and its realization of control.

UNIT - I INTRODUCTION TO DYNAMICS 9

Importance of Multibody Dynamics - Particle Mechanics - Rigid Body Mechanics - Deformable Bodies - Constrained Motion- -Kinematics - Rotation - Translation - Velocity- Acceleration Equations – Mechanics of Deformable Bodies - Floating Frame Reference Formulation – Inertia - Generalized Forces - Equation of Motions - Multi Body Systems - Sub Systems - Friction and Spring Nonlinear Model - Nonlinear Dynamic Equations Formulation

UNIT- II COMPUTATIONAL METHODS FOR DYNAMIC ANALYSIS 10

Jacobian Matrix - Newton-Rasphon Method - Nonlinear Kinematic Constrain Equation – System Mass Matrix - External and Elastic Forces - Acceleration Vector – Lagrangian Multiplier - Langrage's Equation – Kinetic Energy – Hamilton Equation - Hamilton vector Field- Euler - Langrage Equation- Generalized Reaction Forces – State Vector and Equation Formulation.

UNIT - III NONLINEAR SYSTEMS AND CONCEPTS 10

Linear Time Varying and Linearization – Input and Output Stability - Lyapunov Stability Analysis – Asymptotic Stability - Popov's and Circle Criterion - Perturbed System – Chaos – Periodic Orbits- Index theory and Limit Cycle – Center Manifold Theory- Normal Forms- Nonlinear analysis- Poincare Maps - Bifurcations – Maps - Vector Fields - Methods – Control System Design using Lyapunov's Direct Method

UNIT - IV SYSTEM CHARACTERIZATION 8

Stability, Controllability, Observability - Phase Plane Analysis - Phase Portrait - Limit Cycle - Describing Function - Assumption – Limit Cycles

UNIT - V CONTROL OF NONLINEAR MECHANICAL SYSTEMS 8

Double Inverted Pendulum – Nonlinear Machineries – Robots - Suspension System - Aircraft.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO1: Use the important concepts in multi-body dynamics.
CO2: Formulate mathematical model for capturing the dynamics of multi-body interactions.
CO3: Describe the nonlinear behavior of multi-body dynamics.
CO4: Practice the control in nonlinear dynamics of multi body interactions.
CO5: Demonstrate control for the nonlinear behavior of multi body systems.

COURSE OUTCOMES COs	Programme Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	√	√	√	√							√	√
2		√	√	√							√	√
3		√	√	√							√	√
4		√	√	√							√	√
5	√	√	√	√							√	√

REFERENCES

1. Ahmed A. Shabana, "Dynamics of Multibody Systems", Cambridge University Press, 2013.
2. Brian L. Stevens, Frank L. Lewis, "Aircraft Control and Simulation", Wiley India Pvt Ltd, 2010.
3. Hasan Khalil, "Nonlinear Systems and Control", Prentice Hall, 2002.
4. Mahmut Reyhanoglu, "Dynamics and Control of a Class of Under Actuated Mechanical Systems", IEEE Transactions on Automatic Control, 44(9), 1999.
5. Stephen Wiggins, "Introduction to Applied Nonlinear Dynamics System and Chaos", Springer-Verlag, 2000.
6. Wei Zhong and Helmut Rock, "Energy and Passivity Based Control of the Double Inverted Pendulum on a Cart", IEEE, 2001.

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MR5006	MODELLING AND FINITE ELEMENT ANALYSIS OF ELECTROMECHANICAL SYSTEMS	L T P C 3 0 0 3

COURSE OBJECTIVES

- To equip students with fundamentals of finite element principles.
- To enable them to understand the behavior of various finite elements and to be able to select appropriate elements to solve physical and engineering problems to emphasis on structural, thermal, Electrical and fluid engineering applications.
- To make them to understand to shape functions and higher order formulation.
- To learn various quantities in engineering problems and also make them to work on preprocessing, meshing, boundary condition assigning and post processing.
- To make them to work on real time problem by giving various case studies and explore them to the FEM software available in the market.

UNIT- I INTRODUCTION 8

Basics of FEM – Initial Value and Boundary Value Problems – Weighted Residual Galerkin and Raleigh Ritz Methods – Review of Variational Calculus – Integration by Parts – Basics of Variational Formulation.

UNIT- II ONE DIMENSIONAL ANALYSIS 10

Steps in FEA – Discretization, Function – Derivation of Element Characteristics Matrix, Shape Function, Assembly and Imposition of Boundary Conditions – Solution and Post Processing – One Dimensional Analysis in Solid Mechanics, Heat Transfer, Fluid Dynamics, Electrostatics and Electromagnetics.

UNIT- III SHAPE FUNCTIONS AND HIGHER ORDER FORMULATIONS 9

Global and Natural Co-Ordinates – Shape Functions for One and Two Dimensional Elements – Three Noded Triangular and Four Noded Quadrilateral Element – Nonlinear Analysis – Isoparametric Elements – Jacobian Matrices and Transformations – Basics of Two Dimensional Axi Symmetric Analysis.

UNIT-IV ELECTROMECHANICAL SYSTEMS AND IMPLEMENTATION 9

Basic quantities – Energy Stored in Electric Field – Capacitance – Magnetic Field – Linked Flux – Inductance – Force – Torque – Stress- Flow- Pre Processing, Mesh Generation, Elements Connectivity, Boundary Conditions, Input of Material and Processing Characteristics – Solution and Post Processing.

UNIT-V CASE STUDIES 9

FE Analysis of biomechanical Modelling – Tissue Modelling - Actuators – Rotating Machines- Sensors - Robot Arm- Overview of Application Packages - ANSYS, ABAQUS and COMSOL – Development of Model and Validation.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

CO1: Understand the fundamentals of finite element principles.

CO2: Select appropriate elements to solve Physical and Engineering problem in structural, thermal, Electrical and fluid engineering applications.

CO3: Understand shape functions and higher order formulation.

CO4: Do pre-processing and select appropriate element, boundary condition, meshing and Post processing for any engineering problem.

CO5: Know about various software packages used for FEM analysis and analyse a production process through FEA and control it's parameters.

COURSE OUTCOMES COs	Programme Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	√										√	√
2	√	√	√	√							√	√
3		√	√								√	√
4	√	√	√	√							√	√
5	√	√	√	√	√	√					√	√

REFERENCES

1. Bathe, K. J. “Finite Element Procedures” Klaus-Jürgen Bathe, 2014.
2. Binns K.J, Lawrenson P.J, Trowbridge C.W, “The Analytical and Numerical Solution of Electric and Magnetic Fields”, John Wiley & Sons, 1993.
3. Matthew. N.O. Sadiku, “Elements of Electromagnetics”, Oxford University Press, 2007.
4. Nathan Ida, Joao P.A.Bastos , “Electromagnetics and Calculation of Fields”, Springer Verlage, 1992.
5. Nicola Biyanchi , “Electrical Machine Analysis using Finite Elements”, Taylor and Francis Group, CRC Publishers, 2005.
6. Reddy, J.N, “An Introduction to the Finite Element Method”, McGrawHill, 1985.
7. Salon S.J, “Finite Element Analysis of Electrical Machines” Kluwer Academic Publishers, 1995,

MR5007 BIOMECHATRONICS

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

- To familiarize the fundamentals of biomechanics.
- To characterize and relate the behaviors of skeletal and muscular systems for engineering solutions.
- To understand the servomechanism of biological systems.
- To design artificial structural elements for replacements.
- To simulate and develop the applications of biomechatronics.

UNIT- I BIOMECHANICS 9

Introduction to Bio-Mechanics, Relation between Mechanics and Medicine, Newton”s Laws, Stress, Strain, Shear Rate, Viscosity, Visco-Elasticity, Non-Newtonian Viscosity, Soft Tissue Mechanics, Mechanical Properties of Soft Biological Tissues - Bio Fluid Mechanics - Introduction to Biomechatronic Systems

UNIT- II MECHANICS IN SKELETAL AND MUSCULAR SYSTEM 9

Bones, Types and Functions **-** Axial and Appendicular Skeleton. Joints: Definition, Types and Functions, Mechanical Properties of Bones. Kinetics and Kinematics Relationship of Skeletal and Muscular System.

UNIT - III CONTROL MECHANISM OF BIOLOGICAL SYSTEMS 9

Skeletal Muscles Servo Mechanism, Cardio Vascular Control Mechanism, Respiratory Control Mechanism – Interfacing Techniques with Natural Servo Mechanism.

UNIT - IV PROSTHETIC AND ORTHOTIC DEVICES 9

Analysis of Force in Orthopaedic Implants, Hand and Arm Replacement, Different Types of Models for Externally Powered Limb Prosthetics, Lower Limb, Upper Limb Orthotics, and Material for Prosthetic and Orthotic Devices, Functional Electrical Stimulation, Sensory Assist Devices. Exoskeletons, Exomusculatures, Space Suits, Physical Therapy and Rehabilitation, Wheelchairs and other Mobility Assistance.

UNIT - V SIMULATION AND MODELLING OF BIOMECHANTRONICS 9

Physics-Based Modelling and Simulation of Biological Structures - Variables Of Interest – Geometry - Introduction to Model the Skeletal System Using Open Source Software – Human Leg Prosthesis And Normal Gait vs. Prosthesis Leg Analysis - Upper Extremity Kinematic Model – Application in Sports, exercise, entertainment.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO1: Know the fundamentals of biomechanics.
CO2: Describe and relate the behaviors of skeletal and muscular systems
CO3: Realize the servomechanism of biological systems for biomechatronic development.
CO4: Design the artificial biomehatronics systems.
CO5: Establish and develop the applications of biomechatronics.

COURSE OUTCOMES COs	Programme Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	√										√	√
2	√	√	√	√							√	√
3			√	√		√					√	√
4	√	√	√	√		√					√	√
5	√	√	√	√	√	√					√	√

REFERENCES

1. Dawson .D and Right, “Introduction to Bio-mechanics of Joints and Joint Replacement”, Mechanical Engineering Publications Ltd., 1989.
2. Fung .Y.C, “Biomechanics: Mechanical Properties in Living Tissues”, Springer Verlag, 1981.
3. Susan J.Hall, “Basics Bio-Mechanics”, McGraw-Hill, 2002.
4. Gillian Pocock & Christopher D.Richards, “The Human Body”, Oxford University Press, 2009.
5. Jacob Segil, “Handbook of Biomechatronics”, Acadamic Press, 2018.
6. Marko Popovic, Biomechatronics, Academic Press, 2019.
7. Ranganathan T S, “Text Book of Human Anatomy” S. Chand and Company, 1994.
8. Scott L. Delp., “OpenSim: Open-Source Software to Create and Analyze Dynamic Simulations of Movement”, IEEE Transaction on Biomedical Engineering, Vol.54 No.11, 2007.

MR5008 APPLIED SIGNAL PROCESSING

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

- To understand the characteristics of various types of signals.
- To carry out the preprocessing of different form of signals using digital filters and denoising methods.
- To learn FFT and ARMA methods in signals processing.
- To demonstrate the signal processing in time and frequency domain
- To utilize the spectral and cepstral analysis of signals

UNIT - I SOURCES OF SIGNALS 9

Generation and Characteristics of Speech Signals – Seismic Signals – Radar - Vibration – Ultrasonic - Pressure – Strain - Temperature Signals - Bio Signals - ECG, EEG, Phonocardiogram - EMG.

UNIT - II PRE-PROCESSING OF SIGNALS 9

Noise Sources & Characteristics – Filters - IIR and FIR Filters -Design of Filters Low Pass, High Pass Filter, Band Pass Filter, Notch Filter Chebshiv Filters. Elliptic Filters, Butter Worth Filters – Kalman Filter - Adaptive Filtering - Comb Filter- Denoising Concepts.

UNIT - III DIGITAL SIGNAL PROCESSING 9

Time Series Analysis –Time Varying Analysis - Time Frequency Representation - ARMA Signal Modelling - FFT - Power Spectral Density Estimation.

UNIT - IV FEATURE EXTRACTION METHODS 9

STFT – DFFT – Sine and Cosine Transform – Wavelet Concept – Empirical Mode Decomposition (EMD) – Time Frequency Representation, Spectrogram – Methods for Extracting the Features of the Signal: Energy, Average Magnitude - Introduction to Feature Extraction and Classification Techniques.

UNIT - V ANALYSIS AND APPLICATION OF SIGNAL PROCESSIONG 9

Cepstral Analysis of Speech Signals – Spectral Analysis Bio Signals and Vibration Signals - Radar Signal Processing for Multiple Sensor Informations - Signal Processing in Affective State Computation and Brain Computer Interface – Introduction to Fusion Technique.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO1: Classify the various types of signals.
CO2: Develop the preprocessing of different form of signals.
CO3: Use the FFT and ARMA methods in signals processing.
CO4: Demonstrate the signal processing in time and frequency domain.
CO5: Utilize the spectral and cepstral analysis of signals.

COURSE OUTCOMES COs	Programme Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	√										√	√
2			√	√	√	√					√	√
3		√	√	√							√	√
4		√	√	√							√	√
5	√	√	√	√	√	√					√	√

REFERENCES

1. Arnon Cohen, “Bio-Medical Signal Processing Vol-I and Vol-II”, CRC Press Inc., Boca Rato, 1999.
2. Emmanuel C. Ifeachor, Barrie W.Jervis, “Digital Signal Processing- A Practical Approach”, Pearson, 2002.
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MR5009 **ADVANCED CONTROL SYSTEMS** **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To recall the fundamentals of PID control and familiar various performance measures used in control systems.
- To interpret the single loop control and it's tuning.
- To model, analyse the system in state space and its observer design in detail
- To familiar the nonlinear control system and its concepts.
- To learn the functions and used of various control methodology.

UNIT - I CONTROLLER AND PEREOFRMANCE MEASURES 9

Review of Feedback Systems and Design of PID Controllers - Electronic PID Controller – Digital PID Algorithm – Auto/Manual Transfer - Reset Windup – Practical Forms of PID Controllers - Evaluation Criteria – IAE, ISE, ITAE And ¼ Decay Ratio – Tuning Using Process Reaction Curve Method, Continuous Cycling Method and Damped Oscillation Method – Pole Placement – Lamda Tuning.

UNIT- II ENHANCEMENT TO SINGLE LOOP CONTROL 8

Feed-Forward– Ratio Control – Cascade Control – Inferential Control – Split-Range – Override Control – Selective Control – Sliding Mode Control - Auto Tuning.

UNIT - III STATE SPACE ANALYSIS 10

Concepts of State Variable and State Model – State Space to Transfer Function and Transfer Function to State Space Modes – Solving Time Invariant State Equation – Controllability – Observability – State Observers – Design of Control Systems with Observers.

UNIT - IV NONLINEAR SYSTEMS AND CONTROL 10

Non-Linear Systems – Common Physical Nonlinearities – Linearization of Nonlinear Systems – Phase Portrait Analysis – Isocline Method – Liapnov's Stability Concept – Popov Criterian – Kalman Algorithm.

UNIT - V OTHER CONTROL METHODS 8

LQR - Adaptive Control – Optimal Control – Robust Control – Model Predictive Control – Multivariable Control systems.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO1: Develop the PID control and capable to analyze performances of the control systems.
CO2: Know the functions of various types of single loop control and its tuning.
CO3: Examine the system in state space and its observer design in detail
CO4: Approach the nonlinear control system and its concepts.
CO5: Recognize the uses of various control methodology.

COURSE OUTCOMES COs	Programme Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	√	√									√	√
2	√	√	√	√	√						√	√
3		√	√	√							√	√
4	√	√	√	√							√	√
5	√	√	√	√	√	√					√	√

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REFERENCES:

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5. Ogata.K, “Modern Controls Engineering“, Prentice Hall, 2005.
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MR5010	HAPTICS AND MIXED REALITY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To identify the terminologies of haptic devices.
- To understand the structure of haptic system and to aware the tele-operation for various applications.
- To acquire the knowledge on modelling for haptic system development relevant to the human.
- To emphasize the significance of knowledge in virtual and augmented reality.
- To know the concepts and hardware of mixed reality.

UNIT - I INTRODUCTION TO HAPTICS 8

Definition - Importance of Touch - Tactile Proprioception - Tactual Stereo Genesis - Kinesthetic Interfaces - Tactile Interfaces - Human Haptics - Overview of Existing applications - Basics of Force Feedback Devices - Kinesthetic Vs. Tactile Haptic Devices - Configurations of Kinesthetic Devices -Types of Kinesthetic Devices -

UNIT – II KINESTHETIC HAPTIC DEVICES AND TELEOPERATION 10

Mechatronics in Haptics System - Haptic Kinematics - Haptic Dynamics - Existing Kinesthetic Devices - Haptic Device Static Rendering - Haptic Device Dynamic Rendering - Control of Haptic Devices - Stability Analysis of Haptic Devices - Stability Analysis of the Rendered Model -Passivity of the Rendered Model. Types of Sensors - Measurement of Haptic Parameters - Types of Actuators - Types of Transmission - Admittance Type Kinesthetic Device - Admittance Control - Comparison of Impedance and Admittance Type Devices - Genesis of Tele-Operation - Tele-Operation Controllers -Tele-Operator Transparency - Stability Analysis of Tele-operator - Tracking and Transparency - Surface Haptic - Exogenous Force Inputs.

UNIT - III HUMAN HAPTICS ITS PLATFORM 9

Introduction - Types of Haptic Sensing - Active vs. Passive Touch - Mechanoreception-Mechanoreceptive Afferents - Kinesthetic Sensing - Force Sensing and Proprioception-Introduction to Psychophysics - Measurement Thresholds - Laws of Psychophysics - Weber's Law - Fechner's Law - Fitt's Law - Psychophysical Methods of Limit, Constant Stimuli and Adjustment - Introduction to Virtual Reality Modelling Language (VRML) – Open Haptic Platform - OpenGL-Virtual Environment Manager - Modelling of Simple Haptic System.

UNIT-IV VIRTUAL AND AUGMENTED REALITY 9

The Reality – Virtuality Continuum - Virtual Reality Definitions - Software, Hardware, Sensation and Perception - Multi-Modal Interaction Challenges - System Architecture of Virtual Reality. Aspects of Geometrical Modelling and Environmental Modelling General Solution for Calculating Geometric & Illumination Consistency in the Augmented Environment. Usability Guidelines - Design and Implementation of an Immersive User Experience - Case Study for VR and AR.

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UNIT-V MIXED REALITY 9

System Architecture of a Mixed Reality System - Common Interaction Techniques for Mixed Reality Environments - Common Navigation Techniques - Common Interface for MR - Menu Design Directions - Haptic Control Panel - Performance of an Interaction Techniques, Advanced Interaction Techniques, Design and Implementation of an Immersive User Experience - Case Study for MR.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO1: Recognize the haptic technology and its concepts in various haptic systems.
CO2: Classify the elements of haptics system and tele-operation in detail.
CO3: Design and use the devices in human haptic applications.
CO4: Combine and build the virtual and augmented reality based models.
CO5: Develop the design and model the hardware of mixed reality.

COURSE OUTCOMES COs	Programme Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	√	√									√	√
2	√	√	√								√	√
3	√	√	√								√	√
4			√	√	√	√					√	√
5	√	√	√	√	√	√					√	√

REFERENCES

1. Burdea, G. C. and P. Coffet. “Virtual Reality Technology”, Wiley-IEEE Press, 2006.
2. Eckehard Steinbach et al, “Haptic Communications”, Vol. 100, 4:937-956, 2012
3. Hannaford B and Okamura A. M “Haptics: Handbook of Robotics”, Springer, pp. 718-735, 2008.
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5. Jean-Pierre Bresciani, Knut Drewing and Marc O. Ernst. “Human Haptic Perception and the Design of Haptic-Enhanced Virtual Environments: The Sense of Touch and Its Rendering”, STAR 45, pp. 61–106, 2008.
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9. Yuichi Ohta, Hideyuki Tamura, “Mixed Reality: Merging Real and Virtual Worlds”, Springer-Verlag, 2013.

MR5011 HUMAN MACHINE INTERFACE

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

- To familiar the need for HMI in mechatronic systems
- To distinguish the software and hardware elements of HMI
- To enlist the requirement of human for machine interaction
- To model the integrated framework for man and machine interface.
- To elaborate the EEG signals and its types based brain machine interface.

UNIT - I INTRODUCTION TO HMI 9

HMI Basics -Human Computer Interaction as an emerging field - Applications of Human Machine Interface (HMI) - HMI types - Human Information Processing -Interaction styles and general design Interaction -strategies Interface metaphors and conceptual models HCI and the World Wide Web HCI - security Accessibility of User Interfaces Usability engineering and evaluation HCI and social computing.

UNIT - II ELEMENTS OF HMI 9

HMI Interfacing Considerations -HMI Hardware Selection -HMI Software Selection - Configuring System Communications - Passive and active – Mental models- Creating a Tag Database - PLC Programming Considerations -Creating Basic Graphical Displays/Screens-Security – Event controlled interface.

UNIT - III PERCEPTION, MEMORY, COGNITION 9

Perception & Cognition - Visual System – Image Generation and Perception-Touch-Hearing-Model Human Processor- STM, LTM, Chunking - Principles of Operation- Power Law - Fitts Law - Hicks Law – Factors Affecting - Perception, Memory, Cognition

UNIT - IV INTEGRATED MODELLING FRAMEWORK 9

Supervisory Control – Criteria for Sharing Task between Operator And Machine – Human – Machine Cooperation - Human–Machine Cooperation - Generic Integrated Modelling Framework - Car Driver Cognitive Architecture of the Human Cognitive System - Control Loops - Tactical Module – HMI in Automation.

UNIT - V BRAIN COMPUTER INTERFACE 9

Introduction to BCI – Brain Regions and Responsibilities - Active Methods for Measuring Brain Activity – Invasive and Non-Invasive Procedures - EEG – P300 - VEP- ERD- NIRS – Application in Prosthetic Control - Neurorehabilitation – Neurotraining – Brain Controlled Wheel Chairs

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO1: Understand the need for HMI in mechatronic systems
CO2: Know the software and hardware elements of HMI
CO3: Familiar the requirement for human machine interaction
CO4: Model the integrated framework for man and machine interface
CO5: Design and analyze EEG signals based machine interface.

COURSE OUTCOMES COs	Programme Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	√										√	√
2	√	√									√	√
3	√	√			√	√					√	√
4	√	√	√	√	√	√					√	√
5			√	√	√	√					√	√

REFERENCES

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2. Bernhard Graimann, Bredan Allison, Gert Pfurtscheller, “Brain – Computer Interfaces”, Springer-Verlag Berlin Heidelberg, 2010.
3. Guy A.Boy ed., “The Hand Book of Human Machine Interaction”, Ashgate Publishing Limited, 2011.
4. Jean-Yves Fiset, “Human-Machine Interface Design for Process Control Applications”, ISA Publisher, 2008.
5. Jonathan Wolpaw, Elizabeth Winter Wolpaw, “Brain Computer Interfaces: Principles and Practice”, Oxford University Press, 2012.

MR5012	COMPUTER VISION AND DEEP LEARNING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To familiar the fundamentals of image processing and functioning of camera.
- To appreciate 3 dimensional structure and motions.
- To learn the visual servicing for robotic applications
- To understand the fundamentals of Neural network
- To appreciate and develop the deep learning networks for image processing

UNIT – I IMAGE FORMATION AND CAMERA CALIBRATION 9

Basics: Sampling Theorem – Numerical Differentiation – Singular Value Decomposition Introduction to Vision, Terminologies of Fields, Comparison of Biological and Computer Vision, Projective Geometry Basics, Modelling of Geometric Image Formation, Modelling of Camera Distortion, Camera Calibration, Methods of Camera Calibration, Estimation of Projection Matrix, Experimental Performance Assessment in Computer Vision.

UNIT – II 3-D STRUCTURE AND MOTION 10

Computational Stereopsis – Geometry, Parameters – Correspondence Problem, Epipolar Geometry, Essential Matrix And Fundamental Matrix, Eight Point Algorithm – Reconstruction by Triangulation, Visual Motion – Motion Field of Rigid Objects – Optical Flow – Estimation of Motion Field – 3D Structure and Motion from Sparse and Dense Motion Fields – Motion Based Segmentation – Image Processing.

UNIT – III ACTIVE AND ROBOT VISION 8

LIDAR - Construction, Working Principle, Specifications and Selection Criteria. Point Cloud Data Processing. Visual Tracking – Kalman Filtering – Visual SLAM, Solutions, Visual Servoing, Types and Architecture.

UNIT – IV INTRODUCTION TO NEURAL NETWORKS 8

Introduction to Neural Networks, Philosophy and Types of Networks, Back propagation, Numerical Problems for Back Propagation, Multi-Layer Perceptrons, Numerical Problems Based on Perceptron, Conventional Neural Networks vs. Deep Learning in the Context of Computer Vision, Loss Function, Optimization, Higher-Level Representations, Image Features, Stochastic Gradient Descent

UNIT – V DEEP LEARNING 10

Convolutional Neural Networks - Convolution, Pooling, Activation Functions, Initialization, Dropout, Batch Normalization, Deep Learning Hardware - CPU, GPU and TPU -Tuning Neural Networks, Best Practices, Training Neural Networks, Update Rules, Ensembles, Data Augmentation, Transfer Learning, Popular CNN Architectures for Image Classification – Alexnet, VGG, Resnet, , Inception, CNN Architectures for Object Detection – RCNN and Types – Yolo - Semantic Segmentation - FCN, Instance Segmentation - Mask RCNN – Deep Learning frameworks.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO1: Process and practice the basic images.
CO2: Develop the 3-Dimensional structures and motions.
CO3: Model the visual serving for robotic applications
CO4: Acquire and practice the basic neural networks.
CO5: Develop and train the deep learning networks for image processing.

COURSE OUTCOMES COs	Programme Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	√										√	√
2		√	√	√							√	√
3		√	√	√	√	√					√	√
4	√	√	√	√	√	√					√	√
5	√	√	√	√	√	√					√	√

REFERENCES

1. Boguslaw Cyganek, J. Paul Siebert, “An Introduction to 3D Computer Vision Techniques and Algorithms”, Willey, 2009.
2. Davies E.R, “Computer and Machine Vision: Theory, Algorithm, Practicalities”, Academic Press, Elsevier, 2012.
3. Emanuele Trucco, Alessandro Verri, “Introductory Techniques for 3D Computer Vision”, Prentice Hall, 1998
4. Rafael C. Gonzales, Richard.E.Woods, “Digital Image Processing”, Pearson, 2018.
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MN5074 QUALITY AND RELIABILITY ENGINEERING L T P C
3 0 0 3

OBJECTIVES:

- To study the approaches and techniques to assess quality by statistical process control.
- To study the methodology to assess and sampling of parameters
- To introduce to experimental design and Taguchi method.
- To illustrate the students the concepts of reliability engineering tools.
- To train students the designfor reliability and maintainability.

UNIT I QUALITY AND STATISTICAL PROCESS CONTROL 8

Quality – Definition – Quality Assurance – Variation in process – Factors – process capability – control charts – variables X, R and X, - Attributes P, C and U-Chart tolerance design. Establishing and interpreting control charts – charts for variables – Quality rating – Short run SPC.

UNIT II ACCEPTANCE SAMPLING 8

Lot by lot sampling – types – probability of acceptance in single, double, multiple sampling plans – OC curves – Producer‘s risk and consumer‘s risk. AQL, LTPD, AOQL, Concepts – standard sampling plans for AQL and LTPD – use of standard sampling plans.

UNIT III EXPERIMENTAL DESIGN AND TAGUCHI METHOD 9

Fundamentals – factorial experiments – random design, Latin square design – Taguchi method – Loss function – experiments – S/N ratio and performance measure – Orthogonal array.

UNIT IV CONCEPT OF RELIABILITY AND DESIGN 9

Definition – reliability vs quality, reliability function – MTBF, MTTR, availability, bathtub curve – time dependent failure models – distributions – normal, Weibull, lognormal – Reliability of system and models – serial, parallel and combined configuration – Markove analysis, load sharing systems, standby systems, covariant models, static models, dynamic models.

UNIT V DESIGN FOR RELIABILITY AND MAINTAINABILITY 11

Reliability design process, system effectiveness, economic analysis and life cycle cost, reliability allocation, design methods, parts and material selection, derating, stress-strength and analysis, failure analysis, identification determination of causes, assessments of effects, computation of criticality index, corrective action, system safety

– analysis of down-time – the repair time distribution, stochastic point processes system repair time, reliability under preventive maintenance state dependent system with repair. MTTR – mean system down time, repair vs replacement, replacement models, proactive, preventive, predictive maintenance maintainability and availability, optimization techniques for system reliability with redundancy heuristic methods applied to optimal system reliability.

TOTAL: 45 PERIODS

OUTCOMES:

Student will be able to

CO1 : Understand the basic techniques of quality improvement, fundamental knowledge of statistics and probability and use control charts.

CO2 : Describe different sampling plans.

CO3 : Solve problems by various design methods.

CO4 : Acquire basic knowledge of reliability.

CO5 : Implement the concepts of reliability and maintainability.

REFERENCES:

1. Amitava Mitra, Fundamentals of Quality Control and Improvement, 4th Edition, Pearson Education, 2016.
2. Charles E Ebling, An Introduction to Reliability and Maintainability Engineering, Tata-McGraw Hill, 2018.
3. David J Smith, Reliability, Maintainability and Risk: Practical Methods for Engineers, Butterworth 2010.
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6. Patrick D T O'Connor, Practical Reliability Engineering, 4th Edition, John-Wiley and Sons Inc, 2012.

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

MR5013 MACHINE VISION

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

- To understand human vision, computer vision, machine vision and physics of light.
- To learn about the different light source, lighting technique, lens, sensors, interfacing and need to learn how to select all of them based on application.
- To understand various image processing techniques and need to develop image processing algorithm.
- To learn about various 3D image reconstruction techniques.
- To apply hardware selection steps, to develop software for various application.

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UNIT- I INTRODUCTION TO MACHINE VISION 9

Human Vision – Machine Vision and Computer Vision – Benefits of Machine Vision – Block Diagram and Function of Machine Vision System Implementation of Industrial Machine Vision System – Physics of Light – Interactions of Light – Refraction at a Spherical Surface – Thin Lens Equation.

UNIT – II IMAGE ACQUISITION 10

Scene Constraints – Lighting Parameters – Lighting Sources, Selection – Lighting Techniques – Types and Selection – Machine Vision Lenses and Optical Filters, Specifications and Selection – Imaging Sensors – CCD and CMOS, Specifications – Interface Architectures – Analog and Digital Cameras – Digital Camera Interfaces – Camera Computer Interfaces, Specifications and Selection – Geometrical Image Formation Models – Camera Calibration.

UNIT – III IMAGE PROCESSING 8

Machine Vision Software – Fundamentals of Digital Image – Image Acquisition Modes – Image Processing in Spatial and Frequency Domain – Point Operation, Thresholding, Grayscale Stretching – Neighborhood Operations, Image Smoothing and Sharpening – Edge Detection – Binary Morphology – Colour image processing.

UNIT – IV IMAGE ANALYSIS 9

Feature extraction – Region Features, Shape and Size features – Texture Analysis – Template Matching and Classification – 3D Machine Vision Techniques – Decision Making.

UNIT – V MACHINE VISION APPLICATIONS 9

Machine Vision Applications in Manufacturing, Electronics, Printing, Pharmaceutical, Textile, Applications in Non-Visible Spectrum, Metrology and Gauging, OCR And OCV, Vision Guided Robotics – Field and Service Applications – Agricultural, and Bio Medical Field, Augmented Reality, Surveillance, Bio-Metrics.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon the completion of this course, the students will be able to;

CO1: Understand the difference between the vision systems and were able to remember the functions of vision system.

CO2: Select appropriate lighting source, lighting technique, lens, sensor and interfacing.

CO3: Develop image processing algorithms.

CO4: Understand various 3D image reconstruction techniques.

CO5: Select appropriate hardware and develop algorithms to solve the real time monitoring and inspection problem.

COURSE OUTCOMES COs	Programme Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	√										√	√
2	√	√	√	√	√	√					√	√
3		√	√	√							√	√
4		√	√	√							√	√
5	√	√	√	√	√	√					√	√

REFERENCES

1. Alexander Hornberg, “Handbook of Machine Vision”, John Wiley & Sons, 2006.
2. Davies E.R, “Computer and Machine Vision: Theory, Algorithm, Practicalities” Academic Press, Elsevier, 2012.
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5. Rafael C.Gonzales, Richard.E.Woods, “Digital Image Processing”, Pearson, 2017.

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MR5014 **VETRONICS**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

- To introduce the architecture, sub-systems of car and engines types and its functions of automobile.
- To familiar the elements and functions of manual and automatic transmission, suspension and steering systems
- To understand functions of safety and diagnostic system and to familiar the role of ECU, communication protocols and modern automotive.
- To understand integration of various subsystem in aerial vehicles.
- To appreciate the integration of various subsystems in aerial vehicles.

UNIT – I INTRODUCTION TO AUTOMOTIVE AND ENGINE CONTROL 10

Need for Automobile - Architecture of Automobile – Car, Types of Sub-System in Car and its Integration, Chassis, Classification Engine – Types – Modern Engines – Advanced GDI, Turbo-charged Engines - Components of Electronic Engine Management – Engine Control Functions - Modes, Fuel Delivery Systems - MPFI, CRDI - Ignition Systems, Diagnostics.

UNIT – II TRANSMISSION, SUSPENSION, STEERING SYSTEMS 9

Transmissions Systems – Sub Systems, Manual, Automatic - Suspension – Suspension Modelling, Conventional, Semi Active and Active - Steering Systems – Manual and Automatic - Break Systems - ABS - Stability - Emission Control Management – Hybrid Power Plants - Autonomous Cruise Control.

UNIT – III SAFETY SYSTEMS AND ECU 8

Safety Systems - Airbag - Automatic Door and Mirror - Parking Assist Systems - Blind Spot Avoidance – Telematics, Automatic Navigation - Dashboard - Diagnostics Systems – OBD - Communication Protocols - Cloud Connected Car – Level 4, Level 5 Automation - Autonomous Car.

UNIT – IV AIRCRAFT MECHATRONICS 9

Fundamentals - Components of an Airplane and their Functions - Motions of a Plane - Inertial Navigation – Sensors - Gyroscope- Principles , Gyro Equations, Rate Gyros - Rate Integration and Free Gyro, Vertical and Directional Gyros, Laser Gyroscopes, Accelerometers. Direct Reading Compass, Types of Actuation Systems - Linear And Non - Linear Actuation System, Modelling of Actuation Systems, Servo-Loop Analysis Actuator Design - Testing Methodologies, Performance Testing Equipment's For Sensors and Actuation Systems. Measurement and Control of Pressure, Temperature Fuel Quantity, RPM, Torque, Engine Vibration And Power. Electrical Power Requirement For Military and Civil Standards. Satellite Navigation - GPS - System Description - Basic Principles -Position and Velocity Determination

UNIT – V MARINE MECHATRONIC SYSTEMS 9

Basics of Marine Engineering – Architecture of Ships, Submarines – Types - Variable Buoyancy Systems - AUV - ROV - Propulsion Systems - Thrusters - Rudders – Marine Electrical – Power Generation - Lighting – Ventilation - Communication and Navigation- Stability and Control in Water.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO1: Acquainted the architecture, sub-systems of car and engines types and its functions of automobile.
CO2: Model automatic transmission, suspension and steering systems
CO3: Use the ECU with communication protocols for modern automotive sub-systems.
CO4: Model and realize the integrated functions of various subsystem in aerial vehicles.
CO5: Model and understand the integrated functions of various subsystems in marine vehicles.

COURSE OUTCOMES COs	Programme Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	√										√	√
2		√	√	√							√	√
3		√	√	√	√	√					√	√
4	√	√	√	√	√	√					√	√
5	√	√	√	√	√	√					√	√

REFERENCES

1. Jurgen R.K, “Automotive Electronics Handbook”, McGraw Hill, 1999.
2. Robert N Brady, “Automotive Computers and Digital Instrumentation”, Prentice Hall, 2000.
3. William B.Ribbens, “Understanding Automotive Electronics”, Butterworth, Heinemann Wobum, 2003.
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9. Jane‘s,” Unmanned Aerial Vehicles and Targets”, 1999.

MR5015 **MOBILE ROBOTICS**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

- To introduce mobile robotic technology and its types in detail.
- To learn the kinematics of wheeled and legged robot.
- To familiarize the intelligence into the mobile robots using various sensors.
- To acquaint the localization strategies and mapping technique for mobile robot.
- To aware the collaborative mobile robotics in task planning, navigation and intelligence.

UNIT-I INTRODUCTION TO MOBILE ROBOTICS 8

Introduction – Locomotion of the Robots – Key Issues on Locomotion – Legged Mobile Roots – Configurations and Stability – Wheeled Mobile Robots – Design Space and Mobility Issues – Unmanned Aerial and Underwater Vehicles – Teleportation and Control.

UNIT - II KINEMATICS 10

Kinematic Models – Representation of Robot – Forward Kinematics – Wheel and Robot Constraints – Degree of Mobility and Steerability – Maneuverability – Workspace – Degrees of Freedom – Path and Trajectory Considerations – Motion Controls - Holonomic Robots – Open Loop and Feedback Motion Control – Humanoid Robot - Kinematics Overview.

UNIT - III PERCEPTION 9

Sensor for Mobile Robots – Classification and Performance Characterization – Wheel/Motor Sensors – Heading Sensors - Ground-Based Beacons - Active Ranging - Motion/Speed Sensors – Vision Based Sensors – Uncertainty - Statistical Representation - Error Propagation - Feature Extraction Based on Range Data (Laser, Ultrasonic, Vision-Based Ranging) - Visual Appearance based Feature Extraction.

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UNIT- IV LOCALIZATION 9

The Challenge of Localization - Sensor Noise and Aliasing - Effector Noise – Localization Based Navigation Versus Programmed Solutions - Belief Representation – Single - Hypothesis Belief And Multiple-Hypothesis Belief - Map Representation - Continuous Representations - Decomposition Strategies - Current Challenges In Map Representation - Probabilistic Map-Based Localization - Markov Localization - Kalman Filter Localization - Landmark-Based Navigation - Globally Unique Localization - Positioning Beacon Systems - Route-Based Localization - Autonomous Map Building - Stochastic Map Technique - Other Mapping Techniques.

UNIT - V PLANNING, NAVIGATION AND COLLABORATIVE ROBOTS 9

Introduction - Competences for Navigation: Planning and Reacting - Path Planning - Obstacle Avoidance - Navigation Architectures - Modularity for Code Reuse and Sharing - Control Localization - Techniques for Decomposition - Case Studies – Collaborative Robots – Swarm Robots.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO1: Select and configure the appropriate mobile robots for the desired application.
CO2: Formulate the kinematics of wheeled and legged robot.
CO3: Select the sensors for the intelligence of mobile robotics.
CO4: Articulate the localization strategies and mapping technique for mobile robot.
CO5: Plan the collaborative mobile robotics for planning, navigation and intelligence for desired applications.

COURSE OUTCOMES COs	Programme Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	√	√	√	√	√	√					√	√
2		√	√								√	√
3		√	√	√							√	√
4	√	√	√	√	√	√					√	√
5	√	√	√	√	√	√					√	√

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1. Dragomir N. Nenchev, Atsushi Konno, Teppei Tsujita, “Humanoid Robots: Modelling and Control”, Butterworth-Heinemann, 2018
2. Mohanta Jagadish Chandra, “Introduction to Mobile Robots Navigation”, LAP Lambert Academic Publishing, 2015.
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5. Ulrich Nehmzow, “Mobile Robotics: A Practical Introduction”, Springer, 2003.
6. Xiao Qi Chen, Y.Q. Chen and J.G. Chase, “Mobile Robots - State of the Art in Land, Sea, Air, and Collaborative Missions”, Intec Press, 2009.

MR5016 FIELD PROGRAMMABLE GATE ARRAYS FOR EMBEDDED SYSTEMS

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

- To understand the various architectures of field programmable gate arrays.
- To familiar synchronous and asynchronous sequential circuit design
- To aware the fault diagnosis methods in FPGA.
- To learn the system design and programming of FPGA.
- To create the application specific system design.

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UNIT - I ARCHITECTURE OVERVIEW OF FPGA 9

Architecture of EPLD, Programmable Electrically Erasable Logic, CPLD Architectures – Xilinx FPGA – Xilinx 2000 - Xilinx 4000 family - Architecture of EPLD, Programmable Electrically Erasable Logic –TMS320C54x and TMS320C6x Architecture - Finite State Machines (FSM).

UNIT-II SYNCHRONOUS AND ASYNCHRONOUS SEQUENTIAL CIRCUIT DESIGN 10

FPGA Programming Technologies - FPGA Logic Cell Structures - FPGA Programmable Interconnect and I/O Ports - FPGA Implementation of Combinational Circuits - FPGA Sequential Circuits - Timing Issues in FPGA Synchronous Circuits - Analysis of Clocked Synchronous Sequential Networks (CSSN) - Modelling of CSSN – State Stable Assignment and Reduction – Design of CSSN – ASM Chart – ASM Realization - Analysis of Asynchronous Sequential Circuit (ASC) – Flow Table Reduction – Races in ASC – State Assignment Problem and the Transition Table – Design of ASC – Static and Dynamic Hazards – Essential Hazards

UNIT -III PROGRAMMING OF FPGA 9

FPGA Arithmetic Circuits - Design of SDRAM, Partial Reconfigurable FIR Filter Design, Design of A/D Converter - Introduction to Verilog HDL and FPGA Design Flow with using Verilog HDL - Programming FPGAs - Application Specific Integrated Circuit (ASIC) Systems Design and Library Cell Design - Verilog and Logic Synthesis - VHDL and Logic Synthesis - Types of Simulation - Boundary Scan Test - Fault Simulation - Automatic Test Pattern Generation.

UNIT IV FAULT DIAGNOSIS AND TESTABILITY ALGORITHMS 8

Fault Table Method – Path Sensitization Method – Boolean Difference Method – Kohavi Algorithm – Tolerance Techniques-Built-in Self-Test.

UNIT-V DEVELOPMENT OF FPGA BASED HARDWARE 9

Design of Data Acquisition Device – 4 Channel, 8 Channel, Variable Sampling Rate and Design of FPGA Based Controller - Design of Controller for High Speed Drives - Applications in Automation-Automotive.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon completion of this course, the students will be able to: students learn to

CO1: Select the architectures of field programmable gate arrays for the desired applications.
CO2: Design the synchronous and asynchronous sequential circuits
CO3: Perform the fault diagnosis and Testing FPGA.
CO4: Develop system design and programming of FPGA.
CO5: Demonstrate the application of FPGA based specific system development.

COURSE OUTCOMES COs	Programme Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	√										√	√
2		√	√	√							√	√
3		√	√	√							√	√
4		√	√	√	√						√	√
5	√	√	√	√	√						√	√

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7. Rahul Dubey, “Introduction to Embedded System Design using Field Programmable Gate Arrays”, Springer Verlag London Ltd., 2009.
8. Steve Kilts, “Advanced FPGA Design,” Wiley-IEEE Press, 2007.

MR5017 **ANALYTICAL ROBOTICS**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

- To know the structure of robots and grippers in details
- To familiar the various approaches of kinematics solution of manipulator
- To accomplish the understanding of dynamics analysis of manipulator.
- To acquire the knowledge of AI techniques in robotics.
- To learn the computer oriented Modelling of Robots

UNIT-I INTRODUCTION **8**

Definition, Types and Classifications of Robots – Control Loops, Controls and Intelligence, Specify Degrees of Freedoms, Actuators and End Effectors – Grippers, Force Analysis, Serial and Parallel Manipulators.

UNIT-II ROBOT KINEMATICS **10**

Introduction – Representation of A Rigid Body – Mappings and Operators – Homogeneous Transformation, Position Analysis - Forward Kinematics – Geometric Approach, Algebraic Approach, Denvit–Hartenbers Representations – Inverse Kinematics. Velocities - Differential Motion and Velocity of Frames – Jacobian

UNIT- III ROBOT DYNAMICS AND TRAJECTORY PLANNING **10**

Lagrangeon Mechanics, Dynamic Equations for Single, Double and Multiple DOF Robots – Static Force Analysis of Robots, Trajectory Planning – Joint Space, Cartesian Space Description and Trajectory Planning – Third Order, Fifth Order - Polynomial Trajectory Planning

UNIT-IV ROBOT PROGRAMMING AND AI **9**

Types of Programming – Teach Pendant programming – Requirement of Robot Programing Language, Structure of Robot Programming Language – Offline Programming Systems – Basic concepts in AI Techniques – Concept of Knowledge Representations and Inference – Robot Learning

UNIT-V MODELLING AND SIMULATION **8**

Modelling and Simulation of Robotic Joints - Position, Velocity and Acceleration Analyses of Simple Mechanisms and Robots, -Synthesis of Robots - Simulation of Robot Configuration.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO1: Configure the robot and grippers in details
CO2: Solve the kinematics solution of manipulator
CO3: Analyze the dynamics analysis of manipulator.
CO4: Use the AI techniques in robotics.
CO5: Practice the computer oriented Modelling of Robots

COURSE OUTCOMES COs	Programme Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	√										√	√
2		√	√	√							√	√
3		√	√	√							√	√
4		√	√	√	√	√					√	√
5		√	√	√	√	√					√	√

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REFERENCES
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2. Fu.K.S, Gonzalac R.C, Lee C.S.G, “Robotics Control, Sensing, Vision and Intelligence”, McGraw Hill, 2011.
3. John J. Craig, “Introduction to Robotics: Mechanics and Control”, Pearson, 2008.
4. Saeed.B.Niku, “Introduction to Robotics, Analysis, System, Applications”, Pearson educations, 2002.
5. SK Saha, “Introduction to Robotics”, McGraw Hill, 2008
6. Yoram Koren, “Robotics”, McGraw Hill, 2006.

MR5018 **MACHINE LEARNING**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES
- To know the basic supervised learning methods for classification
- To understand the unsupervised learning and reinforced learning methods for classification
- To acquire the knowledge on neural network concepts and its types
- To recognize the fuzzy theory and classifications.
- To understand the genetic algorithm for various applications.

UNIT I SUPERVISED AND SEMI SUPERVISED LEARNING METHODS 10

Introduction to Learning & Classifiers - LDA – ANN - Naive Bayes Classifier - Decision Tree - Regression-Ordinary Least Squares – Linear And Logistic Regression- Gaussian Process - Stepwise Regression - Multivariate Adaptive Regression Splines (MARS) - Locally Estimated Scatterplot Smoothing (LOESS) - Overview of Nearest Neighbour - Support Vector Machines - Temporal Difference Learning - Q-Learning.

UNIT II UNSUPERVISED & REINFORCEMENT LEARNING METHODS 8

Expectation – Maximization (EM) - Vector Quantization, Clustering Fuzzy K & C Means Algorithm – Density - Based Spatial Clustering of Applications with Noise (DBSCAN) - Conceptual Clustering - Association Rule Learning - Apriori Algorithm - SVD.

UNIT III NEURAL NETWORK 9

Perceptron – Basic Networks, Probabilistic Neural Network (PNN) - Back-Propagation (BPN) - Hopfield Network - Self-Organizing Map (SOM) - Learning Vector Quantization (LVQ)- Adaptive Resonance Theory I – Adaptive Resonance Theory II - Case Studies on GA based Algorithm Development.

UNIT IV FUZZY CLASSIFICATION 9

Basic Concepts in Fuzzy Set Theory - Fuzzy Logic Controllers – Principles – Various Industrial Applications of Fuzzy Logic Control – Adaptive Fuzzy Systems – Fuzzy Decision Making – Fuzzy Classification – Fuzzy Pattern Recognition – Image Processing Applications – Fuzzy Optimization - Case Studies On Fuzzy Based Algorithm Development.

UNIT V GENETIC ALGORITHMS 9

Introduction to Genetic Algorithm – Initialization, Selection, Mutation and Termination- Swarm Intelligence – PSO - ACO - Tabu Search - Reactive Search Optimization (RSO)- Cross-Entropy (CE) Methods. Case Studies on GA Based Algorithm Development.

OTAL: 45 PERIODS

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO1: Use supervised learning methods for classification
CO2: practice unsupervised learning and reinforced learning methods for classification
CO3: Experiment the neural network concepts and its types
CO4: Establish the fuzzy theory for classifications in various applications.
CO5: Demonstrate the genetic algorithm for various applications

COURSE OUTCOMES COs	Programme Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	√										√	√
2		√	√	√							√	√
3		√	√	√	√						√	√
4	√	√	√	√	√						√	√
5		√	√	√	√						√	√

REFERENCES

1. Ethem Alpaydin, “Introduction to Machine Learning” The MIT Press, Cambridge, London, 2015.
2. Klir G.J. Yuan Bo, “Fuzzy sets and Fuzzy Logic: Theory and Applications”, Prentice Hall, 2015.
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MR5019 MEDICAL MECHATRONICS

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

- To know the various types of human functional system and basic human functional measurement instrumentations.
- To understand the mechatronic elements in various assisting and therapeutics equipment.
- To realize the integrations of in cardiac and regulatory functions assist systems.
- To acquire the architecture and functions of medical imaging equipment.
- To introduce the sensory assist devices and automated analysed in medical field.

UNIT- I INTRODUCTION TO MEDICAL MECHATRONICS 10

Role of Mechatronics in Medical – Overview of Human Functional System – Cell and Origin Bioelectric Potential - Measurement of Blood Pressure - Invasive and Noninvasive Methods- Transducers Role in Measurement – Heart Rate – Pressure - Temperature- Heart Sound – Pulmonary Function Measurements. ECG, EEG and EMG Systems.

UNIT - II ASSISTING AND THERAPEUTIC EQUIPMENTS 8

Diathermy – Heart Lung Machine –– Dialyzers – Centrifuge- Coagulators- Aspirator – Oximeter – Spirometer - Nebulizer – Anesthesia Machine - Operating Table – Examination Couches - Infusion Systems – Surgical Robots.

UNIT- III CARDIAC AND REGULATORY ASSIST SYSTEM 10

Pacemakers – Defibrillators – Ventilators – Nerve and Muscle Stimulators - Location For Stimulation - Synchronous Counter Pulsation, Assisted through Respiration Right Ventricular Bypass Pump, Left Ventricular Bypass Pump, Open Chest and Closed Chest Type, Intra-Aortic Balloon Pumping Veno Arterial Pumping, Prosthetic Cardio Valves, Principle and Problem, Biomaterials for Implantable Purposes, its Characteristics and Testing. Lithotripsy - Indication and Principle of Hemodialysis, Membrane, Dialysate, Different Types of Hemodialysis, Monitoring Systems, Wearable Artificial Kidney, Implanting Type.

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UNIT-IV MEDICAL IMAGING 8

Radio Graphic and Fluoroscopic Techniques – XRAY Machine - Computer Tomography – MRI – FMRI- Ultrasonography – Endoscopy – Colonoscopy -Thermography – Different Types of Biotelemetry Systems and Patient Monitoring – PET- Introduction to Biometric Systems.

UNIT- V SENSORY ASSIST DEVICES AND AUTOMATED ANALYZER 9

Types of Deafness, Hearing Aids, Application of DSP in Hearing Aids - Ear Irrigator- Voice Synthesizer, Speech Trainer. Ultra Sonic and Laser Canes, Intra Ocular Lens, Braille Reader - Tactile Devices for Visually Challenged - Ophthalmoscopy - Text Voice Converter - Screen Readers and Automated Analyzer.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO1: Realize the uses of human functional measurement instrumentations.
CO2: Recognize the mechatronic elements in various assisting and therapeutics equipment.
CO3: Observe the integrations of in cardiac and regulatory functions assist systems.
CO4: Describe the elements and functions of medical imaging equipment.
CO5: Suggest the appropriate sensory assist devices and automated analysed in medical field.

COURSE OUTCOMES COs	Programme Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	√										√	√
2	√	√	√	√	√	√					√	√
3		√	√	√	√	√					√	√
4	√			√							√	√
5	√	√	√	√	√	√					√	√

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7. Leslie Cromwell, Fred J.Weibell, Erich A.Pfeiffer, “Bio-Medical Instrumentation and Measurements”, Pearson Education, 2002.

MR5020 COMMUNICATION PROTOCOLS

L	T	P	C
3	0	0	3

COURSE OUTCOMES

- To study the various types wired protocols for electronic system.
- To know the various types wireless protocols for electronic system.
- To aware the various industrial wired protocols in automation.
- To study the various types wireless protocols for industrial automation.
- To develop the wired and wireless functions of various protocols.

UNIT - I WIRED BUSES AND PROTOCOLS 9

Wireless - Wired Networks Comparison - Serial Communication Protocols - RS232-UART-SPI - I2C –UNI/O Bus -1 Wire - Camara Link - Parallel Communication - PPI - Wishbone Bus – AMBA – JTAG - Fireware IEEE 1394 Bus - Ethernet Overview - RS485

UNIT - II WIRELESS PROTOCOLS 9

Antenna Technology- Network Topologies - Wireless Local Area Networks (WLAN) - Wireless Personal Area Networks (WPAN) - Wimedia – Wimax - RF – Bluetooth- Wi-Fi – Zigbee – Wireless Industrial Automation Protocols.

UNIT - III INDUSTRIAL AND AUTONOMOUS SYSTEMS WIRED NETWORKS 9

Overview of Industrial Wired Networks – Terminal Bus- Modbus - HART Network - Mechatrolink-II – Ether CAT- Sercos II/III – CAN- Canopen - Modbus IDA-PROFINET-PROFIBUS-Ethernet/IP-Ethernet Powerlink- AG Automation and Drives (AS-I) - Device Net

UNIT - IV INDUSTRIAL WIRELESS NETWORKS 9

Overview of Industrial Wireless Networks - IWLAN - ISA100 Standards – Remote Networks-Controller-Based Networks - Wireless HART Technology - 3G/4G for Automation – RFID Data Tags.

UNIT - V APPLICATION OF COMMUNICATION PROTOCALS 9

Wired Machine Networking of Sub-elements and Machines - Wireless Machine Networking of Sub-elements and Machines – Networking of Industry - Communication Network Layout Design - Networking for TIA- Cloud Computing – IOT - Case Studies in Automation Applications.

TOTAL =45 PERIODS

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO1: Design wired protocols for electronic system.
CO2: Use wireless protocols for electronic system.
CO3: Practice industrial wired protocols in automation.
CO4: Select wireless protocols for industrial automation.
CO5: Demonstrate the wired and wireless functions of various protocols in application development.

COURSE OUTCOMES COs	Programme Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	√	√	√	√							√	√
2	√	√	√	√							√	√
3		√	√	√	√						√	√
4		√	√	√	√						√	√
5	√	√	√	√	√		√				√	√

REFERENCES

1. Borko Furht, “Encyclopedia of Wireless and Mobile Communications - Three Volume Set”, CRC Press, 2012.
2. Dick Caro, “Wireless Networks for Industrial Automation”, 2013.
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MR5072 **INDUSTRY 4.0 AND INTERNET OF THINGS** **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To introduce and familiarize the industry 4.0 and its physical structure and inter-connectivity.
- To understand the architecture, IOT and its protocols
- To outline the cloud computing and data analytics
- To familiar the concepts of integrated IOT.
- To learn the IOT, cloud computing, data analytics and Industry 4.0

UNIT - I INDUSTRY 4.0 **10**

Digitalization and the Networked Economy - Introduction to Industry 4.0 - Comparison of Industry 4.0 Factory and Today's Factory - Internet of Things (IoT) - Industrial Internet of Things (IIoT) - Smart Devices and Products - Smart Logistics - Support System for Industry 4.0 - Cyber-physical Systems Requirements - Data as a New Resource for Organizations - Cloud Computing - Trends of Industrial Big Data and Predictive Analytics for Smart Business- Architecture of Industry 4.0.

UNIT - II IOT AND ITS PROTOCOLS **8**

Definitions and Functional Requirements – Motivation – Architecture - Web 3.0 View of IoT – Ubiquitous IoT Applications – Four Pillars of IoT – DNA of IoT - The Toolkit approach for End - User Participation in the Internet of Things. Middleware for IoT: Overview – Communication Middleware for IoT – IoT Information Security. IIoT Reference Architecture - Designing Industrial Internet Systems - Access Network Technology and Protocols Standardization for IoT – Efforts – M2M and WSN Protocols – SCADA and RFID Protocols – Issues with IoT Standardization – Unified Data Standards – Protocols – IEEE 802.15.4 – BAC Net Protocol – Modbus –KNX – Zigbee Architecture – Network layer APS layer – Security.

UNIT - III CLOUD COMPUTING **10**

Web of Things versus Internet of Things – Two Pillars of the Web – Architecture Standardization for WoT – Platform Middleware for WoT – Unified Multitier WoT Architecture – WoT Portals and Business Intelligence. Cloud of Things: Grid/SOA and Cloud Computing – Cloud Middleware – Cloud Standards – Cloud Providers and Systems – Mobile Cloud Computing – The Cloud of Things Architecture and Data Analytics

UNIT - VI INTEGRATED IOT **9**

Integrated Billing Solutions in the Internet of Things Business Models for the Internet of Things - Network Dynamics: Population Models – Information Cascades - Network Effects - Network Dynamics: Structural Models - Cascading Behavior in Networks - The Small - World Phenomenon

UNIT - V APPLICATIONS **8**

The Role of the Internet of Things for Increased Autonomy and Agility in Collaborative Production Environments - Resource Management in the Internet of Things: Clustering, Synchronization and Software Agents - Industry 4.0 in Car Manufacturing – Electronics Manufacturing – IOT Based Building Automation - Agricultural Automation.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO1: Realize the need of industry 4.0 and its inter-connectivity.
CO2: Interpret the architecture of IOT and its protocols
CO3: Recognize the uses of cloud computing and data analytics
CO4: Familiar the concepts of integrated IOT.
CO5: Plan the uses of IOT, cloud computing, data analytics and Industry 4.0 technologies.

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COURSE OUTCOMES COs	Programme Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	√										√	√
2		√	√	√							√	√
3		√	√	√	√						√	√
4		√	√	√	√						√	√
5	√	√	√	√	√		√				√	√

REFERENCES:

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MR5021 COMPUTER AIDED PRODUCTION AND AUTOMATION OF PLANTS

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

- To acquire the knowledge on computer oriented digital factory modelling, process planning, inventory control, factory layout and machine works cell design.
- To understand the grouping and technology and flexible manufacturing systems and its techniques.
- To familiar the architecture of various types of material transportation and storage system and its functions in detail.
- To acquainted the manual and automated assembly design for automation.
- To learn the application of automation in various production industry

UNIT - I COMPUTER AIDED PRODUCTION PLANING 9

Application – Process, Demand, Volume, Quality, Manufacturing Task. Automated Factory- Requirements - Factory Planning – Layout - Macro, Micro, and Submicro Layouts - Work Cell Design - Manufacturing Task - Equipment, Tools and Resources Identification – Levels of Automation- Device, Machine, Cell, Plant, Enterprises - Computer Aided Process Planning (CAPP) - MRP – Capacity Planning- Shop Floor Planning – Inventory Control - Tools for Digital Factory Modelling.

UNIT - II GROUP TECHNOLOGY AND FLEXIBLE MANUFACTURING SYSTEMS 10

FMS - Overview – Levels- Manufacturing Module - Assembly Cell -Manufacturing Group - Production Systems-Manufacturing Line - Part Families – Visual – Parts Classification and Coding – Production Flow Analysis – Grouping of Parts and Machines by Rank Order Clustering Method – Benefits of GT – FMS – Components – Workstations – FMS Layout Configurations – Computer Control Systems – FMS Planning and Implementation Issues – Architecture of FMS – Flow Chart Showing Various Operations in FMS. Intelligent Manufacturing – Virtual Manufacturing- Internet Controlled Manufacturing - Intelligent Agents – Advanced Manufacturing Systems - Robots Role in Various Levels of manufacturing - Sensors in Manufacturing Process - Automated Measurement and Inspections- Vision based inspection Manufacturing Process

UNIT - III AUTOMATED MATERIAL TRANSFER AND STORAGE SYSTEM 9

Automated Production Line – System Configurations, Work Part Transfer Mechanisms – Fundamentals of Automated Assembly System – System Configuration, Part Delivery at Workstations – Design for Automated Assembly – Overview of Material Handling Equipment's – Consideration in Material Handling System Design – Conveyor Systems – Types of Conveyors – Operations and Features. Automated Guided Vehicle System – Types of Vehicles and AGVs Applications - Automated Transport System – extended transportation system (XTS) - Cranes - Hoist - Conventional Storage Methods and Equipments – Automated Storage/Retrieval System and Carousel Storage System - Deadlocks in Automated Manufacturing Systems – Petrinet Models – Applications in Dead Lock Avoidance.

UNIT - IV ASSEMBLY LINE SYSTEMS AND AUTOMATION 8

Design for Manual Assembly - Automatic Assembly - Continuous - Intermittent Transfer- Automatic Feeding and Orienting - Vibratory Feeders - Automatic Feeding and Orienting Systems - Types - Gravity Feed Tracks - Powered Feed Tracks - Escapements - Parts-Placing Mechanisms - Assembly Robots - High-Speed Feeding and Orienting - High-Speed Automatic Assembly.

UNIT - V CASE STUDIES 9

Case studies of Automated Factory – Manufacturing Task - Car Manufacturing & Assembly – Electronics Manufacturing – Food Processing – Textile Processing.

TOTAL =45 PERIODS

OUTCOMES

Upon the completion of this course, the students will able to;

CO1: Model the digital factory and its process planning, inventory control, factory layout and machine works cell design.

CO2: Exercise the grouping technology and flexible manufacturing systems for industry.

CO3: Apply the automated material transportation in the industrial floors.

CO4: Experiment the automated assembly in production line.

CO5: Practise the application of automation concepts in various production industry to meet out the quality, demand and reduction of production cost.

COURSE OUTCOMES COs	Programme Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	√										√	√
2		√	√	√	√						√	√
3		√	√	√	√	√					√	√
4		√	√	√	√	√					√	√
5	√	√	√	√	√	√					√	√

REFERENCES

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8. Phillip R. Edwards, "Manufacturing Technology in the Electronics Industry: An introduction", Springer-Science+Business Media, B.V, 1991.

MR5022 INSTRUMENTATION IN NON-DESTRUCTIVE EVALUATION

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

- To understand the basic principles of various NDT methods, Visual Inspection and Liquid Penetrant Testing.
- To learn the principle, instrumentation in Eddy current and Acoustic Emission techniques to determine and analyse defects.
- To understand the principle, instrumentation in Magnetic Particle Testing, Thermography, Ultrasonic Testing and Radiography to determine and analyse defects.
- To understand the role of NDT in quality assurance.
- To select suitable NDT technique based on application.

UNIT - I NON-DESTRUCTIVE TESTING: AN INTRODUCTION, VISUAL INSPECTION & LIQUID PENETRANT TESTING 9

Introduction to Various Non-Destructive Methods - Comparison of Destructive and Nondestructive Tests - Visual Inspection, Optical Aids used for Visual Inspection, Applications - Instrumentation in NDT Equipment's - Physical Principles, Procedure for Penetrant Testing, Penetrant Testing Materials, Penetrant Testing Methods - Water Washable, Post – Emulsification Methods, Applications

UNIT – II EDDY CURRENT TESTING & ACOUSTIC EMISSION 9

Principles, Instrumentation for ECT, Absolute, Differential Probes, Techniques – High Sensitivity Techniques, Multi Frequency, Phased Array ECT, Applications - Principle of AET, Instrumentation, Applications - Testing of Metal Pressure Vessels, Fatigue Crack Detection in Aerospace Structures.

UNIT – III MAGNETIC PARTICLE TESTING & THERMOGRAPHY 9

Principle of MPT, Procedure Used for Testing a Component, Equipment Used For MPT, Magnetizing Techniques, Applications - Principle of Thermography, Infrared Radiometry, Active and Passive Thermography Measurements, Applications – Instrumentation for Thermal Imaging.

UNIT – IV ULTRASONIC TESTING & RADIOGRAPHY 9

Principle, Ultrasonic Transducers, Ultrasonic Flaw Detection Equipment - Modes of Display A - Scan, B-Scan and C- Scan, Applications, Inspection Methods - Normal Incident Pulse - Echo Inspection, Normal Incident Through - Transmission Testing, Angle Beam Pulse - Echo Testing, Instrumentation in Ultrasonic Inspection - Principle of Radiography, Effect of Radiation on Film, Radiographic Imaging, Inspection Techniques – Single Wall Single Image, Double Wall Penetration, Multiwall Penetration Technique, Real Time Radiography – Digital Radiography – Instrumentation for Signal Acquisition and Display in Radiography.

UNIT – V COMPARISON AND SELECTION OF NDT METHODS 9

Case Studies on Defects in Cast, Rolled, Extruded, Welded and Heat Treated Components, Comparison and Selection of Various NDT Techniques, Codes, Standards, Specification and Procedures.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO1: Understand the principle of Visual Inspection and Liquid Penetrant Testing.

CO2: Understand the working of Eddy current and Acoustic Emission techniques and apply to determine and analyse defects.

CO3: Apply Magnetic Particle Testing, Thermography, Ultrasonic Testing and Radiography and able to determine and analyse defects.

CO4: Understand the role of NDT in quality assurance.

CO5: Select suitable NDT technique based on application and acquainted the knowledge of all types of NDT and their applications in Engineering.

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COURSE OUTCOMES Cos	Programme Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	√										√	√
2		√	√	√	√	√					√	√
3		√	√	√	√	√					√	√
4				√	√	√					√	√
5	√	√	√	√	√	√					√	√

REFERENCES:

1. Baldev Raj, Jeyakumar,T., Thavasimuthu,M., "Practical Non Destructive Testing" Narosa Publishing House, New Delhi, 2002
2. Krautkramer. J., "Ultra Sonic Testing of Materials", Springer – Verlag Publication, New York, 1996.
3. Peter J. Shull "Non Destructive Evaluation: Theory, Techniques and Application" Marcel Dekker, Inc., New York, 2002
4. www.ndt.net.
5. Charles J. Helliar, "Handbook of Nondestructive Evaluation", McGraw Hill, New York, 2002.
6. "Nondestructive Testing Handbook", vol. 3-7, ASNT, 2012.

MR5023 MECHATRONICS IN ADVANCED MANUFACTURING SYSTEMS

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

- To understand various mechatronics elements present in unconventional machines.
- To learn about Additive Manufacturing types, equipment's and its impact on product development.
- To understand, analyse and make new compatible products using reverse engineering.
- To learn the principle, advantage and limitations of Additive Manufacturing base on liquid, solid, powder and various other types.
- To select an Additive Manufacturing process and material for a specific application.

UNIT -I UNCONVENTIONAL MACHINING PROCESSES 9

Architecture – Key Elements of Mechatronics in USM – EDM – WCEDM – MEDM – ECDM – ECM – EBM – LBM – IBM – PAM – AJM – WJM.

UNIT -II INTRODUCTION TO ADDITIVE MANUFACTURING 9

Need - Classification of AM Processes – SLA – SLS – FDM – LOM – SGC – PLT – LENS - Architecture of Additive Manufacturing Equipment – Key Elements of Mechatronics – Functions Development of AM Systems – AM Process Chain - Impact of AM on Product Development - Virtual Prototyping - Rapid Tooling – RP to AM

UNIT -III REVERSE ENGINEERING AND CAD MODELLING 8

Basic Concept - Digitization Techniques – Model Reconstruction – Data Processing for Rapidprototyping: CAD Model Preparation, Data Requirements – Geometric Modelling Techniques: Wireframe, Surface and Solid Modelling – Data Formats - Data Interfacing, Part Orientation and Support Generation, Support Structure Design, Model Slicing, Tool Path Generation - Software for AM.

UNIT - IV LIQUID AND SOLID BASED ADDITIVE MANUFACTURING 9

Stereo-Lithography Apparatus (SLA): Principle, Pre-Build Process, Part-Building and Post-Build processes, Photo Polymerization of SL Resins, Part Quality and Process Planning, Recoating Issues, Materials, Advantages, Limitations and Applications. Solid Ground Curing (SGC): Working Principle, Process, Strengths, Weaknesses and Applications Fused Deposition Modelling (FDM): Principle, Details of Processes, Process Variables, Types, Products, Materials and Applications. Laminated Object Manufacturing (LOM): Working Principles, Details of Processes, Products, Materials, Advantages, Limitations and Applications

UNIT - V POWDER BASED AND OTHER ADDITIVE MANUFACTURING 10

Selective Laser Sintering (SLS): Principle, Process, Indirect and Direct SLS- Powder Structures, Materials, Post Processing, Surface Deviation and Accuracy, Applications. Laser Engineered Net Shaping (LENS): Processes, Materials, Products, Advantages, Limitations and Applications - Three Dimensional Printing (3DP): Principle, Basic Process, Physics of 3DP, and Types of Printing, Process Capabilities, and Material System. Solid Based, Liquid Based and Powder Based 3DP Systems, Shape Deposition Manufacturing (SDM), Ballastic Particle Manufacturing (BPM), Selective Laser Melting, Electron Beam Melting.

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO1: Understand and compare various mechatronics elements present in unconventional machines.

CO2: Know the additive manufacturing types, equipment's, its impact on product development and concepts of Rapid Prototyping.

CO3: Acquire the skills for modelling and developing the product using reverse engineering.

CO4: Understand the concept and compare product development using various additive manufacturing methods.

CO5: Select appropriate additive manufacturing method and develop a cutting-edge perspective on digital transformation and the factory of the future

COURSE OUTCOMES Cos	Programme Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	√										√	√
2	√	√	√	√	√	√					√	√
3		√	√	√	√	√					√	√
4	√	√	√	√	√	√					√	√
5	√	√	√	√	√	√					√	√

REFERENCES

1. Chua, C.K., Leong K.F. and Lim C.S., "Rapid Prototyping: Principles and Applications", World Scientific Publishers, 2010.
2. Gebhardt, A., "Rapid Prototyping", Hanser Gardener Publications, 2003.
3. Gibson, I., Rosen, D.W. and Stucker, B., "Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010.
4. Hilton, P.D. and Jacobs, P.F., Rapid Tooling: Technologies and Industrial Applications, CRC Press, 2005
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6. Liou, L.W. and Liou, F.W., "Rapid Prototyping and Engineering Applications : A Tool Box For Prototype Development", CRC Press, 2011.
7. Pandley P. S. & Shah. N., "Modern Manufacturing Processes", McGraw Hill Inc, 2007.

Attested

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MR5024 **INDUSTRIAL SOLID STATE DRIVES** **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To understand electrical actuator steady state operation and transient dynamics of a motor load system.
- To learn the operation and construction of solid state switching devices.
- To study the operation of various D.C Motor drives and to select appropriate drive for speed and position control.
- To study the operation of various A.C Motor drives and to select appropriate drive for speed control.
- To study the operation of various Special Motor drives.

UNIT- I ELECTRICAL ACUATORS AND DRIVE CHARACTERISTICS 9

AC - DC Power Sources -Types – Electrical Actuator Input Types - DC Motors, AC Motors, Special Electrical Motors - Solenoids - Electric Drives – Equations Governing Motor Load Dynamics – Steady State Stability – Multi Quadrant Dynamics - Acceleration, Deceleration, Starting & Stopping – Typical Load Torque Characteristics – Selection of Motor.

UNIT- II SOLID STATE SWITCHING DEVICES 9

Solid State Relay - Switching Characteristics - Bipolar Junction Transistor (BJT), Metal Oxide Semiconductor - Field Effect Transistor Silicon Controlled Rectifier (SCR) - DIAC- TRIAC- Gate Turn-Off Thyristor (GTO) – Insulated Gate Bipolar Transistor (IGBT) - Classification Of PWM Techniques

UNIT-III D.C. MOTOR DRIVES 9

Thyristor D.C. Drives – Single and Three Phase Converter - Control Arrangements For D.C. Drives -Chopper-Fed D.C. Motor Drives - D.C. Servo Drives – Speed - Position Control -Digitally Controlled Drives – H Bridge Circuits.

UNIT-IV A.C. MOTOR DRIVES 9

Induction Motor Drives –Inverter Fed Drives – Open And Closed Loop Speed Control - Energy Efficient Drive–V/F Control– Voltage / Current Fed Inverter – Closed Loop Control -Synchronous Motors - V/F Control And Self - Control of Synchronous Motor: Power Factor Control – Permanent Magnet Synchronous Motor Drives.

UNIT-V SPECIAL ELECTRICAL MOTOR DRIVES 9

Stepper Motor Driver Circuits –Constant Voltage Drive – Current Forced Drive- Chopper Drive – Single Phase and Three Phase BLDC Driver Circuits – Sensorless Motor Drives.

TOTAL = 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

CO1: Understand electrical actuator steady state operation and transient dynamics of a motor load system.
CO2: Select suitable solid state switching devices.
CO3: Identify and apply appropriate drive for speed and position control for various D.C Motors.
CO4: Identify and apply appropriate drive for speed control for various A.C Motors.
CO5: Select suitable drives for special motors.

COURSE OUTCOMES Cos	Programme Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	√										√	√
2		√	√	√	√	√					√	√
3		√	√	√	√	√					√	√
4				√	√	√					√	√
5		√	√	√	√	√					√	√

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1. Austin Hughes, “Electric Motor and Drives: Fundamentals, Types and Applications”, Newnes Publications, 2013
2. Bimal K.Bose, “Modern Power Electronics and AC Drives”, Academic Press, 2010,.
3. Gopal K.Dubey, “Fundamentals of Electrical Drives”, CRC Press, 2002.
4. Krishnan R, “Electric Motor & Drives: Modelling, Analysis and Control”, Prentice Hall of India, 2001.
5. Muhammad H.Rashid, “Power Electronics Handbook”, Butterworth-Heinemann Publications, 2017.

OPEN ELECTIVE COURSES (OEC)

OE5091	BUSINESS DATA ANALYTICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the basics of business analytics and its life cycle.
- To gain knowledge about fundamental business analytics.
- To learn modeling for uncertainty and statistical inference.
- To understand analytics using Hadoop and Map Reduce frameworks.
- To acquire insight on other analytical frameworks.

UNIT I OVERVIEW OF BUSINESS ANALYTICS 9

Introduction – Drivers for Business Analytics – Applications of Business Analytics: Marketing and Sales, Human Resource, Healthcare, Product Design, Service Design, Customer Service and Support – Skills Required for a Business Analyst – Framework for Business Analytics Life Cycle for Business Analytics Process.

Suggested Activities:

- Case studies on applications involving business analytics.
- Converting real time decision making problems into hypothesis.
- Group discussion on entrepreneurial opportunities in Business Analytics.

Suggested Evaluation Methods:

- Assignment on business scenario and business analytical life cycle process.
- Group presentation on big data applications with societal need.
- Quiz on case studies.

UNIT II ESSENTIALS OF BUSINESS ANALYTICS 9

Descriptive Statistics – Using Data – Types of Data – Data Distribution Metrics: Frequency, Mean, Median, Mode, Range, Variance, Standard Deviation, Percentile, Quartile, z-Score, Covariance, Correlation – Data Visualization: Tables, Charts, Line Charts, Bar and Column Chart, Bubble Chart, Heat Map – Data Dashboards.

Suggested Activities:

- Solve numerical problems on basic statistics.
- Explore chart wizard in MS Excel Case using sample real time data for data visualization.
- Use R tool for data visualization.

Suggested Evaluation Methods:

- Assignment on descriptive analytics using benchmark data.
- Quiz on data visualization for univariate, bivariate data.

UNIT III MODELING UNCERTAINTY AND STATISTICAL INFERENCE 9

Modeling Uncertainty: Events and Probabilities – Conditional Probability – Random Variables – Discrete Probability Distributions – Continuous Probability Distribution – Statistical Inference: Data Sampling – Selecting a Sample – Point Estimation – Sampling Distributions – Interval Estimation – Hypothesis Testing.

Suggested Activities:

- Solving numerical problems in sampling, probability, probability distributions and hypothesis testing.
- Converting real time decision making problems into hypothesis.

Suggested Evaluation Methods:

- Assignments on hypothesis testing.
- Group presentation on real time applications involving data sampling and hypothesis testing.
- Quizzes on topics like sampling and probability.

UNIT IV ANALYTICS USING HADOOP AND MAPREDUCE FRAMEWORK 9

Introducing Hadoop – RDBMS versus Hadoop – Hadoop Overview – HDFS (Hadoop Distributed File System) – Processing Data with Hadoop – Introduction to MapReduce – Features of MapReduce – Algorithms Using Map-Reduce: Matrix-Vector Multiplication, Relational Algebra Operations, Grouping and Aggregation – Extensions to MapReduce.

Suggested Activities:

- Practical – Install and configure Hadoop.
- Practical – Use web based tools to monitor Hadoop setup.
- Practical – Design and develop MapReduce tasks for word count, searching involving text corpus etc.

Suggested Evaluation Methods:

- Evaluation of the practical implementations.
- Quizzes on topics like HDFS and extensions to MapReduce.

UNIT V OTHER DATA ANALYTICAL FRAMEWORKS 9

Overview of Application development Languages for Hadoop – PigLatin – Hive – Hive Query Language (HQL) – Introduction to Pentaho, JAQL – Introduction to Apache: Sqoop, Drill and Spark, Cloudera Impala – Introduction to NoSQL Databases – Hbase and MongoDB.

Suggested Activities:

- Practical – Installation of NoSQL database like MongoDB.
- Practical – Demonstration on Sharding in MongoDB.
- Practical – Install and run Pig
- Practical – Write PigLatin scripts to sort, group, join, project, and filter data.
- Design and develop algorithms to be executed in MapReduce involving numerical methods for analytics.

Suggested Evaluation Methods:

- Mini Project (Group) – Real time data collection, saving in NoSQL, implement analytical techniques using Map-Reduce Tasks and Result Projection.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student will be able to:

- Identify the real world business problems and model with analytical solutions.
- Solve analytical problem with relevant mathematics background knowledge.
- Convert any real world decision making problem to hypothesis and apply suitable statistical testing.
- Write and Demonstrate simple applications involving analytics using Hadoop and MapReduce

- Use open source frameworks for modeling and storing data.
- Apply suitable visualization technique using R for visualizing voluminous data.

REFERENCES:

1. Vignesh Prajapati, “Big Data Analytics with R and Hadoop”, Packt Publishing, 2013.
2. Umesh R Hodeghatta, Umesha Nayak, “Business Analytics Using R – A Practical Approach”, Apress, 2017.
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7. Rui Miguel Forte, “Mastering Predictive Analytics with R”, Packt Publication, 2015.

OE5092 INDUSTRIAL SAFETY L T P C
3 0 0 3

COURSE OBJECTIVES:

- Summarize basics of industrial safety
- Describe fundamentals of maintenance engineering
- Explain wear and corrosion
- Illustrate fault tracing
- Identify preventive and periodic maintenance

UNIT I INTRODUCTION 9

Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

UNIT II FUNDAMENTALS OF MAINTENANCE ENGINEERING 9

Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

UNIT III WEAR AND CORROSION AND THEIR PREVENTION 9

Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

UNIT IV FAULT TRACING 9

Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment’s like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

UNIT V PERIODIC AND PREVENTIVE MAINTENANCE 9

Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Ability to summarize basics of industrial safety
CO2: Ability to describe fundamentals of maintenance engineering
CO3: Ability to explain wear and corrosion
CO4: Ability to illustrate fault tracing
CO5: Ability to identify preventive and periodic maintenance

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

REFERENCES:

1. Audels, Pump-hydraulic Compressors, Mcgrew Hill Publication, 1978.
2. Garg H P,Maintenance Engineering, S. Chand and Company,1987.
3. Hans F. Winterkorn ,Foundation Engineering Handbook, Chapman & Hall London,2013.
4. Higgins & Morrow , Maintenance Engineering Handbook, Eighth Edition, 2008

OE5093 OPERATIONS RESEARCH L T P C

3 0 0 3

COURSE OBJECTIVES:

- Solve linear programming problem and solve using graphical method.
- Solve LPP using simplex method
- Solve transportation , assignment problems
- Solve project management problems
- Solve scheduling problems

UNIT I LINEAR PROGRAMMING 9

Introduction to Operations Research – assumptions of linear programming problems - Formulations of linear programming problem – Graphical method

UNIT II ADVANCES IN LINEAR PROGRAMMING 9

Solutions to LPP using simplex algorithm- Revised simplex method - primal dual relationships – Dual simplex algorithm - Sensitivity analysis

UNIT III NETWORK ANALYSIS – I 9

Transportation problems -Northwest corner rule, least cost method,Voges's approximation method - Assignment problem -Hungarian algorithm

UNIT IV NETWORK ANALYSIS – II 9

Shortest path problem: Dijkstra's algorithms, Floyds algorithm, systematic method -CPM/PERT

UNIT V NETWORK ANALYSIS – III **9**

Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1: To formulate linear programming problem and solve using graphical method.
CO2: To solve LPP using simplex method
CO3: To formulate and solve transportation, assignment problems
CO4: To solve project management problems
CO5: To solve scheduling problems

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

REFERENCES:

1. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010
2. Hitler Libermann, Operations Research: McGraw Hill Pub. 2009
3. Pant J C, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008
4. Pannerselvam, Operations Research: Prentice Hall of India 2010
5. Taha H A, Operations Research, An Introduction, PHI, 2008

OE5094 COST MANAGEMENT OF ENGINEERING PROJECTS **L T P C**
3 0 0 3

OBJECTIVES:

- Summarize the costing concepts and their role in decision making
- Infer the project management concepts and their various aspects in selection
- Interpret costing concepts with project execution
- Develop knowledge of costing techniques in service sector and various budgetary control techniques
- Illustrate with quantitative techniques in cost management

UNIT I INTRODUCTION TO COSTING CONCEPTS **9**

Objectives of a Costing System; Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost; Creation of a Database for operational control.

UNIT II INTRODUCTION TO PROJECT MANAGEMENT **9**

Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities, Detailed Engineering activities, Pre project execution main clearances and documents, Project team: Role of each member,Importance Project site: Data required with significance, Project contracts.

UNIT III PROJECT EXECUTION AND COSTING CONCEPTS **9**

Project execution Project cost control, Bar charts and Network diagram, Project commissioning: mechanical and process, Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis, Various decision-making problems, Pricing strategies: Pareto Analysis, Target costing, Life Cycle Costing.

UNIT IV COSTING OF SERVICE SECTOR AND BUDGETERY CONTROL 9

Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis, Budgetary Control: Flexible Budgets; Performance budgets; Zero-based budgets.

UNIT V QUANTITATIVE TECHNIQUES FOR COST MANAGEMENT 9

Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Learning Curve Theory.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1 – Understand the costing concepts and their role in decision making
CO2–Understand the project management concepts and their various aspects in selection
CO3–Interpret costing concepts with project execution
CO4–Gain knowledge of costing techniques in service sector and various budgetary control techniques
CO5 - Become familiar with quantitative techniques in cost management

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

REFERENCES:

1. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher, 1991
2. Charles T. Horngren and George Foster, Advanced Management Accounting, 1988
3. Charles T. Horngren et al Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi, 2011
4. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting, 2003
5. Vohra N.D., Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd, 2007

OE5095 COMPOSITE MATERIALS L T P C
3 0 0 3

COURSE OBJECTIVES:

- Summarize the characteristics of composite materials and effect of reinforcement in composite materials.
- Identify the various reinforcements used in composite materials.
- Compare the manufacturing process of metal matrix composites.
- Understand the manufacturing processes of polymer matrix composites.
- Analyze the strength of composite materials.

UNIT I INTRODUCTION 9

Definition – Classification and characteristics of Composite materials - Advantages and application of composites - Functional requirements of reinforcement and matrix - Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

UNIT II REINFORCEMENTS 9

Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers - Properties and applications of whiskers, particle reinforcements - Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures - Isostrain and Isostress conditions.

UNIT III MANUFACTURING OF METAL MATRIX COMPOSITES 9

Casting – Solid State diffusion technique - Cladding – Hot isostatic pressing - Properties and applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving - Properties and applications.

UNIT IV MANUFACTURING OF POLYMER MATRIX COMPOSITES 9

Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding - Properties and applications.

UNIT V STRENGTH 9

Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- CO1 - Know the characteristics of composite materials and effect of reinforcement in composite materials.
- CO2 – Know the various reinforcements used in composite materials.
- CO3 – Understand the manufacturing processes of metal matrix composites.
- CO4 – Understand the manufacturing processes of polymer matrix composites.
- CO5 – Analyze the strength of composite materials.

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

REFERENCES:

1. Cahn R.W. - Material Science and Technology – Vol 13 – Composites, VCH, West Germany.
2. Callister, W.D Jr., Adapted by Balasubramaniam R, Materials Science and Engineering, An introduction, John Wiley & Sons, NY, Indian edition, 2007.
3. Chawla K.K., Composite Materials, 2013.
4. Lubin.G, Hand Book of Composite Materials, 2013.

OE5096 WASTE TO ENERGY L T P C
3 0 0 3

OBJECTIVES:

- Interpret the various types of wastes from which energy can be generated
- Develop knowledge on biomass pyrolysis process and its applications
- Develop knowledge on various types of biomass gasifiers and their operations
- Invent knowledge on biomass combustors and its applications on generating energy
- Summarize the principles of bio-energy systems and their features

UNIT I INTRODUCTION TO EXTRACTION OF ENERGY FROM WASTE 9

Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors

UNIT II BIOMASS PYROLYSIS 9

Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

UNIT III BIOMASS GASIFICATION 9

Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

UNIT IV BIOMASS COMBUSTION 9

Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

UNITV BIO ENERGY 9

Properties of biogas (Calorific value and composition), Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production -Urban waste to energy conversion - Biomass energy programme in India.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1 – Understand the various types of wastes from which energy can be generated
CO2 – Gain knowledge on biomass pyrolysis process and its applications
CO3 – Develop knowledge on various types of biomass gasifiers and their operations
CO4 – Gain knowledge on biomass combustors and its applications on generating energy
CO5 – Understand the principles of bio-energy systems and their features

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

REFERENCES:

1. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
2. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
4. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.

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AUDIT COURSES (AC)

AX5091 ENGLISH FOR RESEARCH PAPER WRITING L T P C
2 0 0 0

COURSE OBJECTIVES

- Teach how to improve writing skills and level of readability
- Tell about what to write in each section
- Summarize the skills needed when writing a Title
- Infer the skills needed when writing the Conclusion
- Ensure the quality of paper at very first-time submission

UNIT I INTRODUCTION TO RESEARCH PAPER WRITING 6

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNIT II PRESENTATION SKILLS 6

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction

UNIT III TITLE WRITING SKILLS 6

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check

UNIT IV RESULT WRITING SKILLS 6

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

UNIT V VERIFICATION SKILLS 6

Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first- time submission

TOTAL: 30 PERIODS

COURSE OUTCOMES

CO1 –Understand that how to improve your writing skills and level of readability
CO2 – Learn about what to write in each section
CO3 – Understand the skills needed when writing a Title
CO4 – Understand the skills needed when writing the Conclusion
CO5 – Ensure the good quality of paper at very first-time submission

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

REFERENCES

1. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011
2. Day R How to Write and Publish a Scientific Paper, Cambridge University Press 2006
3. Goldbort R Writing for Science, Yale University Press (available on Google Books) 2006
4. Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book 1998.

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AX5092 **DISASTER MANAGEMENT** **L T P C**
2 0 0 0

COURSE OBJECTIVES

- Summarize basics of disaster
- Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Develop the strengths and weaknesses of disaster management approaches

UNIT I INTRODUCTION **6**

Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT II REPERCUSSIONS OF DISASTERS AND HAZARDS **6**

Economic Damage, Loss of Human and Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

UNIT III DISASTER PRONE AREAS IN INDIA **6**

Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics

UNIT IV DISASTER PREPAREDNESS AND MANAGEMENT **6**

Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT V RISK ASSESSMENT **6**

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival

TOTAL : 30 PERIODS

COURSE OUTCOMES

CO1: Ability to summarize basics of disaster
CO2: Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
CO3: Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
CO4: Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
CO5: Ability to develop the strengths and weaknesses of disaster management approaches

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

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REFERENCES

1. Goel S. L., Disaster Administration And Management Text And Case Studies", Deep & Deep Publication Pvt. Ltd., New Delhi,2009.
2. NishithaRai, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'NewRoyal book Company,2007.
3. Sahni, PardeepEt.Al. ," Disaster Mitigation Experiences And Reflections", Prentice Hall OfIndia, New Delhi,2001.

AX5093 SANSKRIT FOR TECHNICAL KNOWLEDGE L T P C
2 0 0 0

COURSE OBJECTIVES

- Illustrate the basic sanskrit language.
- Recognize sanskrit, the scientific language in the world.
- Appraise learning of sanskrit to improve brain functioning.
- Relate sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power.
- Extract huge knowledge from ancient literature.

UNIT I ALPHABETS 6
Alphabets in Sanskrit

UNIT II TENSES AND SENTENCES 6
Past/Present/Future Tense - Simple Sentences

UNIT III ORDER AND ROOTS 6
Order - Introduction of roots

UNIT IV SANSKRIT LITERATURE 6
Technical information about Sanskrit Literature

UNIT V TECHNICAL CONCEPTS OF ENGINEERING 6
Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics

TOTAL: 30 PERIODS

COURSE OUTCOMES

- CO1 - Understanding basic Sanskrit language.
- CO2 - Write sentences.
- CO3 - Know the order and roots of Sanskrit.
- CO4 - Know about technical information about Sanskrit literature.
- CO5 - Understand the technical concepts of Engineering.

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

REFERENCES

1. "Abhyaspustakam" – Dr. Vishwas, Samskrita-Bharti Publication, New Delhi
2. "Teach Yourself Sanskrit" Prathama Deeksha-Vempati Kutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication
3. "India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi, 2017.

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AX5094 **VALUE EDUCATION** **L T P C**
2 0 0 0

COURSE OBJECTIVES
Students will be able to
- Understand value of education and self-development
- Imbibe good values in students
- Let the should know about the importance of character

UNIT I
Values and self-development–Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non-moral valuation. Standards and principles. Value judgements

UNIT II
Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism. Love for nature, Discipline

UNIT III
Personality and Behavior Development-Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking. Free from anger, Dignity of labour.
Universal brother hood and religious tolerance. True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature

UNIT IV
Character and Competence–Holy books vs Blind faith. Self-management and Good health. Science of reincarnation. Equality, Nonviolence, Humility, Role of Women. All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively.

TOTAL: 30 PERIODS

COURSE OUTCOMES
Students will be able to
- Knowledge of self-development.
- Learn the importance of Human values.
- Developing the overall personality.

SUGGESTED READING
1. Chakroborty, S.K.“Values and Ethics for organizations Theory and practice”, Oxford University Press, New Delhi

AX5095 **CONSTITUTION OF INDIA** **L T P C**
2 0 0 0

COURSE OBJECTIVES
Students will be able to:
- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals’ constitutional
- Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolutionin1917and its impact on the initial drafting of the Indian Constitution.

UNIT I HISTORY OF MAKING OF THE INDIAN CONSTITUTION:
History, Drafting Committee, (Composition & Working)

UNIT II PHILOSOPHY OF THE INDIAN CONSTITUTION:
Preamble, Salient Features

UNIT III CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES:
Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT IV ORGANS OF GOVERNANCE:
Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

UNIT V LOCAL ADMINISTRATION:
District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO, Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level:Role of Elected and Appointed officials, Importance of grass root democracy.

UNIT VI ELECTION COMMISSION:
Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.

TOTAL: 30 PERIODS

COURSE OUTCOMES

Students will be able to:

- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origins of the framework of argument that informed the conceptualization
- of social reforms leading to revolution in India.
- Discuss the circumstances surrounding the foundation of the Congress Socialist Party[CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
- Discuss the passage of the Hindu Code Bill of 1956.

SUGGESTED READING

1. The Constitution of India,1950 (Bare Act),Government Publication.
2. Dr.S.N.Busi, Dr.B. R.Ambedkar framing of Indian Constitution,1st Edition, 2015.
3. M.P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis,2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

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AX5096 **PEDAGOGY STUDIES** **L T P C**
2 0 0 0

COURSE OBJECTIVES

Students will be able to:

- Review existing evidence on there view topic to inform programme design and policy
- Making under taken by the DfID, other agencies and researchers.
- Identify critical evidence gaps to guide the development.

UNIT I INTRODUCTION AND METHODOLOGY:

Aims and rationale, Policy background, Conceptual framework and terminology - Theories of learning, Curriculum, Teacher education - Conceptual framework, Research questions **-** Overview of methodology and Searching.

UNIT II THEMATIC OVERVIEW

Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries - Curriculum, Teacher education.

UNIT III EVIDENCE ON THE EFFECTIVENESS OF PEDAGOGICAL PRACTICES

Methodology for the in depth stage: quality assessment of included studies - How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? - Theory of change - Strength and nature of the body of evidence for effective pedagogical practices - Pedagogic theory and pedagogical approaches - Teachers' attitudes and beliefs and Pedagogic strategies.

UNIT IV PROFESSIONAL DEVELOPMENT

Professional development: alignment with classroom practices and follow up support - Peer support - Support from the head teacher and the community - Curriculum and assessment - Barriers to learning: limited resources and large class sizes

UNIT V RESEARCH GAPS AND FUTURE DIRECTIONS

Research design – Contexts – Pedagogy - Teacher education - Curriculum and assessment - Dissemination and research impact.

TOTAL: 30 PERIODS

COURSE OUTCOMES

Students will be able to understand:

- What pedagogical practices are being used by teachers informal and informal classrooms in developing countries?
- What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
- How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

SUGGESTED READING

1. Ackers J, HardmanF (2001) Classroom interaction in Kenyan primary schools, Compare, 31(2): 245-261.
2. Agrawal M (2004)Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36(3):361-379.
3. Akyeampong K (2003) Teacher training in Ghana-does it count? Multi-site teacher education research project (MUSTER) country report 1.London:DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal

Educational Development, 33(3): 272–282.
5. Alexander RJ(2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
6. Chavan M(2003) Read India: Amass scale, rapid, 'learning to read' campaign.
7. www.pratham.org/images/resource%20working%20paper%202.pdf

AX5097 **STRESS MANAGEMENT BY YOGA** **L T P C**
2 0 0 0

COURSE OBJECTIVES
- To achieve overall health of body and mind
- To overcome stress

UNIT I
Definitions of Eight parts of yoga.(Ashtanga)

UNIT II
Yam and Niyam - Do`s and Don't's in life - i) Ahinsa, satya, astheya, bramhacharya and aparigraha, ii) Ahinsa, satya, astheya, bramhacharya and aparigraha.

UNIT III
Asan and Pranayam - Various yog poses and their benefits for mind & body - Regularization of breathing techniques and its effects-Types of pranayam

TOTAL: 30 PERIODS

COURSE OUTCOMES
Students will be able to:
- Develop healthy mind in a healthy body thus improving social health also
- Improve efficiency

SUGGESTED READING
1. 'Yogic Asanas for Group Tarining-Part-I":Janardan Swami Yoga bhyasi Mandal, Nagpur
2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata

AX5098 **PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS** **L T P C**
2 0 0 0

COURSE OBJECTIVES
- To learn to achieve the highest goal happily
- To become a person with stable mind, pleasing personality and determination
- To awaken wisdom in students

UNIT I
Neetisatakam-holistic development of personality - Verses- 19,20,21,22 (wisdom) - Verses- 29,31,32 (pride & heroism) – Verses- 26,28,63,65 (virtue) - Verses- 52,53,59 (dont's) - Verses- 71,73,75,78 (do's)

UNIT II
Approach to day to day work and duties - Shrimad Bhagwad Geeta: Chapter 2-Verses 41, 47,48 - Chapter 3-Verses 13, 21, 27, 35 Chapter 6-Verses 5,13,17,23, 35 - Chapter 18-Verses 45, 46, 48.

UNIT III

Statements of basic knowledge - Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62, 68 Chapter 12 -Verses 13, 14, 15, 16,17, 18 - Personality of role model - shrimad bhagwad geeta - Chapter2-Verses 17, Chapter 3-Verses 36,37,42 - Chapter 4-Verses 18, 38,39 Chapter18 – Verses 37,38,63

TOTAL: 30 PERIODS

COURSE OUTCOMES

Students will be able to

- Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life
- The person who has studied Geeta will lead the nation and mankind to peace and prosperity
- Study of Neet is hatakam will help in developing versatile personality of students.

SUGGESTED READING

1. Gopinath, Rashtriya Sanskrit Sansthanam P, Bhartrihari's Three Satakam, Niti-sringar-vairagya, New Delhi,2010
2. Swami Swarupananda , Srimad Bhagavad Gita, Advaita Ashram, Publication Department, Kolkata, 2016.

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