ANNA UNIVERSITY, CHENNAI
NON- AUTONOMOUS COLLEGES AFFILIATED ANNA UNIVERSITY
M.E. MECHATRONICS
REGULATIONS 2021
CHOICE BASED CREDIT SYSTEM
I TO IV SEMESTERS CURRICULA & SYLLABI

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

I. To create a high qualified mechatronics engineer, who have ability to design, develop and analyze the mechatronic system and provide optimal solutions with basic and advanced technology for industrial and societal problems.
II. To develop innovative and sustainable products with multidisciplinary expertise.
III. To develop a successful entrepreneur in their field with strong communication and high ethics.
IV. To develop industry readiness engineer with complex solving capability and lifelong learning.
V. To develop high employability in industry and academia.

PROGRAMME OUTCOMES (POs):

PO	Programme Outcome
1	An ability to independently carry out research/investigation and development work to solve practical problems
2	An ability to write and present a substantial technical report/document
3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program.
4	Post Graduates able to acquaint the knowledge in key concepts, methods, core elements, design, modern tools and techniques for unified mechatronic systems and their intelligence.
5	Post Graduates will apply to develop the solution for various engineering system needs using a mechatronics-based approach.
6	Post Graduates able to build the real-time/virtual mechatronics system within realistic constraints such as industrial, economic, environmental, ethical, social, health and safety aspects.

PEO & PO Mapping

	PO					
	1	2	3	4	5	6
I.	3	-	-	2	2	3
II.	2	-	-	1	1	3
III.	-	3	2	-	-	1
IV.	2	-	1	1	1	1
V.	-	-	-	-	-	-
VI.						

PROGRAMME ARTICULATION MATRIX

		COURSE NAME	PO1	PO2	PO3	PO4	PO5	PO6
YEAR I	SEMESTER I	Applied Mathematics for Mechatronics Engineers	2	-	-	-	2	-
		Concepts in Electronics Engineering	1.8	-	2.4	2	1.8	2.2
		Concepts of Machines and Mechanisms	1.8	-	2.4	2	1.8	2.2
		Sensors and Actuators	2.2	-	-	3	3	3
		Control System Design	1	-	2	3	3	3
		Industrial Automation	2	-	-	3	3	3
		Research Methodology and IPR	-	3	-	-	1	1
		Professional Elective I						
		Audit Course I						
		Sensors and Actuators Laboratory	-	2	3	3	2	1.3
		Industrial Automation Laboratory	-	2	3	3	2	1.3
	SEMESTER II	Mechatronics System Design	2	-	-	3	3	3
		Industrial Robotics and Control	2	-	-	3	3	3
		Machine Vision systems	2	-	-	3	3	3
		Intelligence in systems	2	-	-	3	3	3
		Smart Embedded Systems	1	-	-	3	2	2
		Professional Elective – II						
		Audit Course II						
		Industrial Robotics and Embedded Systems Laboratory	-	1.3	3	2	2	2
		Machine Vision and Intelligence Laboratory	-	1.3	3	2	2	2
YEAR I	SEMESTER III	Professional Elective - III						
		Professional Elective - IV						
		Open Elective						
		Project Work I	2	1	2	3	3	3
	SEMESTER IV	Project Work II	2	1	2	3	3	3

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M.E. MECHATRONICS

REGULATIONS – 2021

CHOICE BASED CREDIT SYSTEM

I TO IV SEMESTERS CURRICULA AND SYLLABI

SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	MA4104	Applied Mathematics for Mechatronics	FC	3	1	0	4	4
2	MR4101	Concepts in Electronics Engineering	FC	2	0	2	4	3
	MR4102	Concepts of Machines and Mechanisms			0	2		
3	MR4103	Sensors and Actuators	PCC	3	0	0	3	3
4	MR4104	Control System Design	PCC	3	0	2	5	4
5	MR4105	Industrial Automation	PCC	3	0	0	3	3
6	RM4151	Research Methodology and IPR	RMC	2	0	0	2	2
7		Professional Elective – I	PEC	3	0	0	3	3
8		Audit Course -I	AC	2	0	0	2	0
PRACTICAL								
9	MR4111	Sensors and Actuators Laboratory	PCC	0	0	4	4	2
10	MR4112	Industrial Automation Laboratory	PCC	0	0	2	2	1
			TOTAL	**21**	**1**	**10**	**32**	**25**

* 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.	MR4201	Mechatronics System Design	PCC	4	0	0	4	4
2.	MR4202	Industrial Robotics and Control	PCC	3	0	0	3	3
3.	MR4203	Machine Vision Systems	PCC	3	0	0	3	3
4.	MR4204	Intelligence in Systems	PCC	3	0	0	3	3
5.	MR4205	Smart Embedded Systems	PCC	3	0	0	3	3
6.		Professional Elective – II	PEC	3	0	0	3	3
7.		Audit Course II*	AC	2	0	0	2	0
PRACTICAL								
8.	MR4211	Industrial Robotics and Embedded Systems Laboratory	PCC	0	0	4	4	2
9.	MR4212	Machine Vision and Intelligence Laboratory	PCC	0	0	4	4	2
			TOTAL	**21**	**0**	**8**	**29**	**23**

* Audit Course is optional

SEMESTER III

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.		Professional Elective - III	PEC	3	0	0	3	3
2.		Professional Elective - IV	PEC	3	0	0	3	3
3.		Open Elective	OEC	3	0	0	3	3
PRACTICAL								
4.	MR4311	Project Work - I	EEC	0	0	12	12	6
			TOTAL	**9**	**0**	**12**	**21**	**15**

SEMESTER IV

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICAL								
1	MR4411	Project Work-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

FOUNDATION COURSES (FC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	MA4104	Applied Mathematics for Mechatronics	3	1	0	4	1
2.	MR4101	Concepts in Electronics Engineering	2	0	2	3	1
	MR4102	Concepts of Machines and Mechanisms	2	0	2		1

PROFESSIONAL CORE COURSES (PCC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	MR4103	Sensors and Actuators	3	0	0	3	1
2.	MR4104	Control System Design	3	0	2	4	1
3.	MR4105	Industrial Automation	3	0	0	3	1
4.	MR4111	Sensors and Actuators Laboratory	0	0	4	4	2
5.	MR4112	Industrial Automation Laboratory	0	0	2	1	1
6.	MR4201	Mechatronics System Design	3	0	2	5	2
7.	MR4202	Industrial Robotics and Control	3	0	0	3	2
8.	MR4203	Machine Vision Systems	3	0	0	3	2
9.	MR4204	Intelligence in Systems	3	0	0	3	2
10.	MR4205	Smart Embedded Systems	3	0	0	3	3
11.	MR4211	Industrial Robotics and Embedded Systems Laboratory	0	0	4	4	2
12.	MR4212	Machine Vision and Intelligence Laboratory	0	0	4	4	2

PROFESSIONAL ELECTIVES

SEMESTER I, ELECTIVE - I

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	MR4001	Computer Aided Inspection	PEC	3	3	0	0	3
2.	MR4002	Digital Manufacturing	PEC	3	3	0	0	3
3.	MR4003	Computer Aided Production and Automation of Plants	PEC	3	3	0	0	3
4.	MR4004	Design of Machine Elements and Product Development	PEC	3	3	0	0	3
5.	MR4005	Multi-Body Dynamics	PEC	3	3	0	0	3
6.	MR4006	Onboard Computers and Python Programming	PEC	3	3	0	0	3

SEMESTER II, ELECTIVE - II

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	MR4007	Micro and Nano Systems	PEC	3	3	0	0	3
2.	MR4008	Advanced Control Systems	PEC	3	3	0	0	3
3.	MR4009	Biomechatronics	PEC	3	3	0	0	3
4.	MR4010	Solid State Drives	PEC	3	3	0	0	3
5.	MR4011	Automotive Electronics	PEC	3	3	0	0	3
6.	MR4012	Unmanned Aerial Vehicle	PEC	3	3	0	0	3

SEMESTER III, ELECTIVE - III & IV

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	MR4013	Intelligent Product Design	PEC	3	3	0	0	3
2.	IL4073	Human Industrial Safety and Hygiene	PEC	3	3	0	0	3
3.	MR4071	Internet of Things for Manufacturing	PEC	3	3	0	0	3
4.	MR4014	Communication Protocols	PEC	3	3	0	0	3
5.	MR4015	Advanced Computer Vision	PEC	3	3	0	0	3
6.	MR4016	Mechatronics in Aero Systems	PEC	3	3	0	0	3
7.	MR4017	Medical Mechatronics	PEC	3	3	0	0	3
8.	MR4018	Mobile Robotics	PEC	3	3	0	0	3
9.	CM4091	Green Manufacturing	PEC	3	3	0	0	3
10.	MR4019	Haptics and Augmented Reality	PEC	3	3	0	0	3
11.	MR4020	Industrial Instrumentation and Control	PEC	3	3	0	0	3
12.	MR4021	Modeling and Analysis of Electromechanical Systems	PEC	3	3	0	0	3

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	MR4311	Project Work - I	0	0	12	6	3
2.	MR4411	Project Work-II	0	0	24	12	4
						TOTAL CREDITS	18

RESEARCH METHODOLOGY AND IPR COURSES (RMC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
				Tutorial	Practical		
1.	RM4151	Research Methodology and IPR	2	0	0	2	1
						TOTAL CREDITS	2

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.	AX4091	English for Research Paper Writing	2	0	0	0
2.	AX4092	Disaster Management	2	0	0	0
3.	AX4093	Constitution of India	2	0	0	0
4.	AX4094	நற்றமிழ் இலக்கியம்	2	0	0	0

MA4104 APPLIED MATHEMATICS FOR MECHATRONICS

L	T	P	C
3	1	0	4

COURSE OBJECTIVES:

1. Mathematical foundations of numerical techniques for solving linear systems, eigenvalue problems and generalized inverse.
2. To expose the students to variational formulation and numerical integration techniques and demonstrate solution methodology for the variational problems.
3. To understand the basics of random variables with emp0hasis on the standard discrete and continuous distributions.
4. To make the students appreciate the purpose of using Laplace transforms to solve the partial differential equation.
5. To introduce the Fourier transforms and its properties.

UNIT – I MATRIX THEORY **12**

Matrix representation of Linear Transformation – Eigen values – Generalized Eigenvectors – Rank of Matrix – The Cholesky decomposition – Canonical basis – QR factorization – Least squares method – Singular value decomposition.

UNIT – II CALCULUS OF VARIATIONS **12**

Concept of variation and its properties – Euler's equations – Functional dependent on first and higher order derivatives – Functional dependent on functions of several independent variables – Variational problems with moving boundaries – Isoperimetric problems – Direct methods: Ritz and Kantorovich methods – Taylor polynomials and Taylor series.

UNIT – III PROBABILITY AND RANDOM VARIABLES **12**

Probability – Axioms of probability – Conditional probability – Bayes' theorem – Random variables – Probability function – Moments – Moment generating functions and their properties – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions – Function of a random variable.

UNIT – IV LAPLACE TRANSFORM TECHNIQUES FOR PDE **12**

Laplace transform – Definitions – Properties – Transform error function – Bessel's functions – Dirac delta function – Unit step functions – Convolution theorem – Inverse Laplace transform: Complex inversion formula – Solutions to Partial Differential Equations (PDE): Heat equations – Wave equation.

UNIT – V FOURIER TRANSFORM TECHNIQUES FOR PDE **12**

Fourier transform: Definitions, properties – Transform of elementary functions - Dirac Delta function – Convolution theorem - Parseval's identity – Solutions to partial differential equations: Heat equation - Wave equation - Laplace and Poisson's equations.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of the course, students will be able to

1. apply various methods in matrix theory to solve system of linear equations.
2. maximizing and minimizing the functional that occur in various branches of Engineering disciplines.
3. computation of probability and moments, standard distributions of discrete and continuous random variables and functions of a random variable.
4. application of Laplace transforms to initial value, initial- boundary value and boundary value problems in Partial Differential Equations.
5. obtain Fourier transforms for the functions which are needed for solving application problems.

REFERENCES:

1. Andrews, L. C. and Shivamoggi, B., "Integral Transforms for Engineers", Prentice Hall of India, New Delhi, 2003.
2. Bronson, R.," Matrix Operations", Schaum's outline series, 2nd Edition, McGraw Hill, 2011.
3. James, G., "Advanced Modern Engineering Mathematics", 3rd Edition, Pearson Education, 2004.
4. Johnson, R.A., Miller, I and Freund J., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 8th Edition, 2015.
5. O'Neil P.V., "Advanced Engineering Mathematics", Thomson Asia Pvt. Ltd., Singapore, 2003.
6. Sankara Rao,K., " Introduction to Partial Differential Equations", Prentice Hall of India Pvt. Ltd., New Delhi, 1997.

MR4101 CONCEPTS IN ELECTRONICS ENGINEERING L T P C
2 0 2 3

COURSE OBJECTIVES

1. To understand the functionality of fundamental electronic components.
2. To understand the functions of the operational amplifier and its applications.
3. To review and use the logic gates for various digital circuit development.
4. To understand the functions and uses in measurement.
5. To learn the power management of various electronic units.

UNIT I ELECTRONIC COMPONENTS AND DEVICES 6

Resistors, capacitors, inductors, transformers – types and properties - junction diodes, Zener diodes, transistors and thyristors - types-operating mechanism-characteristics and applications. LED – characteristics and applications

UNIT II OPERATIONAL AMPLIFIERS AND APPLICATIONS 6

Operational amplifiers – principles, specifications, characteristics and applications- arithmetic operations, integrator, differentiator, comparator, Schmitt trigger, instrumentation amplifiers, active filters, linear rectifiers, waveform generators, A/D converters, feedback and power amplifiers, sine wave oscillators

UNIT III DIGITAL ELECTRONICS 6

Number systems – Logic gates – Boolean algebra – Simplification of Boolean functions– Study of Combinational Logic Circuits-Full Adder, Code Converters, Multiplexers, Encoder and Decoders, Study of Sequential Logic Circuits-Flip-flops, Counters, Shift registers – D/A Converters.

UNIT IV SIGNAL PROCESSING AND MEASURING DEVICES 6

Rectifiers and Filters - Regulated Power Supply – 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**

Pulse width modulation and pulse position modulation – batteries–SMPS - sensors, actuators and controllers' energy consumption -power optimization of integrated system.

TOTAL: 30 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: Create the digital electronic circuits using logic gate ICs'.
CO4: Apply 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.

CO-PO MAPPING:

Course Outcomes	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	2	2	2	2
CO2	2	-	3	2	1	3
CO3	2	-	2	2	2	2
CO4	1	-	2	3	2	2
CO5	2	-	3	1	2	2
AVG.	1.8	-	2.4	2	1.8	2.2

REFERENCES

1. Helfrick A.D and Cooper .W. D. "Modern Electronic Instrumentation and Measurements Techniques", Prentice Hall, 2008.
2. Jocob Mill Man, Microelectronics Digital and Analog Circuits & Systems – McGraw-Hill, 2004.
3. Malvino & Leach, Digital Principles &Application, TMH, 2015.
4. Mill Man and Halkias, "Electron Devices and Circuits", McGraw-Hill 2010.
5. Ray & Chaudary, Linear Integrated Circuits, New Age, 2006.

LABORATORY

LIST OF EXPERIMENTS

1. Study of digital storage oscilloscope.
2. Experimentation with CRO.
3. Design of DC power supplies
4. Design of inverting amplifier and non-inverting amplifiers
5. Design of Instrumentation amplifier.
6. Design of analog filters.
7. Design of combinational circuits and sequential circuits.
8. Design of A/D converters and D/A converters.
9. RC Servo motor driver circuit.
10. Design of stepper motor driver circuit.

TOTAL: 30 PERIODS

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

1. CRO-1
2. DSO-1
3. DC Power supply
   5V – 5 No's

12V, 10A - 1 No
24V, 10A or higher - 1 No

4. Function generator-1
5. OP-Amp trainer kit (inverting and non-inverting amplifier module)
6. Analog filters trainer kit
7. Sequential circuit trainer kit
8. Combination circuit trainer kit
9. A/D Converter trainer kit -1 No
10. D/A Converter Trainer kit-1 No
11. Driver Circuit Module for servomotor-1 No
12. Driver Circuit module for stepper motor-1 No
13. Multi-Meter, bread board, and solder machine.
14. Electronic components for power supply (transformer, regulator, diode, capacitors) -5 No's.

MR4102 CONCEPTS OF MACHINES AND MECHANISMS

L	T	P	C
2	0	2	3

COURSE OBJECTIVES

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

UNIT I MECHANISMS 6

Definition – Machine and Structure – Kinematic link, pair and chain – classification of Kinematic pairs – Constraint& motion - 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 6

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 – Jockey pulley – open and crossed belt drives – Ratio of tensions – Effect of centrifugal and initial tension – condition for maximum power transmission.

UNIT III GEARING AND CAMS 6

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

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

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.

TOTAL : 30 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.

CO-PO MAPPING:

Course Outcomes	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	2	2	2	2
CO2	2	-	3	2	1	3
CO3	2	-	2	2	2	2
CO4	1	-	2	3	2	2
CO5	2	-	3	1	2	2
AVG.	1.8	-	2.4	2	1.8	2.2

REFERENCES

1. Bansal R.K, “Theory of Machines”, Laxmi Publications (P) ltd., New Delhi. 2016.
2. G.C.Sen and A. Bhattacharya, “Principles of Machine Tools”, New Central book Agency, 2009.
3. Joseph Edward Shigley, Charles R.Mischke, “Mechanical Engineering Design”, Mcgraw Hill International Edition, 2008.
4. Malhotra .D.R. and Gupta .H.C. “The Theory of Machines” SatyaPrakasam, Tech. India Publications, 1989.
5. R.S.Khurmi and Gupta, “Theory of Machines” Eurasia Publishing House Pvt Ltd. 2020.

LABORATORY

LIST OF EXPERIMENTS

1. 2D modeling and 3D modeling of Bearing, and Couplings.
2. 2D modeling and 3D modeling of Gears and Ball screw.
3. 2D modeling and 3D modeling of Sheet metal components
4. 2D modeling and 3D modeling of Jigs, fixtures and Die.
5. 2D modeling and 3D modeling of Structures and frames
6. Modeling and simulation of mechanism of 4 Bar chain
7. Modeling and simulation of mechanism of Slider crank,
8. Modeling and simulation of mechanism of Ball and screw and Rack and pinion.
9. Modeling and simulation of mechanism of Belt and chain drives.
10. Modeling and simulation of mechanism of Quick return and elliptical trammel.

TOTAL: 30 PERIODS

LIST OF SOFTWARES

Solid Works/ OpenCAD /CREO /CATIA/ NX CAD/MSC-Adams – 15 No’s

MR4103	SENSORS AND ACTUATORS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To learn the various types of sensors, transducers, sensor output signal types, calibration techniques, formulation of system equation and its characteristics.
2. To understand basic working principle, construction, Application and characteristics of motion, proximity and ranging sensors.
3. To understand and analyse the working principle, construction, application and characteristics of force, magnetic and heading sensors.
4. To learn and analyse the working principle, construction, application and characteristics of optical, pressure, temperature and other sensors.
   To understand basic working principle, construction, Application and characteristics of linear and rotary actuators.

UNIT I INTRODUCTION TO SENSORS 9

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 Output Signal Types. Temperature – IC, Thermistor, RTD, Thermocouple.

UNIT II MOTION, OPTICAL AND RANGING SENSORS 9

Motion Sensors – Brush Encoders, Potentiometers, Resolver, Encoders – Optical, Magnetic, Inductive, Capacitive, LVDT – RVDT – Synchro – Microsyn, Accelerometer.,– GPS, Range Sensors – RF beacons, Ultrasonic Ranging, Reflective beacons, Laser Range Sensor (LIDAR). Photo conductive cell, photo voltaic, Photo resistive, LDR – Fiber optic sensors.

UNIT III FORCE, MAGNETIC, AND HEADING SENSORS 9

Strain Gage, Load Cell Magnetic Sensors –types, principle, requirement and advantages: Magneto resistive – Hall Effect – Current sensor Heading Sensors – Compass, Gyroscope, Inclinometers.

UNIT IV FLUID POWER ACTUATORS 9

Hydraulic and Pneumatic System– ISO Symbols for their Elements - Hydraulic Pumps and Motor - Linear Actuators and Types - Control and Regulating Elements — Direction, Flow and Pressure Control Valves - Methods of Actuation, Types, Sizing of Ports - Spool Valves - Electro Hydraulic Servo Valves - Types - Sequencing Circuits Design - Combinational Logic Circuit Design – Interfacing to PLC.

UNIT V ELECTRICAL DRIVES AND ACTUATORS 9

DC Motors and Types – Single Phase and Three Phase AC Motors – Servomotors - Stepper Motors - BLDC Motor and its Operating Modes - Piezo Electric Actuators – Linear Electrical Actuators - Switching Devices - Relay, BJT, MOSFET, IGBT, SCR - H-Bridge DC Drives under PWM Mode**.** VFD Drives – AC Servo Drives – Stepper Motor Drives - Drives for BLDC Motor - Selection of Drives – Protection and Switchgears.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

1. Understand various sensor effects, sensor characteristics, signal types, calibration methods and obtain transfer function and empirical relation of sensors. They can also analyse the sensor response.
2. Analyze and select suitable sensor for motion, proximity and range measurement.
3. Analyze and select suitable sensor for force, magnetic field, speed, position and direction measurement.
4. Analyze and Select suitable sensor for light detection, pressure and temperature measurement and also familiar with other miniaturized smart sensors.
5. Understand the working principles of various actuators and their applications.

REFERENCES

1. Bolton W., "Mechatronics", Pearson; 5th edition, 2015
2. Bradley D.A., and Dawson, Burd and Loader, "Mechatronics", Thomson Press India Ltd., 2004
3. Ernest O. Doeblin, "Measurement system, Application and Design", Tata McGraw Hill Publishing Company Ltd., Fiftieth Edition, 2004
4. Patranabis D., "Sensor and Actuators", Prentice Hall of India (Pvt) Ltd., 2005.
5. Renganathan S., "Transducer Engineering", Allied Publishers (P) Ltd., 2003
6. Antony Esposito, "Fluid Power Systems and Control", Prentice-Hall, 2006.
7. Austin Hughes, "Electric Motors and Drives Fundamentals, Types and Applications", Fourth Edition, Elsevier, 2013

CO-PO MAPPING:

Course Outcomes	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	-	3	3	3
CO2	2	-	-	3	3	3
CO3	1	-	-	3	3	3
CO4	3	-	-	3	3	3
CO5	2	-	-	3	3	3
AVG.	2.2	-	-	3	3	3

MR4104 **CONTROL SYSTEM DESIGN** **L T P C**

3 0 2 4

COURSE OBJECTIVES

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

UNIT I SYSTEM REPRESENTATION AND MODELLING 9

Introduction and need for Control Systems with examples – Feedback systems – Block Diagram – Definition of Process variable, Set-point, Manipulated variable and Final control element with examples -Open loop and Closed loop systems – Transfer Function Model – State Space Model – Mathematical Modelling of Mechanical, Electrical, Pneumatic and Hydraulic systems – Block Diagram reduction – Signal flow graph.

UNIT II DESIGN OF FEEDBACK CONTROL SYSTEM 9

Feedback systems – Block Diagram – Definition of process variable, set –point, manipulated variable and final control element with examples – characteristics of on –off,P, PI, PD and PID controllers – Implementation issues of PID controller – Modified PID controller – Tuning of controller.

UNIT III TIME AND FREQUENCY DOMAIN ANALYSIS 9

Time response of First & Second order systems – Time domain specifications - steady state errors and error constants – Routh Hurwitz criterion – Root locus – Bode Plot – Polar Plot – Nyquist stability criterion – Stability analysis – Experimental determination of Transfer Functions

UNIT IV CONTROL SYSTEM DESIGN 9

Root locus approach to control system design – lead, lag, lag-lead compensation using time domain analysis. Control system design using frequency domain analysis - lead, lag, lag-lead compensation using frequency domain analysis– P, PI, and PID controllers – tuning methods and rule.

UNIT V CONTROL AND ANALYSIS OF SERVO MOTOR 9

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 PID Controller.

TOTAL : 45 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.

CO-PO MAPPING:

Course Outcomes	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	2	3	3	3
CO2	1	-	2	3	3	3
CO3	1	-	2	3	3	3
CO4	1	-	2	3	3	3
CO5	1	-	2	3	3	3
AVG.	1	-	2	3	3	3

REFERENCES

1. A. NagoorKani, “Control Systems”, RBA Publications (P) Ltd., 2020.
2. B.C. Kuo, “Automatic Control Systems”, Prentice Hall of India Pvt. Ltd., New Delhi, 2018.
3. I.J.Nagrath and Gopal, “Control System Engineering”, New Age international (P) Ltd., 2006.
4. K.Ogata, “Modern Controls Engineering“, Prentice Hall of India Pvt. Ltd., New Delhi, 2005.
5. M. Nakamura .S.Gata&N.Kyura, Mechatronic Servo System Control, Springer.

LABORATORY

LIST OF EXPERIMENTS

1. Mathematical Modelling and Simulation of a Physical Systems.
2. Simulation and Reduction of Cascade and Parallel, and Closed Loop Sub-System.
3. Plot the pole-zero configuration in s-plane for the given Transfer Function.
4. Simulation and Analysis of First and Second Order System Equations in Time and frequency Domain
5. Simulation and Analysis of Root-Locus and Bode Plot.
6. Simulation and Implementation of PID Controller Combinations for First and Second Order Systems.
7. Simulation of Motor velocity, position and torque control.

TOTAL: 30 PERIODS

LIST OF SOFTWARE FOR A BATCH OF 30 STUDENTS:

1. MATLAB/ SCILAB – Control System Tool Box - 15 No’s

MR4105	INDUSTRIAL AUTOMATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To understand the importance of automation in industry and various industrial standard sensors and process parameters to control the production process.
2. To learn PLC hardware, and practice the PLC programming and simulation in real systems.
3. To get knowledge on industrial standard data communication protocols, SCADA, centralized and decentralized control.
4. To get introduced to factory layout, Total Integrated Automation on factory and Industry 4.0.
5. 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 PLCs – Programming Timers and counters – Data Handling - PLC modules - Advanced PLCs.

UNIT III DATA COMMUNICATION AND SUPERVISORY CONTROL SYSTEMS 9

Industrial data communications - fiber optics – Modbus – HART – Device Net – Profibus – Fieldbus – Introduction to supervisory control systems – SCADA - Distributed control system (DCS) – Safety systems – man-machine interfaces.

UNIT IV FACTORY AUTOMATION 9

Factory layout - Tools and software based factory modeling -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 & 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

CO-PO MAPPING:

Course Outcomes	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	-	3	3	3
CO2	2	-	-	3	3	3
CO3	2	-	-	3	3	3
CO4	1	-	-	3	3	3
CO5	3	-	-	3	3	3
AVG.	2	-	-	3	3	3

REFERENCES

1. Clarke, G., Reynders, D. and Wright, E., "Practical Modern SCADA Protocols: DNP3, 60870.5 and Related Systems", Newnes, 1st Edition, 2004.
2. D.Patranabis, "Principles of Industrial Instrumentation", Tata McGraw-Hill Publishing Ltd., New Delhi, 2010.
3. Frank D. Petruzella, "Programmable Logic Controller" McGraw – Hill Publications, 2016.
4. Frank Lamb, "Hands on Industrial Automation", McGraw-Hill Profession, 2013.
5. Hughes, T., "Programmable Logic Controllers", ISA Press, 2000.
6. Lucas, M.P., "Distributed Control System", Van Nastrand Reinhold Company, New York, 1986.
7. Shengwei Wang, "Intelligent Buildings and Building Automation", Routledge Publishers, 2009.

RM4151 RESEARCH METHODOLOGY AND IPR L T P C
2 0 0 2

UNIT I RESEARCH DESIGN 6

Overview of research process and design, Use of Secondary and exploratory data to answer the research question, Qualitative research, Observation studies, Experiments and Surveys.

UNIT II DATA COLLECTION AND SOURCES 6

Measurements, Measurement Scales, Questionnaires and Instruments, Sampling and methods. Data - Preparing, Exploring, examining and displaying.

UNIT III DATA ANALYSIS AND REPORTING 6

Overview of Multivariate analysis, Hypotheses testing and Measures of Association. Presenting Insights and findings using written reports and oral presentation.

UNIT IV INTELLECTUAL PROPERTY RIGHTS 6

Intellectual Property – The concept of IPR, Evolution and development of concept of IPR, IPR development process, Trade secrets, utility Models, IPR & Bio diversity, Role of WIPO and WTO in IPR establishments, Right of Property, Common rules of IPR practices, Types and Features of IPR Agreement, Trademark, Functions of UNESCO in IPR maintenance.

UNIT V PATENTS **6**

Patents – objectives and benefits of patent, Concept, features of patent, Inventive step, Specification, Types of patent application, process E-filling, Examination of patent, Grant of patent, Revocation, Equitable Assignments, Licences, Licensing of related patents, patent agents, Registration of patent agents.

TOTAL :30 PERIODS

REFERENCES

1. Cooper Donald R, Schindler Pamela S and Sharma JK, "Business Research Methods", Tata McGraw Hill Education, 11e (2012).
2. Catherine J. Holland, "Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets", Entrepreneur Press, 2007.
3. David Hunt, Long Nguyen, Matthew Rodgers, "Patent searching: tools & techniques", Wiley, 2007.
4. The Institute of Company Secretaries of India, Statutory body under an Act of parliament, "Professional Programme Intellectual Property Rights, Law and practice", September 2013.

MR4111	SENSORS AND ACTUATORS LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES

1. To learn about various force, pressure and vibration measuring sensors.
2. To learn about various Temperature, light and magnetic field measuring sensors
3. To learn about various displacement and speed measuring sensors.

LIST OF EXPERIMENTS

SENSORS AND TRANSDUCERS

1 Experiments Using Strain Gauge Sensor: Load, Torque and Force Measurement.
2 Determine the characteristics of Pressure Sensor and Piezoelectric Force Sensor
3 Displacement Measurement using LVDT.
4 Determine the Characteristics of Various Temperature Sensors.
5 Determine the Characteristics of Various Light Detectors (Optical Sensors).
6 Distance Measurement using Ultrasonic and Laser Sensor.
7 Determine angular velocity using gyroscope, Vibration measurement using Accelerometer and Direction measurement using Magnetometer.
8 Speed and Position Measurement Using Encoders.

ACTUATORS

1 Experiments on control of Speed and Direction Control of DC Motor
2 Experiments on control of Position, Speed and Direction Control of Stepper Motor.
3 Experiments on control of Position, Speed and Direction Control of AC Servo Motors.
4 Experiment on control of Position, Speed and Direction Control of DC Servo Motors.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

1. Understand and demonstrate various contact and non-contact sensors.
2. Analyze and Identify appropriate sensors for given applications.
3. Create a sensor system for given requirements.

CO-PO MAPPING:

Course Outcomes	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	2	3	3	2	1
CO2	-	2	3	3	2	2
CO3	-	2	3	3	2	1
AVG.	-	2	3	3	2	1.3

MR4112 INDUSTRIAL AUTOMATION LABORATORY

L	T	P	C
0	0	2	1

COURSE OBJECTIVES

1. To learn the basic operations in PLC.
2. To learn to integrate various sensors and actuators to PLC.
3. To apply the PLC controller to various systems through real-time applications.

LIST OF EXPERIMENTS

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. Experiments on Sensor and Actuator Interfacing and PLC to PLC Communication.
5. Experimental Verification of Speed Control Circuits in Pneumatic and Hydraulic Trainer.
6. Experimental Verification of Single and Double Acting Cylinder Circuits Using Different Directional Control Values.
7. Experimental Verification of Pneumatic Sequencing Circuits.
8. Experiments on Control of PLC Based Electro Pneumatic Sequencing Circuits.
9. Experiments on Control of PLC Based Electro Hydraulic Sequencing Circuits.
10. Develop PLC Program to Maintain the Pressure and Level in a Bottle Filling System.
11. Develop Ladder Diagram Program in PLC For Material Filling and Object Shorting.
12. Develop the Ladder Diagram Program in PLC for Material Handling, Delaying Conveyor, Pick and Place Operation.

Note : Any of the 10 experiments to be conducted

TOTAL: 30 PERIODS

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

- PLC Software -2 Users
- PLC Station with Communication Protocol, Sensors and Actuators – 2 No’s
- Electro Pneumatic Sequencing -1 Unit
- Electro Hydraulic Sequencing Circuits – 1 Unit
- PLC station with Pressure and Level in a Bottle Filling System – 1 Unit
- PLC station with Material Handling, Delaying Conveyor, Pick and Place Operation – 1 Unit.

COURSE OUTCOMES:

Upon completing this course Students able to

1. Understand and demonstrate PLC controller programming.
2. Analyse and Identify appropriate sensors and its integration with PLC for given applications.
3. Create a PLC controller system for given requirements

CO-PO MAPPING:

Course Outcomes	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	2	3	3	2	1
CO2	-	2	3	3	2	2
CO3	-	2	3	3	2	1
AVG.	-	2	3	3	2	1.3

MR4201 MECHATRONICS SYSTEM DESIGN L T P C

4 0 0 4

COURSE OBJECTIVES:

1. To enlist the various elements required to design and integrate the mechatronic systems.
2. To acquire the Modelling skills 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.
3. 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.
4. To apply the optimization procedure for the appropriate selection of mechatronic system elements and process parameter optimization.
5. To understand, apply, analyze and evaluate the functions of systems models for integrating the virtual elements of mechatronics.

UNIT I ELEMENTS OF MECHATRONICS 12

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 12

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 12

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 12

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 12

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.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon Completion of the course, the students will be able to

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

CO2. Create 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. Understand standard simulation procedure for algorithm and controller development.

CO4. Apply 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.

REFERENCES:

1. Bradley, D. Dawson, N.C.Burd and A.J. Loader, "Mechatronics: Electronics in Product and Process", Chapman and Hall, London, 1999.
2. Bolton, "Mechatronics – Electronic Control Systems in Mechanical and Electrical Engineering", Addison Wesley Longman Ltd., 2009.
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.

CO-PO MAPPING:

Course Outcomes	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	-	3	3	3
CO2	2	-	-	3	3	3
CO3	2	-	-	3	3	3
CO4	2	-	-	3	3	3
CO5	2	-	-	3	3	3
AVG.	2	-	-	3	3	3

MR4202	INDUSTRIAL ROBOTICS AND CONTROL	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To know the basic terminologies, classification, configurations and components of serial manipulator.
2. To understand the mechanical design and robot arm kinematics
3. To learn and understand the various linear control techniques on manipulators
4. To learn and understand the various non-linear control techniques on manipulators
5. To learn the robot programming and demonstrate the robot in various applications

UNIT I INTRODUCTION 9

Definition – Robot anatomy – Classification - Geometrical configurations, wrist and its motions - End effectors and its type - links and joints. Robot drive system: – Hydraulic, Electric and pneumatic drive system, Resolution, accuracy and repeatability, Advantage and disadvantage of drive system. - Robot actuation and Feedback component – position, velocity sensors – Robotic vision

UNIT II ROBOT ARM KINEMATICS 9

Introduction – Matrix representation Homogeneous transformation, forward and inverse – Kinematic equations, Denvit – Hartenberg representations – Inverse Kinematic relations. Fundamental problems with D-H representation, differential motion and velocity of frames – Jacobian, Differential Charges between frames:

UNIT III ROBOT DYNAMICS AND TRAJECTORY PLANNING 9

Lagrangeon mechanics, dynamic equations for sing, 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 NONLINEAR CONTROL OF MANIPULATORS 9

Introduction - nonlinear and time - varying systems - multi-input, multi-output control systems - the control problem for manipulators - practical considerations - current industrial-robot control systems - Lyapunov stability analysis – Cartesian - based control systems - adaptive control

UNIT V ROBOT PROGRAMMING AND APPLICATIONS 9

Lead through Programming, Robot programming Languages - VAL Programming - Motion Commands, Sensor Commands, End Effector commands and simple Programs – Applications: Robotic Surgery - Manufacturing Industries - Material Handling, Assembly, Inspection - Space – Underwater – Nuclear industry – Humanoid Robots.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon Completion of the course, the students will be able to

CO1. Understand the basics of Industrial Robotics and Control.
CO2. Create the kinematic solutions for the serial manipulators

CO3. Analyze linear control of manipulators
CO4. Analyze non-linear control of manipulators
CO5. Create robotic program for specific applications.

REFERENCES:

1. John J. Craig, "Introduction to Robotics – Mechanics and control", 3rd edition, Prentice hall, 2005.
2. Groover,M.P., Weis,M., Nagel,R.N. and Odrey,N.G., "Industrial Robotics Technology, Programming and Applications", Mc Graw-Hill, Int., 1986.
3. K.S.Fu, Gonzalez, R.C. and Lee, C.S.G., "Robotics Control, Sensing, Vision and Intelligence", McGraw Hill, 1987.
4. Saeed B. Niku, "Introduction to Robotics: Analysis, Control, Applications", 2nd edition, John Wiley & sons, Inc., 2011
5. Klafter,R.D., Chmielewski, T.A. and Negin,M., "Robotics Engineering – An Integrated Approach", Prentice-Hall of India Pvt. Ltd., 1984.

CO-PO MAPPING:

Course Outcomes	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	-	3	3	3
CO2	2	-	-	3	3	3
CO3	2	-	-	3	3	3
CO4	2	-	-	3	3	3
CO5	2	-	-	3	3	3
AVG.	2	-	-	3	3	3

MR4203 MACHINE VISION SYSTEMS

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. To understand the basics concepts of optics and machine vision systems.
2. To learn and understand the fundamentals of image processing
3. To impart knowledge on stereo vision and structure from motion.
4. To understand the design factors in machine vision system design.
5. To demonstrate the various applications of machine vision system.

UNIT I INTRODUCTION **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 PROCESSING FUNDAMENTALS **9**

Introduction to Digital Image Processing - Image sampling and quantization - Image enhancement: Gray Value Transformations, Radiometric Calibration, Image Smoothing– Geometric transformation– Image segmentation– Object Recognition and Image Understanding - Feature extraction: Region Features, Gray Value Features, Contour Features–Morphology– Edge extraction– Fitting and Template matching.

UNIT III COMPUTATIONAL STEREO AND MOTION 9

Computational Stereopsis – Geometry, parameters –correlation-based methods, feature-based methods – Epipolar Geometry, eight-point algorithm – Reconstruction by triangulation, scale factor and up to a projective transformation – 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.

UNIT IV SMART VISION SYSTEM DESIGN 9

Camera types– Field view– Resolution: camera sensor resolution, Spatial resolution, Measurement of accuracy, Calculation of resolution, Resolution for a Line Scan Camera - Choice of camera, Frame grabber and hardware platform– Pixel rate– Lens design - digital and smart cameras.

UNIT V APPLICATIONS AND CASE STUDIES 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 Completion of the 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. Understand various image processing techniques and develop algorithms.
CO3. Create the visual serving for mechatronics applications
CO4. Evaluate and select appropriate lighting source, lighting technique, lens, sensor and interfacing.
CO5. Apply various machine vision techniques in various engineering fields.

REFERENCES:

1. Alexander Hornberg, “Handbook of Machine Vision”, First Edition
2. Rafael C. Gonzales, Richard. E. Woods, “Digital Image Processing Publishers”, Fourth Edition
3. Emanuele Trucco, Alessandro Verri, “Introductory Techniques For 3D Computer Vision”, First Edition
4. Yi Ma, Jana Kosecka, Stefano Soatto, Shankar Sastry, “An Invitation to 3-D Vision From Images to Models”, First Edition, 2004
5. Davies E.K., “Machine Vision: Theory, Algorithms, Practicalities”, 3rd Edition, Elsevier, 2005.
6. Milan Sonka, “Image Processing Analysis and Machine Vision”, Vikas Publishing House,2007.

CO-PO MAPPING:

Course Outcomes	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	-	3	3	3
CO2	2	-	-	3	3	3
CO3	2	-	-	3	3	3
CO4	2	-	-	3	3	3
CO5	2	-	-	3	3	3
AVG.	2	-	-	3	3	3

MR4204	INTELLIGENCE IN SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To understand the basic concepts of artificial intelligence available in systems.
2. To learn and understand the basic concepts of artificial neural networks
3. To impart knowledge genetic algorithm.
4. To understand the components and concepts in fuzzy systems
5. To demonstrate the various applications of Artificial intelligence in systems

UNIT I INTRODUCTION 9

Approaches to intelligent control. Architecture for intelligent control. Symbolic reasoning system, rule-based systems, the AI approach. Knowledge representation. Expert systems

UNIT II ARTIFICIAL NEURAL NETWORKS 9

Concept of Artificial Neural Networks and its basic mathematical model, McCulloch-Pitts neuron model, simple perceptron, Adaline and Madeline, Feed-forward Multilayer Perceptron. Learning and Training the neural network. Hopfield network, Self-organizing network and Recurrent network. Neural Network based controller - Case studies: Identification and control of linear and nonlinear dynamic systems using Matlab-Neural Network toolbox. Stability analysis of Neural-Network interconnection systems.

UNIT III GENETIC ALGORITHM 9

Basic concept of Genetic algorithm and detail algorithmic steps, adjustment of free parameters. Solution of typical control problems using genetic algorithm. Concept on some other search techniques like tabu search and ant-colony search techniques for solving optimization problems.

UNIT IV FUZZY LOGIC SYSTEM 9

Introduction to crisp sets and fuzzy sets, basic fuzzy set operation and approximate reasoning. Introduction to fuzzy logic modeling and control. Fuzzification, inferencing and defuzzification. Fuzzy knowledge and rule bases. Fuzzy modeling and control schemes for nonlinear systems. Self-organizing fuzzy logic control. Fuzzy logic control for nonlinear time delay system – Applications: Implementation of fuzzy logic controller using Matlab fuzzy-logic toolbox. Stability analysis of fuzzy control systems.

UNIT V ADVANCED LEARNING 9

Learning Sets of Rules – Sequential Covering Algorithm – Learning Rule Set – First Order Rules – Sets of First Order Rules – Induction on Inverted Deduction – Inverting Resolution – Analytical Learning – Perfect Domain Theories – Explanation Base Learning – FOCL Algorithm – Reinforcement Learning – Task – Q-Learning – Temporal Difference Learning

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon Completion of the course, the students will be able to

CO1. Understand the various intelligence concepts available in the mechatronics system.
CO2. Demonstrate and design any mechatronics system with artificial neural networks
CO3. Select and implement appropriate techniques and genetic algorithm
CO4. Design and implement the real time application with fuzzy logic.
CO5. Familiar with advanced learning techniques

REFERENCES:

1. Padhy.N.P.(2005), Artificial Intelligence and Intelligent System, Oxford University Press.
2. KOSKO.B. "Neural Networks and Fuzzy Systems", Prentice-Hall of India Pvt. Ltd., 1994.
3. Jacek.M.Zurada, "Introduction to Artificial Neural Systems", Jaico Publishing House,1999.
4. KLIR G.J. & FOLGER T.A. "Fuzzy sets, uncertainty and Information", Prentice-Hall of India Pvt. Ltd., 1993.
5. Zimmerman H.J. "Fuzzy set theory-and its Applications"-Kluwer Academic Publishers, 1994.
6. Driankov, Hellendroon, "Introduction to Fuzzy Control", Narosa Publishers.
7. Goldberg D.E. (1989) Genetic algorithms in Search, Optimization and Machine learning, Addison Wesley.

CO-PO MAPPING:

Course Outcomes	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	-	3	3	3
CO2	2	-	-	3	3	3
CO3	2	-	-	3	3	3
CO4	2	-	-	3	3	3
CO5	2	-	-	3	3	3
AVG.	2	-	-	3	3	3

MR4205 SMART EMBEDDED SYSTEMS

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. To understand the inclusion of embedded system in smart system design
2. To learn and understand the basic concepts in ARM 7 Core processor
3. To learn and understand the basic concepts in ARM 9 Core processor
4. To impart knowledge on real time models, language and operating systems
5. To demonstrate the embedded processors and various applications of embedded systems

UNIT I MICROCONTROLLER 9

Microprocessor - Microcontrollers – CISC and RISC - Introduction to Embedded systems - Architecture 8051 family - Instruction set – Addressing modes – I/O Programming- Timer/Counter - Interrupts – Serial communication of 8051.

UNIT II 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 III INTRODUCTION TO ARM PROCESSOR 9

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.

Introduction about ARM 9 Processor--DSP Processor—Sharc Processor -- Internal Architecture - Modes of Operations – Register set – Pipelining – AMBA - Applications.

UNIT IV REAL TIME MODELS, LANGUAGE AND OPERATING SYSTEMS 9

Models and languages – State Machine and state tables in embedded design – High level language descriptions - Java based embedded system design – Petrinet models-Real time languages – The real time Kernel - OS tasks - Task Scheduling - kernel services – Real time languages and their features.

UNIT V OTHER PROCESSORS AND APPLICATIONS 9

Architecture and Programming – Single board computers – Introduction to IoT – Specific examples of time-critical and safety-critical embedded systems – interfacing - applications in automation - automotive – aerospace - medical and manufacturing.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon Completion of the course, the students will be able to

CO1. Understand and implement embedded technologies in the field of smart system design.
CO2. Understand and interface the peripherals with 8051.
CO3. Design, program and implement ARM 7 and ARM 9 based system
CO4. Familiarize and select real time models, language and operating system in their system design
CO5. Demonstrate various applications of embedded systems in various fields.

REFERENCES:

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CO-PO MAPPING:

Course Outcomes	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	-	3	2	2
CO2	1	-	-	3	2	2
CO3	1	-	-	3	2	2
CO4	1	-	-	3	2	2
CO5	1	-	-	3	2	2
AVG.	1	-	-	3	2	2

MR4211	INDUSTRIAL ROBOTICS AND EMBEDDED SYSTEMS LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

1. To introduce different types of robotics and demonstrate them to identify different parts and components.
2. To write programming for simple operations.
3. To write program for identification and recognition of object parameters.

LIST OF EXPERIMENTS

1. Determination of maximum and minimum position of links.
2. Verification of transformation (Position and orientation) with respect to gripper and world coordinate system
3. Estimation of accuracy, repeatability and resolution.
4. Robot programming and simulation for pick and place
5. Robot programming and simulation for Color identification.
6. Robot programming and simulation for Shape identification.
7. Robot programming and simulation for machining (cutting, welding).
8. Robot programming and simulation for writing practice.
9. Robot programming and simulation for any industrial process (Packaging, Assembly).
10. Robot programming and simulation for multi process.
11. Build an Artificial Neural Network by implementing the Backpropagation algorithm and test the same using appropriate data sets.
12. Program to construct a Bayesian network. Use this model to implement any application using standard Data Set. You can use Java/Python ML library classes/API.

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR A BATCH OF 18 STUDENTS

1. ROS (Robotic Operating System)
2. 18 Systems with server
3. Verification of direct kinematics equations and inverse kinematics equations of 1DOF “R-configuration” robot.
4. Verification of direct kinematics equations and inverse kinematics equations of 2DOF “R-R-configuration” robot.

COURSE OUTCOMES:

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

CO1. Apply any robotic simulation software to model the different types of robots and calculate work volume for different robots.

CO2. Analyse and estimate the various robotic specifications.

CO3. Create program for object identification and recognition, machining operation and simulate the same in any robotic simulation software.

CO-PO MAPPING:

Course Outcomes	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	2	3	3	2	2
CO2	-	1	3	3	2	2
CO3	-	1	3	3	2	2
AVG.	-	1.3	3	3	2	2

		L	T	P	C
MR4212	**MACHINE VISION AND INTELLIGENCE LABORATORY**	**0**	**0**	**4**	**2**

COURSE OBJECTIVES:

1. To gather the practical exposure on machine vision elements, lighting technique, processing software and algorithms.
2. To learn and practice various image processing techniques.
3. To learn various application of machine vision and programming

LIST OF EXPERIMENTS

1. Study on different kinds of vision sensors.
2. Study on lighting techniques for machine vision
3. Study on Design of Machine Vision System.
4. Experimentation on image acquisition towards the computation platform.
5. Pre-processing techniques in image processing
6. Edge detection and region of interest extraction.
7. Experimentation with image processing algorithm for feature extraction.
8. Experimentation with pattern recognition.
9. Vision based pallet inspection.
10. Vision based Gear parameter measurement.
11. Vision based classification of objects.
12. Implement the SIFT blob detector and tracker
13. Object recognition by SIFT, SURF

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR A BATCH OF 18 STUDENTS

1. CMOS Camera (USB/Ethernet)- 1 No
2. CCD Camera (USB/Ethernet)- 1 No
3. Standard Boom Stand (Bench top setup) - 2 No's
4. Extension Tube (5mm to 50mm) - 2 No's
5. Lenses (between 3mm to 50mm focal length)- 2 No's
6. Tele-centric lens - 1 No
7. Lighting (Coaxial, ring lighting, Diffused, backlighting) - 1 No Each.
8. Machine vision software - 2 No's
9. PC-2 No's

COURSE OUTCOMES:

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

CO1. To select a vision sensor for any kind of application.

CO2. To understand and implement various image processing techniques.

CO3. To understand and implement industrial applications.

CO-PO MAPPING:

Course Outcomes	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	2	3	3	2	2
CO2	-	1	3	3	2	2
CO3	-	1	3	3	2	2
AVG.	-	1.3	3	3	2	2

MR4311	PROJECT WORK - I	L	T	P	C
		0	0	12	6

COURSE OBJECTIVES:

1. 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.
2. To review and analyse literature/ data of selected problem for study and propose objective and scope of dissertation work.
3. To develop hypothesis and identify methodology based on ethical, scientific and systematic application of knowledge in the proposed field of dissertation work.
4. To design, model and experiment/develop optimal solution for problem being investigated.
5. To analysis and interpretation of system and its performance, data, and synthesis of the information to provide valid conclusions and submit dissertation.

EVALUATION:

1. 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 Phase–I.
2. 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.
3. The project work is evaluated jointly by external and internal examiners constituted by anna university based on oral presentation and the project report.
4. A project report for dissertation-I is to be submitted at the end.
5. Project work evaluation is based on the Regulations of the Credit system for the Post graduate programmes of Anna University Obtain Fourier transforms for the functions which are needed for solving application problems.

TOTAL: 180 PERIODS

COURSE OUTCOMES:

CO1 - The students would apply the knowledge gained from theoretical and practical courses in solving problems

CO2 - The students would be able to create a novel mechatronics-based solution for an engineering problem and get trained in planning, organizing and executing the method.

CO3 – The students would be able to analyse and evaluate the result and can be able to record and write a technical document in form of thesis.

CO-PO MAPPING:

Course Outcomes	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3		3	3	3	3
CO2	3		3	3	3	3
CO3		3		3	3	3
Avg.	2	1	2	3	3	3

MR4411 **PROJECT WORK - II**

L	T	P	C
0	0	24	12

COURSE OBJECTIVES:

1. 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 phase -I or newly formulated problem for phase - I.
2. 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.
3. 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.
4. To analyse and interpretation of system and its performance, data, and synthesize of the factual information's to arrive at valid conclusions
5. To enable students to communicate technical information in form of oral presentation and technical report in form of dissertation

EVALUATION:

1. The progress of the project is evaluated based on a minimum of three reviews.
2. The review committee may be constituted by the Head of the Department.
3. 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 anna university based on oral presentation and the project report.
4. Project work evaluation is based on the Regulations of the Credit system for Post graduate programmes of Anna University.

TOTAL: 180 PERIODS

COURSE OUTCOMES:

CO1 - The students would apply the knowledge gained from theoretical and practical courses in solving problems

CO2 - The students would be able to create a novel mechatronics-based solution for an engineering problem and get trained in planning, organizing and executing the method.

CO3 – The students would be able to analyse and evaluate the result and can be able to record and write a technical document in form of thesis.

CO-PO MAPPING:

Course Outcomes	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3		3	3	3	3
CO2	3		3	3	3	3
CO3		3		3	3	3
Avg.	2	1	2	3	3	3

MR4001	COMPUTER AIDED INSPECTION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To familiar the measurement standards and to know the instruments used and various errors in measurements
2. To recognize the use of basic and advanced instruments for measurements.
3. To learn the applications of opto-electronics device for measurements.
4. To observe the machine vision-based inspections.
5. 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 – Angular measurements – Surface Roughness – Form errors and measurements.

UNIT II INSPECTION AND GENERAL MEASUREMENTS 9

Inspection of gears and threads – Tool makers' microscope – Universal measuring machine – use of Laser interferometer in machine tool Inspection – use of laser in on-line Inspection – Laser micrometer – Laser Alignment telescope.

UNIT III OPTO ELECTRONICS IN ENGINEERING INSPECTION 9

Use of opto electronics in Tool wear measurement – Micro hole 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

Co-ordinate measuring machines – Applications and case-studies of CMM in Inspection – Use of Computers in quality control – Control charts – Reliability.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course, students will be able to

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

CO1: Evaluate the standards in measurements and to avoid the various forms of errors in measurements.

CO2: Apply 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: Create the measurement strategies in inspection using CMM

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3. Jain R.K., "Engineering Metrology", Khanna Publishers, 2018.
4. Manuals of C.M.M. and Systems.
5. Robert G. Seippel, "Opto Electronics for technology and engineering", Prentice Hall, New Jersey, 1989.

CO-PO MAPPING:

Course Outcomes	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	-	3	3	3
CO2	2	-	-	3	2	2
CO3	1	-	-	3	3	2
CO4	2	-	-	3	2	2
CO5	2	-	-	3	2	2
AVG.	1.8	-	-	3	2.4	2.2

MR4002 DIGITAL MANUFACTURING

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

1. To learn the concept of NC and CNC technologies on practical problems with feedback and adaptive control.
2. To learn the configuration of CNC system, PLC programming for CNC and also case studies on machine structure elements.
3. To learn the mechatronics elements in CNC measuring system and tooling system, EEPROM tools, automatic tool changing system, tool magazine and sensors in CNC.
4. To learn about the CNC programming tools with computer assisted programming using APT, generation and execution of APT programs.
5. To learn the methods for verification, testing and Maintenance of CNC machines during idle running and machine tooling.

UNIT I INTRODUCTION OF NC, CNC, DNC AND ADAPTIVE CONTROL 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 MECHATRONICS ELEMENT IN CNC MEASURING SYSTEM AND 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 - EEPROM tools. 19 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 **9**

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 **9**

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: Get the knowledge of the differences of NC, CNC and DNC.

CO2: Analyse 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 programming in CNC machine.

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

REFERENCES

1. HMT Limited, “Mechatronics”, Tata Mcgraw-Hill Publishing Co Ltd, 2017.
2. Groover, M.P., “Automation, Production System and CIM”, Prentice Hall of India Pvt. Ltd, 2016.
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CO-PO MAPPING:

Course Outcomes	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	-	3	3	3
CO2	2	-	-	3	2	2
CO3	1	-	-	3	3	2
CO4	2	-	-	3	2	2
CO5	2	-	-	3	2	2
AVG.	1.8	-	-	3	2.4	2.2

MR4003 COMPUTER AIDED PRODUCTION AND AUTOMATION OF PLANTS

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

1. To learn various production planning processes, capacity planning, and shop floor planning processes.
2. To learn about the fundamentals of Automated assembly and part transferring systems.
3. To learn about Group Technology and Flexible manufacturing systems.
4. To learn about automation systems and advanced manufacturing techniques.
5. To familiarize computer-aided production and automation of plants through various case studies.

UNIT I COMPUTER AIDED PRODUCTION PLANNING 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 Modeling

UNIT II 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- 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 III GROUP TECHNOLOGY AND FLEXIBLE MANUFACTURING SYSTEMS 9

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 – Case Studies. FMS – Components – Workstations – FMS Layout Configurations – Computer Control Systems – FMS Planning and Implementation Issues – Architecture of FMS – Flow Chart Showing Various Operations in FMS

UNIT IV AUTOMATION SYSTEMS AND ADVANCED MANUFACTURING TECHNIQUES **9**

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 - Network and Computer Interface - Industrial Networks for Production Line Control

UNIT V CASE STUDIES **9**

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

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course, students will be able to

1. Understand various production planning processes, capacity planning, and shop floor planning processes
2. Understand the fundamentals of Automated assembly and part transferring systems.
3. Understand the concepts of Group Technology and Flexible manufacturing systems.
4. Understand about automation systems and advanced manufacturing techniques.
5. Apply the concepts of “computer aided production and automation” in various manufacturing industries.

CO-PO MAPPING:

Course Outcomes	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	-	3	3	3
CO2	1	-	-	3	3	3
CO3	1	-	-	3	3	3
CO4	1	-	-	3	3	3
CO5	1	-	-	3	3	3
AVG.	1	-	-	3	3	3

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1. Alavudeen and Venkateshwaran, — Computer Integrated Manufacturing ǁ, PHI Learning Pvt. Ltd., New Delhi, 2008.
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MR4004	DESIGN OF MACHINE ELEMENTS AND PRODUCT DEVELOPMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To introduce the students about basic concepts, practices, standard data, terminology and symbols for designing.
2. To learn the design procedures of shafts and couplings to withstand various loads.
3. To learn the design procedures of transmission components to transfer power and to withstand various loads.
4. To introduce the students about basic concepts of product development.
5. To learn the basic formulation of finite element analysis for various components

UNIT I INTRODUCTION 9

Introduction to national and international symbols- Engineering materials and their physical properties and applied to design- Selection of materials- selection for new design and material considerations-Factors of safety in design- Dimensioning and detailing- Fitness and tolerance- Surface finish and machining symbols –Product development- Elementary concept of functional, aesthetic and form design- Principles of design optimization- Future trends- CAD.

UNIT II STATIC AND VARIABLE STRESSES 9

Static and variable loading in machine elements- Stress concentration- Goodmen and soderberg method of design- Design of power transmission shafts- Subjected to torsion, bending and axial loads- Design of close 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- Principle of hydrodynamic lubrication – Design of journal bearings – Selection and specification of anti-friction bearings – Life rating of roller bearings.

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 can able to

1. Understand the basic concepts, practices, standard data, terminology and symbols for designing.
2. Create the shafts and couplings for given various types of loads.
3. Create the transmission components to transfer given power and to withstand various types of loads.
4. Understand the basics concepts of product development.
5. Analyze and formulate finite element equations for some general machine components.

REFERENCES

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CO-PO MAPPING:

Course Outcomes	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	-	3	3	3
CO2	1	-	-	3	3	3
CO3	1	-	-	3	3	3
CO4	1	-	-	3	3	3
CO5	1	-	-	3	3	3
AVG.	1	-	-	3	3	3

MR4005 MULTI-BODY DYNAMICS L T P C
3 0 0 3

COURSE OBJECTIVES

1. To understand the important concepts of multi-body dynamics.
2. To familiar the various computational methods multi-body dynamics.
3. To characterize the nonlinear concepts of multi-body dynamics.
4. To recognize the need of control in nonlinear dynamics multi body interactions.
5. 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 9

Jacobian Matrix - Newton-Raphson Method - Nonlinear Kinematic Constrain Equation – System Mass Matrix - External and Elastic Forces - Acceleration Vector – Lagrangean 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 9

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 – Centre 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 9

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

UNIT V CONTROL OF NONLINEAR MECHANICAL SYSTEMS 9

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: Apply the important concepts in multi-body dynamics.
CO2: Create mathematical model for capturing the dynamics of multi-body interactions.
CO3: Understand the nonlinear behaviour of multi-body dynamics.
CO4: Evaluate the control in nonlinear dynamics of multi body interactions.
CO5: Apply control for the nonlinear behaviour of multi body systems.

REFERENCES

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CO-PO MAPPING:

Course Outcomes	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	-	3	3	3
CO2	1	-	-	3	3	3
CO3	1	-	-	3	3	3
CO4	1	-	-	3	3	3
CO5	1	-	-	3	3	3
AVG.	1	-	-	3	3	3

MR4006	ONBOARD COMPUTERS AND PYTHON PROGRAMMING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To understand the basics of single board computers.
2. To learn about real-time operating system.
3. To get knowledge on python programming basics.
4. To learn to embed python in various hardware
5. To learn various case studies of python and onboard computers.

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 9

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

UNIT III PYTHON PROGRAMMING 9

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

Case Studies in Automotive- Robotics - IOT- Factory Automation - Home Automation.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

1. Understand the basics of single board computers.
2. Understand about real-time operating system.
3. Understand basics of python programming.
4. Apply python programming concepts in various hardware.
5. Apply python programming and onboard computer concepts in various systems.

REFERENCES

1. Gabriele Manduchi and Ivan Cibrario Bertolotti, Real-Time Embedded Systems: Open-Source Operating Systems, CRC Press, 2012.
2. Guttag, John. Introduction to Computation and Programming Using Python. MIT Press, 2013.
3. Mark Lutz,"Learning Python, Powerful OOPs,O'reilly,2011
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, 1st ed. edition, 2014

CO-PO MAPPING:

Course Outcomes	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	-	3	3	3
CO2	1	-	-	3	3	3
CO3	1	-	-	3	3	3
CO4	1	-	-	3	3	3
CO5	1	-	-	3	3	3
AVG.	1	-	-	3	3	3

MR4007 MICRO AND NANO SYSTEMS

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

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

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 V 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.

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.

CO-PO MAPPING :

Course Outcomes	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	-	3	3	3
CO2	1	-	-	3	3	3
CO3	1	-	-	3	3	3
CO4	1	-	-	3	3	3
CO5	1	-	-	3	3	3
AVG.	1	-	-	3	3	3

MR4008 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	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	-	3	3	3
CO2	1	-	-	3	3	3
CO3	1	-	-	3	3	3
CO4	1	-	-	3	3	3
CO5	1	-	-	3	3	3
AVG.	1	-	-	3	3	3

REFERENCES:

1. Bequette. B.W., “Process Control Modelling, Design and Simulation”, Prentice Hall of India, 2004.
2. Gopal. M, “Control Systems Principles and Design”, Tata McGraw Hill Publishing Ltd, 2003.
3. Kuo .B.C, “Automatic Control Systems”, Prentice Hall, 2004.
4. Nagrath .I.J. and Gopal, “Control System Engineering”, New Age International (P) Ltd., 2006.
5. Ogata.K, “Modern Controls Engineering“, Prentice Hall, 2005.
6. Zbigniew Ogonowski , “Advanced Control with MATLAB and Simulink”, Ellis Horwood, Ltd, 1995

MR4009 BIOMECHATRONICS

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

- To familiarize the fundamentals of biomechanics.
- To characterize and relate the behaviours 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 bio-mechatronics.

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, Exo musculatures, 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 behaviours of skeletal and muscular systems
CO3: Realize the servomechanism of biological systems for bio mechatronics development.
CO4: Design the artificial bio Mehatronics systems.
CO5: Establish and develop the applications of bio mechatronics.

Course Outcomes	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	-	3	3	3
CO2	1	-	-	3	3	3
CO3	1	-	-	3	3	3
CO4	1	-	-	3	3	3
CO5	1	-	-	3	3	3
AVG.	1	-	-	3	3	3

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.

MR4010	SOLID STATE DRIVES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To understand electrical actuator steady state operation and transient dynamics of a motor load system.
2. To learn the operation and construction of solid-state switching devices.
3. To study the operation of various D.C Motor drives and to select appropriate drive for speed and position control.
4. To study the operation of various A.C Motor drives and to select appropriate drive for speed control.
5. 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

REFERENCES:

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.

CO-PO MAPPING:

Course Outcomes	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	-	3	3	3
CO2	1	-	-	3	3	3
CO3	1	-	-	3	3	3
CO4	1	-	-	3	3	3
CO5	1	-	-	3	3	3
AVG.	1	-	-	3	3	3

MR4011 AUTOMOTIVE ELECTRONICS

L	T	P	C
3	0	0	3

OBJECTIVES:

- To impart knowledge to the students in the principles of operation and constructional details of various Automotive Electrical and Electronic Systems
- To understand the need for starter batteries, starter motor and alternator in the vehicle.
- To differentiate the conventional and modern vehicle architecture and the data transfer among the different electronic control unit using different communication protocols
- To list common types of sensor and actuators used in vehicles.
- To understand dash – Board Instruments, various sensors and networking in vehicles.

UNIT I FUNDAMENTALS OF AUTOMOTIVE ELECTRONICS 9

Components for an electronic engine management system, open and closed-loop control strategies, PID control, Lookup tables, introduction to modern control strategies like Fuzzy logic and adaptive control. Switches, active resistors, Transistors, Current mirrors/amplifiers, Voltage and current references, Comparator, Multiplier. Amplifier, filters, A/D and D/A converters.

UNIT II ELECTRONIC SENSORS IN AUTOMOBILE 9

Throttle position, mass air flow, crankshaft position, cam position, engine speed sensor, exhaust oxygen level (two step, linear lambda and wideband), knock, manifold temperature, and pressure sensors. Solenoid, relay (four and five pins), stepper motor

UNIT III ELECTRONIC COMPONENTS FOR ENGINE CONTROL 9

Cold start and warm-up phases, idle speed control, acceleration and full load enrichment, deceleration fuel cut-off. Fuel control maps, open loop and closed-loop control – Integrated engine control system, Electromagnetic compatibility – EMI Suppression techniques – Electronic dashboard instruments – Onboard diagnosis system.

UNIT IV ELECTRONIC COMPONENTS FOR IGNITION AND INJECTION SYSTEMS 9

Types of electronic ignition systems - variable ignition timing, distributor less ignition. Spark timing control. TBI, MPFI, GDI Systems. Engine mapping.

UNIT V MICROPROCESSOR IN AUTOMOBILES 9

Microprocessor and Microcomputer controlled devices in automobiles such as instrument clusters, Voice warning systems, Travel information systems, and Keyless entry system. Environmental requirements (vibration, Temperature, and EMI).

OUTCOMES:

At the end of this course the student should be able to

- Explain the fundamentals, operation, function of various sensors and actuators in engine management systems.
- Define the glossary related to vehicle electrical and electronic system
- Understand the need for starter batteries, starter motor, and alternator in the vehicle.
- Differentiate the conventional and modern vehicle architecture and the data transfer among the different electronic control units using different communication protocols
- List common types of sensors and actuators used in vehicles.
- Understand networking in vehicles.

CO PO MAPPING:

Course Outcomes	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	-	3	3	3
CO2	1	-	-	3	3	3
CO3	1	-	-	3	3	3
CO4	1	-	-	3	3	3
CO5	1	-	-	3	3	3
AVG.	1	-	-	3	3	3

REFERENCES:

1. Judge. A.W., Modern Electrical Equipment of Automobiles, Chapman & Hall, London, 1992.
2. William B. Ribbens -Understanding Automotive Electronics, 5th edition- Butter worth Heinemann, 1998.
3. Young. A.P., & Griffiths. L., Automobile Electrical Equipment, English Language Book Society & New Press, 1990.
4. Vinal. G.W., Storage Batteries, John Wiley & Sons inc., New York, 1985.
5. Crouse.W.H., Automobile Electrical Equipment, McGraw Hill Book Co Inc., New York, 1980.
6. Spreadbury.F.G., Electrical Ignition Equipment, Constable & Co Ltd., London, 1962.
7. Robert N Brady Automotive Computers and Digital Instrumentation, Prentice Hall, Eagle Wood Cliffs, New Jersey, 1988.

MR4012 **UNMANNED AERIAL VEHICLE** **L T P C**

3 0 0 3

COURSE OBJECTIVES:

1. To understand the basic concepts of UAVs.
2. To learn and understand the various components of UAVs.
3. To familiarize the basic concepts of flights.
4. To impart knowledge on maintenance of drone equipment.
5. To understand the various regulatories and regulations.

UNIT I INTRODUCTION TO UNMANNED AERIAL VEHICLES (UAV) 9

Overview and background: history of UAVs, classifications of UAVs, lift generation method. Contemporary applications like military, government and civil areas. Operational considerations like liability / legal issues, ethical implications LOS / BLOS

UNIT II UNMANNED AERIAL SYSTEM (UAS) COMPONENTS 9

Platforms - configurations - characteristics – applications. Propulsion: internal combustion engines, turbine engines, electric systems. On-board flight control – Payloads: sensing/surveillance, weaponized UAS and delivery. Communications: command/control, telemetry. Launch/recovery systems - Ground control stations

UNIT III BASIC CONCEPTS OF FLIGHT 9

Aerodynamics: lift, weight, thrust, and drag. Flight performance: climbing vs. gliding flight, range / endurance - Stability and control: flight axes, flight controls, autopilots. Emergency identification and handling - Fixed wing operations: Types of fixed wing drones, make, parts, terminology and operation.

UNIT IV DRONE EQUIPMENT MAINTENANCE 9

Maintenance of drone, flight control box - Maintenance of ground equipment- batteries - Scheduled servicing - Repair of equipment - Fault finding and rectification - Weather and meteorology.

UNIT V REGULATORIES AND REGULATIONS 9

Homeland regulatories: FCC, FAA and foreign regulatory. Regulations: FCC compliance, UAS registration, Federal Aircraft Regulations (FARs) - Safety considerations

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1. Understand and familiarize the basic concepts on UAVs
CO2. Select and choose the components of UAV
CO3. Understand the basic concepts of flight
CO4. To maintain the drone equipment.
CO5. To understand various regulatories and regulations.

CO-PO MAPPING:

Course Outcomes	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	-	3	3	3
CO2	1	-	-	3	3	3
CO3	1	-	-	3	3	3
CO4	1	-	-	3	3	3
CO5	1	-	-	3	3	3
AVG.	1	-	-	3	3	3

REFERENCES:

1. Paul Fahlstrom, Thomas Gleason, “Introduction to UAV Systems”, 4th edition, John Wiley & Sons, 2012.
2. Randal W. Beard and Timothy W. McLain, “Small Unmanned Aircraft: Theory and Practice “, Princeton University Press, 2010.
3. Jha, “Theory, Design, and Applications of Unmanned Aerial Vehicles”, CRC Press, 2016.

MR4013	INTELLIGENT PRODUCT DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To understand the basics of intelligent design and manufacturing.
2. To learn and understand the knowledge representation techniques.
3. To learn and understand the intelligent product modelling techniques.
4. To demonstrate the applications of neural networks.
5. To study the applications of internet based collaborative CAD/CAM.

UNIT – I INTRODUCTION TO INTELLIGENT DESIGN AND MANUFACTURING 9

Need - Internet technology and Manufacturing Industry - Digital enterprises - Manufacturing portals – Benefits.

UNIT – II TECHNIQUES OF KNOWLEDGE REPRESENTATION 9

Artificial Neural Networks, Fuzzy Logic, Genetic Algorithms, Expert Systems with case studies.

UNIT – III INTELLIGENT PRODUCT MODELING TECHNIQUES 9

Intelligent CAD systems, integrating product and process design, manufacturing analysis and CAD/CAM integration, design methodology for automated manufacture, the impacts of intelligent process control on product design, and fuzzy knowledge-based controller design.

UNIT – IV APPLICATION OF NEURAL NETWORKS 9

Neural Networks for Intelligent Process Monitoring and Control : Applications to CNC machining, Metal Forming - Intelligent Manufacturing Planning, Scheduling and Control - Intelligent Assembly and Layout Planning.

UNIT – V INTERNET BASED COLLABORATIVE CAD/CAM 9

Applications to web based CAD, CAPP, CNC, Assembly planning, and Rapid Prototyping - Challenging issues of Collaborative CAD/CAM.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

1. Identify and understand the intelligent design and manufacturing.
2. Familiarize the knowledge representation techniques.
3. Understand the various techniques in intelligent product modeling.
4. Demonstrate the applications of neural networks
5. Apply internet on collaborative CAD/CAM

CO-PO MAPPING:

Course Outcomes	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	-	2	2	2
CO2	1	-	-	2	2	2
CO3	1	-	-	2	2	2
CO4	1	-	-	2	2	2
CO5	1	-	-	2	2	2
AVG.	1	-	-	2	2	2

REFERENCES:

1. Dagli, C.H., "Intelligent systems in design and manufacturing", ASME, 1994.
2. Huang, G.Q. and Mak, K.L., "Internet Applications in Product design and Manufacturing", Springer, 2003.
3. Kusiak, A., "Intelligent Design and Manufacturing", Wiley-Inter science, 1992.
4. Parsaei, H.R. and Jamshidi, M., "Design and implementation of intelligent manufacturing systems", Prentice Hall, 1995.

IL4073 HUMAN INDUSTRIAL SAFETY AND HYGIENE L T P C
3 0 0 3

OBJECTIVES:

- Identify and prevent operational hazard
- Categorize, analyze and interpret the accidents data based on various safety techniques.
- Use proper safety techniques on safety engineering and management.
- Design the system with environmental consciousness by implementing safety regulation
- Use safety management practices in Industries.

UNIT I OPERATIONAL SAFETY 9

Hot metal operation, boiler, pressure vessels – heat treatment shop – gas furnace operation – electroplating – hot bending pipes – safety in welding and cutting, Cold – metal operation – safety in machine shop – cold bending and chamfering of pipes- metal cutting – shot blasting, grinding, painting – power press and other machines. Management of toxic gases and chemicals – industrial fires and prevention – road safety – highway and urban safety – safety of sewage disposal and cleaning – control of environmental pollution – managing emergencies in industries – planning security and risk assessments, on – site and off site. Control of major industrial hazards.

UNIT II SAFETY APPRAISAL AND ANALYSIS 9

Human side of safety – personal protective equipment – causes and cost of accidents. Accidents prevention program – specific hazard control strategies – HAZOP training and development of employees – first aid – fire fight devices – accident reporting, investigation .Measurement of safety performance, accident reporting and investigation – plant safety inspection, job safety analysis – safety permit procedures. Product safety – plant safety rules and procedures – safety sampling – safety inventory systems. Determining the cost effectiveness of safety measurement.

UNIT III OCCUPATIONAL HEALTH 9

Concept and spectrum of health functional units and activities of operational health service – occupational and related disease – levels of prevention of diseases – notifiable occupational diseases Toxicology Lead – Nickel, chromium and manganese toxicity – gas poisoning (such as CO, Ammonia Chlorise, So2, H2s.) their effects and prevention – effects of ultra violet radiation and infrared radiation on human system.

UNIT IV SAFETY AND HEALTH REGULATIONS 9

Safety and health standards – industrial hygiene – occupational diseases prevention welfare facilities. The object of factories act 1948 with special reference to safety provisions, model rules 123a, history of legislations related to safety – pressure vessel act – Indian boiler act – the environmental protection act – electricity act – explosive act.

UNIT V SAFETY MANAGEMENT 9

Evaluation of modern safety concepts – safety management functions – safety organization, safety department- safety committee, safety audit – performance measurements and motivation – employee participation in safety - safety and productivity.

TOTAL: 45 PERIODS

OUTCOMES:

CO1: Ability to Identify and prevent operational hazard
CO2:Ability to collect, analyze and interpret the accidents data based on various safety techniques.
CO3: Ability to apply proper safety techniques on safety engineering and management.
CO4: Ability to design the system with environmental consciousness by implementing safety regulation
CO5: Ability to apply safety management practices in Industries.

REFERENCES:

1. John. V. Grimaldi and Rollin. H Simonds, “Safety Management”, All India traveler Book seller, New Delhi – 1989.
2. John V Grimaldi, Safety Management. AITB publishers, 2003.
3. Krishnan N.V, “Safety in Industry”, Jaico Publisher House, 1996.
4. Singh, U.K and Dewan, J.M., “Sagety, Security and Risk Management”, APH publishing company, New Delhi, 1996.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	-	-	1	-	-
CO2	1	-	-	-	1	-
CO3	2	-	-	1	1	-
CO4	-	-	2	-	-	1
CO5	-	-	-	-	1	1
Avg.	(1+2)/2=1.5	(1+2)/2=1.5	2/1=2	(1+1)/2=1	(1+1+1)/3=1	(1+1)/2=1

1-low, 2-medium, 3-high, ‘-“- no correlation

MR4071 INTERNET OF THINGS FOR MANUFACTURING L T P C
3 0 0 3

COURSE OBJECTIVES:

1. To understand the basics of IoT, Opportunities and challenges in IoT
2. To design a IoT solution
3. To develop an IoT protype
4. To explain the various protocols used in IoT and Localization
5. To examine the applications of IoT in Manufacturing

UNIT I INTRODUCTION 9

Technology of the IoT and applications,. IoT data management requirements, Architecture of IoT, Security issues Opportunities for IoT -Issues in implementing IoT. Technological challenges, RFID and the Electronic Product Code (EPC) network, the web of things.

UNIT II DESIGN OF IoT 9

Design challenges in IoT -Standardization, Security and privacy, Infrastructure, Analytics. Design steps for implementing IoT.

UNIT III PROTOTYPING OF IoT 9

Design principles for connected devices -Embedded devices, physical design, online components, embedded coding system. Informed Manufacturing plant – Elements, IoT implementation in Transportation and logistics, Energy and utilities, Automotive Connected supply chain, Plant floor control automation, remote monitoring, Management of critical assets, Energy management and resource optimization, proactive maintenance.

UNIT IV PREREQUISITES FOR IoT 9

IOT Technologies Wireless protocols low-power design (Bluetooth Low Energy), range extension techniques (data mining and mesh networking), and data-intensive IoT for continuous recognition applications Data storage and analysis Localization algorithms Localization for mobile systems

UNIT V APPLICATION IN MANUFACTURING 9

Applications HCI and IoT world - Multilingual interactions Robotics and Autonomous Vehicles Sensing and data processing-Simultaneous mapping and localization-Levels of autonomy, Smart factories, Future research challenges

TOTAL : 45 PERIODS

COURSE OUTCOME:

On completion of the course, the students will be able to

CO1: Identify the Opportunities and challenges in IoT
CO2: Propose a suitable IoT design
CO3: Develop an optimized IoT protype
CO4: Understand the various protocols used in IoT and Localization
CO5: Understand the applications of IoT in Manufacturing

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1. Adrian McEwan and Hakim Cassimally, “Designing the internet of things”, Wiley, 2013
2. Code Halos: How the Digital Lives of People, Things, and Organizations are Changing the Rules of Business, by Malcolm Frank, Paul Roehrig and Ben Pring, published by John Wiley & Sons.

3. Internet of Things: A Hands-On Approach by Vijay Madisetti, Arshdeep Bahga, VPT; 1st edition 2014.
4. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stamatis Karnouskos, Stefan Avesand, David Boyle, "From Machine-to-Machine to the Internet of Things -Introduction to a New Age of Intelligence" Elsevier
5. Meta Products -Building the Internet of Things by Wimer Hazenberg, Menno Huisman, BIS Publishers 2014.

CO	PO					
	1	2	3	4	5	6
1	1		2	1		
2	1		2			3
3	1		2			3
4	1		2			3
5	1		2			3
Avg	**(5/5)=1**		**(10/5)=2**	**(1/1)=1**		**(12/4)=3**

MR4014 COMMUNICATION PROTOCOLS **L T P C**
3 0 0 3

COURSE OBJECTIVES

1. To study the various types wired protocols for electronic system.
2. To know the various types wireless protocols for electronic system.
3. To aware the various industrial wired protocols in automation.
4. To study the various types wireless protocols for industrial automation.
5. 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:

1. Design wired protocols for electronic system.
2. Use wireless protocols for electronic system.
3. Practice industrial wired protocols in automation.
4. Select wireless protocols for industrial automation.
5. Demonstrate the wired and wireless functions of various protocols in application development.

CO-PO MAPPING:

Course Outcomes	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	-	3	3	3
CO2	1	-	-	3	3	3
CO3	1	-	-	3	3	3
CO4	1	-	-	3	3	3
CO5	1	-	-	3	3	3
AVG.	1	-	-	3	3	3

REFERENCES:

1. Bolton W., “Mechatronics”, Pearson; 5th edition, 2015.
2. Bradley D.A., and Dawson, Burd and Loader, “Mechatronics”, Thomson Press India Ltd., 2004.
3. Ernest O. Doeblin, “Measurement system, Application and Design”, Tata McGraw Hill Publishing Company Ltd., Fiftieth Edition, 2004.
4. Renganathan S., “Transducer Engineering”, Allied Publishers (P) Ltd., 2003.
5. Antony Esposito, “Fluid Power Systems and Control”, Prentice-Hall, 2006.
6. Austin Hughes, “Electric Motors and Drives Fundamentals, Types and Applications”, Fourth Edition, Elsevier, 2013.

MR4015	ADVANCED COMPUTER VISION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To understand the various fundamental mathematics behind computer vision algorithms.
2. To expose students to various image formation and camera calibration techniques
3. To expose students to various 3D surface reconstruction algorithms.
4. To impart knowledge on stereo vision and structure from motion.
5. To impart knowledge on applying the computer vision techniques to robots

UNIT – I BASIC CONCEPTS FOR COMPUTER VISION 9

Sampling Theorem – Numerical Differentiation – Differential Geometry – Singular Value Decomposition – Robust Estimators and Model Fitting

UNIT – II IMAGE FORMATION AND CAMERA CALIBRATION 9

Projective Geometry - Imaging through lenses and pin-hole – Basic Photometry – Basic model of imaging geometry – Ideal Camera – Camera with intrinsic parameters – Approximate camera models – Camera Calibration – Methods and Procedure

UNIT – III SURFACE RECONSTRUCTION TECHNIQUES 9

Depth Perception in Humans, Cues – Shape from Texture, Shading, Focus, Defocus, Structured Light Reconstruction – Time of Flight Methods

UNIT – IV COMPUTATIONAL STEREO AND MOTION 9

Computational Stereopsis – Geometry, parameters –correlation-based methods, feature-based methods – Epipolar Geometry, eight-point algorithm – Reconstruction by triangulation, scale factor and up to a projective transformation – 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.

UNIT – V ROBOT VISION 9

Visual Tracking – Kalman Filtering and Sequential Monte Carlo – Visual SLAM, solutions, EKF-SLAM, FastSLAM – 3D SLAM – Advanced Visual Servoing, hybrid visual servo, partitioned visual servo.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Understand the basic concepts behind computer vision algorithms.
CO2: Understand various image formation and camera calibration techniques.
CO3: Understand various 3D surface reconstruction algorithms.
CO4: Understand stereo vision and structure from motion.
CO5: Apply the computer vision techniques to robots

CO-PO MAPPING:

Course Outcomes	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	-	3	3	3
CO2	1	-	-	3	3	3
CO3	1	-	-	3	3	3
CO4	1	-	-	3	3	3
CO5	1	-	-	3	3	3
AVG.	1	-	-	3	3	3

REFERENCES:

1. Eugene Hecht, A.R. Ganesan “Optics”, Fourth Edition, 2001.
2. Emanuele Trucco, Alessandro Verri, “Introductory Techniques For 3D Computer Vision”, First Edition, 1998.
3. Boguslaw Cyganek, J. Paul Siebert, An Introduction To 3D Computer Vision Techniques and Algorithms, First Edition, 2009.
4. Yi Ma, Jana Kosecka, Stefano Soatto, Shankar Sastry, An Invitation to 3-D Vision from Images to Models, First Edition, 2004.

MR4016	MECHATRONICS IN AERO SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To learn about the aircraft system and its automation requirements.
2. To learn about various sensors, measurement, actuators, navigation systems and its control of aircraft systems.
3. To learn various actuators and other mechanisms related to aircraft.
4. To understand the stability and control of an aircraft.
5. To learn about GPS and other navigation techniques used in aircraft.

UNIT – I OVERVIEW OF AIRCRAFT ENGINEERING 9

Aircraft Systems Engineering Overview - Concept Map - The Seven Steps Systems Engineering - Conceptual System Design - Fundamentals - Components of an Airplane - Functions - Motions of a Plane - Components of a Helicopters - Functions Helicopters. Types of Aerial Vehicles – functions – Unmanned aerial vehicles - Quadcopter – Drone – Micro Aerial Vehicles.

UNIT – II SENSORS AND MEASUREMENTS 9

Sensors – Gyroscope - Rate Gyros - Rate Integration and Free Gyro, Vertical and Directional Gyros, Laser Gyroscopes, Accelerometers. Direct Reading Compass, Classification of Aircraft Instruments - Engine Power and Control Instruments - Measurement of RPM, Manifold Pressure, Torque, Exhaust Gas Temperature, EPR, Fuel Flow, Engine Vibration, Monitoring Air Data Instruments - Airspeed, Altitude, Vertical Speed Indicators. Static Air Temperature, Angle of Attack Measurement - Instrument Displays Panels and Cockpit Layout.

UNIT – III MECHANISMS AND ACTUATORS 9

Types of Actuation Systems - Linear and Non-Linear Actuation System, Valves, Modelling of Actuation Systems, Flight Control - Landing Gear - Brake Actuation - Servo-Loop Analysis Actuator Design - Testing Methodologies, Performance Testing Equipment’s for Sensors and Actuation Systems

UNIT – IV STABILITY AND CONTROL 9

Automatic Flight Control Systems – Auto Pilot – Longitudinal – Lateral - Fly-By-Wire Flight and Digital Fly-By-Wire Flight Control Systems - Elements, Architecture, System Design. Longitudinal and Lateral Control Law Design - Back Stepping Algorithm – Active Control Technology

UNIT – V NAVIGATION **9**

Introduction to Navigation – Types – Inertial Navigation Systems - Radio Navigation - Approach and Landing Aids - Ground Controlled Approach System – Surveillance Systems-Radio Altimeter – GPS - Integration of GPS and INS.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

1. Understand the aircraft system and its automation requirements.
2. Understand various sensors, measurement, actuators, navigation systems and its control of aircraft systems.
3. Understand various actuators and other mechanisms related to aircraft.
4. Understand the stability and control of an aircraft.
5. Understand GPS and other navigation techniques used in aircraft.

CO-PO MAPPING:

Course Outcomes	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	-	3	3	3
CO2	1	-	-	3	3	3
CO3	1	-	-	3	3	3
CO4	1	-	-	3	3	3
CO5	1	-	-	3	3	3
AVG.	1	-	-	3	3	3

REFERENCES:

1. AGARD-AG-234, "Active controls aircraft Design", 1978.
2. Collinson R.P.G, ―Introduction to Avionics', Chapman and Hall, India, 1996.
3. Ian Moir and Allan Seabridge, Aircraft Systems Mechanical, electrical, and avionics subsystems integration, John Wiley & Sons Ltd, 2009.
4. Jane's Unmanned Aerial Vehicles and Targets, Jane's Information Group; ASIN: 0710612575, 1999.
5. Nelson R.C ―Flight stability & Automatic Control', McGraw Hill, 1989.
6. Pallet, E.H.J. Aircraft Instruments & Integrated systems‖, Longman Scientific and Technical, McGraw-Hill, 1992.
7. Robert C. Nelson, Flight Stability and Automatic Control, McGraw-Hill, Inc, 1998.
8. Stevens B.L & Lewis F.L, Aircraft control & simulation', John Wiley Sons, New York, 1992.

MR4017 MEDICAL MECHATRONICS

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

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

UNIT – I INTRODUCTION TO MEDICAL MECHATRONICS 9

Role of Mechatronics in Medical – Overview of Human Functional System – Cell and Origin Bioelectric Potential - Measurement of Blood Pressure - Invasive and Non-invasive 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 9

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

UNIT – III CARDIAC AND REGULATORY ASSIST SYSTEM 9

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 Haemodialysis, Membrane, Dialysate, Different Types of Haemodialysis, Monitoring Systems, Wearable Artificial Kidney, Implanting Type.

UNIT – IV MEDICAL IMAGING 9

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- Voi Synthesizer, Speech Trainer. Ultra-Sonic and Laser Canes, Intra Ocular Lens, Braille Reade Tactile Devices for Visually Challenged - Ophthalmoscopy - Text Voice Converter - Scre Readers and Automated Analyzer.

TOTAL: 42 PERIODS

COURSE OUTCOMES:

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

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

CO-PO MAPPING:

Course Outcomes	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	-	3	3	3
CO2	1	-	-	3	3	3
CO3	1	-	-	3	3	3
CO4	1	-	-	3	3	3
CO5	1	-	-	3	3	3
AVG.	1	-	-	3	3	3

REFERENCES:

1. Albert M Cook and Webster J G, “Therapeutic Medical Devices’’, Prentice Hall Nee York, 1982.
2. Alfred Horowitz, “MRI Physics for Radiologists – A Visual Approach”, Springer Verlag Network, 1991.
3. Geddes L A and Baker L.E, “Principals of Applied Biomedical Instrumentation”, John Wiley and Sons Newyork, 1989.
4. Jerry L.Prince and Jnathan M.Links, ”Medical Imaging Signals and Systems”, Pearson Education Inc., 2006
5. Khandpur R.S, “Hand Book of Bio-Medical Instrumentation”, Tata McGraw Hill Publishing Co Ltd., 2003.
6. Kolff W.J., “Artificial Organs”, John Wiley and Sons, New York, 1979.
7. Leslie Cromwell, Fred J.Weibell, Erich A.Pfeiffer, “Bio-Medical Instrumentation and Measurements”, Pearson Education, 2002.

MR4018	MOBILE ROBOTICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

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

UNIT – I INTRODUCTION TO MOBILE ROBOTICS 9

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 9

Kinematic Models – Representation of Robot – Forward Kinematics – Wheel and Robot Constraints – Degree of Mobility and Steerability – Manoeuvrability – 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.

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: Evaluate the appropriate mobile robots for the desired application.
CO2: Create the kinematics for given wheeled and legged robot.
CO3: Analyse the sensors for the intelligence of mobile robotics.
CO4: Create the localization strategies and mapping technique for mobile robot.
CO5: Create the collaborative mobile robotics for planning, navigation and intelligence for desired applications.

CO-PO MAPPING:

Course Outcomes	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	-	3	3	3
CO2	1	-	-	3	3	3
CO3	1	-	-	3	3	3
CO4	1	-	-	3	3	3
CO5	1	-	-	3	3	3
AVG.	1	-	-	3	3	3

REFERENCES:

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.
3. Peter Corke, “Robotics, Vision and Control”, Springer, 2017.
4. Roland Siegwart and Illah R.Nourbakish, “Introduction to Autonomous Mobile Robots” MIT Press, Cambridge, 2004.
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.

CM4091	GREEN MANUFACTURING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To expose the students to the basics of environmental sustainability and impact assessment objectives.
2. To incorporate knowledge about the environmental based improvements towards lean manufacturing systems.
3. To analyze various machineries with intent to conserve energy
4. To analyze hazardous and solid wastes with intent to point out areas of adverse environmental impact and how this impact could be minimized or prevented.
5. To impart the knowledge about the need, procedure and benefits of Green-Co rating.

UNIT – I ENVIRONMENTAL SUSTAINABILITY AND IMPACT ASSESSMENT 9

Environmental impact assessment objectives – Legislative development – European community directive – Hungarian directive. Strategic environmental assessment and sustainability appraisal. Regional spatial planning and environmental policy.

UNIT – II LEAN MANUFACTURING AND GREEN ENERGY SYSTEM 9

Conventional Manufacturing versus Lean Manufacturing – Principles of Lean Manufacturing. World energy consumption – Greenhouse effect, Global warming. Energy conservation and measurement principles with their applicability in engineering and process industries.

UNIT – III ENERGY SAVING MACHINERY AND COMPONENTS 9

Electricity Billing: Components and Costs – kVA – Need and Control – Determination of kVA demand and Consumption. Selection of fans, pumps and Compressors – Performance Evaluation – Cause for inefficient operation – scope for energy conservation.

UNIT – IV HAZARDOUS AND SOLID WASTE MANAGEMENT 9

Hazardous waste: definition, terminology, classification and Sources – Need for hazardous waste management: Need, Handling, methods of collection, storage and transport with suitable examples. Solid waste management: Need, Waste prevention and Life cycle assessment. Collection, storage, reuse and recycling of solid waste with suitable examples.

UNIT – V GREEN CO-RATING 9

Ecological Footprint - Need for Green Co-Rating – Green Co-Rating System – Intent – System Approach – Weightage- Assessment Process – Types of Rating – Green Co-Benefits – Case Studies of Green Co-Rating.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Understand the Concepts of environmental sustainability and environmental impact assessment objectives

CO2: Apply suitable schemes towards design of green manufacturing requirements.

CO3: Analyze manufacturing processes towards conservation of energy.

CO4: Analyze manufacturing processes towards minimization or prevention of hazardous and solid wastes.

CO5: Acquire Knowledge of green co-rating and its benefits are well known to the students.

CO-PO MAPPING:

Course Outcomes	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	-	1	1	1
CO2	1	-	-	1	1	1
CO3	1	-	-	1	1	1
CO4	1	-	-	1	1	1
CO5	1	-	-	1	1	1
AVG.	1	-	-	1	1	1

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
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5. University Press 2005.
6. Green Co Case Study Booklet, CII – Sohrabji Godrej Green Business Centre, 2015

MR4019 HAPTICS AND AUGMENTED REALITY

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

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

UNIT – I INTRODUCTION TO HAPTICS **9**

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 **9**

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 - 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.

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.

CO-PO MAPPING:

Course Outcomes	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	-	3	3	3
CO2	1	-	-	3	3	3
CO3	1	-	-	3	3	3
CO4	1	-	-	3	3	3
CO5	1	-	-	3	3	3
AVG.	1	-	-	3	3	3

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.
4. Kenneth Salisbury, Francois Conti and Federico Barbagli, “Haptic Rendering: Introductory Concepts”, pp. 24 -32, 2004.
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.
6. MacLean K. E, "Haptic Interaction Design for Everyday Interfaces: Reviews of Human Factors and Ergonomics", 4:149-194, 2008.
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8. Sherman, William R. and Alan B. Craig. "Understanding Virtual Reality – Interface, Application, and Design", Morgan Kaufmann, 2002.
9. Yuichi Ohta, Hideyuki Tamura, "Mixed Reality: Merging Real and Virtual Worlds", Springer-Verlag, 2013.

MR4020 INDUSTRIAL INSTRUMENTATION AND CONTROL

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

1. To understand the overview of the industrial automation and control.
2. To familiarize with data communication and supervisory control systems.
3. To learn and understand the basic concepts of factory automation.
4. To understand various control elements in industry.
5. To understand and select final control element for process control.

UNIT – I INDUSTRIAL INSTRUMENTATION 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 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 – III 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 – IV CONTROL ELEMENTS 9

Characteristic of on-off, proportional, single speed floating, integral and derivative controllers – P+I, P+D and P+I+D control modes – Electronic PID controller – Auto/manual transfer - Reset windup – Practical forms of PID Controller.

UNIT – V FINAL CONTROL ELEMENTS 9

I/P converter - Pneumatic and electric actuators – Valve Positioner – Control Valves – Characteristic of ControlValves:- Inherent and Installed characteristics – Modeling of pneumatic control valve – Valve body:-Commercial valve bodies – Control valve sizing – Cavitation and flashing – Selection criteria.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

1. Understand the concepts of industrial instrumentation.
2. Select and design a system with data communication and supervisory control.
3. Understand the concepts and layout of automation in factory.
4. Understand the various control elements in industry.
5. Evaluate and select control elements for the system design.

CO-PO MAPPING:

Course Outcomes	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	-	3	3	3
CO2	1	-	-	3	3	3
CO3	1	-	-	3	3	3
CO4	1	-	-	3	3	3
CO5	1	-	-	3	3	3
AVG.	1	-	-	3	3	3

REFERENCES:

1. B.G.Liptak, 'Process Control', Chilton Book Company, 1994.
2. Curtis D. Johnson, 'Process Control Instrumentation Technology', 7th Edition, Pearson Education, New Delhi, 2002 / PHI.
3. Lucas, M.P., "Distributed Control System", Van Nastrand Reinhold Company, 1986.
4. Mackay S., Wrijut E., Reynders D. and Park J., "Practical Industrial Data Networks Design, Installation and Troubleshooting", Newnes Publication - Elsevier, 2004.
5. Patranabis. D, "Principles of Industrial Instrumentation", Tata McGraw-Hill Publishing Ltd., 1999.
6. Mackay, S., Wrijut, E., Reynders, D. and Park, J., "Practical Industrial Data Networks Design, Installation and Troubleshooting", Newnes Publication, Elsevier, 1st Edition, 2004.
7. Frank Lamb, "Hands on Industrial Automation", McGraw-Hill Profession, 2013.
8. Bequette, B.W., "Process Control Modeling, Design and Simulation", Prentice Hall of India, 2004.

MR4021	MODELING AND ANALYSIS OF ELECTRO MECHANICAL SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To equip students with fundamentals of finite element principles.
2. 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.
3. To make them to understand to shape functions and higher order formulation.
4. To learn various quantities in engineering problems and also make them to work on preprocessing, meshing, boundary condition assigning and post processing.
5. 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 FINITE ELEMENT MODELLING 9

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 9

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: Evaluate and 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: Evaluate and select appropriate element, boundary condition, meshing and Post processing for any engineering problem.

CO5: create FEM model on various software packages used for FEM analysis tool toi analyse a production process through FEA and control it's parameters.

CO-PO MAPPING:

Course Outcomes	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	-	3	3	3
CO2	1	-	-	3	3	3
CO3	1	-	-	3	3	3
CO4	1	-	-	3	3	3
CO5	1	-	-	3	3	3
AVG.	1	-	-	3	3	3

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”,
5. Springer Verlage, 1992.
6. Nicola Biyanchi , “Electrical Machine Analysis using Finite Elements”, Taylor and
7. Francis Group, CRC Publishers, 2005.
8. Reddy, J.N, “An Introduction to the Finite Element Method”, McGrawHill, 1985.
9. Salon S.J, “Finite Element Analysis of Electrical Machines” Kluwer Academic Publishers, 1995.

AUDIT COURSES

AX4091 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

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.

AX4092 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

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.

AX4093 CONSTITUTION OF INDIA L T P C

2 0 0 0

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

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.

AX4094 **நற்றமிழ் இலக்கியம்** **L T P C**
2 0 0 0

UNIT I சங்க இலக்கியம் **6**

1. தமிழின் துவக்க நூல் தொல்காப்பியம் – எழுத்து, சொல், பொருள்
2. அகநானூறு (82) - இயற்கை இன்னிசை அரங்கம்
3. குறிஞ்சிப் பாட்டின் மலர்க்காட்சி
4. புறநானூறு (95,195)

- போரை நிறுத்திய ஔவையார்

UNIT II **அறநெறித் தமிழ்** **6**

1. அறநெறி வகுத்த திருவள்ளுவர்
   - அறம் வலியுறுத்தல், அன்புடைமை, ஒப்புறவு அறிதல், ஈகை, புகழ்
2. பிற அறநூல்கள் - இலக்கிய மருந்து

– ஏலாதி, சிறுபஞ்சமூலம், திரிகடுகம், ஆசாரக்கோவை (தூய்மையை வலியுறுத்தும் நூல்)

UNIT III **இரட்டைக் காப்பியங்கள்** **6**

1. கண்ணகியின் புரட்சி
   - சிலப்பதிகார வழக்குரை காதை
2. சமூகசேவை இலக்கியம் மணிமேகலை
   - சிறைக்கோட்டம் அறக்கோட்டமாகிய காதை

UNIT IV **அருள்நெறித் தமிழ்** **6**

1. சிறுபாணாற்றுப்படை
   - பாரி முல்லைக்குத் தேர் கொடுத்தது, பேகன் மயிலுக்குப் போர்வை கொடுத்தது, அதியமான் ஔவைக்கு நெல்லிக்கனி கொடுத்தது, அரசர் பண்புகள்
2. நற்றிணை
   - அன்னைக்குரிய புன்னை சிறப்பு
3. திருமந்திரம் (617, 618)
   - இயமம் நியமம் விதிகள்
4. தர்மச்சாலையை நிறுவிய வள்ளலார்
5. புறநானூறு
   - சிறுவனே வள்ளலானான்
6. அகநானூறு (4) - வண்டு
   நற்றிணை (11) - நண்டு
   கலித்தொகை (11) - யானை, புறா
   ஐந்தினை 50 (27) - மான்
   ஆகியவை பற்றிய செய்திகள்

UNIT V **நவீன தமிழ் இலக்கியம்** **6**

1. உரைநடைத் தமிழ்,
   - தமிழின் முதல் புதினம்,
   - தமிழின் முதல் சிறுகதை,
   - கட்டுரை இலக்கியம்,
   - பயண இலக்கியம்,

- நாடகம்,

2. நாட்டு விடுதலை போராட்டமும் தமிழ் இலக்கியமும்,
3. சமுதாய விடுதலையும் தமிழ் இலக்கியமும்,
4. பெண் விடுதலையும் விளிம்பு நிலையினரின் மேம்பாட்டில் தமிழ் இலக்கியமும்,
5. அறிவியல் தமிழ்,
6. இணையத்தில் தமிழ்,
7. சுற்றுச்சூழல் மேம்பாட்டில் தமிழ் இலக்கியம்.

TOTAL: 30 PERIODS

<u>தமிழ் இலக்கிய வெளியீடுகள் / புத்தகங்கள்</u>

1. தமிழ் இணைய கல்விக்கழகம் (Tamil Virtual University)
   - www.tamilvu.org
2. தமிழ் விக்கிப்பீடியா (Tamil Wikipedia)
   -https://ta.wikipedia.org
3. தர்மபுர ஆதின வெளியீடு
4. வாழ்வியல் களஞ்சியம்
   - தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்
5. தமிழ்கலைக் களஞ்சியம்
   - தமிழ் வளர்ச்சித் துறை (thamilvalarchithurai.com)
6. அறிவியல் களஞ்சியம்
   - தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்