UNIVERSITY DEPARTMENTS

ANNA UNIVERSITY : : CHENNAI 600 025

REGULATIONS - 2015

CHOICE BASED CREDIT SYSTEM

M.E. MECHATRONICS (FT)

PROGRAM EDUCATIONAL OBJECTIVES (PEO)

1. The graduates acquire ability to create mathematical model, design, analysis and synthesis the system based on the knowledge of integration specifically from the mechanical, electrical, electronic, control, computer science, fluid and other engineering domains.
2. The graduates use their talent, self-confidence, knowledge and engineering practice which facilitate them to presume position of scientific and/or managerial leadership in their career paths.
3. The graduates apply their consciousness of moral, professional responsibilities and motivation to practice life-long learning in a team work environment.

PROGRAMME OUTCOMES (PO)

1. Graduate will demonstrate strong basics in mathematics, mechanics and its design, electronics engineering serves the foundation for the Programme.
2. Graduate will be familiar about the importance of the sensors, signal conditioning, and control system design for the appropriate use of mechatronic system developments.
3. Graduate able to demonstrate the effective use of actuators and its elements for the generation, control and conversion of energy for the typical automation.
4. Graduate able to develop the mechatronic systems by the integration mechanical, electrical, electronics, fluid, and other multidisciplinary systems.
5. Graduate able to build the real time automation system within realistic constraints such as industrial, economic, environmental, ethical, social, health and safety.
6. Graduate will become familiar with modern automation tools and such as incorporating robots and vision based intelligence automation.
7. Graduate will acquire the capability to identify, formulate and solve engineering problems related to mechatronic systems.
8. Graduate will has an understanding of social, professional and ethical responsibility when developing automated system.
9. Graduate will be able to communicate effectively both in verbal and non verbal forms.
10. Graduate will be trained towards developing and understanding the impact of development of mechatronics system on global, economic, environmental and societal context.
11. Graduate will be capable of understanding the value for life-long learning and motivating them to involve the research works.

12. Graduate will be able to design and develop innovative/ manufacturable / marketable / environmental friendly products useful to the nation and the society.
13. Graduate will be able to manage any organisation well and will be able to emerge as a successful entrepreneur.

Mapping of PEOs with POs

Programme Educational Objectives	Programme Outcomes												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
I	✓	✓	✓	✓									
II					✓	✓	✓	✓	✓				
III										✓	✓	✓	✓

			PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
YEAR 1	SEM 1	Advanced Engineering Mathematics	✓	✓	✓	✓	✓								
		Concepts in Electronics Engineering	✓	✓	✓	✓	✓								
		Concepts of Machines and Mechanisms	✓		✓	✓									
		Sensors and Signal Conditioning		✓	✓	✓	✓	✓							
		Control System Design		✓	✓	✓	✓	✓			✓				
		Drives and Actuators for Automation		✓	✓	✓	✓								
		Elective – I													
		Computer Aided Modeling, Simulation and Automation Laboratory	✓		✓		✓								
	SEM 2	Design of Machine Elements and Product Development	✓			✓	✓								
		Mechatronics System Design	✓	✓	✓	✓	✓	✓	✓			✓	✓		
		Industrial Robotics	✓			✓	✓	✓	✓						
		Microcontrollers		✓	✓	✓	✓								
		Elective II													
		Microcontrollers Laboratory		✓	✓	✓	✓						✓		
		Automation Laboratory				✓	✓						✓		
YEAR 2	SEM 3	Machine Vision					✓	✓					✓		
		Elective – III													
		Elective – IV													
		Elective – V													
		Project Work- Phase I	✓			✓	✓		✓	✓	✓	✓	✓	✓	
		Industrial Training/ Internships (2 weeks)				✓	✓		✓	✓	✓	✓			
	SEM 4	Project Work- Phase II	✓			✓	✓		✓	✓	✓	✓	✓	✓	✓

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REGULATIONS - 2015

M.E. MECHATRONICS

I TO IV SEMESTERS CURRICULUM AND SYLLABUS

SEMESTER I

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	MA7101	Advanced Engineering Mathematics	FC	4	4	0	0	4
2.	MR7101	Concepts in Electronics Engineering	FC	4	2	0	2	3
	MR7102	Concepts of Machines and Mechanisms	FC	4	2	2	0	3
3.	MR7103	Control System Design	PC	4	2	2	0	3
4.	MR7104	Drives and Actuators for Automation	PC	5	3	0	2	4
5.	MR7105	Sensors and Signal Conditioning	PC	5	3	0	2	4
6.		Elective – I	PE	3	3	0	0	3
PRACTICALS								
7	MR7111	Computer Aided Modeling, Simulation and Automation Laboratory	PC	4	0	0	4	2
			TOTAL	**29**	**15**	**2**	**10**	**23**

SEMESTER II

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	MR7201	Design of Machine Elements and Product Development	FC	5	3	2	0	4
2.	MR7202	Industrial Robotics	PC	3	3	0	0	3
3.	MR7203	Mechatronics System Design	PC	4	2	0	2	3
4.	MR7204	Microcontrollers	PC	3	3	0	0	3
5.		Elective – II	PC	3	3	0	0	3
PRACTICALS								
6	MR7211	Automation Laboratory	PC	4	0	0	4	2
7.	MR7212	Microcontrollers Laboratory	PC	4	0	0	4	2
			TOTAL	**26**	**14**	**2**	**10**	**20**

SEMESTER III

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	MR7301	Machine Vision	PC	5	3	0	2	4
2.		Elective - III	PE	3	3	0	0	3
3.		Elective - IV	PE	3	3	0	0	3
4.		Elective - V	PE	3	3	0	0	3
PRACTICALS								
5.	MR7311	Industrial Training* / Internships*	EEC	2	0	0	2	1
6.	MR7312	Project Work - Phase I	EEC	12	0	0	12	6
			TOTAL	**28**	**12**	**0**	**14**	**20**

***** Minimum 2 weeks during vacation

SEMESTER IV

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
PRACTICALS								
1	MR7411	Project Work - Phase II	EEC	24	0	0	24	12
			TOTAL	**24**	**0**	**0**	**24**	**12**

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

FOUNDATION COURSES (FC)

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.		Advanced Engineering Mathematics	FC	4	4	0	0	4
2.		Concepts in Electronics Engineering	FC	4	2	2	0	3
3.		Concepts of Machines and Mechanisms	FC	4	2	2	0	3
4.		Design of Machine Elements and Product Development	FC	5	3	2	0	4

PROFESSIONAL CORE (PC)

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.		Sensors and Signal Conditioning	PC	5	3	0	2	4

2.		Control System Design	PC	4	2	2	0	3
3.		Drives and Actuators for Automation	PC	5	3	0	2	4
4.		Mechatronics System Design	PC	4	2	0	2	3
5.		Microcontrollers	PC	3	3	0	0	3
6.		Industrial Robotics	PC	3	3	0	0	3
7.		Machine Vision	PC	5	3	0	2	4
8.		Computer Aided Modeling, Simulation and Automation Laboratory	PC	4	0	0	4	2
9.		Automation Laboratory	PC	4	0	0	4	2
10.		Microcontroller Laboratory	PC	4	0	0	4	2

PROFESSIONAL ELECTIVES (PE)

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	MR7001	Advanced Computer Vision	PE	3	3	0	0	3
2.	MR7002	Advanced Control Systems	PE	3	3	0	0	3
3.	MR7003	Analytical Robotics	PE	3	3	0	0	3
4.	MR7004	Applied Signal Processing	PE	3	3	0	0	3
5.	MR7005	Appropriate Manufacturing Processes	PE	3	3	0	0	3
6.	MR7006	Biomechatronics	PE	3	3	0	0	3
7.	MR7007	Computer Aided Inspection	PE	3	3	0	0	3
8.	MR7008	Concepts of Sustainable Manufacturing	PE	3	3	0	0	3
9.	MR7009	Digital Manufacturing	PE	3	3	0	0	3
10.	MR7010	Embedded Systems With Advanced Microcontrollers	PE	3	3	0	0	3
11.	MR7011	Haptics and Augmented Reality	PE	3	3	0	0	3
12.	MR7012	Human Machine Interface	PE	3	3	0	0	3
13.	MR7013	Industrial Automation	PE	3	3	0	0	3
14.	MR7014	Machine Learning	PE	3	3	0	0	3
15.	MR7015	Materials Management and Logistics	PE	3	3	0	0	3
16.	MR7016	Medical Mechatronics	PE	3	3	0	0	3
17.	MR7017	Micro and Nano Systems	PE	3	3	0	0	3
18.	MR7018	Mobile Robotics	PE	3	3	0	0	3
19.	MR7019	Modeling and Finite	PE	3	3	0	0	3

		Element Analysis of Electromechanical Systems						
20.	MR7020	Non Destructive Evaluation	PE	3	3	0	0	3
21.	MR7021	Vetronics	PE	3	3	0	0	3

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.		Project Work – Phase I	EEC	12	0	0	12	6
2.		Project Work - Phase II	EEC	24	0	0	24	12
3.		Industrial Training* / Internships*	EEC	2	0	0	2	1

MA7101 ADVANCED ENGINEERING MATHEMATICS L T P C
4 0 0 4

OBJECTIVE

- To relate the mathematical concepts in their field of Engineering and apply the same in their respective main stream.

UNIT I VECTOR SPACE AND LINEAR TRANSFORMATION 10

Vector spaces – Subspaces – Linear spans – Linear independence and Linear dependence – Basis and Dimension – Linear Transformation, Null space and range – Dimension theorem (no proof) – Matrix representation of Linear Transformation.

UNIT II LINEAR ALGEBRA, INTERPOLATION, NUMERICAL DIFFERENTIATION AND INTEGRATION 16

Gauss elimination method-Gauss Jordan method – Jacobi, Gauss- Seidel iterative Method – Lagrange's and Newton's divided difference interpolation - Newton's forward and backward difference interpolation – Numerical differentiation by finite differences – Trapezoidal, Simpson's 1/3 and Gaussian Quadrature formula.

UNIT III NUMERICAL SOLUTION OF ORDINANRY DIFFERENTIAL EQUATIONS 12

Numerical solution of first order ordinary differential equations by tailor series method – Euler Method - Fourth order Runge -Kutta Method – Multi step methods: Adam's Bash forth, Milne's Predictor Corrector methods- Finite difference methods for two point boundary value problems.

UNIT IV FUNDAMENTALS OF GRAPHS 12

Graphs-sub graphs-Graph Isomorphism- vertex degree: Eulerian Graphs- Planar Graphs- Hamiltonian paths

UNIT V ALGORITHMS- GRAPHS 10

Kriskal's algorithm- Dijkstra's shortest path Algorithm, Prim's Algorithm- Transport Networks

TOTAL: 60 PERIODS

OUTCOME

- The students would be acquainted with the basic concepts of Linear Algebra and numerical methods & their applications, basics in Graph theory and also this course will helpful for mathematical modeling for engineering problems.

REFERENCES

1. Kumaresan, S.,"Linear Algebra – A geometric approach", Prentice –Hall of India, New Delhi, 2000.
2. Friedberg, A.H., Insel, A.J. and Spence, L., "Linear Algebra", Prentice Hall of India, New Delhi, 2004.
3. Strang, G., "Linear Algebra and its applications", Thomson (Brooks/Cole), New Delhi, 2005.
4. Jain, M.K, Iyengar, S.R.K, and Jain, R.K., "Numerical methods for Scientific and Engineering Computation", New Age International Publishers, New Delhi, 2003.
5. Faires, J.D. and Burder, R., "Numerical Methods", Brooks/Cole (Thomson Publications), New Delhi, 2002.
6. Gerald, C.F, and Wheatly, P.O., "Applied Numerical Analysis", Pearson Education, New Delhi, 2002.

MR7101 CONCEPTS IN ELECTRONICS ENGINEERING

L	T	P	C
2	0	2	3

OBJECTIVE

- To understand the basics and working principles of electronic components and their applications.

UNIT I ELECTRONIC COMPONENTS AND DEVICES 7

Resistors, Capacitors, Inductors, Transformers – types and properties - Junction diodes, Zener diodes, transistors and thyristors- types-operating mechanism-characteristics and applications. LEDs – Characteristics and applications

UNIT II OPERATIONAL AMPLIFIERS AND APPLICATIONS 7

Operational amplifiers – Principles, Specifications, characteristics and applications- Arithmetic Operations, Integrator, Differentiator, Comparator, Schmitt Trigger, Instrumentation Amplifier, Active filters, Linear Rectifiers, Waveform Generators, D/A 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, Decoders, Study of Sequential Logic Circuits-Flip-flops, Counters, Shift registers – A/D Converters.

UNIT IV MEASURING INSTRUMENTS 5

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, analysers and printers.

UNIT V POWER MANAGEMENT 5

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

TOTAL: 30 PERIODS

OUTCOME

- This course is intended for learning the fundamentals and applications of Electronic Components, Devices, analog circuits, digital circuits, test and measuring instruments. Further, students will learn to develop customized electronics components for mechatronic applications.

REFERENCES

1. Mill Man and Halkias, “Electron Devices and Circuits”, McGraw-Hill 2004.
2. Jocob Mill Man, Microelectronics Digital and Analog Circuits & Systems – McGraw-Hill, 2004.
3. Ray & Chaudary, Linear Integrated Circuits, New Age, 2006.
4. Malvino & Leach, Digital Principles & Application, TMH, 2002.
5. Helfrick A.D and Cooper .W. D. “ Modern Electronic Instrumentation and Measurements Techniques”, Prentice Hall, 2008.

LABORATORY

OBJECTIVE

- To give hands on experience on basic electronics unit developments for the mechanical stream students.

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

OUTCOME

- The laboratory experiments provides a hands on experience onboard electronics developments particularly the students come from mechanical stream.

MR7102 CONCEPTS OF MACHINES AND MECHANISMS

L	T	P	C
2	2	0	3

OBJECTIVE

- To impart knowledge of basic mechanical engineering to the students.

UNIT I MECHANISMS 6+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+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+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+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+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.

L=30, P=30 TOTAL =60 PERIODS

OUTCOME

- The students will understand the concepts, design, construction and properties of mechanical elements and machines.

REFERENCES

1. Bansal R.K,"Theory of Machines", Laxmi Publications (P) ltd., New Delhi. 2011.
2. G.C.Sen and A. Bhattacharya, "Principles of Machine Tools", New Central book Agency, 1999.

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” Satya Prakasam, Tech. India Publications, 1989.
5. R.S.Khurmi and Gupta, “Theory of Machines” Eurasia Publishing House Pvt Ltd. 2012.

MR7103 CONTROL SYSTEM DESIGN

L	T	P	C
2	2	0	3

OBJECTIVE

- To understand dynamics, design and analysis of control systems to meet the desired specifications.

UNIT I SYSTEM REPRESENTATION AND MODELLING 6+6

Introduction and need for Control Systems 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 6+6

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 controllers.

UNIT III TIME DOMAIN ANALYSIS 6+6

Time response of First & Second order systems – Time domain specifications - steady state errors and error constants – Routh Hurwitz criterion – Root locus – Root locus approach to control system design – Lead, Lag, Lag-Lead Compensation using time domain analysis.

UNIT IV FREQUENCY DOMAIN ANALYSIS 6+6

Bode Plot – Polar Plot – Nyquist stability criterion – Stability analysis – Experimental determination of Transfer Functions – Control system design using Frequency domain analysis - Lead, Lag, Lag-Lead Compensation using frequency domain analysis.

UNIT V CONTROL AND ANALYSIS OF SERVO MOTOR 6+6

Servo motor – Mathematical Modelling of Servo Motor – Analysis of Servo motor system using Routh Hurwitz criterion, Root locus, Bode Plot, Polar Plot and stability analysis – Implementation of P, PI , PD and PID controllers for servo motor and analysis - Bumpless Control Transfer Between Manual and PID Control- Anti-Windup Control Using a PID Controller

L=30, P=30 TOTAL =60 PERIODS

OUTCOME

- The students will know the various types of control systems and their modelling. with reference to mode controls, and determination of stability in time and frequency domain.

REFERENCES

1. K.Ogata, “Modern Controls Engineering“, Prentice Hall of India Pvt. Ltd., New Delhi, 2005.
2. B.C. Kuo, “Automatic Control Systems”, Prentice Hall of India Pvt. Ltd., New Delhi, 2004.
3. I.J.Nagrath and Gopal, “Control System Engineering”, New Age international (P) Ltd., 2006.
4. A. Nagoor Kani, “Control Systems”, RBA Publications (P) Ltd., 2014.
5. M.Nakamura .S.Gata & N.Kyura, Mechatronic Servo System Control, Springer 2009.

MR7104 DRIVES AND ACTUATORS FOR AUTOMATION

L	T	P	C
3	0	2	4

OBJECTIVE

- To impart knowledge in the area of hydraulic, pneumatic electric actuators and their control.

UNIT I FLUID POWER SYSTEM GENERATION AND ACTUATORS 8

Need for automation, Classification of drives-hydraulic, pneumatic and electric –comparison – ISO symbols for their elements, Selection Criteria. Generating Elements**-** Hydraulic pumps and motor gears, vane, piston pumps-motors-selection and specification -Drive characteristics – Utilizing Elements- Linear actuator – Types, mounting details, cushioning – power packs –accumulators.

UNIT II CONTROL AND REGULATION ELEMENTS 7

Control and regulation Elements—Direction, flow and pressure control valves--Methods of actuation, types, sizing of ports. Spool valves-operating characteristics-electro hydraulic servo valves-Different types-characteristics and performance

UNIT III CIRCUIT DESIGN FOR HYDRAULIC AND PNEUMATICS 12

Typical Design methods – sequencing circuits design - combinational logic circuit design-cascade method - Karnaugh map method- Electrical control of pneumatic and hydraulic circuits-use of relays, timers, counters, Programmable logic control of Hydraulics Pneumatics circuits, PLC ladder diagram for various circuits, motion controllers, use of field busses in circuits.

UNIT IV ELECTRICAL ACTUATORS 8

D.C Motor-Working principle, classification, characteristics, Merits and Demerits, Applications- AC Motor- Working principle, Types, Speed torque characteristics, Merits and demerits, Applications Stepper motor- principle ,classification, construction. Piezo electric actuators – Linear actuators Hybrid actuators – Applications

UNIT V ELECTRICAL DRIVE CIRCUITS 10

DC Motors - Speed, direction and position control using H-bridge under PWM mode**.** Control of AC motor drives – Need for V/ F drives – Energy saving AC drives. – Stepper Motor – Drive circuits for speed and position control, BLDC motor – Controller – Switched reluctance motor.

TOTAL: 45 PERIODS

OUTCOMES

- The students able to familiar with basic concepts of hydraulic, pneumatics and electric drives and their controlling elements and also gather the knowledge on designing the hydraulic and pneumatic circuits using ladder diagram.

REFERENCES

1. Antony Esposito, “Fluid Power Systems and Control”, Prentice-Hall, 2006.
2. Peter Rohner, Fluid Power Logic Circuit Design”, The Macmillan Press Ltd., London, 1979.
3. W.Bolton, “Mechatronics, Electronic Control Systems in Mechanical and Electrical Engineering”, Pearson Education, 2003.
4. Gopal K.Dubey, “Fundamentals of Electrical Drives”, Narosa Publications, 2001.

LABORATORY

OBJECTIVE

- To study the functional aspects of different pneumatic and hydraulic Components and its use in circuits and also to train the student in designing different pneumatic and hydraulic circuits for different applications.

OUTCOME

- The outcome of this laboratory is to create familiarization with fluid power drives and its electronic control for automation application.

LIST OF EXPERIMENTS

1. Simulation of speed control circuits in a hydraulic trainer.
2. Simulation of hydraulic circuits in a hydraulic trainer.
3. Simulation of single and double acting cylinder circuits using different directional control values.
4. One shot and regenerative pneumatic circuits.
5. Simulation of Ladder diagram program.
6. Sequencing of pneumatic circuits.
7. Simulation of Electro-pneumatic circuits.
8. Simulation of Logic pneumatic circuits.
9. Simulation of electro pneumatic sequencing circuits.
10. Simulation of PLC based electro pneumatic sequencing circuits.
11. Simulation of pneumatic circuits using PLC.
12. To design and connect the circuits for the given problem (case study).
13. To compare the ladder diagram for electrical and PLC control for the given sequence.

TOTAL: 30 PERIODS

MR 7105	SENSORS AND SIGNAL CONDITIONING	L	T	P	C
		3	0	2	4

OBJECTIVE

- To learn the various types of sensors, transducers and signal conditioning circuits for Mechatronics system development.

UNIT I INTRODUCTION 7

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.

UNIT II MOTION, PROXIMITY AND RANGING SENSORS 10

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).

UNIT III FORCE, MAGNETIC AND HEADING SENSORS 8

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

UNIT IV OPTICAL, PRESSURE AND TEMPERATURE SENSORS 8

Photo conductive cell, photo voltaic, Photo resistive, LDR – Fiber optic sensors – Pressure – Diaphragm, Bellows, Piezoelectric, Temperature – IC, Thermistor, RTD, Thermocouple.

UNIT V SIGNAL CONDITIONING 12

Need for Signal Conditioning – DC and AC Signal conditioning – Filter and Isolation Circuits – Operational Amplifier Specifications, Characteristics and Circuits – Voltage, Current and Power Amplifiers – Transmitting Circuits – Fundamentals of Data Acquisition System.

TOTAL: 45 PERIODS

OUTCOME

- The students will learn the principles of various sensors and transducers and also able to study the characteristics of sensors.

REFERENCES

1. Patranabis D., “Sensor and Actuators”, Prentice Hall of India (Pvt) Ltd., 2005.
2. Renganathan S., “Transducer Engineering”, Allied Publishers (P) Ltd., 2003

3. Ernest O. Doeblin, “Measurement system, Application and Design”, Tata McGraw Hill Publishing Company Ltd., Fiftieth Edition, 2004
4. Bradley D.A., and Dawson, Burd and Loader, “Mechatronics”, Thomson Press India Ltd., 2004
5. Bolton W., “Mechatronics”, Thomson Press, 2003.

LABORATORY

OBJECTIVE

- To learn and gather the practical experience on sensors and its measurements for mechatronics system development.

LIST OF EXPERIMENTS

1. Study on various kinds of sensors and its characteristics.
2. Study on signal conditioning units.
3. Experimentation on voltage, current, power, and frequency measurement.
4. Strain gage, load cell and torque transducer characterization & applications – data acquisition & instrument control.
5. Experimentation with tactile sensor for force and touch detection.
6. LVDT, acoustics ranging, Hall Effect sensor and ultrasonic distance measurement applications.
7. Temperature & Optical transducers Characterization – Data Acquisition & Instrument Control.
8. Study on eddy current sensor for thickness measurement.
9. Study on ultrasonic sensors for material fault diagnosis.
10. Experimentation on laser sensor for non-contact dimension measurement.
11. Study on Experimentation with Gyroscope, Accelerometer and magnetometer.
12. Experimentation with speed and position measurement using encoders.

TOTAL: 30 PERIODS

OUTCOME

- Students able to come with suitable sensor selection for the mechatronics system development based on the laboratory experience.

MR7111	COMPUTER AIDED MODELING, SIMULATION AND AUTOMATION LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVES

- To learn the drawing, modeling, simulation of machine components.
- To learn the open and closed loop control of electrical drives.

OUTCOMES

- The computer aided modeling and simulation laboratory will give the hands on experience on modeling the mechanical structure and its elements and also it delivers the simulation of mechanisms.
- The automation lab will delivers the basic control of DC, AC, servo, and stepper motor through various control modes.

COMPUTER AIDED MODELING AND SIMULATION

1. 2D modeling and 3D modeling of components such as
    - Bearing
    - Couplings.
    - Ball screw

- Gears
- Sheet metal components
- Jigs, Fixtures and Die assemblies.

2. 3D modeling of machine components using 3D printer.
   - Gears
   - Links
3. Modeling and simulation of mechanism
   - 4 Bar chain
   - Slider crank,
   - Quick return and elliptical trammel.
4. Analysis of mechanical components
   - Introduction to FEA packages.
   - Machine elements under Static loads and dynamic loads.

AUTOMATION

1. DC brush motor characteristics & modelling.
2. Power control of AC & DC motors.
3. Electrical energy planning and management of autonomous system.
4. Closed loop position and velocity control of a DC brush servo motor.
5. Tuning of P, PI and PID controller using simulation software.
6. Various types of stepper motor control.

TOTAL: 60 PERIODS

MR7201	DESIGN OF MACHINE ELEMENTS AND PRODUCT DEVELOPMENT	L	T	P	C
		3	2	0	4

OBJECTIVE

- To impart the knowledge in the design of machine elements and product design used in mechatronics systems.

UNIT I INTRODUCTION 9+6

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+6

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+6

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+6

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+6

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.

L=45, T=30 TOTAL =75 PERIODS

OUTCOME

- The students will learn the design of machine elements, product design concepts and introduction to finite element analysis.

REFERENCES

1. Khurmi R.S and Gupta J.K, “A Text Book of Machine Design”, Eurasia Publishing House (P) Ltd, New Delhi, 2006.
2. Jain R.K., “Machine design”, Khanna Publishers, Delhi, 2006.
3. Shigley J.E. “Mechanical Engineering Design”, McGraw-Hill Book Co., Delhi,2004.
4. Spotts N.F. “Design of Machine Elements”, Prentice-Hall of India, 2004.
5. George E.Dieter, Linda C.Schmidt, “Engineering Design”, McGraw-Hill International Edition, 4th Edition, 2009, ISBN 978-007-127189-9.
6. Ramamurthi, V., “Finite Element Method in Machine Design”, Narosa Publishing House, January 2009, ISBN: 978-81-7319-965-3
7. PSG Design data Handbook, Kalaikhathir Publications, CBE 2002.

MR7202 INDUSTRIAL ROBOTICS

L	T	P	C
3	0	0	3

OBJECTIVE

- To make the students to learn about the mechanical design of robots, various sensors and its application in the area of industrial robotics.

UNIT I INTRODUCTION 10

Types of Industrial Robots, definitions – classifications based on work envelope – Generations configurations and control loops, co-ordinate system – need for robot – basic parts and functions – specifications

UNIT II MECHANICAL DESIGN OF ROBOT SYSTEM 12

Robot motion – Kinematics of Robot motion – Direct and Indirect kinematics Homogeneous transformations – linkages and joints – mechanism – method for location and orientation of objects – drive systems – end effectors – types, selection, classification and design of grippers – gripper force analysis.

UNIT III SENSORS 8

Functions of Sensors – Position and proximity’s sensing – tactile sensing – sensing joint forces – vision system – object recognition and image transformation – safety monitoring sensor systems – image analysis – application of image processing.

UNIT IV ROBOT PROGRAMMING & AI TECHNIQUES 8

Types of Programming – Teach pendant programming – Basic concepts in A1 techniques – Concept of knowledge representations – Expert system and its components.

UNIT V ROBOTIC WORK CELLS AND APPLICATIONS OF ROBOTS 7

Robotic cell layouts – Inter locks – Humanoid robots – Micro robots – Application of robots in surgery, Manufacturing industries, space and underwater.

TOTAL: 45 PERIODS

OUTCOME

- The students will learn basis of robotics, sensors, programming and AI techniques used in robotics.

REFERENCES:

1. Groover.M.P. Industrial Robotics, technology, programming and application Mc-Graw Hill book and co. 2012
2. Fu.K.S, Gonzalac R.C ,Lee C.S.G, Robotics Control, sensing ,vision and intelligence, Mc-Graw Hill book co 2011.
3. Yoram Koren , Robotics, McGraw Hill 2006
4. Janakiraman P.A. Robotics and Image Processing, Tata McGraw Hill, 2002
5. Saeed B.Niku ,Introduction to Robotics , analyses , systems, applications, Prentice Hall Pvt Ltd. 2005

MR7203 MECHATRONICS SYSTEM DESIGN

L	T	P	C
2	0	2	3

OBJECTIVE

- To impart through knowledge in system modelling, system identification and simulation of mechatronic system.

UNIT I INTRODUCTION 6

Mechatronics system overview – recent advancements – application – key elements – mechatronics system design process.

UNIT II MODELING OF SYSTEM 6

Need for modeling – systems overview – representation of systems (block diagram, signal flow graphs, transfer function and state space) - Modeling technique (analytical and identification techniques) – direct method- analogue approach – bond graph approach – modeling of electrical, mechanical, thermal, fluid and hybrid systems – system identification methods overview – Least square method.

UNIT III SIMULATION 6

Simulation fundamentals – simulation life cycle – Monte Carlo simulation – solution for model equations and their interpretations zeroth and first and second order system and its response – scaling – validation – hardware in loop simulation (HIL) - Controller prototyping – simulation systems in software environment.

UNIT IV DESIGN OPTIMIZATION 6

Optimization – problem formulation - constraints – over view of linear and nonlinear programming techniques – other optimization techniques- optimal design of mechatronics system with case studies.

UNIT V CASE STUDIES ON BUILDING A MECHATRONICS SYSTEM 6

Modeling and simulation of automotive system - power window, engine timing, building clutch look up - antilock braking system ABS and automatic transmission controller - modeling of stewart platform with actuators.

TOTAL: 30 PERIODS

OUTCOME

- The students will gain the basic system modeling, simulation and design optimization for mechatronics systems developments.

REFERENCES

1. Devadas Shetty, Richard A.Kolkm, “Mechatronics System Design”, PWS Publishing Company, 2009.
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. Bradley, D. Dawson, N.C.Burd and A.J. Loader, “Mechatronics: Electronics in Product and Process”, Chapman and Hall, London, 1999.

LABORATORY

OBJECTIVE

- To learn the system design and its integration for modeling the mechatronics systems.

LIST OF EXPERIMENTS

1. Modeling of electrical motors and with gear train
2. Modeling and simulation of automotive system
   - Power window.
   - Engine timing.
   - Building clutch look up.
   - Antilock braking system ABS.
   - Automatic transmission controller.
3. Modeling of Stewart platform with actuators.
4. Modeling of object sorting system using various sensors.
5. Modeling of quadcopter.
6. Modeling of 6 DOF articulated robot.

TOTAL: 30 PERIODS

OUTCOME

- The students will acquire the hands on experience in design, modeling and simulation of mechatronic system.

MR7204	MICROCONTROLLERS	L	T	P	C
		3	0	0	3

OBJECTIVE

- To understand the programming interfacing and applications of various microcontrollers.

UNIT I INTRODUCTION TO MICRO CONTROLLER 8

Microcontrollers – CISC and RISC - Architecture - 8051 family - PIC 18FXXX family – Memory organization.

UNIT II PROGRAMMING OF MICROCONTROLLER 12

Instruction set – Addressing modes -Addressing modes – I/O Programming-Timer/Counter - Interrupts – Serial Communication of 8051 & PIC Microcontroller. Fundamentals of Assembly Language Programming – Instruction to Assembler – Compiler and IDE- C Programming for 8051& PIC Microcontroller.

UNIT III PROGRAMMING & PERIPHERAL INTERFACING 9

CCP, ECCP, PWM programming of PIC18FXXX - Interfacing of Relays, Memory, key board, Displays – Alphanumeric and Graphic, RTC, ADC and DAC, Stepper motors and DC Motors, I^2C, SPI with 8051 and PIC family.

UNIT IV INTRODUCTION TO ARM 7 CORE 8

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

UNIT V REAL TIME MODELS, LANGUAGE AND OPERATING SYSTEMS 12

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

TOTAL: 45 PERIODS

OUTCOME

- This course is intended for learning the Introduction and Architecture of Microcontroller, fundamentals of Assembly language Programming, and Interfacing of Microcontroller.

REFERENCES

1. Muhammad Ali Mazidi and Janice Gillispic Mazdi, “The 8051 Microcontroller and Embedded Systems” Pearson Education, Inc 2006.
2. John B. Peatman, “PIC Programing”, McGraw Hill International, USA, 2005.
3. John B. Peatman, “Design with Microcontrollers”, McGraw Hill International, USA, 2005.
4. Kenneth J. Aylala, “The 8051 Micro controller, the Architecture and Programming Applications”:2003.
5. James W. Stewart, “The 8051 Microcontroller Hardware, Software and Interfacing, Regents Prentice Hall, 2003.
6. Wayne Wolf, “Computers as Components – Principles of Embedded Computing System Design”, Morgan Kaufmann Publishers, 2009.
7. Ball S.R., “Embedded microprocessor Systems – Real World Design”, Prentice Hall, 2006
8. C.M. Krishna, Kang G. Shin, “Real Time systems”, McGraw Hill, 2009.
9. Frank Vahid and Tony Givagis, “Embedded System Design”, 2011, Wiley.

MR7211 AUTOMATION LABORATORY

L	T	P	C
0	0	4	2

OBJECTIVE

- To create exposure in the computer aided inspection and manufacturing, robot modeling and programming.

COMPUTER AIDED INSPECTION

1. Measurements of Surface Roughness.
2. Measurements using CMM.
3. Measurements using toolmaker Microscope.

CNC AND WATER JET MACHINING

1. Profile milling operation, circular interpolation.
2. Programming for Drilling cycle and NC code generation.
3. Experimentation on EDM and ECM.
4. Experimentation on water jet cutting.

ROBOT MODELING and PROGRAMMING

1. Modeling and simulation five different configuration of serial manipulator.
2. Forward and inverse kinematics and trajectory planning of robot using computation software.
3. Programming and experimentation with articulated robot.
4. Programming and experimentation with SCARA robot for pick and place application

TOTAL: 60 PERIODS

OUTCOME

- The students will get the practical experience in computer aided inspection, basic machining process, robot modeling and programming.

MR7212	MICROCONTROLLERS LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVE

- To learn the programming of 8051, PIC microcontroller and also to learn the programing of ARM processer.

LIST OF EXPERIMENTS

1. Assembly language programming and simulation of 8051 in Keil IDE.
2. Assembly language programming and simulation of PIC using MP lab.
3. Alphanumeric and Graphic LCD interfacing using X8051 & PIC Microcontroller.
4. Sensor interfacing with ADC to X8051 & PIC18FXXX.
5. DAC & RTC interfacing to X8051 & PIC18FXXX.
6. Timer, Counter and Interrupt program application for X8051 and PIC18FXXX.
7. Step motor (unipolar & bipolar motor) and PWM servo motor control to interfacing with X8051.
8. UART serial programming in X8051 and PIC.
9. Program of Microcontroller using Keil C.
10. Introduction to computation and data acquisition software.
11. PC Interfacing of stepper motor - Unipolar & Bipolar.
12. Programming of ARM Processor for sensor interface.
13. Programming of ARM Processor for display interface.
14. Stepper motor and Servo motor control using ARM processor.
15. Serial communication of ARM processor with computation platform.

TOTAL = 60 PERIODS

OUTCOME

- The students will acquire the hands on experience in programming 8051, PIC, and ARM processor.

MR 7301	MACHINE VISION	L	T	P	C
		3	0	2	4

OBJECTIVE

- To impart knowledge on imaging machine vision and its applications.

UNIT I INTRODUCTION **8**

Human vision – Machine vision and Computer vision – Benefits of machine vision – Block diagram and function of machine vision system implementation of industrial machine vision system – Physics of Light – Interactions of light – Refraction at a spherical surface – Thin Lens Equation

UNIT II IMAGE ACQUISITION **12**

Scene constraints – Lighting parameters – Lighting sources, Selection – Lighting Techniques – Types and Selection – Machine Vision Lenses and Optical Filters, Specifications and Selection – Imaging Sensors – CCD and CMOS, Specifications – Interface Architectures – Analog and Digital Cameras – Digital Camera Interfaces – Camera Computer Interfaces, Specifications and Selection – Geometrical Image formation models – Camera Calibration

UNIT III IMAGE PROCESSING 10

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

UNIT IV IMAGE ANALYSIS 6

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

UNIT V MACHINE VISION APPLICATIONS 9

Machine vision applications in manufacturing, electronics, printing, pharmaceutical, textile, applications in non-visible spectrum, metrology and gauging, OCR and OCV, vision guided robotics – Field and Service Applications – Agricultural, and Bio medical field, augmented reality, surveillance, bio-metrics.

TOTAL: 45 PERIODS

OUTCOME

- The outcome of this course is to apply the vision concepts in various mechatronics applications.

REFERENCES

1. Eugene Hecht, A.R. Ganesan “Optics”, Fourth Edition
2. Alexander Hornberg, “Handbook of Machine Vision”, First Edition
3. Emanuele Trucco, Alessandro Verri, “Introductory Techniques For 3D Computer Vision”, First Edition
4. Rafael C.Gonzales, Richard.E.Woods, “Digital Image Processing Publishers”, Fourth Edition

PRACTICAL

OBJECTIVE

- To gather the practical exposure on machine vision elements, lighting technique, processing softwares and algorithms.

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.

TOTAL: 30 PERIODS

MR7312 PROJECT WORK PHASE I L T P C
0 0 12 6

OBJECTIVES

- 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 to design, fabricate,

analyse, test and research. Literature survey and a part of the project work be carried out in phase I.

- The project work is evaluated jointly by external and internal examiners constituted by the Head of the Department based on oral presentation and the project report.
- A project report for phase I is to be submitted at the end.

EVALUATION

- Project work evaluation is based on the Regulations of the Credit system for the Post graduate programmes of Anna University

TOTAL : 90 PERIODS

OUTCOME

The students would apply the knowledge gained from theoretical and practical courses in solving problems, so as to give confidence to the students to be creative, well planned, organized, coordinated in their project work phase – II.

MR7411 PROJECT WORK PHASE II L T P C
0 0 24 12

OBJECTIVES

- To continue the work from phase I and complete the project work in order to meet the stated objectives of the topic chosen.
- The progress of the project is evaluated based on a minimum of three reviews.
- The review committee may be constituted by the Head of the Department.
- A project report is required at the end of the semester. The project work is evaluated jointly by external and internal examiners constituted by the Head of the Division based on oral presentation and the project report
- To improve the research and development activities of the students.

EVALUATION

- Project work evaluation is based on the Regulations of the Credit system for Post graduate programmes of Anna University

TOTAL = 180 PERIODS

OUTCOME

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

MR7001 ADVANCED COMPUTER VISION L T P C
3 0 0 3

OBJECTIVES

- To impart knowledge on imaging machine vision and its applications.

UNIT I IMAGE FORMATION AND CAMERA CALIBRATION 6

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 II BASICS FOR COMPUTER VISION 6

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

UNIT III SHAPE FROM X 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 12

Computational Stereopsis – Geometry, parameters – Correspondence problem, correlation based methods, feature-based methods – Epipolar Geometry, essential matrix and fundamental matrix, 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 12

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

TOTAL: 45 PERIODS

OUTCOMES

- The students exposed to the techniques used in the computer vision analysis and its applications.

REFERENCES

1. Eugene Hecht, A.R. Ganesan “Optics”, Fourth Edition
2. Emanuele Trucco, Alessandro Verri, “Introductory Techniques For 3D Computer Vision”, First Edition
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.

MR7002 ADVANCED CONTROL SYSTEMS

L	T	P	C
3	0	0	3

OBJECTIVE

- To learn and model the nonlinear and complex control strategies for advanced mechatronics system developments.

UNIT I CONVENTIONAL CONTROL SYSTEM DESIGN 7

Review of feedback systems and design of PID Controllers - Electronic PID controller – Digital PID algorithm – Auto/manual transfer - Reset windup – Practical forms of PID Controller - 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 7

Feed-forward control – Ratio control – Cascade control – Inferential control – Split-range – override control–- selective control –Auto tuning.

UNIT III STATE SPACE ANALYSIS 12

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 12

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 7

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

TOTAL: 45 PERIODS

OUTCOME

- The students will acquire the knowledge in nonlinear control and methods used to design the stable system.

REFERENCES:

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

MR7003 ANALYTICAL ROBOTICS

L	T	P	C
3	0	0	3

OBJECTIVE

- To impart knowledge in the advanced area of Robotics.

UNIT I INTRODUCTION 8

Definition, Types and Classifications of robots – control loops, controls and intelligence, specify degrees of freedoms, actuators and end effectors – grippers, force analysis, serial and parallel manipulators.

UNIT II ROBOT KINEMATICS 10

Introduction – Representation of a rigid body – Mappings and Operators – Homogeneous Transformation, position analysis - Forward Kinematics – Geometric Approach, Algebraic approach, Denvit–Hartenbers representations – Inverse Kinematics. Velocities -Differential motion and velocity of frames – Jacobian

UNIT III ROBOT DYNAMICS AND TRAJECTORY PLANNING 10

Lagrangeon mechanics, dynamic equations for single, double and multiple DOF robots – static force analysis of robots, Trajectory planning – Joint space, Cartesian space description and trajectory planning – third order, fifth order - Polynomial trajectory planning

UNIT IV ROBOT PROGRAMMING & AI 9

Types of Programming – Teach Pendant programming – Requirement of Robot Programing Language, Structure of Robot Programming Language – Offline Programming Systems – Basic concepts in AI techniques – Concept of knowledge representations and Inference – Robot Learning

UNIT V MODELLING AND SIMULATION 8

Modeling and simulation of robotic joints,- position , velocity and acceleration analyses of simple mechanisms and robots, -synthesis of robots,- simulation of robot configuration.

TOTAL: 45 PERIODS

OUTCOME

- To teach the students about the kinematic arrangement of robots and its applications in the area of manufacturing sectors.

REFERENCES

1. Fu.K.S, Gonzalac R.C, Lee C.S.G, "Robotics Control, sensing ,vision and intelligence", Mc-Graw Hill book co 2011.
2. John J. Craig, "Introduction to Robotics: Mechanics and Control", Third Edition.2008.
3. Yoram Koren , Robotics, McGraw Hill 2006
4. Groover.M.P., "Industrial Robotics", McGraw – Hill International edition, 2004.
5. Saeed.B.Niku, "Introduction to Robotics, Analysis, system, Applications", Pearson educations, 2002.

MR7004 APPLIED SIGNAL PROCESSING

L	T	P	C
3	0	0	3

OBJECTIVE

- To emphasize the significance of knowledge on signal processing.

UNIT I SOURCES OF SIGNALS 9

Generation and characteristics of Speech signals – seismic signals – Radar- vibration – ultrasonic-pressure- strain- temperature signals- bio signals (ECG, EEG, phonocardiogram & EMG).

UNIT II PRE-PROCESSING SIGNALS 9

Noise sources & characteristics - Filters- IIR and FIR filters -Design of filters low pass, high pass filter, band pass filter, notch filter chebshiv filters. Elliptic filters, butter worth filters – Kalman Filter-adaptive filtering - Comb Filter- Denoising concepts.

UNIT III DIGITAL SIGNAL PROCESSING 9

Time series analysis –Time varying analysis - Time frequency representation - ARMA Signal modelling- FFT - power spectral density Estimation

UNIT IV FEATURE EXTRACTION METHODS 9

STFT – DFFT – sine and cosine transform – wavelet concept – Empirical Mode Decomposition (EMD) – Time frequency representation, spectrogram – Methods for extracting the parameters: Energy, Average Magnitude - Introduction to feature extraction and Classification

UNIT V ANALYSIS AND APPLICATION OF SIGNAL PROCESSIONG 9

Cepstral analysis of speech signals– spectral analysis bio signals and vibration signals- Radar signal processing for multiple sensor information- signal processing in affective state computation and brain computer interface – introduction to Fusion technique.

TOTAL: 45 PERIODS

OUTCOME

- The outcome of this course is to get exposure with various kinds of signal acquisition, processing and feature extraction technique that used process the information's in the various kinds of sensors.

REFERENCES

1. Arnon Cohen, "Bio-Medical Signal Processing Vol I and Vol II", CRC Press Inc., Boca Rato, Florida 1999.
2. Rangaraj M. Rangayyan, 'Biomedical Signal Analysis-A case study approach", Wiley-Interscience/IEEE Press, 2002.

3. Willis J. Tompkins, Biomedical Digital Signal Processing, Prentice Hall of India, New Delhi, 2003.
4. Emmanuel C. Ifeachor, Barrie W.Jervis, 'Digital Signal processing- A Practical Approach", Pearson education Ltd., 2002.
5. Raghuveer M. Rao and Ajith S.Bopardikar, Wavelets transform – Introduction to theory and its applications, Pearson Education, India 2000.

MR7005 APPROPRIATE MANUFACTURING PROCESSES L T P C
3 0 0 3

OBJECTIVE

- To introduce the unconventional manufacturing process, latest manufacturing process for micro fabrication and devices.

UNIT I NEWER MACHINING PROCESSES - I 9

Non thermal energy– Abrasive machining – water jet machining - ultrasonic machining – chemical machining – electro chemical machining – construction working principle – steps - types – process parameters – derivations – problems, merits, demerits and applications .

UNIT II NEWER MACHINING PROCESS – II 9

Wire cut EDM - Electro chemical machining – ECG - Electric discharge machining – construction – principle – types – control - circuits – tool design – merits, demerits & applications.

UNIT III NEWER MACHINING PROCESS – III 9

Laser beam machining – Electron beam machining – Plasma arc machining – Ion beam machining – construction working principle types – process parameter – derivations – problems, merits, demerits and applications.

UNIT IV FABRICATION OF MICRO DEVICES 9

Semiconductors – films and film depurification – Oxidation - diffusion – ion implantation – etching – metallization – bonding – surface and bulk machining – LIGA Process – Solid free form fabrication.

UNIT V MICROFABRICATION TECHNOLOGY 9

Wafer preparation – monolithic processing – moulding – PCB board hybrid & mcm technology – programmable devices & ASIC – electronic material and processing.– steriolithography SAW devices, Surface Mount Technology.

TOTAL: 45 PERIODS

OUTCOME

- The students will gather the knowledge on latest manufacturing process.

REFERENCES

1. Serope Kelpekijian & Stevan R. Schmid- Manufacturing Process Engg Material – 2003.
2. Micro Senors MEMS & Smart devices- Julian W.Hardner, 2002
3. Brahem T. Smith, Advanced machining, I.F.S. UK, 1989.
4. Jaeger R.C., Introduction to microelectronic fabrication Addison Wesley, 1988.
5. Nario Taniguchi – Nano technology – Oxford University Press 1996.
6. Pandey P.C. & Shan HS Modern Machining Processes, Standard Publishing Co., 1980
7. More Madon, Fundamentals of Micro fabrication, CRC Press, 1997.

MR7006 **BIOMECHANTRONICS** **L T P C**
3 0 0 3

OBJECTIVES

- To get the clear understanding of application of mechanics in medicine.
- To study the properties and kinematics of bone and muscles.

UNIT I INTRODUCTION 10

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 10

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 8

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.

UNIT V SIMULATION AND MODELLING OF BIOMECHANTRONICS 8

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

TOTAL: 45 PERIODS

OUTCOMES

- The students able to understand the skeletal mechanics for rehabilitation and prosthetic developments.
- The students will learn to develop the rehabilitation devices and its interface.

REFERENCES

1. Gillian Pocock & Christopher D.Richards, "The Human Body", Oxford University Press, 2009.
2. Ranganathan T S, "Text Book of Human Anatomy" S. Chand and company New Delhi, 1994.
3. Scott L. Delp et L., "OpenSim: Open-Source Software to Create and Analyze Dynamic Simulations of Movement", IEEE Transaction on biomedical engineering vol.54 no.11, 2007.
4. Y.C.Fung, "Biomechanics: Mechanical properties in living tissues", Springer Verlag, New York 1981. 5. Susan J.Hall, Basics Bio Mechanics 4th Edition, McGraw-Hill Publishing Co, 2002.
5. C.R Ethier and C.A.Simmons, "Biomechanics from Cells to Organisms", Cambridge University Press, 2007.
6. D.Dawson and Right, "Introduction to Bio-mechanics of Joints and Joint Replacement", Mechanical Engineering Publications Ltd., 1989.
7. Jacob Kline, "Hand book of Bio Medical Engineering", Academic Press, 1988.

MR7007 COMPUTER AIDED INSPECTION

L	T	P	C
3	0	0	3

OBJECTIVE

- To make the learner to design and fabricate inspection methods and systems incorporating electronic systems for inspection and quality control in engineering.

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 12

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 6

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

OUTCOME

- The students will acquire the knowledge on computer aided inspection of various geometries

REFERENCES

1. Jain R.K., "Engineering Metrology", Khanna Publishers, 2000.
2. Robert G. Seippel, "Opto Electronics for technology and engineering", Prentice Hall, New Jersey, 1989.
3. Anil.K.Jain, "Fundamentals of Digital Image Processing", Prentice Hall of India Pvt. Ltd., 2004.
4. Dale.H. Besterfield, "Total Quality Management", Pearson Education Asia, 2002.
5. Manuals of C.M.M. and Systems.

MR7008 CONCEPTS OF SUSTAINABLE MANUFACTURING

L	T	P	C
3	0	0	3

OBJECTIVE

- To provide the student with the knowledge of sustainability in manufacturing, its evaluation, strategy to achieve sustainability, supply chain management and sustainable operations.

UNIT I ENVIRONMENTAL VALUATION 9

Introduction to the environmental issues pertaining to the manufacturing sector - pressure to reduce costs - processes that minimize negative environmental impacts - environmental legislation and energy costs - acceptable practice in society - adoption of low carbon technologies - need to reduce the carbon footprint of manufacturing operations. Techniques for non-market valuation: cost and income based approaches, demand estimation methods - expressed and revealed

preference, choice modeling - Multi-criteria analysis- Stakeholder analysis - Environmental accounting at sector and national levels.

UNIT II EVALUATING SUSTAINABILITY 9

Sustainability performance evaluators- Frameworks and techniques - environmental management systems - life cycle assessment - strategic and environmental impact assessments - carbon and water foot-printing.

UNIT III MANUFACTURING STRATEGY FOR SUSTAINABILITY 9

Concepts of Competitive Strategy and Manufacturing Strategies and development of a strategic improvement programme - Manufacturing strategy in business success Strategy formation and formulation - Structured strategy formulation - Sustainable manufacturing system design options - Approaches to strategy formulation - Realization of new strategies/system designs.

UNIT IV SUPPLY CHAIN MANAGEMENT 9

Challenges in logistics and supply chain - developing the right supply chain strategy for the products - need to align the supply network around the strategy - Tools that can be used systematically to identify areas for improvement in supply chains - Specific challenges and new thinking in the plan, source and delivering of sub-processes.

UNIT V SUSTAINABLE OPERATIONS 9

Principles of sustainable operations - Life cycle assessment Manufacturing and service activities - Influence of product design on operations - Process analysis - Capacity management - Quality management -Inventory management - Just-In-Time systems - Resource efficient design - Consumerism and sustainable well-being - Sustainable manufacturing and practices.

TOTAL: 45 PERIODS

OUTCOME

- On completion of the course the students will be able to apply techniques of environmental valuation, formulate strategy for sustainable manufacturing and plan sustainable operations and supply chain management.

REFERENCES

1. Seliger, G ,"Sustainable Manufacturing: Shaping Global Value Creation", Springer, 2012.
2. Seliger, G.,"Sustainability in Manufacturing: Recovery of Resources in Product and Material Cycles", 2007.
3. Jovane, F., Ęmper, W.E. and Williams, D. J., "The ManuFuture Road: Towards Competitive and Sustainable High-Adding-Value Manufacturing", Springer, 2009.
4. Kutz, M.," Environmentally Conscious Mechanical Design", John Wiley & Sons, 2007.
5. Davim, J.P., "Sustainable Manufacturing", John Wiley & Sons, 2010.

MR7009 DIGITAL MANUFACTURING

L	T	P	C
3	0	0	3

OBJECTIVE

- To explain in detail about the various Mechatronics elements in CNC machines and also programming of CNC machines.

UNIT I INTRODUCTION OF NC, CNC, DNC AND ADAPTIVE CONTROL 6

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 12

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 14

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 5

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

OUTCOME

- The students will learn mechatronics elements, control and programming in CNC machine.

REFERENCES:

1. Jonathan Lin,S.C., “Computer Numerical Control (From Programming to Networking)”, Delmar Publishers Inc., 2000.
2. HMT Limited, “Mechatronics”, Tata Mcgraw-Hill Publishing Co Ltd, 2002.
3. Groover,M.P., “Automation, Production System and CIM”, Prentice Hall of India Pvt. Ltd, 2003.
4. Grahamt.Smith, “Advanced Machining: The Handbook of Cutting Technology”, IFS Publications Ltd., 1989
5. Sehrawatt,M.S., and Narang,J.S., “CNC Machine”, Dhanpat Rai And Co, 2002.
6. Jayakumar,V., and Mahendran,B., “Computer Aided Manufacturing”, Lakshmi Publications, 2005.
7. Radhakrishnan,P., “CNC Machine”, New Central Book Agency, 2000.
8. Stenerson and Curran, “Computer Numerical Control-Operation and Programming”, PHI Learning Pvt. Ltd., 2008

MR7010 EMBEDDED SYSTEMS WITH ADVANCED MICROCONTROLLERS

L	T	P	C
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OBJECTIVES

- To impart knowledge in the area of real time embedded system.
- To understand the ARM & FPGA Processor, high level language descriptions of software for embedded system.

UNIT I INTRODUCTION TO EMBEDDED SYSTEMS AND ARM 9 CORE 10

Definitions – Brief overview of micro-controllers - DSPs,-Typical classifications –Memory Devices and application scenarios of embedded systems. Introduction about ARM 9 Processor-DSP Processor-Sharc Processor - Internal Architecture – Modes of Operations – instruction set – Pipelining – AMBA – Applications and futures.

UNIT II PROGRAMMING OF ARM PROCESSOR 8

Programming of C – ARM Compiler - introduction to linker – librarian –image conversion utility and supporting libraries.

UNIT III INTRODUCTION TO FPGA 10

FPGA & CPLD Architectures - FPGA Programming Technologies- FPGA Logic Cell Structures- FPGA Programmable Interconnect and I/O Ports - FPGA Implementation of Combinational Circuits - FPGA Sequential Circuits - Timing Issues in FPGA Synchronous Circuits

UNIT IV PROGRAMMING OF FPGA 8

Introduction to Verilog HDL and FPGA Design flow with using Verilog HDL - FPGA Arithmetic Circuits - FPGAs in DSP Applications - Design of SDRAM & Halftone Pixel Converter - Programming FPGAs. Introduction to DSP processor - TMS320C54x and TMS320C6x architecture

UNIT V APPLICATIONS OF ARM 9 AND FPGA CONTROLLERS 9

Specific examples of time-critical and safety-critical embedded systems - applications in automation- automotive – aerospace - medical and manufacturing.

TOTAL: 45 PERIODS

OUTCOMES

- The students learn to develop the controller for the real time application.
- The students will gather the knowledge for the effective use of advanced controllers and its programing in real time product development.

REFERENCES

1. Wayne Wolf, “Computers as Components – Principles of Embedded Computing System Design”, Morgan Kaufmann Publishers 2009.
2. Ball S.R., “Embedded microprocessor Systems – Real World Design”, Prentice Hall, 2006.
3. C.M. Krishna, Kang G. Shin, “Real Time systems”, McGraw Hill, 2009.
4. Frank Vahid and Tony Givagis, “Embedded System Design”. Wiley, 2001.
5. Tim Wilmshurst, “An Introduction to the Design of Small – Scale Embedded Systems”, Palgrave Macmillan, 2011.
6. Steve Kilts, “Advanced FPGA Design,” Wiley Inter-Science, Wiley-IEEE Press, 2007.
7. P. Chu, “FPGA Prototyping by Verilog Examples,” Wiley, 2008

MR7011 HAPTICS AND AUGMENTED REALITY

L	T	P	C
3	0	0	3

OBJECTIVES

- To learn the human touch perception and Tactile Proprioception.
- To learn the haptic components and virtual models.
- To emphasize the significance of knowledge on haptic and augmented reality.

UNIT I INTRODUCTION TO HAPTICS 6

Definition - Importance of Touch - Tactile Proprioception - Tactual Stereo genesis - Kinesthetic Interfaces - Tactile Interfaces - Human Haptics - Overview of existing applications.

UNIT II KINESTHETIC HAPTIC DEVICES 10

Basics of force feedback devices-Kinesthetic vs. Tactile Haptic Devices-Configurations of Kinesthetic devices-Types of Kinesthetic Devices-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.

UNIT III TELEOPERATION 10

Types of Sensors-Measurement of Haptic Parameters-Types of Actuators-Types of Transmission-Admittance type Kinesthetic Device-Admittance Control-Comparison of Impedance and Admittance type devices-Genesis of Tele-operation- Tele-operation Controllers-Tele-operator Transparency-Stability Analysis of Teleoperator-Tracking and Transparency-Surface Haptics-Exogenous Force Inputs

UNIT IV HUMAN HAPTICS 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.

UNIT V INTRODUCTION TO HAPTIC PLATFORM 10

Introduction to Virtual Reality Modeling Language (VRML) – open haptic platform - OpenGL-virtual environment manager-Modeling of simple haptic system.

TOTAL: 45 PERIODS

OUTCOMES

- The students will learn to build and control haptic devices.
- The students learn the salient properties of human touch perception that are necessary to be recreated in virtual environments.
- The students will gather the knowledge to use the modeling software that used in the Haptics device development.

REFERENCES

1. K. E. MacLean, “Haptic interaction design for everyday interfaces”, Reviews of Human Factors and Ergonomics, 4:149-194, 2008.
2. B. Hannaford and A. M. Okamura. Chapter 30: Haptics. In B. Siciliano and O. Khatib, Eds., Handbook of Robotics, Springer, pp. 718-735, 2008.
3. D. W. Weir and J. E. Colgate. Stability of haptic displays. In M. C. Lin and M. Otaduy, Eds., Haptic Rendering: Foundations, Algorithms, and Applications. AK Peters, 2008.
4. Eckehard Steinbach et al, Haptic Communications, vol. 100, 4:937-956, 2012 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. In A. Bicchi et al. (Eds.): The Sense of Touch and Its Rendering, STAR 45, pp. 61–106, 2008.

MR7012 HUMAN MACHINE INTERFACE

L	T	P	C
3	0	0	3

OBJECTIVES

- The students gain insight into the field of human-computer interaction

UNIT I INTRODUCTION TO HMI 8

HMI Basics -Human Computer Interaction as an emerging field - Applications of Human Machine Interface (HMI) - HMI types - Human Information Processing -Interaction styles and general design

Interaction -strategies Interface metaphors and conceptual models HCI and the World Wide Web HCI - security Accessibility of User Interfaces Usability engineering and evaluation HCI and social computing.

UNIT II ELEMENTS OF HMI 8

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

UNIT III PERCEPTION, MEMORY, COGNITION 8

Perception & Cognition - Visual system – image generation and perception-Touch-Hearing- Model Human Processor- STM, LTM, Chunking - Principles of Operation- Power Law - Fitts Law - Hicks Law – factors affecting - Perception, Memory, Cognition

UNIT IV INTEGRATED MODELLING FRAMEWORK 9

Supervisory control – criteria for sharing task between operator and machine - human–machine cooperation - human–machine cooperation -generic integrated modeling framework - Car driver Cognitive architecture of the human cognitive system - control loops - tactical Module – HMI in automation.

UNIT V BRAIN COMPUTER INTERFACE 12

Introduction to BCI – brain regions and responsibilities- Active methods for measuring brain activity – invasive and non-invasive procedures - EEG –P300- VEP- ERD- NIRS – Application in Prosthetic Control- Neurorehabilitation – Neurotraining – Brain controlled wheel chairs

TOTAL: 45 PERIODS

OUTCOMES

- The students gather the ideas about the human machine and brain computer interface for the advanced mechatronics system development.

REFERENCES

1. Guy A.Boy ed., “The hand book of human machine interaction”, Ashgate publishing limited, England 2011.
2. 2 Allen Klinger, “Human machine interactive systems”, New York: Plenum Press, 1991.
3. Bernhard Graimann, Bredan Allison, Gert Pfurtscheller, “Brain – computer interfaces”, Springer-Verlag Berlin Heidelberg, 2010.
4. Jonathan Wolpaw,Elizabeth Winter Wolpaw,”Brain Computer Interfaces: Principles and practice”, Edition 1, Oxford University Press, USA, January 2012.
5. Jean-Yves Fiset, “Human-Machine Interface Design for Process Control Applications”, ISA Publisher, 2008

MR7013 INDUSTRIAL AUTOMATION

L	T	P	C
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OBJECTIVE

- To impart the knowledge on PLC, Supervisory control and factory automation

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 – DeviceNet – 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

OUTCOME

- The students to able to develop the automation models by the use of PLC, Supervisory control and factory and building automated tools.

REFERENCE

1. D.Patranabis, “Principles of Industrial Instrumentation”, Tata McGraw-Hill Publishing Ltd., New Delhi, 1999.
2. Bequette, B.W., “Process Control Modeling, Design and Simulation”, Prentice Hall of India, 2004.
3. Frank D. Petro Zella, “Programmable Logic Controller” McGraw – Hill Publications, 1998.
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5. Mc-Millan, G.K., “Process/Industrial Instrument and Controls Handbook”, McGraw-Hill, NewYork, 1999.
6. Berge, J., “Field Buses for Process Control: Engineering, Operation, and Maintenance”, ISA Press, 2004.
7. Mackay, S., Wrijut, E., Reynders, D. and Park, J., “Practical Industrial Data Networks Design, Installation and Troubleshooting”, Newnes Publication, Elsevier, 1st Edition, 2004.
8. Lucas, M.P., “Distributed Control System”, Van Nastrand Reinhold Company, New York, 1986.
9. Clarke, G., Reynders, D. and Wright, E., “Practical Modern SCADA Protocols: DNP3, 60870.5 and Related Systems”, Newnes, 1st Edition, 2004.
10. Shengwei Wang, “Intelligent Buildings and Building Automation”, Routledge Publishers, 2009.
11. Frank Lamb, “Hands on Industrial Automation”, McGraw-Hill Profession, 2013.

MR7014 MACHINE LEARNING

L	T	P	C
3	0	0	3

OBJECTIVE

- To know fundamental behind the various machine algorithms, and also to familiarize the important methods in ANN, Fuzzy and Genetic algorithm.

UNIT I SUPERVISED AND SEMI SUPERVISED LEARNING METHODS 10

Introduction to learning & classifiers- LDA – ANN - Naive Bayes classifier- decision tree- Regression-Ordinary Least Squares – linear and Logistic Regression- Gaussian process -

Stepwise Regression - Multivariate Adaptive Regression Splines (MARS) - Locally Estimated Scatterplot Smoothing (LOESS) - overview of nearest neighbour - Support vector machines- Temporal difference learning Q-learning.

UNIT II UNSUPERVISED & REINFORCEMENT LEARNING METHODS 8

Expectation–maximization (EM) - Vector quantization, Clustering Fuzzy K &C means algorithm - Density-based spatial clustering of applications with noise (DBSCAN) - Conceptual clustering- Association rule learning - Apriori algorithm- SVD.

UNIT III NEURAL NETWORK 9

Perceptron – Probabilistic Neural Network (PNN) - Back-Propagation (BPN) - Hopfield Network - Self-Organizing Map (SOM) - Learning Vector Quantization (LVQ)-Adaptive Resonance Theory 1 – Adaptive Resonance Theory 2 - Case studies on GA based algorithm development.

UNIT IV FUZZY CLASSIFICATION 9

Basic concepts in Fuzzy Set theory-Fuzzy logic controllers – Principles – Various industrial Applications of Fuzzy logic control – Adaptive Fuzzy systems – Fuzzy Decision making – Fuzzy classification – Fuzzy pattern Recognition – Image Processing applications – Fuzzy optimization - Case studies on fuzzy based algorithm development.

UNIT V GENETIC ALGORITHMS 9

Introduction to genetic algorithm –initialization, selection, mutation and termination- Swarm intelligence – PSO-ACO - Tabu search - Reactive search optimization (RSO)- cross-entropy (CE) methods. Case studies on GA based algorithm development.

TOTAL: 45 PERIODS

OUTCOME

- The students will gain the knowledge on artificial learning and classification algorithms for the implementation of intelligent machine.

REFERENCES

1. Simon Haykin, “Neural Networks – A comprehensive foundation”, Prentice Hall, 3rd Edition, 2004.
2. Laurene Fausett, “Fundamentals of Neural Networks, Architectures, Algorithms and Applications”, Prentice Hall, Englewood cliffs, 2000.
3. S. Rajasekaran, GA Vijayalakshmi Pai, “Neural Networks, Fuzzy Logic and Genetic Algorithms”, Prentice Hall of India Private Limited, 2003.
4. Klir, G.J. Yuan Bo, “Fuzzy sets and Fuzzy Logic: Theory and Applications”, Prentice Hall of India Pvt. Ltd., 2005.
5. Randy L. Haupt, Sue Ellen Haupt Practical Genetic Algorithms, Wiley interscience 2004.
6. Ethem Alpaydin, “Introduction to Machine Learning” The MIT Press, Cambridge, London.

MR7015 MATERIALS MANAGEMENT AND LOGISTICS

L	T	P	C
3	0	0	3

OBJECTIVE

- To introduce to the students the various functions of materials management and logistics

UNIT I INTRODUCTION 6

Introduction to materials management – Objectives – Functions – Operating Cycle – Value analysis – Make or buy decisions.

UNIT II MANAGEMENT OF PURCHASE 7

Purchasing policies and procedures – Selection of sources of supply – Vendor development – Vendor evaluation and rating – Methods of purchasing – Imports – Buyer – Seller relationship – Negotiations.

UNIT III MANAGEMENT OF STORES AND LOGISTICS 12

Stores function – Location – Layout – Stock taking – Materials handling – Transportation – Insurance – Codification – Inventory pricing – stores management – safety – warehousing – Distribution linear programming – Traveling Salesman problems – Network analysis – Logistics Management.

UNIT IV MATERIALS PLANNING 10

Forecasting – Materials requirements planning – Quantity – Periodic – Deterministic models – Finite production.

UNIT V INVENTORY MANAGEMENT 10

ABC analysis – Aggregate planning – Lot size under constraints – Just in Time (JIT) system.

TOTAL: 45 PERIODS

OUTCOME

- The students familiar with the various concepts and functions of material management, so that the students will be in a position to manage the materials management department independently.

REFERENCES

1. Lamer Lee and Donald W.Dobler, “Purchasing and Material Management, Text and cases”, Tata McGraw Hill, 1996.
2. Gopalakrishnan.P, “Handbook of Materials Management”, Prentice Hall of India, 1996.
3. Guptha P.K. and Manmohan, “Problems in Operations Research”, Suttan Chand & Sons, 2003.
4. Dr. R. Kesavan, C.Elanchezian and T.SundarSelwyn, “Engineering Management”, Eswar Press – 2005.
5. Dr.R. Kesavan, C.Elanchezian and B.Vijaya Ramnath, Production Planning and Control, Anuratha Publications, Chennai, 2008.
6. G. Reghuram, N. Rangaraj, “Logistics and supply chain management – cases and concepts”, Macmillan India Ltd., 2006.

MR7016 MEDICAL MECHATRONICS L T P C

3 0 0 3

OBJECTIVE

- To know the principle, design and application of various human measurement and assisted device for the human functional system.

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 noninvasive methods-transducers role in measurement–Heart rate – pressure-temperature- Heart sound – Pulmonary function measurements

UNIT II ASSISTING AND THERAPEUTIC EQUIPMENTS 9

Pacemakers – Defibrillators – Ventilators – Nerve and muscle stimulators – Diathermy – Heart Lung machine –— Dialyzers – centrifuge- coagulators- aspirator – oximeter – spirometer- Nebulizer – Anesthesia machine-Operating Table – examination couches- infusion systems.

UNIT III CARDIAC AND REGULATORY ASSIST SYSTEM 12

Defibrillator - Muscle and nerve stimulator, 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 12

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 ANALYSER 9

Types of deafness, hearing aids, application of DSP in hearing aids- Ear irrigator- Voice synthesizer, speech trainer. Ultra sonic and laser canes, Intra ocular lens, Braille Reader, Tactile devices for visually challenged, ophthalmoscopy Text voice converter, screen readers and automated analyser and medical equipment's.

TOTAL: 45 PERIODS

OUTCOMES

- The students able to know the role and importance of artificial assisting devices and also able to gather functionality and development related issues of assisting devices used in the medical field

REFERENCES

1. R.S.Khandpur, "Hand Book of Bio-Medical instrumentation", Tata McGraw Hill Publishing Co Ltd., 2003.
2. 2. Leslie Cromwell, Fred J.Weibell, Erich A.Pfeiffer, "Bio-Medical Instrumentation and Measurements", II edition, Pearson Education, 2002 / PHI.
3. M.Arumugam, "Bio-Medical Instrumentation", Anuradha Agencies, 2003.
4. Geddes LA and Baker L.E Principals of Applied Biomedical Instrumentation, John Wiley and sons Newyork 1975.
5. Albert M Cook and Webster J G – Therapeutic medical devices Prentice Hall Nee York 1982.
6. Alfred Horowitz, "MRI Physics for Radiologists – A Visual Approach', Second edition Springer Verlag Network, 1991.
7. John L.Semmlow,"Biosignal and Biomedical Image Processing Matlab Based applications" Marcel Dekker Inc.,New York,2004.
8. Jerry L.Prince and Jnathan M.Links," Medical Imaging Signals and Systems"- Pearson Education Inc. 2006
9. Kolff W.J., Artificial Organs, John Wiley and Sons, New York, 1979.
10. Andreas.F.Von racum, Hand book of bio material evaluation, Mc-Millan publishers, 1980.

MR7017 MICRO AND NANO SYSTEMS

L	T	P	C
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OBJECTIVES

- To inspire the students about the trends in development and synthesizing of micro and nano systems.
- To introduce students the characterisation tools required in micro and Nano material synthesis and fabrication.

UNIT I INTRODUCTION TO MICRO AND NANO TECHNOLOGY 6

Over view of nanotechnology and MEMS- Nano structuring- Nano defects, Nano particles and Nano layers-science and synthesis of Nano materials-lithography-based micromachining-Photolithography, vacuum systems, etching methods, deposition methods, and process integration -LIGA and laser-assisted processing

UNIT II CHARACTERIZATION OF NANO MATERIALS 11

Nano measuring systems – characterization – analytical imaging techniques – microscopy techniques, confocal LASER scanning microscopy - scanning electron microscopy, - transmission electron microscopy, scanning tunnelling microscopy, atomic force microscopy, diffraction techniques – spectroscopy techniques – Raman spectroscopy, 3D surface analysis – Mechanical, Magnetic and thermal properties –Auger Electron Spectroscopy (AES), X-Ray Photoelectron Spectroscopy (XPS), Extended X-ray absorption fine structure (EXAFS) - Electron probe micro-analyser (EPMA)- Application.

UNIT III MICRO AND NANO SENSORS 10

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 10

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 8

Micro engine driven by electrostatically actuated comb drive – Micro robots and Nano robots – Micro insects, Night Vision System, BioMEMS

TOTAL: 45 PERIODS

OUTCOMES

- The students exposed to the evolution of micro- Nano systems elements and fabrication technique.
- The Students aware a characterisation tools for synthesizing materials for micro and nano sensors, devices and actuators and its fabrication technique.

REFERENCE

1. Tai – Ran Hsu, “MEMS and Microsystems Design and Manufacture”, Tata-McGraw Hill, New Delhi, 2002.
2. Fahrner W.R., “Nanotechnology and Nanoelectronics”, Springer (India) Private Ltd., 2011.
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10. Chang Liu, “Foundations of MEMS”, Pearson Education International, New Jersey, USA, 2006.
11. Victor.C.Yang, That.T.Ngo.”Biosensors and their Applications”, Springer, 2006.

MR7018 MOBILE ROBOTICS

L	T	P	C
3	0	0	3

OBJECTIVE

- To impart the knowledge on mobile robots and its autonomy, locomotion and navigation.

UNIT I INTRODUCTION 8

Introduction – Locomotion of the robots – key issues on locomotion – Legged mobile roots – configurations and stability – wheeled mobile robots – design space and mobility issues – unmanned aerial and underwater vehicles – teleportation and control.

UNIT II KINEMATICS 10

Kinematic models – representation of robot – forward kinematics – wheel and robot constraints – degree of mobility and steerability – maneuverability – workspace – degrees of freedom – path and trajectory considerations – motion controls-holonomic robots – open loop and feedback motion control.

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

OUTCOME

- To make the students to learn concepts of mobile robots and also gather the ideas on building an autonomous robot, motion, path planning and navigation.

REFERENCES

1. Roland Siegwart and Illah R.Nourbakish, “Introduction to Autonomous Mobile Robots” 2nd edition – MIT press, Cambridge, 2004.
2. XiaoQi Chen, Y.Q. Chen and J.G. Chase, “Mobile Robots - State of the Art in Land, Sea, Air, and Collaborative Missions”, Intec Press, Austria, 2009.
3. Ulrich Nehmzow, “Mobile Robotics: A Practical Introduction”, 2nd edition, Springer, 2003.

MR7019 MODELING AND FINITE ELEMENT ANALYSIS OF ELECTROMECHANICAL SYSTEMS

L	T	P	C
3	0	0	3

OBJECTIVE

- To equip students with fundamentals of finite element principles so as 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 with emphasis on structural and thermal engineering applications.

UNIT I INTRODUCTION 6

Basics of FEM – Initial value and boundary value problems – weighted residual Galerkin and Raleigh Ritz methods – review of Variational calculus – Integration by parts – Basics of variational formulation.

UNIT II ONE DIMENSIONAL ANALYSIS 10

Steps in FEA – Discretization, function – derivation of element characteristics matrix, shape function, assembly and imposition of boundary conditions – solution and post processing – One dimensional analysis in solid mechanics and heat transfer.

UNIT III SHAPE FUNCTIONS AND HIGHER ORDER FORMULATIONS 10

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 ANALYSIS OF PRODUCTION PROCESSES 10

FE Analysis of metal casting – Special considerations, latent heat incorporation, gap element – time stepping procedures – Crank – Nicholson algorithm – Prediction of grain structure - Basic concepts of plasticity – Solid and flow formulation – small incremental deformation formulation – FE Analysis of metal cutting, chip separation criteria, incorporation of strain rate dependency.

UNIT V COMPUTER IMPLEMENTATION 9

Pre Processing, Mesh generation, elements connectivity, boundary conditions, input of material and processing characteristics – Solution and post processing – Overview of application packages such as ANSYS and DEFORM – Development of code for one dimensional analysis and validation.

TOTAL: 45 PERIODS

OUTCOMES:

- To equip students with fundamentals of finite element principles so as 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 with emphasis on structural and thermal engineering applications.

TEXT BOOKS

1. Reddy, J.N, “An Introduction to the Finite element Method”, McGraw – Hill, 1985.
2. Rao, “Finite Element Method in Engineering”, Pergammon Press, 1989.

REFERENCES

1. Bathe, K.J., “Finite Element Procedures in Engineering Analysis, 1990.
2. Kobayashi, S, Soo-IK-Oh and Altan, T, “Metal forming and the Finite element Methods”, Oxford University Press, 1989.
3. Lewis, R.W., Morgan, K, Thomas, H.R., and Seetharaman, K.N., “The Finite Element Method in Heat Transfer Analysis”, John Wiley, 1994.
4. Srinivas, Paleti , Sambana, Krishna Chaitanya , Datti, Rajesh Kumar, “, Finite Element Analysis Using Ansys® 11.0”, PHI Learning Private Limited, 2010.

MR7020 NON DESTRUCTIVE EVALUATION

L	T	P	C
3	0	0	3

OBJECTIVE

- To learn the NDT, methods and their applications

UNIT I NON-DESTRUCTIVE TESTING: AN INTRODUCTION, VISUAL INSPECTION & LIQUID PENETRANT TESTING 6

Introduction to various non-destructive methods, Comparison of Destructive and Nondestructive Tests, Visual Inspection, Optical aids used for visual inspection, Applications. Physical principles, procedure for penetrant testing, Penetrant testing materials, Penetrant testing methods-water washable, Post – Emulsification methods, Applications

UNIT II EDDY CURRENT TESTING & ACOUSTIC EMISSION 10

Principles, Instrumentation for ECT, Absolute, differential probes, Techniques – High sensitivity techniques, Multi frequency, Phased array ECT, Applications. Principle of AET, Instrumentation, Applications - testing of metal pressure vessels, Fatigue crack detection in aerospace structures.

UNIT III MAGNETIC PARTICLE TESTING & THERMOGRAPHY 10

Principle of MPT, procedure used for testing a component, Equipment used for MPT, Magnetizing techniques, Applications. Principle of Thermography, Infrared Radiometry, Active thermography measurements, Applications – Imaging entrapped water under an epoxy coating, Detection of carbon fiber contaminants.

UNIT IV ULTRASONIC TESTING & RADIOGRAPHY 10

Principle, Ultrasonic transducers, Ultrasonic Flaw detection Equipment, Modes of display A- scan, B-Scan, C- Scan, Applications, Inspection Methods - Normal Incident Pulse-Echo Inspection, Normal Incident Through-transmission Testing, Angle Beam Pulse-Echo testing, Applications of Normal Beam Inspection in detecting fatigue cracks, Inclusions, Slag, Porosity and Intergranular cracks. Principle of Radiography, Effect of radiation on Film, Radiographic imaging, Inspection Techniques – Single wall single image, Double wall Penetration, Multiwall Penetration technique, Real Time Radiography.

UNIT V COMPARISON AND SELECTION OF NDT METHODS 9

Case studies on defects in cast, rolled, extruded, welded and heat treated components.
Comparison and selection of various NDT techniques. Codes, standards, specification and procedures.

TOTAL: 45 PERIODS

OUTOCOME

- The students will acquainted the knowledge of all types of NDT and their applications in Engineering.

REFERENCES:

1. Baldev Raj, Jeyakumar,T., Thavasimuthu,M., “Practical Non Destructive Testing” Narosa publishing house, New Delhi, 2002
2. Krautkramer. J., “Ultra Sonic Testing of Materials”, 1st Edition, Springer – Verlag Publication, New York, 1996.
3. Peter J. Shull “Non Destructive Evaluation: Theory, Techniques and Application” Marcel Dekker, Inc., New York, 2002
4. www.ndt.net.

MR7021	VETRONICS	L	T	P	C
		3	0	0	3

OBJECTIVES

- To understand the design and specifications of various automotive electronic control systems.

UNIT I FUNDAMENTALS OF VEHICLE ENGINEERING 6

Engine – Types – Modern Engines – Advanced GDI, Turbo-charged engines Transmissions, Chassis systems – Need for Avionics in Civil and Military aircraft and Space systems

UNIT II AUTOMOTIVE ENGINE CONTROL, MONITORING AND DIAGNOSTICS SYSTEMS 9

Components of Electronic Engine Management– Engine control functions, Engine control modes, Fuel delivery systems, MPFI, Ignition Systems, Diagnostics – Compression Ignition Engines – Emission control Management – Hybrid Power Plants - BAS

UNIT III AUTOMOTIVE TRANSMISSION AND SAFETY SYSTEMS 12

Transmission control – Autonomous cruise control – Braking control, ABS – Traction control, ESP, ASR – Suspension control – Steering control – Stability control – Parking Assist Systems – Safety Systems, SRS, Blind Spot Avoidance – Auto transmission electronic control, Telematics, Automatic Navigation, Future Challenges

UNIT IV AIRCRAFT MECHATRONICS 12

Fundamentals - components of an airplane and their functions - motions of a plane - Inertial Navigation – Sensors - Gyroscope- Principles , Gyro equations, Rate Gyros - Rate integration and free Gyro, Vertical and Directional Gyros, Laser Gyroscopes, Accelerometers. Direct reading compass, Types of actuation systems-Linear and non-linear actuation system, modeling of actuation systems, Servo-loop analysis actuator design - testing methodologies, Performance testing equipment's for sensors and actuation systems. Measurement and control of Pressure, temperature fuel quantity, rpm, torque, engine vibration and power. Electrical Power requirement for Military and Civil standards. Satellite navigation - GPS -system description -basic principles - position and velocity determination

UNIT V MARINE MECHATRONIC SYSTEMS 6

Basics of Marine Engineering – Marine Propulsion Mechatronics elements in ships, submarines, Variable Buoyancy Systems

TOTAL: 45 PERIODS

OUTCOMES

- The students able to gather the knowledge in particularly of automotive engines, engine controls, Fuel delivery systems, all types of transmission control systems, electromagnetic interference and electronic dashboard instruments in Automobiles, Aircraft and Marine applications.

REFERENCES

1. William B.Ribbens, "Understanding Automotive Electronics – 5th Edition, Butterworth, Heinemann Wobum, 1998.
2. Tom Weather Jr and Cland C. Hunter, "Automotive Computers and Control System" Prentice Hall Inc., New Jersey.
3. Young A.P. and Griffths, L., Automobile Electrical Equipment "English Language Book Society and New Press.
4. Crouse, W.H. Automobile Electrical Equipment, McGraw Hill Book Co Inc., New York, 1955.
5. Robert N Brady, Automotive Computers and Digital Instrumentation, Areston Book Prentice Hall, Eagle Wood Cliffs, New Jersey, 1988.
6. T. Mellard, Automotive Electronics.
7. R.K. Jurgen, Automotive Electronics Handbook, McGraw Hill 2nd Edition.