ANNA UNIVERSITY: : CHENNAI 600 025

AFFILIATED INSTITUTIONS

REGULATIONS - 2017

M.E. MECHATRONICS ENGINEERING

CHOICE BASED CREDIT SYSTEM

PROGRAMME EDUCATIONAL OBJECTIVES (PEO)

1. The graduates acquire ability to create mathematical model, design, analysis and synthesis the system integration based on the knowledge of mechanical, electrical, electronic, control, computer, communication, fluid and other engineering domains.
2. The graduates use their talent, self-confidence, knowledge and engineering practice which facilitate them to pursue 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 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 of 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 nonverbal 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 systems useful to the nation and the society.
13. Graduate 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	Concepts in Electronics Engineering	✓	✓	✓	✓	✓								
		Concepts of Machines and Mechanisms	✓		✓	✓									
		Sensors and Signal Conditioning		✓	✓	✓	✓	✓							
		Control System Design		✓	✓	✓	✓	✓		✓	✓				
		Microcontrollers and PLC		✓	✓	✓	✓								
		Applied Mathematics for Engineers		✓	✓	✓	✓								
		Professional Elective I													
		Modeling, Simulation and Analysis Laboratory	✓		✓		✓								
	SEM 2	Design of Machine Elements and Product Developments	✓			✓	✓			✓					
		Mechatronics System Design	✓	✓	✓	✓	✓	✓	✓			✓	✓		
		Drives and Actuators for Automation	✓			✓	✓	✓	✓	✓					
		Machine Vision		✓	✓	✓	✓								
		Professional Elective II													
		Professional Elective III		✓	✓	✓	✓						✓		
		Microcontrollers Laboratory		✓	✓	✓	✓						✓		
		Machine Vision Laboratory				✓	✓						✓		
Year 2	SEM 3	Industrial Robotics	✓			✓	✓	✓	✓	✓					
		Professional Elective – IV													
		Professional Elective – V													
		Project Work Phase I	✓			✓	✓		✓	✓	✓	✓	✓	✓	
	SEM 4	Project Work Phase II	✓			✓	✓		✓	✓	✓	✓	✓	✓	✓

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REGULATIONS - 2017

M.E. MECHATRONICS ENGINEERING

I TO IV SEMESTERS CURRICULUM AND SYLLABUS

SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	MR5101	Concepts in Electronics Engineering	FC	4	2	0	2	3
	MR5102	or Concepts of Machines and Mechanisms				2	0	
2.	MA5156	Applied Mathematics for Engineers	FC	4	4	0	0	4
3.	MR5103	Sensors and Signal Conditioning	PC	5	3	0	2	4
4.	MR5104	Control System Design	PC	5	3	0	2	4
5.	MR5105	Microcontroller and PLC	PC	3	3	0	0	3
6.		Professional Elective – I	PE	3	3	0	0	3
PRACTICALS								
7.	MR5111	Modeling, Simulation and Analysis Laboratory	PC	2	0	0	2	1
			TOTAL	**28**	**18**	**2**	**8**	**22**

SEMESTER II

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	MR5251	Design of Machine Elements and Product Developments	FC	5	4	0	0	4
2.	MR5252	Mechatronics System Design	FC	5	3	0	2	4
3.	MR5201	Machine Vision	PC	3	3	0	0	3
4.	MR5202	Drives and Actuators for Automation	PC	5	3	0	2	4
5.		Professional Elective – II	PE	3	3	0	0	3
6.		Professional Elective – III	PE	3	3	0	0	3
PRACTICALS								
7.	MR5211	Microcontroller Laboratory	PC	4	0	0	4	2
8.	MR5212	Machine Vision Laboratory	PC	4	0	0	4	2
9.	MR5213	Technical Seminar	EEC	2	0	0	2	1
			TOTAL	**35**	**18**	**2**	**16**	**26**

SEMESTER III

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	MR5391	Industrial Robotics	PC	3	3	0	0	3
2.		Elective - IV	PE	3	3	0	0	3
3.		Elective - V	PE	3	3	0	0	3
PRACTICALS								
4.	MR5311	Project Work Phase I	EEC	12	0	0	12	6
			TOTAL	**21**	**9**	**0**	**12**	**15**

SEMESTER IV

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
PRACTICALS								
1	MR5411	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 = (22+ 26+15+12) = 75

FOUNDATION COURSES (FC)

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	MR5101	Concepts in Electronics Engineering	FC	4	2	2	0	3
2.	MR5102	Concepts of Machines and Mechanisms	FC	4	2	0	2	3
3.	MA5156	Applied Mathematics for Engineers	FC	4	4	0	0	4
4.	MR5251	Design of Machine Elements and Product Developments	FC	5	4	0	0	4
5.	MR5252	Mechatronics System Design	FC	5	3	0	2	4

PROFESSIONAL CORE (PC)

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	MR5103	Sensors and Signal Conditioning	PC	5	3	0	2	4
2.	MR5104	Control System Design	PC	5	3	0	2	4
3.	MR5105	Microcontroller and PLC	PC	3	3	0	0	3
4.	MR5111	Modeling, Simulation and Analysis Laboratory	PC	2	0	0	2	1
5.	MR5201	Machine Vision	PC	3	3	0	0	3
6.	MR5202	Drives and Actuators for Automation	PC	5	3	0	2	4
7.	MR5211	Microcontroller Laboratory	PC	4	0	0	4	2
8.	MR5212	Machine Vision Laboratory	PC	4	0	0	4	2
9.	MR5391	Industrial Robotics	PC	3	3	0	0	3

PROFESSIONAL ELECTIVES(PE)

SEMESTER I (Elective I)

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	MR5001	Nonlinear Systems Dynamics	PE	3	3	0	0	3
2.	MR5002	Computer Aided Inspection	PE	3	3	0	0	3
3.	MR5003	Digital Manufacturing	PE	3	3	0	0	3
4.	MR5004	Modeling and Finite Element Analysis of Electromechanical Systems	PE	3	3	0	0	3
5.	MR5005	Computer Aided Production and Automation of Plants	PE	3	3	0	0	3

SEMESTER II (Elective II & III)

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	MR5006	Micro and Nano Systems	PE	3	3	0	0	3
2.	MR5007	Embedded Systems with Advanced Microcontrollers	PE	3	3	0	0	3
3.	PD5091	Product Lifecycle Management	PE	3	3	0	0	3
4.	MR5008	Human Machine Interface	PE	3	3	0	0	3
5.	MR5009	Machine Learning	PE	3	3	0	0	3
6.	MR5010	Haptics and Augmented Reality	PE	3	3	0	0	3
7.	MR5011	Communication Protocols	PE	3	3	0	0	3
8.	MR5012	Solid State Drives	PE	3	3	0	0	3
9.	CM5071	Intelligent Product Design and Manufacturing	PE	3	3	0	0	3

SEMESTER III (Elective IV &V)

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	MF5075	Industrial Safety	PE	3	3	0	0	3
2.	MR5013	Industrial Automation for Mechatronics	PE	3	3	0	0	3
3.	MR5014	Advanced Control Systems	PE	3	3	0	0	3
4.	CP5292	Internet of Things	PE	3	3	0	0	3
5.	MR5015	Biomechatronics	PE	3	3	0	0	3
6.	MR5016	Advanced Computer Vision	PE	3	3	0	0	3
7.	MR5017	Onboard Computers and Programming	PE	3	3	0	0	3
8.	MR5018	Automotive Electronics	PE	3	3	0	0	3
9.	MR5019	Marine Mechatronics	PE	3	3	0	0	3
10.	MR5020	Avionics for Mechatronics Engineers	PE	3	3	0	0	3
11.	MR5021	Medical Mechatronics	PE	3	3	0	0	3
12.	MF5074	Entrepreneurship Development	PE	3	3	0	0	3
13.	CM5092	Environment Conscious Manufacturing	PE	3	3	0	0	3
14.	CM5073	Green Manufacturing	PE	3	3	0	0	3

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	MR5213	Technical Seminar	EEC	2	0	0	2	1
2.	MR5311	Project Work – Phase I	EEC	12	0	0	12	6
3.	MR5411	Project Work - Phase II	EEC	24	0	0	24	12

MR5101	CONCEPTS IN ELECTRONICS ENGINEERING	L	T	P	C
		2	0	2	3

OBJECTIVES:

- 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. LED – 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 amplifiers, active filters, linear rectifiers, waveform generators, A/D converters, feedback and power amplifiers, sine wave oscillators

UNIT III DIGITAL ELECTRONICS 6

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

UNIT IV 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, analyzers and printers.

UNIT V POWER MANAGEMENT 5

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

TOTAL : 30 PERIODS

OUTCOMES:

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

LABORATORY

L	T	P	C
0	0	2	0

OBJECTIVES:

- 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

OUTCOMES:

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

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

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

1. CRO-1
2. DSO-1
3. DC Power supply
   5V – 5 No's
   12V, 10A - 1 No
   24V, 10A or higher - 1 No
4. Function generator-1
5. OP-Amp trainer kit (inverting and non-inverting amplifier module)
6. Analog filters trainer kit
7. Sequential circuit trainer kit
8. Combination circuit trainer kit
9. A/D Converter trainer kit -1 No
10. D/AConverter Trainer kit-1 No
11. Driver Circuit Module for servomotor-1 No
12. Driver Circuit module for stepper motor-1 No
13. Multi-Meter, bread board, and solder machine.
14. Electronic components for power supply (transformer, regulator, diode, capacitors) -5 No's

MR5102 CONCEPTS OF MACHINES AND MECHANISMS

L	T	P	C
2	2	0	3

OBJECTIVES:

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

UNIT I MECHANISMS 12

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 12

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 12

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 12

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 12

Machine tool construction-features – operations of lathe, milling machine, drilling machine – Drive system for machine tools – mechanical, hydraulic and electric stepped and variable speeds – spindle speeds and feed drives-linear and reciprocation motion generation.

TOTAL : 60 PERIODS

OUTCOMES:

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

MA5156 APPLIED MATHEMATICS FOR ENGINEERS

L	T	P	C
4	0	0	4

OBJECTIVES :

This course is designed to enrich the knowledge in various advanced mathematical techniques such as matrix theory, calculus of variations, probability and random variables, Laplace transforms and Fourier transforms. The fundamental concepts in these areas will be more useful for the students to model the engineering problems and solving them by applying these methods.

UNIT I MATRIX THEORY 12

The Cholesky decomposition - Generalized Eigenvectors - Canonical basis - QR factorization - Least squares method - Singular value decomposition.

UNIT II CALCULUS OF VARIATIONS 12

Concept of variation and its properties – Euler's equation – Functional dependant on first and higher order derivatives – Functionals dependant on functions of several independent variables – Variational problems with moving boundaries – Isoperimetric problems - Direct methods : Ritz and Kantorovich methods.

UNIT III PROBABILITY AND RANDOM VARIABLES 12

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

UNIT IV LAPLACE TRANSFORM TECHNIQUES FOR PARTIAL DIFFERENTIAL EQUATIONS 12

Laplace transform - Definitions - Properties – Transform error function - Bessel's function - Dirac delta function - Unit step functions – Convolution theorem – Inverse Laplace transform : Complex inversion formula – Solutions to partial differential equations : Heat equation - Wave equation.

UNIT V FOURIER TRANSFORM TECHNIQUES FOR PARTIAL DIFFERENTIAL EQUATIONS 12

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

TOTAL : 60 PERIODS

OUTCOMES :

After completing this course, students should demonstrate competency in the following skills:

- Apply various methods in matrix theory to solve system of linear equations.
- Maximizing and minimizing the functional that occur in various branches of engineering disciplines.
- Computation of probability and moments, standard distributions of discrete and continuous random variables and functions of a random variable.
- Application of Laplace and Fourier transforms to initial value, initial–boundary value and boundary value problems in Partial Differential Equations.

REFERENCES :

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

MR5103	SENSORS AND SIGNAL CONDITIONING	L	T	P	C
		3	0	2	4

OBJECTIVES:

- 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 : L=45+P(30)=75 PERIODS

OUTCOMES:

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

REFERENCES

1. Bolton W., “Mechatronics”, Thomson Press, 2003.
2. Bradley D.A., and Dawson, Burd and Loader, “Mechatronics”, Thomson Press India Ltd., 2004
3. Ernest O. Doeblin, “Measurement system, Application and Design”, Tata McGraw Hill Publishing Company Ltd., Fiftieth Edition, 2004
4. Patranabis D., “Sensor and Actuators”, Prentice Hall of India (Pvt) Ltd., 2005.
5. Renganathan S., “Transducer Engineering”, Allied Publishers (P) Ltd., 2003

LAB COMPONENT	L	T	P	C
	0	0	2	0

OBJECTIVES:

- 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

OUTCOMES:

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

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

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

1. Temperature Sensors (RTD, Thermocouple, Thermistor, & IC Temperature sensor)- 1 in Each
2. Optical sensors (Photovoltaic, Photo Conductive, Photo Transistor, & Photo Diode) - 1 in Each
3. Strain Gauge Trainer – 1 No’s
4. Load cell Trainer – 1 No’s
5. Torque Transducer Trainer – 1 No’s
6. LVDT, Acoustics Ranging and Hall Effect Trainer – 1 No’s on Each

7. Pressure sensor, ultrasonic senor Trainer – 1 No's on Each
8. Proximity sensor (Eddy current, optical, inductive, capacitive principle) – 1 No's on Each
9. Gyroscope, Accelerometer and Magnetometer Trainer – 1 No's on Each
10. Encoders(Absolute, incremental)– 1 No's on Each
11. Tactile sensor (force and touch) Trainer– 1 No
12. DAQ card – 5 No
13. PC- 5

MR5104	CONTROL SYSTEM DESIGN	L	T	P	C
		3	0	2	4

OBJECTIVES:

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

UNIT I SYSTEM REPRESENTATION AND MODELLING 9

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

UNIT II DESIGN OF FEEDBACK CONTROL SYSTEM 9

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

UNIT III TIME AND FREQUENCY DOMAIN ANALYSIS 9

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

UNIT IV CONTROL SYSTEM DESIGN 9

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

UNIT V CONTROL AND ANALYSIS OF SERVO MOTOR 9

Servo motor – Mathematical Modelling of Servo Motor – Analysis of Servo motor system using Routh Hurwitz criterion, Root locus, Bode Plot, Polar Plot and stability analysis – Implementation of P, PI , PD and PID controllers for servo motor and analysis - bumpless control transfer between manual and PID Control- anti-windup control using PID Controller.

L=45+P(30)=75 PERIODS

OUTCOMES:

- 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. A. NagoorKani, “Control Systems”, RBA Publications (P) Ltd., 2014.
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. K.Ogata, “Modern Controls Engineering“, Prentice Hall of India Pvt. Ltd., New Delhi, 2005.
5. M. Nakamura .S.Gata&N.Kyura, Mechatronic Servo System Control, Springer.

LABORATORY	L	T	P	C
	0	0	2	0

OBJECTIVES:

- To study the classical concepts behind the control system design for various systems in both time and frequency domain.

LIST OF EXPERIMENTS

1. Series, cascaded, feedback system modelling.
2. State space modeling
3. Study on time domain representation and specifications
4. Study on Routh-Hurwitz criterion and Root locus techniques
5. Study on frequency domain representation and specifications
6. Bode plot and polar plot technique
7. Study on tuning and finding of controller gain using combination of PID controllers.
8. Study on velocity vs. torque control.
9. Study on position vs. torque control.
10. Study on various motion control systems

TOTAL: 30 PERIODS

OUTCOMES:

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

- The outcome of this laboratory is to create familiarization with control system design for various systems.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

1. MATLAB/ SCILAB – Control System Tool Box with - 15 No’s
2. Motion control PLC with motor, load setup and feedback setup-1

MR5105	MICROCONTROLLER AND PLC (PROGRAMMABLE LOGIC CONTROLLERS)	L	T	P	C
		3	0	0	3

OBJECTIVES:

This course is intended for learning the Introduction and Architecture of Microcontroller, Fundamentals of Assembly language Programming, Programming of Microcontroller and Interfacing of Microcontroller. This course is also gives the ideas of Fundamentals. Architecture and Operations of programmable logic controller, Problem solving using logic ladder diagrams and communication in PLCs.

UNIT I INTRODUCTION TO MICRO CONTROLLER 9

Microprocessors and Microcontrollers – CISC and RISC - Fundamentals of Assembly language Programming – Instruction to Assembler – C Programming for Microcontrollers – Compiler and IDE – Introduction to Embedded systems - Architecture 8051 family - PIC 18FXXX – family – Memory organization

UNIT II PROGRAMMING OF 8051 MICROCONTROLLER 9

Instruction set – Addressing modes – I/O Programming-Timer/Counter - Interrupts – Serial communication of 8051.

UNIT III PROGRAMMING OF PIC18FXXX MICROCONTROLLER 9

Instruction set – Addressing modes – I/O Programming-Timer/Counter - Interrupts – Serial communication, CCP, ECCP PWM programming of PIC18FXXX.

UNIT IV PERIPHERAL INTERFACING 9

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 V PLC PROGRAMMING 9

Fundamentals of programmable logic controller – Functions of PLCs – PLC operations – Evaluation of the modern PLC – Memory– Selection of PLC – Features of PLC – Architecture – Basics of PLC programming – Developing Fundamental wiring diagrams – Problem solving using logic ladder diagrams – communication in PLCs – Programming Timers – Programming counters – Data Handling**.**

TOTAL : 45 PERIODS

REFERENCES

1. Frank D. Petro Zella, “Programmable logic controller” McGraw – Hill Publications, 1998
2. James W. Stewart, “The 8051 Micro controller hardware, software and interfaciung, regents Prentice Hall, 2003.
3. John B. Peatman, PIC programing, McGraw Hill International, USA, 2005.
4. John B. Peatman, Design with Micro controllers, McGraw Hill International, USA, 2005.
5. Kenneth J. Aylala, “The 8051 Micro controller, the Architecture and Programming applications”,2003.
6. Muhammad Ali Mazidi and Janice GillispicMazdi, “The 8051 Microcontroller and Embedded Systems” Pearson Education, Inc 2006.

MR5111 MODELING, SIMULATION AND ANALYSIS LABORATORY

L	T	P	C
0	0	2	1

OBJECTIVES:

- To learn the drawing, modeling, simulation and assembly of machines and its components.

LIST OF EXPERIMENTS

1. 2D modeling and 3D modeling of components such as
    - Bearing.
    - Couplings.
    - Ball screw.
    - Gears.
    - Sheet metal components
    - Jigs, fixtures and die.
    - Structures and frames
2. Modeling and simulation of mechanism
    - 4 Bar chain
    - Slider crank,
    - Ball and screw,
    - Rack and pinion.
    - Belt and chain drives.
    - Quick return and elliptical trammel.
3. Assembly and simulation of system
    - Serial manipulators
    - Automotive systems
    - Manufacturing machineries
4. Analysis of mechanical components
    - Introduction to FEA packages.
    - Machine elements (link, gear, joints) under static loads and dynamic loads.

TOTAL: 30 PERIODS

OUTCOMES:

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

- 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 Assembly and simulation of Machine and mechanisms.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

PC with Solidworks & FEA packages -15 No’s

MR5251	DESIGN OF MACHINE ELEMENTS AND PRODUCT DEVELOPMENTS	L	T	P	C
		4	0	0	4

OBJECTIVES:

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

UNIT I INTRODUCTION 12

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 12

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 12

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 12

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 12

Basic Concept of FEA - finite element analysis of one dimensional and two dimensional problems-variational formulation of B.V.P. – Ritz Method-Examples related to one-dimensional and two-dimensional problems.

TOTAL : 60 PERIODS

OUTCOMES:

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

REFERENCES

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

MR5252 MECHATRONICS SYSTEM DESIGN

L	T	P	C
3	0	2	4

OBJECTIVES:

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

UNIT I INTRODUCTION 7

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

UNIT II MODELING OF SYSTEM 12

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 12

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 7

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 7

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.

L=45+P(30)=75 PERIODS

OUTCOMES:

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

REFERENCES

1. Bolton, “Mechatronics – Electronic Control Systems in Mechanical and Electrical Engineering”, Addison Wesley Longman Ltd., 2009.
2. Bradley, D. Dawson, N.C.Burd and A.J. Loader, “Mechatronics: Electronics in Product and Process”, Chapman and Hall, London, 1999.
3. Brian morriss, “Automated Manufacturing Systems – Actuators Controls, Sensors and Robotics”, McGraw Hill International Edition, 2000.
4. Devadas Shetty, Richard A.Kolkm, “Mechatronics System Design”, PWS Publishing Company, 2009

LABORATORY **L T P C**

OBJECTIVES:

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

LIST OF EXPERIMENTS

1. Modeling of various types 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 6 DOF articulated robot.
4. Modeling of SCARA robot.
5. Modeling and Simulation of mobile robot.
6. Modeling of stewart platform with actuators.
7. Modeling of conveyor and object sorting system using various sensors.
8. Modeling of quadcopter.

TOTAL: 30 PERIODS

OUTCOMES:

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

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

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

Adam's Software and MATLAB software packages are to be used to carryout the listed experiments.

MR5201	MACHINE VISION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- 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

OUTCOMES:

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

REFERENCES

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

MR5202	DRIVES AND ACTUATORS FOR AUTOMATION	L	T	P	C
		3	0	2	4

OBJECTIVES:

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

UNIT I FLUID POWER SYSTEM GENERATION AND ACTUATORS 9

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

UNIT II CONTROL AND REGULATION ELEMENTS 9

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 9

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 9

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 9

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.

L=45+P(30)=75 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. GopalK.Dubey, “Fundamentals of Electrical Drives”,Narosa Publications, 2001.

LABORATORY **L T P C**
0 0 2 0

OBJECTIVES:

- 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.

LIST OF EXPERIMENTS

Hydraulic and Pneumatic Drives

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 logic program.
6. Sequencing of pneumatic circuits.
7. Simulation of logic and electro-pneumatic circuits.
8. Simulation of electro pneumatic sequencing circuits.
9. Simulation of PLC based electro pneumatic sequencing circuits.
10. To design and connect the circuits for the given problem (case study).

Electrical Drives

1. Speed and torque characterization and control of DC motors.
2. Speed and Torque characterization and control of AC motors.
3. Speed and torque characterization and sequence control of stepper motor
4. Electrical energy planning and management of autonomous system.
5. Closed loop position and velocity control of a DC servo motor.
6. Tuning of P, PI and PID controller using simulation software.

TOTAL: 30 PERIODS

OUTCOMES:

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

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

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

1. Hydraulic Trainer with Pump and Valves
2. Pneumatic Trainer with Compressor and Valves
3. Electro Pneumatic Trainer
4. Electro Hydraulic Trainer
5. Hydraulics and Pneumatics Simulation Software
6. System Controlled DCMotor with Feedback Setup
7. System Controlled ACMotor with Feedback Setup
8. System Controlled Stepper Motor Setup
9. MATLAB/SCILAB/ any other Software for Controller Tuning.
10. PC-7

MR5211	MICROCONTROLLERS LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVES:

- To introduce and train the students to use microcontroller for actuation and control of speed

LIST OF EXPERIMENTS

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

TOTAL: 60 PERIODS

OUTCOMES:

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

- To use microcontroller and other processor to control different motors like DC motor, stepper motor, servo motor etc.,

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

1. 8051 Microcontroller Trainer Kit with Software-3 No’s
2. PIC Trainer Kit with Software -3 No’s
3. ARM 7 Trainer Kit with Software - 3 No’s
4. Single Board Computer Evaluation Board with Software -3 No’s
5. Computers- 12 No’s
6. ADC interface- 3
7. Servomotor – 3 no’s
8. Stepper motor -3 no’s

MR5212 MACHINE VISION LABORATORY

L	T	P	C
0	0	4	2

OBJECTIVES:

- 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: 60 PERIODS

OUTCOMES:

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

- The students will acquire the hands on experience in machine vision techniques.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

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

MR5391 INDUSTRIAL ROBOTICS

L	T	P	C
3	0	0	3

OBJECTIVE:

- To teach students the basics of robotics, construction features, sensor applications, robot cell design, robot programming and application of artificial intelligence and expert systems in robotics.

UNIT I INTRODUCTION AND ROBOT KINEMATICS 10

Definition need and scope of Industrial robots – Robot anatomy – Work volume – Precision movement – End effectors – Sensors.

Robot Kinematics – Direct and inverse kinematics – Robot trajectories – Control of robot manipulators – Robot dynamics – Methods for orientation and location of objects.

UNIT II ROBOT DRIVES AND CONTROL 9

Controlling the Robot motion – Position and velocity sensing devices – Design of drive systems – Hydraulic and Pneumatic drives – Linear and rotary actuators and control valves – Electro hydraulic servo valves, electric drives – Motors – Designing of end effectors – Vacuum, magnetic and air operated grippers.

UNIT III ROBOT SENSORS 9

Transducers and Sensors – Tactile sensor – Proximity and range sensors – Sensing joint forces – Robotic vision system – Image Representation - Image Grabbing –Image processing and analysis – Edge Enhancement – Contrast Stretching – Band Rationing - Image segmentation – Pattern recognition – Training of vision system.

UNIT IV ROBOT CELL DESIGN AND APPLICATION 9

Robot work cell design and control – Safety in Robotics – Robot cell layouts – Multiple Robots and machine interference – Robot cycle time analysis. Industrial application of robots.

UNIT V ROBOT PROGRAMMING, ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS 8

Methods of Robot Programming – Characteristics of task level languages lead through programming methods – Motion interpolation. Artificial intelligence – Basics – Goals of artificial intelligence – AI techniques – problem representation in AI – Problem reduction and solution techniques - Application of AI and KBES in Robots.

TOTAL: 45 PERIODS

OUTCOME:

The student will be able to design robots and robotic work cells and write program for controlling the robots. The student will be able to apply artificial intelligence and expert systems in robotics.

REFERENCES

1. Deb, S.R.” Robotics Technology and Flexible Automation”, Tata Mc Graw-Hill, 1994.
2. Groover,M.P., Weis,M., Nagel,R.N. and Odrey,N.G., “Industrial Robotics Technology, Programming and Applications”, Mc Graw-Hill, Int., 1986.
3. Jordanides,T. and Torby,B.J., ,”Expert Systems and Robotics “, Springer –Verlag, New York, May 1991.
4. K.S.Fu, Gonzalez, R.C. and Lee, C.S.G., “Robotics Control, Sensing, Vision and Intelligence”, McGraw Hill, 1987.
5. Klafter,R.D., Chmielewski, T.A. and Negin,M., “Robotics Engineering – An Integrated Approach”, Prentice-Hall of India Pvt. Ltd., 1984.
6. Koren,Y., “Robotics for Engineers”, McGraw-Hill, 1987.
7. Kozyrey, Yu. “Industrial Robots”, MIR Publishers Moscow, 1985.

MR5001	NONLINEAR SYSTEMS DYNAMICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To impart through knowledge in basic and advance multi body mechanical system dynamics and its mathematical preliminaries.

UNIT I INTRODUCTION TO DYNAMICS 9

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

UNIT II COMPUTATIONAL METHODS FOR DYNAMIC ANALYSIS 10

Jacobian Matrix- Newton-Pasphon Method- Nonlinear Kinematic Constrain Equation – System Mass Matrix- External and Elastic Forces- Acceleration Vector – Lagrangian Multiplier - langarge's equation – kinetic energy – Hamilton Equation- Hamilton vector field- Euler-Lagrangian equation- generalized reaction forces –state vector and equation formulation

UNIT III NONLINEAR SYSTEMS AND CONCEPTS 10

Linear System Time Invarying and Linearization - Linear Time Varying and Linearization – Input and Output Stability - Lyapunov Stability Analysis – Asymptotically stability - Popov's and circle criterion –- Perturbed System – Chaos – periodic orbits- Index theory and limit cycle – center manifold theory- normal forms- Nonlinear analysis- Poincare maps- - bifurcations - maps- vector fields - Methods – Control System Design using Lyapunov's direct method

UNIT IV SYSTEM CHARACTERIZATION 9

Stability, controllability, observability - Phase Plane Analysis- Phase Portrait- Limit Cycle- Describing Function- Assumption – Limit Cycles

UNIT V CONTROL OF NONLINEAR MECHANICAL SYSTEMS 7

Double inverted pendulum – nonlinear machineries – robot- suspension system- aircraft.

TOTAL : 45 PERIODS

OUTCOMES:

- On successful completion of this course, all students will have ability to understand and analysis the multi-body system dynamics for mechanical systems.
- Students able to develop an equation and able to understand the behaviour of the nonlinear systems.

REFERENCES

1. Ahmed A. Shabana, Dynamics of multibody Systems, Third Edition, Cambridge University Press, 2005.
2. Brian L. Stevens, Frank L. Lewis, Aircraft Control and Simulation, Wiley India Pvt Ltd; Second edition, 2010.
3. Hasan Khalil, Nonlinear systems and control, Third edition, Prentice Hall, 2002.
4. MahmutReyhanoglu, Dynamics and control of a class of under actuated mechanical systems, IEEE Transactions on Automatic Control, 44(9), 1999.
5. Stephen Wiggins, Introduction to applied nonlinear dynamics system and Chaos, Second Edition, Springer-Verlag, 2000.
6. Wei Zhong and Helmut Rock, Energy and passivity based control of the double inverted pendulum on a cart, IEEE, 2001.

MR5002	COMPUTER AIDED INSPECTION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- 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

OUTCOMES:

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

REFERENCES

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

MR5003	DIGITAL MANUFACTURING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- 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 9

Measuring systems - feedback devices - velocity feedback - analog and digital - position feedback - rotary and linear. Tooling - requirement and planning - preset, qualified and semi qualified tools. Fixtures – requirement - unified and modular fixtures - tool identification - touch trigger probe- tool coding - EEPROM tools. 19 Tool condition monitoring - various indirect and direct methods. Identification and gauging of work piece. Tool locking system - ball lock mechanism and contact pressure monitoring. Automatic tool changing system - types and benefits - tool magazine –sensors in CNC.

UNIT IV CNC PROGRAMMING 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

OUTCOMES:

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

REFERENCES

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

7. Sehrawatt,M.S., and Narang,J.S., “CNC Machine”, DhanpatRai And Co, 2002.
8. Stenerson and Curran, “Computer Numerical Control-Operation and Programming”, PHI Learning Pvt. Ltd., 2008.

MR5004	MODELING AND FINITE ELEMENT ANALYSIS OF ELECTROMECHANICAL SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

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.

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. Rao, “Finite Element Method in Engineering”, Pergammon Press, 1989.
5. Reddy, J.N, “An Introduction to the Finite element Method”, McGraw – Hill, 1985.
6. Srinivas, Paleti , Sambana, Krishna Chaitanya , Datti, Rajesh Kumar, “, Finite Element Analysis Using Ansys® 11.0”, PHI Learning Private Limited, 2010.

MR5005	COMPUTER AIDED PRODUCTION AND AUTOMATION OF PLANTS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To impart the system development knowledge on automation production and manufacturing system integration in different applications.

UNIT I COMPUTER AIDED PRODUCTION PLANNING 8

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

UNIT II AUTOMATED MATERIAL TRANSFER AND STORAGE SYSTEM 10

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

UNIT III GROUP TECHNOLOGY AND FLEXIBLE MANUFACTURING SYSTEMS 10

FMS - Overview – Levels- Manufacturing Module -Assembly Cell -Manufacturing Group - Production Systems-Manufacturing Line - Part Families – Visual – Parts Classification and Coding – Production Flow Analysis – Grouping of Parts And Machines by Rank Order Clustering Method – Benefits of GT – Case Studies. FMS – Components – Workstations – FMS Layout Configurations – Computer Control Systems – FMS Planning and Implementation Issues – Architecture of FMS – Flow Chart Showing Various Operations in FMS

UNIT IV AUTOMATION SYSTEMS AND ADVANCED MANUFACTURING TECHNIQUES 8

Intelligent Manufacturing – Virtual Manufacturing- Internet Controlled Manufacturing- Intelligent Agents – Advanced Manufacturing Systems - Robots Role in Various Levels of manufacturing- Sensors in Manufacturing Process-Automated Measurement and Inspections- Vision based inspection Manufacturing Process - Network and Computer Interface - Industrial Networks for Production Line Control

UNIT V CASE STUDIES 9

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

TOTAL : 45 PERIODS

OUTCOMES:

- Students will familiar the automated plant design, material handling, storage, flexible manufacturing technique and advanced manufacturing concepts.

REFERENCES

1. Alavudeen and Venkateshwaran, — Computer Integrated Manufacturing ‖, PHI Learning Pvt. Ltd., New Delhi, 2008.
2. Marion I. Tobler-Rohr, Handbook of Sustainable Textile Production, Woodhead Publishing Limited, 2011
3. Mikell P.Groover, —Automation, Production system and Computer integrated Manufacturing‖, Prentice Hall of India Pvt. Ltd., 2008. 3. Kant Vajpayee,S., —Computer Integrated Manufacturing‖, Prentice Hall of India, New Delhi, 2007.
4. Mohammed A. Omar, The automotive body manufacturing systems and Process, John Willey and Sons, First edition, 2011.
5. P. Fellows, Food Processing Technology: Principles and Practice Second Edition, CRC Press, 2000.
6. Phillip R. Edwards, Manufacturing Technology in the Electronics Industry: An introduction, Springer-Science+Business Media, B.V, First Edition, 1991.
7. SabrieSoloman, Sensors and control systems in Manufacturing, Second Edition, McGrew Hill Publications, 2010.
8. Viswanathan,N., and Narahari,Y., —Performance Modeling and Automated Manufacturing Systems‖, Prentice Hall of India Pvt. Ltd., 2000 .

MR5006 MICRO AND NANO SYSTEMS

L	T	P	C
3	0	0	3

OBJECTIVES:

- To inspire the students about the trends in development and synthesizing of micro and nano systems.
- To introduce students the characterization 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 characterization tools for synthesizing materials for micro and nano sensors, devices and actuators and its fabrication technique.

REFERENCES

1. Chang Liu,“Foundations of MEMS”, Pearson Education International, New Jersey, USA, 2006.
2. Charles P Poole, Frank J Owens, “Introduction to Nano technology”, John Wiley and Sons, 2003
3. Fahrner W.R., “Nanotechnology and Nanoelectronics”, Springer (India) Private Ltd., 2011.
4. Julian W. Hardner Micro Sensors,“Principles and Applications”, CRC Press 1993.
5. Mark Madou , “Fundamentals of Microfabrication”, CRC Press, New York, 1997.
6. Mohamed Gad-el-Hak,“MEMS Handbook”,CRC press, 2006,ISBN: 8493-9138-5.
7. Norio Taniguchi, “Nano Technology”, Oxford University Press, New York, 2003
8. Sami Franssila, “Introduction to Micro fabrication”, John Wiley & sons Ltd, 2004.

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9. Tai – Ran Hsu, “MEMS and Microsystems Design and Manufacture”, Tata-McGraw Hill, New Delhi, 2002.
10. Victor.C.Yang, That.T.Ngo.”Biosensors and their Applications”, Springer, 2006.
11. Waqar Ahmed and Mark J. Jackson, “Emerging Nanotechnologies for Manufacturing”, Elsevier Inc.,2013.

MR5007	EMBEDDED SYSTEMS WITH ADVANCED MICROCONTROLLERS	L	T	P	C
		3	0	0	3

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 9

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 9

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 programming in real time product development.

REFERENCES

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

PD5091 PRODUCT LIFECYCLE MANAGEMENT L T P C
3 0 0 3

OBJECTIVE:

To understand history, concepts and terminology of PLM
To understand functions and features of PLM/PDM
To understand different modules offered in commercial PLM/PDM tools
To understand PLM/PDM implementation approaches
To understand integration of PLM/PDM with other applications

UNIT I HISTORY, CONCEPTS AND TERMINOLOGY OF PLM 9

Introduction to PLM, Need for PLM, opportunities of PLM, Different views of PLM - Engineering Data Management (EDM), Product Data Management (PDM), Collaborative Product Definition Management (cPDm), Collaborative Product Commerce (CPC), Product Lifecycle Management (PLM). PLM/PDM Infrastructure – Network and Communications, Data Management, Heterogeneous data sources and applications.

UNIT II PLM/PDM FUNCTIONS AND FEATURES 9

User Functions –Data Vault and Document Management, Workflow and Process Management, Product Structure Management, Product Classification and Programme Management. Utility Functions – Communication and Notification, data transport, data translation, image services, system administration and application integration.

UNIT III DETAILS OF MODULES IN A PDM/PLM SOFTWARE 9

Case studies based on top few commercial PLM/PDM tools

UNIT IV ROLE OF PLM IN INDUSTRIES 9

Case studies on PLM selection and implementation (like auto, aero, electronic) - other possible sectors, PLM visioning, PLM strategy, PLM feasibility study, change management for PLM, financial justification of PLM, barriers to PLM implementation, ten step approach to PLM, benefits of PLM for–business, organisation, users, product or service, process performance.

UNIT V BASICS ON CUSTOMISATION/INTEGRATION OF PDM/PLM SOFTWARE 9

PLM Customization, use of EAI technology (Middleware), Integration with legacy data base, CAD, SLM and ERP

TOTAL: 45 PERIODS

OUTCOMES:

The students will be able to

- Understand history, concepts and terminology of PLM.
- Apply the functions and features of PLM/PDM.
- Understand different modules offered in commercial PLM/PDM tools.
- Understand PLM/PDM implementation approaches.
- Integrate PLM/PDM with other applications.
- Analyse the case studies.

REFERENCES

1. Antti Saaksvuori and Anselmi Immonen, "Product Lifecycle Management", Springer Publisher, 2008 (3rd Edition).
2. International Journal of Product Lifecycle Management, Inderscience Publishers
3. Ivica Crnkovic, Ulf Asklund and Annita Persson Dahlqvist, "Implementing and Integrating Product Data Management and Software Configuration Management", Artech House Publishers, 2003.
4. John Stark, "Global Product: Strategy, Product Lifecycle Management and the Billion Customer Question", Springer Publisher, 2007.
5. John Stark, "Product Lifecycle Management: 21st Century Paradigm for Product Realisation", Springer Publisher, 2011 (2nd Edition).
6. Michael Grieves, "Product Life Cycle Management", Tata McGraw Hill, 2006.

MR5008	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 9

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

UNIT II ELEMENTS OF HMI 9

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

UNIT III PERCEPTION, MEMORY, COGNITION 9

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

UNIT IV INTEGRATED MODELING 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 9

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

TOTAL : 45 PERIODS

OUTCOMES:

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

REFERENCES

1. Allen Klinger, “Human machine interactive systems”, New York: Plenum Press, 1991.
2. Bernhard Graimann, Bredan Allison, GertPfurtscheller, “Brain – computer interfaces”, Springer-Verlag Berlin Heidelberg, 2010.
3. Guy A.Boy ed.,“The hand book of human machine interaction”, Ashgate publishing limited, England 2011.
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

MR5009	MACHINE LEARNING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- 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 learningQ-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

OUTCOMES:

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

REFERENCES:

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

MR5010	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 9

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

UNIT II KINESTHETIC HAPTIC DEVICES 9

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 9

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 9

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. B. Hannaford and A. M. Okamura. Chapter 30: Haptics. In B. Siciliano and O. Khatib, Eds., Handbook of Robotics, Springer, pp. 718-735, 2008.
2. 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.
3. 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.
4. 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
5. K. E. MacLean, “Haptic interaction design for everyday interfaces”, Reviews of Human Factors and Ergonomics, 4:149-194, 2008.

MR5011 COMMUNICATION PROTOCOLS L T P C
3 0 0 3

OBJECTIVES:

- To provide practical knowledge in the basic concepts of wired and wireless communication protocol for automation system development and networking.
- To create the knowledge on standard communication protocols for industrial automation.

UNIT I WIRED BUSES AND PROTOCOLS 9

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

UNIT II WIRELESS PROTOCOLS 9

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

UNIT III INDUSTRIAL AND AUTONOMOUS SYSTEMS WIRED NETWORKS 9

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

UNIT IV INDUSTRIAL WIRELESS NETWORKS 9

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

UNIT V APPLICATION OF COMMUNICATION PROTOCALS 9

Wired machine networking - wireless machine networking – Networking of industry - Communication network layout design- case studies - various automation applications.

TOTAL : 45 PERIODS

OUTCOMES:

Students will gain the knowledge on system communication process in the system and between an industrial networks for automating the simple machine to entire industries.

REFERENCES

1. Dick Caro, Wireless Networks for Industrial Automation, Third Edition,
2. G&L Motion Control, MMC-SD SERCOS Drive, 2005.
3. Olaf Pfeiffer, Andrew Ayre and Christian Keydel, Embedded Networking with CAN and CANopen, Copperhill Technologies Corporation, 2003, ISBN: 9780976511625
4. Richard Zurawski, Industrial Communication Technology, CRC Press, 2005.
5. Siemens IK, Industrial Ethernet: IEEE 802.3, 2005.
6. The Wireless Book evolution and Communication, CRC Press
7. Wolfram Behardt and JorgWollert, The wireless book: Evolution and communication, Stetue Germany, 2016.

MR5012 SOLID STATE DRIVES

L	T	P	C
3	0	0	3

OBJECTIVES:

To give the exposure to various switching circuits for electrically operated actuators for the speed, position, direction and breaking task of the automation systems.

UNIT I ELECTRICAL ACUATORS AND DRIVE CHARACTERISTICS 9

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

UNIT II SOLID STATE SWITCHING DEVICES 9

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

UNIT III D.C. MOTOR DRIVES 9

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

UNIT IV A.C. MOTOR DRIVES 9

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

UNIT V SPECIAL ELECTRICAL MOTOR DRIVES 9

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

TOTAL : 45 PERIODS

OUTCOMES:

Student's able to understand and apply the solid state devices for various electrical actuator for automation applications.

REFERENCES

1. Austin Hughes, Electric Motor and Drives: fundamentals, types and applications, Third Edition, Newnes publications, ISBN: 0750647183
2. GopalK.Dubey, Fundamentals of Electrical Drives, CRC Press, 2002.
3. Muhammad H.Rashid - Power Electronics Handbook, Third Edition, and Butterworth-Heinemann Publications: ISBN: 0123820367.
4. BimalK.Bose. Modern Power Electronics and AC Drives, Academic Press, 2010, ISBN: 008045738X.
5. R.Krishnan, Electric Motor & Drives: Modelling, Analysis and Control, Prentice Hall of India, 2001.

CM5071 INTELLIGENT PRODUCT DESIGN AND MANUFACTURING L T P C

3 0 0 3

OBJECTIVE:

- To teach the student the principles and practices of intelligent product design and manufacturing

UNIT I INTRODUCTION TO INTELLIGENT DESIGN AND MANUFACTURING 9

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

UNIT II TECHNIQUES OF KNOWLEDGE REPRESENTATION 9

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

UNIT III INTELLIGENT PRODUCT MODELING TECHNIQUES: 9

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

UNIT IV APPLICATION OF NEURAL NETWORKS: 9

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

UNIT V INTERNET BASED COLLABORATIVE CAD/CAM : 9

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

TOTAL: 45 PERIODS

OUTCOME:

At the end of this course the student will be able to apply Internet technology in manufacturing Industry and use techniques of Knowledge Representation.

REFERENCES

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

MF5075 INDUSTRIAL SAFETY L T P C
3 0 0 3

OBJECTIVE:

To develop and strengthen the safety ideas and motivate the students to impart basic safety skills and understandings to run an industry efficiently and effectively

UNIT I OPERATIONAL SAFETY 9

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

UNIT II SAFETY APPRAISAL AND ANALYSIS 9

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

UNIT III OCCUPATIONAL HEALTH 9

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

UNIT IV SAFETY AND HEALTH REGULATIONS 9

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

UNIT V SAFETY MANAGEMENT 9

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

TOTAL: 45 PERIODS

OUTCOME:

At the end of this course the students are expected to gain knowledge and skills needed to run an industry with utmost safety precautions.

REFERENCES:

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

MR5013	INDUSTRIAL AUTOMATION FOR MECHATRONICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- 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

OUTCOMES:

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

REFERENCES

1. Bequette, B.W., “Process Control Modeling, Design and Simulation”, Prentice Hall of India, 2004
2. Berge, J., “Field Buses for Process Control: Engineering, Operation, and Maintenance”, ISA Press, 2004.
3. Clarke, G., Reynders, D. and Wright, E., “Practical Modern SCADA Protocols: DNP3, 60870.5 and Related Systems”, Newnes, 1st Edition, 2004.
4. D.Patranabis, “Principles of Industrial Instrumentation”, Tata McGraw-Hill Publishing Ltd., New Delhi, 1999.
5. Frank D. Petro Zella, “Programmable Logic Controller” McGraw – Hill Publications, 1998
6. Frank Lamb, “Hands on Industrial Automation”, McGraw-Hill Profession, 2013.
7. Hughes, T., “Programmable Logic Controllers”, ISA Press, 2000.
8. Lucas, M.P., “Distributed Control System”, Van Nastrand Reinhold Company, New York, 1986.
9. Mackay, S., Wrijut, E., Reynders, D. and Park, J., “Practical Industrial Data Networks Design, Installation and Troubleshooting”, Newnes Publication, Elsevier, 1st Edition, 2004
10. Mc-Millan, G.K., “Process/Industrial Instrument and Controls Handbook”, McGraw-Hill, NewYork, 1999
11. Shengwei Wang, “Intelligent Buildings and Building Automation”, Routledge Publishers, 2009.

MR5014	ADVANCED CONTROL SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

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

UNIT I CONVENTIONAL CONTROL SYSTEM DESIGN 9

Review of feedback systems and design of PID Controllers - Electronic PID controller – Digital PID algorithm – Auto/manual transfer - Reset windup – Practical forms of PID 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 9

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

UNIT III STATE SPACE ANALYSIS 9

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 9

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 9

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

TOTAL : 45 PERIODS

OUTCOMES:

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

REFERENCES

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

CP5292 **INTERNET OF THINGS** **L T P C**
3 0 0 3

OBJECTIVES:

- To understand the fundamentals of Internet of Things
- To learn about the basics of IOT protocols
- To build a small low cost embedded system using Raspberry Pi.
- To apply the concept of Internet of Things in the real world scenario.

UNIT I INTRODUCTION TO IoT **9**

Internet of Things - Physical Design- Logical Design- IoT Enabling Technologies - IoT Levels & Deployment Templates - Domain Specific IoTs - IoT and M2M - IoT System Management with NETCONF-YANG- IoT Platforms Design Methodology

UNIT II IoT ARCHITECTURE **9**

M2M high-level ETSI architecture - IETF architecture for IoT - OGC architecture - IoT reference model - Domain model - information model - functional model - communication model - IoT reference architecture

UNIT III IoT PROTOCOLS **9**

Protocol Standardization for IoT – Efforts – M2M and WSN Protocols – SCADA and RFID Protocols – Unified Data Standards – Protocols – IEEE 802.15.4 – BACNet Protocol – Modbus– Zigbee Architecture – Network layer – 6LowPAN - CoAP - Security

UNIT IV BUILDING IoT WITH RASPBERRY PI & ARDUINO **9**

Building IOT with RASPERRY PI- IoT Systems - Logical Design using Python – IoT Physical Devices & Endpoints - IoT Device -Building blocks -Raspberry Pi -Board - Linux on Raspberry Pi - Raspberry Pi Interfaces -Programming Raspberry Pi with Python - Other IoT Platforms - Arduino.

UNIT V CASE STUDIES AND REAL-WORLD APPLICATIONS **9**

Real world design constraints - Applications - Asset management, Industrial automation, smart grid, Commercial building automation, Smart cities - participatory sensing - Data Analytics for IoT – Software & Management Tools for IoT Cloud Storage Models & Communication APIs - Cloud for IoT - Amazon Web Services for IoT.

TOTAL : 45 PERIODS

OUTCOMES:

Upon completion of the course, the student should be able to:

- Analyze various protocols for IoT
- Develop web services to access/control IoT devices.
- Design a portable IoT using Rasperry Pi
- Deploy an IoT application and connect to the cloud.
- Analyze applications of IoT in real time scenario

REFERENCES:

1. Arshdeep Bahga, Vijay Madisetti, “Internet of Things – A hands-on approach”, Universities Press, 2015
2. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), “Architecting the Internet of Things”, Springer, 2011.
3. Honbo Zhou, “The Internet of Things in the Cloud: A Middleware Perspective”, CRC Press, 2012.

4. Jan Ho¨ ller, Vlasios Tsiatsis , Catherine Mulligan, Stamatis , Karnouskos, Stefan Avesand. David Boyle, "From Machine-to-Machine to the Internet of Things - Introduction to a New Age of Intelligence", Elsevier, 2014.
5. Olivier Hersent, David Boswarthick, Omar Elloumi , “The Internet of Things – Key applications and Protocols”, Wiley, 2012

MR5015	BIOMECHATRONICS	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 9

Introduction to bio-mechanics, relation between mechanics and Medicine, Newton”s laws, stress, strain, shear rate, viscosity, visco elasticity, non-Newtonian viscosity, soft tissue mechanics, mechanical properties of soft biological tissues-Bio fluid mechanics-Introduction to Biomechatronic Systems

UNIT II MECHANICS IN SKELETAL AND MUSCULAR SYSTEM 9

Bones, types and functions **-** Axial and Appendicular Skeleton. Joints: Definition, Types and functions, Mechanical properties of bones. Kinetics and Kinematics relationship of skeletal and muscular system.

UNIT III CONTROL MECHANISM OF BIOLOGICAL SYSTEMS 9

Skeletal muscles servo mechanism, Cardio vascular control mechanism, respiratory control mechanism – interfacing techniques with natural servo mechanism

UNIT IV PROSTHETIC AND ORTHOTIC DEVICES 9

Analysis of force in orthopaedic implants, Hand and arm replacement, different types of models for externally powered limb prosthetics, Lower limb, Upper limb orthotics, and aterial for prosthetic and orthotic devices, Functional Electrical Stimulation, Sensory Assist Devices.

UNIT V SIMULATION AND MODELLING OF BIOMECHANTRONICS 9

Physics-based modelling and simulation of biological structures- variables of interest – geometry- Introduction to model the skeletal system using open source software– human leg prosthesis and normal gait vs prosthesis leg analysis - Upper Extremity Kinematic Model

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. C.R Ethier and C.A.Simmons, “Biomechanics from Cells to Organisms”, Cambridge University Press, 2007.
2. D.Dawson and Right, “Introduction to Bio-mechanics of Joints and Joint Replacement”, Mechanical Engineering Publications Ltd., 1989.
3. Gillian Pocock & Christopher D.Richards, “The Human Body”, Oxford University Press, 2009
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5. Ranganathan T S, “Text Book of Human Anatomy” S. Chand and company New Delhi, 1994
6. 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.
7. 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.

MR5016	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, EKFSLAM, 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. Boguslaw Cyganek, J. Paul Siebert, An Introduction To 3D Computer Vision Techniques And Algorithms, First Edition, 2009.
2. Emanuele Trucco, Alessandro Verri, “Introductory Techniques For 3D Computer Vision”, First Edition
3. Eugene Hecht, A.R. Ganesan “Optics”, Fourth Edition
4. Yi Ma, Jana Kosecka, Stefano Soatto, Shankar Sastry, “An Invitation to 3-D Vision From Images to Models”, First Edition, 2004

MR5017	ONBOARD COMPUTERS AND PROGRAMMING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Students will understand the on board system architectures and its peripheral features.
- Students will learn the grammar of python programming language.
- Students will understand and be able to use the basic programming principles such as data types, variable, conditionals, loops, recursion and function calls.
- Students will learn how to use on-board computers for real time applications.

UNIT I INTRODUCTION TO SINGLE BOARD COMPUTERS 9

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

UNIT II REAL TIME OPERATING SYSTEM 7

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

UNIT III PYTHON PROGRAMMING 11

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

UNIT IV EMBEDDED PYTHON PROGRAMMING 9

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

UNIT V APPLICATIONS 10

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

TOTAL : 45 PERIODS

OUTCOMES:

- The learners will be able know about the architecture, programming strategies and application overview of single board computers.

REFERENCES

1. Gabriele Manduchi and Ivan CibrarioBertolotti, Real-Time Embedded Systems: Open-Source Operating Systems, CRC press, 2012.
2. Guttag, John. Introduction to Computation and Programming Using Python. MIT Press, 2013.
3. Mark Lutz,"Learning Python, Powerful OOPs,O'reilly,2011
4. NInadSathaye, Learning python application development, Packt publishing, 2016
5. SaiYamanoor, SrihariYamanoor, Raspberry Pi Mechatronics Projects Packt publishing, 2016.
6. Warren Gay, Mastering the Raspberry Pi, Apress, 1st ed. edition, 2014

MR5018	AUTOMOTIVE ELECTRONICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To create a learning on various automotive electronic components and its integration for automotive development.

UNIT I OVERVIEW OF AUTOMOTIVE SYSTEMS 9

Overview of Automotive Systems - Engine – Engine Types- 4 Stroke Engine Working - Fuelling System-Ignition System - Electronic Engine Management System.

UNIT II SENSORS AND ACTUATORS IN AUTOMOTIVE 9

Variables to be Measured - Airflow Rate Sensor -Pressure Measurements - Engine Crankshaft Angular Position Sensor - Magnetic Reluctance Position Sensor - Hall-Effect Position Sensor - Optical Crankshaft Position Sensor - Throttle Angle Sensor - Temperature Sensors - Typical Coolant Sensor - Sensors for Feedback Control - Exhaust Gas Oxygen Sensor - Oxygen Sensor Improvements - Knock Sensors - Automotive Engine Control Actuators - Fuel Injection - Exhaust Gas Recirculation Actuator - Variable Valve Timing - VVP Mechanism Model - Electric Motor Actuators - Brushless DC Motors - Stepper Motors - Ignition System - Ignition Coil Operations.

UNIT III ENGINE CONTROL & MONITORING SYSTEMS 11

Engine control functions- Digital Powertrain Control Systems – Digital Engine Control - Control Modes for Fuel Control - Discrete Time Idle Speed Control EGR Control - Variable Valve Timing Control - Electronic Ignition Control -Closed-Loop Ignition Timing - Spark Advance Correction Scheme - Integrated Engine Control System - Secondary Air Management - Evaporative Emissions Canister Purge - Automatic System Adjustment-System Diagnosis-Summary of Control Modes - Engine Crank (Start) - Engine Warm-Up - Open-Loop Control - Closed-Loop Control - Hard Acceleration - Deceleration and Idle -Fuel delivery systems, MPFI, Ignition Systems, Compression Ignition Engines – Emission control Management – Hybrid Power Plants – BAS - Electronic stability program (ESP) - Electronic diesel control (EDC).

UNIT IV TRANSMISSION AND SAFETY SYSTEMS & DIAGNOSTICS SYSTEMS 10

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- Electronic Control System Diagnostics Service Bay Diagnostic Tool - Onboard Diagnostics - Model-Based Sensor Failure Detection - Diagnostic Fault Codes - Onboard Diagnosis (OBD II) - Model-Based Misfire Detection System - Expert Systems in Automotive Diagnosis - Occupant Protection Systems.

UNIT V AUTOMOTIVE INSTRUMENTATION AND INFOTAINMENT 8

Modern Automotive Instrumentation -Advantages of Computer-Based Instrumentation - Display Devices - LED - LCD - Flat Panel Display -Fuel Quantity Measurement - Coolant Temperature Measurement - Oil Pressure Measurement - Vehicle Speed Measurement - High-Speed Digital Communications (CAN) - CAN Network - Trip Information Computer - Telematics -GPS Navigation - The GPS System Structure - Automotive Diagnostics.

TOTAL : 45 PERIODS

OUTCOMES:

- The learners will be known to various automotive components and its working.
- The students will gain the knowledge on integration of various components in the automotive systems.

REFERENCES

1. Crouse W.H. “Automobile Electrical Equipment” McGraw Hill Book Co., Inc., New York 3rd edition,1986
2. R.K. Jurgen, Automotive Electronics Handbook, McGraw Hill 2nd Edition.
3. Robert N Brady, Automotive Computers and Digital Instrumentation, Areston Book Prentice Hall, Eagle Wood Cliffs, New Jersey, 1988.
4. Tom Weather Jr and Cland C. Hunter, “Automotive Computers and Control System” Prentice Hall Inc., New Jersey.
5. William B.Riddens-Understanding Automotive Electronics, 5th edition-Butter worth Heinemann Woburn-1998.
6. Young A.P. and Griffths, L., Automobile Electrical Equipment “English Language Book Society and New Press.

MR5019	MARINE MECHATRONICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To study the mechanical, electrical, and communication subsystem in marine vehicles.
-

UNIT I INTRODUCTION TO MARINE SYSTEMS 9

Marine Hydrodynamics - Anatomy of Sea Level Variability - Marine Vehicles– Classification- Elements in Marine System – Modelling of Marine Vessels – Waves - Wind – Water Current Model -Types of Marine Systems - Ship, Submersible, Remotely Operated Vehicle and Autonomous Underwater Vehicles.

UNIT II MARINE MECHANICAL SUBSYSTEMS 9

Ships And Machinery - Diesel Engines -Steam Turbines and Gearing- Marine Boiler Pumps And Pumping Systems - Automatic Combustion Control, Air – Fuel Ratio Control, Feed Water Control Single, Two And Three-Element Type, Steam Pressure Control, Fuel Oil Temperature Control, Control In Main Machinery Units for Temperature of Lubricating Oil, Jacket Cooling Water, Fuel Valve Cooling Water, Piston Cooling Water and Scavenge Air, Fuel Oil Viscosity Control- Refrigeration, Air Conditioning and Ventilation - Deck Machinery and Hull Equipment -Shafting and Propellers -Steering Gear - Fire Fighting and Safety

UNIT III MARINE ELECTRICAL SUBSYSTEMS 9

Ships' Electrical System-Ships' Lighting - Incandescent Lamps - Discharge Lamps - Voltage Effects on Lighting - Navigation and Signal Lights - Emergency Lighting - Main Electrical Survey Items - Generators And Governors - Circuit Breakers - Switchboards and Fittings - Cables - Insulation Resistance - Motors and Starters - Emergency Power and Associated Equipment - Steering Gear - Navigation Light Indicators - UMS Operation – Tanker - Introduction-Electric Propulsion Scheme-Power Supply Network.

UNIT IV MARINE MEASUREMENTS, MANOEUVRING AND CONTROL SYSTEMS 9

Manoeuvring, Kinematics & Vessel Dynamics – Marine Positioning Systems - Dynamic Positioning Control Hybrid Control - Weather Optimal Positioning - Propellers and Thrusts- Propulsion Control - Thrust Control Normal- Extreme Conditions - Methods for Thrust Control Marine Automation Systems - Auto Pilot.

UNIT V COMMUNICATION AND NAVIGATION 9

SONAR- Doppler-Underwater acoustics –RADAR– S band RADAR- X-band RADAR – foremast RADAR - AIS – Ship tracking– DGPS

TOTAL : 45 PERIODS

OUTCOMES:

- Students will familiar about various system in marine vehicles.

REFERENCES

1. D.A Taylor, Introduction to Marine Engineering, Elsevier, Butterworth Heinemann publication, Second Edition, 2003.
2. Dennis T. Hall, Practical Marine Electrical Knowledge, Wither Publisher, 1999.
3. Asgeir.J Sorensen, Report: Marine control system, 2013.
4. D.A. Taylor, Marine Control Practice, 2nd Edition, Butter worth & Co (Publishers) Ltd., London, 1987.
5. Ferial El-Hawary, The Ocean Engineering Handbook, CRC Press LLC. 2001.
6. Leslie Jackson, Instrumentation and Control Systems, 3rd Edition, Thomas Reed Publication Ltd., London, 1992.
7. Smith, Application of Automatic Machinery and Alarm Equipment in Ships, Marine Engineering Practice, Vol.1, Part 06, Imarest, London.

MR5020	AVIONICS FOR MECHATRONICS ENGINEERS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To learn about the aircraft system and its automation requirements.
- To study the sensors, measurement, actuators, navigation systems and its control of aircraft systems.

UNIT I OVERVIEW OF AIRCRAFT ENGINEERING 9

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

UNIT II SENSORS AND MEASUREMENTS 9

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

UNIT III MECHANISMS AND ACTUATORS 9

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

UNIT IV STABILITY AND CONTROL 9

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

UNIT V NAVIGATION 9

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

TOTAL: 45 PERIODS

OUTCOMES:

- The learners will be able to know about the sensors, measurement, actuators, navigation systems and its control of aircraft system in the system integration aspect.

REFERENCES

1. AGARD-AG-234, "Active controls aircraft Design", 1978.
2. Collinson R.P.G, ‗Introduction to Avionics', Chapman and Hall, India, 1996.
3. Ian Moir and Allan Seabridge, Aircraft Systems Mechanical, electrical, and avionics subsystems integration, John Wiley & Sons Ltd, 2009.

4. Jane‘s Unmanned Aerial Vehicles and Targets, Jane‘s Information Group; ASIN: 0710612575, 1999.
5. Nelson R.C ‗Flight stability & Automatic Control‘, McGraw Hill, 1989.
6. Pallet, E.H.J. Aircraft Instruments & Integrated systems‖, Longman Scientific and Technical, McGraw-Hill, 1992.
7. Robert C. Nelson, Flight Stability and Automatic Control, McGraw-Hill, Inc, 1998.
8. Stevens B.L & Lewis F.L, Aircraft control & simulation‘, John Wiley Sons, New York, 1992.

MR5021 MEDICAL MECHATRONICS

L	T	P	C
3	0	0	3

OBJECTIVES:

- 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

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 9

Defibrillator - Pacemakers –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 9

Radio graphic and fluoroscopic techniques –XRay machine- Computer tomography – MRI – FMRI- Ultrasonography – Endoscopy – Colonoscopy -Thermography – Different types of biotelemetry systems and patient monitoring – PET- Introduction to Biometric systems.

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

MF5074 ENTREPRENEURSHIP DEVELOPMENT L T P C
3 0 0 3

OBJECTIVE:

- To develop and strengthen entrepreneurial quality and motivation in students. To impart basic entrepreneurial skills and understandings to run a business efficiently and effectively.

UNIT I ENTREPRENEURAL COMPETENCE 6

Entrepreneurship concept – Entrepreneurship as a Career – Entrepreneurial Personality - Characteristics of Successful, Entrepreneur – Knowledge and Skills of Entrepreneur.

UNIT II ENTREPRENEURAL ENVIRONMENT 12

Business Environment - Role of Family and Society - Entrepreneurship Development Training and Other Support Organisational Services - Central and State Government Industrial Policies and Regulations - International Business.

UNIT III BUSINESS PLAN PREPARATION 12

Sources of Product for Business - Prefeasibility Study - Criteria for Selection of Product - Ownership - Capital - Budgeting Project Profile Preparation - Matching Entrepreneur with the Project - Feasibility Report Preparation and Evaluation Criteria.

UNIT IV LAUNCHING OF SMALL BUSINESS 10

Finance and Human Resource Mobilization Operations Planning - Market and Channel Selection - Growth Strategies - Product Launching – Incubation, Venture capital, IT startups.

UNIT V MANAGEMENT OF SMALL BUSINESS 5

Monitoring and Evaluation of Business - Preventing Sickness and Rehabilitation of Business Units- Effective Management of small Business.

TOTAL: 45 PERIODS

OUTCOME:

- Students will gain knowledge and skills needed to run a business.

REFERENCES:

1. Hisrich, Entrepreneurship, Edition 9, Tata McGraw Hill, New Delhi, 2014
2. S.S.Khanka, Entrepreneurial Development, S.Chand and Company Limited, New Delhi, (Revised Edition) 2013.
3. Mathew Manimala, Entrepreneurship Theory at the Crossroads, Paradigms & Praxis, Biztrantra, 2nd Edition ,2005
4. Prasanna Chandra, Projects – Planning, Analysis, Selection, Implementation and Reviews, Tata McGraw-Hill, 1996.
5. P.Saravanavel, Entrepreneurial Development, Ess Pee kay Publishing House, Chennai 1997.
6. Arya Kumar. Entrepreneurship. Pearson, 2012.
7. Donald F Kuratko, T.V Rao. Entrepreneurship: A South Asian perspective. Cengage, 2012

CM5092 ENVIRONMENT CONSCIOUS MANUFACTURING L T P C

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OBJECTIVE:

- To impart the knowledge in sustainable manufacturing, ISO 14000 series standards, green manufacturing**,** recycling and life cycle assessment.

UNIT I SUSTAINABLE MANUFACTURING AND EMS: 9

Sustainable Manufacturing - Concepts and Methodologies to Help Promote Industrial Ecology - ISO 14000 series standards - Concepts of ISO 14001 - requirements of ISO 14001 – Environmental Management System benefits - Environmentally Conscious Manufacturing.

UNIT II GREEN MANUFACTURING: 9

Green Design and Quality Initiatives - Environmental Cost Accounting and Business Strategy - Accounting for an Environmentally Conscious Setting - The Development of Eco labelling Schemes

UNIT III RECYCLING: 9

Recycling as Universal Resource Policy - Innovation Towards Environmental Sustainability In Industry - A Systematic Framework for Environmentally Conscious Design

UNIT IV ENVIRONMENTAL ATTRIBUTES OF MANUFACTURING: 10

Environmental Attributes of Manufacturing Processes - Environmental Decision Support Systems - Decision Models for Reverse Production System Design - Environmentally Sound Supply Chain Management

UNIT V LIFE CYCLE ASSESSMENT 8

Life Cycle Assessment - Multipath way and Cumulative Risk Assessment - Reclamation And Recycling of Waste

TOTAL: 45 PERIODS

OUTCOME:

On completion of the course the students will be able to follow the guidelines of ISO 14000, implement green design, follow environmental norms in manufacturing and do lifecycle assessment of products and processes.

REFERENCES

1. Besterfield, D.H., Besterfield, C.M., Besterfield, G.H. and Besterfield, M.S.,"Total Quality Management ", Pearson Education, 2002.
2. Gupta, S.M. and Lambert, A.J.D., "Environment Conscious Manufacturing", CRC Press, 2008.
3. Madu, C.N., "Handbook of Environmentally Conscious Manufacturing", Kluwer Academic Publisher, 2001.
4. Swamidass, P.M., "Encyclopedia of Production and Manufacturing Management", Kluwer Academic Publisher, 2000.

CM5073	GREEN MANUFACTURING	L	T	P	C
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OBJECTIVES:

To introduce the concept of Green Manufacturing Design to the students

UNIT I INTRODUCTION 9

Environmental effects of design – Environmental damage – In efficient energy use – Design for recycling.

UNIT II ENVIRONMENTAL LIFE CYCLE ASSESSMENT 9

Material flow and cycles – Material recycling – Emissionless manufacturing.

UNIT III GREEN DESIGN METHODS 9

Mass balance analysis – Green indicate – Design for disassembly design for recycle – Rist analysis – Material selection.

UNIT IV DESIGN FOR ENVIRONMENT 9

Eco design – Industrial Ecology – Pollution prevention – Reduction of toxic emission.

UNIT V SUSTAINABLE ECONOMIC ENVIRONMENT 9

Solar energy devices – wind energy resources – Full cost accounting methodology – Selection of natural friendly materials.

TOTAL : 45 PERIODS

OUTCOMES:

- Students will understand the concepts of Green Manufacturing Design
- It will impart green design methods and to assess the life cycle of the product

REFERENCES:

1. Cairn and Francis – Costing the earth – Harvard Business School Press - 2009
2. Gradel.T.E. and B.R. Allenby – Industrial Ecology – Prentice Hall – 2010
3. World commission on Environment and Development (WCED), Our Common Future, Oxford University Press, 2005.