

COURSE OBJECTIVES

- To describe the concept of metrology.
- To explain about metrology instruments and application for various measurements.
- To discuss the concept of computer applications in metrology.
- To acquire the principles of various Inspection, Instruments and Methodology.
- To develop the knowledge in the area of non-contact inspection.

UNIT I BASIC CONCEPTS AND COMPARATORS 9

Basic concept – Legal metrology – Precision – Accuracy – Types of errors – standards of measurement – principle traceability – interchangeability and selective assembly, gauge blocks, limit gauges – fits and tolerances – tailor's of gauge design. Comparators: Mechanical, Electronic, optical and Pneumatic – Automatic gauging.

UNIT II ANGULAR MEASUREMENT AND SURFACE FINISH MEASUREMENT 9

Angular measurement: sine bar – Autocollimator, optical projectors: profile projectors – toolmakers microscope, measurement of surface finish: Terminology – roughness – waviness – analysis of surface finish – stylus probe instrument – Talysurf.

UNIT III SCREW THREAD AND GEAR METROLOGY 9

Screw thread metrology: errors in thread – pitch error – drunkenness – measurement of various elements thread – two and three wire method – best wire size – Thread gauges – floating carriage micrometer. Measurement of gears – Terminology – measurement of various elements of gear – tooth thickness – constant chord and base tangent method – Parkinson Gear Tester.

UNIT IV OPTICAL METROLOGY 9

Laser Metrology: LASER interferometer – constructional features, sources of error, measurement of positional error, straightness and flatness of machine tools – LASER Alignment Telescope – LASER Micrometer – LASER Triangulation technique – in process and on line measurement – white light interferometer.

UNIT V ADVANCES IN METROLOGY 9

Coordinate measuring machine (CMM): Constructional features – types and applications. Computer Aided Inspection: Machine Vision system – Image processing.

TOTAL PERIODS 45**COURSE OUTCOMES**

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

- demonstrate different measurement technologies and to make use of them in Industrial Components.
- compute angular measurement and surface finish measurement.
- improve knowledge on screw thread metrology.
- describe the concept of laser metrology.
- illustrate Coordinate measuring machine.

TEXT BOOKS

1. Jain R.K. "Engineering Metrology", Khanna Publishers, 2005.
2. Gupta. I.C., "Engineering Metrology", Dhanpatrai Publications, 2005.

REFERENCES

1. Connie Dotson, et al., “Fundamentals of Dimensional Metrology”, Thomas Asia, Singapore, First print, 2003.
2. Doebelin E.O., “Measurement System Applications and Design” First Edition, 1990.
3. Groover M.P., “Automation, Production System and Computer Integrated Manufacturing “, Prentice – Hall, New Delhi, 2003.

WEB LINKS

1. [http://nptel.ac.in/courses/112102103//Module%20G/Module%20G\(2\)/p2.htm](http://nptel.ac.in/courses/112102103//Module%20G/Module%20G(2)/p2.htm)
2. https://en.wikipedia.org/wiki/Computer-aided_inspection



Mapping of Course Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)													
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CO1	3	1	-	2	-	2	3	-	2	-	-	3	1	-
CO2	3	-	-	2	-	1	1	-	2	2	-	3	1	-
CO3	2	2	-	2	-	1	2	-	1	1	-	3	2	-
CO4	2	1	-	2	-	2	-	-	3	2	-	3	1	-
CO5	3	1	-	2	-	1	3	-	-	2	-	3	2	-

COURSE OBJECTIVES

- To acquire the basic concepts of fluid mechanics for thorough understanding of the properties of fluids.
- To describe the dynamics of fluids through the control volume approach.
- To construct the concepts of dimensionless parameters and its applications.
- To explain the working principles of pumps and turbines, also their applications.
- To describe and learn the working of reciprocating and rotodynamic hydraulic machines.

UNIT I FLUID PROPERTIES AND FLOW CHARACTERISTICS 8

Units and dimensions-Classification of fluids-Properties of fluids- mass density, specific weight, specific volume, specific gravity, viscosity, compressibility, vapor pressure, surface tension and capillarity. Flow characteristics – concept of control volume - application of continuity equation, energy equation and momentum equation.

UNIT II FLOW THROUGH CIRCULAR CONDUITS 8

Hydraulic and energy gradient - Laminar flow through circular conduits and circular annuli-Boundary layer concepts – types of boundary layer thickness – Darcy Weisbach equation –friction factor- Moody diagram-commercial pipes- minor losses – Flow through pipes in series and parallel.

UNIT III DIMENSIONAL ANALYSIS 9

Need for dimensional analysis – methods of dimensional analysis – Similitude –types of similitude - Dimensionless parameters- application of dimensionless parameters – Model analysis.

UNIT IV HYDRAULIC PUMPS 10

Impact of jets - Euler's equation - Theory of roto-dynamic machines – various efficiencies– velocity components at entry and exit of the rotor- velocity triangles - Centrifugal pumps– working principle -work done by the impeller - performance curves - Reciprocating pump- working principle – Rotary pumps –classification.

UNIT V HYDRAULIC TURBINES 10

Classification of turbines – heads and efficiencies – velocity triangles. Axial, radial and mixed flow turbines. Pelton wheel, Francis turbine and Kaplan turbines- working principles - work done by water on the runner – draft tube. Specific speed - unit quantities – performance curves for turbines –governing of turbines.

TOTAL PERIODS 45**COURSE OUTCOMES**

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

- list the fundamentals of fluid mechanics, including the basics of hydraulics, types of fluids- water, oils and its uses along with fluid properties.
- investigate the fluid flow phenomena with the application of momentum and energy equation.
- improve dimensional analysis and to learn the several non-dimensional numbers with real time applications.
- acquire knowledge about the working principle of turbo machinery.
- distinguish the different types of pumps, fluid machineries and its working principles.

TEXT BOOKS

1. Bansal, R.K., "Fluid Mechanics and Hydraulics Machines", Laxmi publications, New Delhi, (2010)
2. Modi P.N and Seth S.M, "Hydraulics and Fluid Mechanics", Standard Book House, New Delhi (2004).

REFERENCES

1. Som, S.K. and Biswas, G., "Introduction to Fluid Mechanics and Fluid Machines", Tata McGraw-Hill, New Delhi, 2nd Edition, (2007).
2. Kumar. K.L., "Engineering Fluid Mechanics", (VII Ed.) Eurasia Publishing House (P) Ltd., New Delhi, (1995).
3. Graebel.W.P, "Engineering Fluid Mechanics", Taylor Francis, Indian Reprint, (2011).
4. Streeter, V. L. and Wylie E. B., "Fluid Mechanics", McGraw Hill Publishing Co. 2010
5. Rathakrishnan. E, "Fluid Mechanics", Prentice Hall of India (II Ed.), (2007)

WEB LINKS

1. www.mechanical.in/fluid-mechanics-and-machinery
2. <http://nptel.ac.in/courses/105101082/1>



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CO2	2	2	2	-	-	1	-	2	-	2	-	1	1	-
CO3	2	-	2	-	2	1	-	-	-	2	-	-	1	1
CO4	2	2	2	-	2	1	3	2	-	2	-	-	1	-
CO5	2	2	-	-	-	1	3	2	2	2	-	-	-	1

COURSE OBJECTIVES

- To describe the fundamentals of digital logic and minimization technique
- To illustrate the students with various number systems and codes
- To formulate the methods for simplifying boolean expressions
- To justify the formal procedures for the analysis and design of combinational and sequential circuits
- To discuss the concept of memories and programmable logic devices.

UNIT I NUMBER SYSTEM, BOOLEAN LOGIC AND MINIMIZATION TECHNIQUES 15

Introduction to Number systems- Binary, Octal, Hexadecimal, BCD, Grey code, Excess 3 code - Binary Arithmetic, 1's complements, 2's complements, and Code conversions. Boolean theorems, Boolean algebra – **AND, OR, NOT, NAND AND NOR operation**. Minimization – K- Map, Don't care conditions - Five Variable K maps, Tabular Minimization Procedures.

UNIT II COMBINATIONAL CIRCUITS 15

Half and Full Adders - Half and Full Subtractors - **Code Converters- Encoder – Decoder - Multiplexer- Demultiplexer** - Binary/ BCD adders, Subtractors - Magnitude Comparator.

UNIT III SEQUENTIAL CIRCUITS 15

General model of sequential circuits – Latch, Flip Flops– SR, D, JK and T, Level triggering, Edge triggering, Master slave configuration. Realization of one flip flop using other flip flop. counters - Binary counters, Modulo-n counter- Ring counter, Johnson counter.

UNIT IV DESIGN OF SEQUENTIAL CIRCUITS 15

Classification of sequential circuits – Moore and Mealy - Design of Asynchronous counters- state diagram- State table –State minimization –State assignment- **Register – shift registers - Universal shift register**. Hazards: Static – Dynamic.

UNIT V MEMORY AND PROGRAMMABLE LOGIC DEVICES 15

Memories - ROM, PROM, EPROM, **Programmable Array Logic (PAL), Programmable Array Logic (PAL)** - Implementation of combinational logic using PROM and PLA, PAL.

TOTAL PERIODS 75**COURSE OUTCOMES**

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

- solve the fundamentals of digital logic with various number systems and codes.
- explain the concept of how to designing various combinational and sequential circuits
- elaborate the complex arithmetic and logic circuit and to evaluate its function realization using gates.
- discuss the basics about synchronous and asynchronous circuits
- propose the complex logic memories, programmable logic devices and test its functionality and timing.

TEXT BOOKS

1. Morris Mano M., "Digital Circuits and Logic Design", Prentice Hall of India, II Edition, 1996.
2. Ronald J. Tocci Neal S. Widmer and Gregory L. Moss, Digital Systems: Principles and Applications, Prentice Hall of India, New Delhi, 2010.

3. ZainalabedinNavabhi, VHDL Analysis and Modeling of Digital Systems, McGraw-Hill, 1998.

REFERENCES

1. W.H. Gothmann, "Digital Electronics – Introduction Theory and Practice", PHI, 1992.
2. S. Salivahanan and S. Arivazhagan, "Digital Circuits and Design", 2nd Edition, Vikas Publishing House Pvt. Ltd, New Delhi, 2004.
3. W.H. Gothmann, "Digital Electronics – Introduction Theory and Practice", Prentice Hall of India Pvt. Ltd New Delhi, 1992.
4. R.R. Jain, "Modern digital electronics", Third edition, Tata McGraw – Hill, 3rd edition 2003.
5. Leach and Malvino, "Digital Principles of Electronics & Applications", Tata McGraw – Hill, 5th Edition, 2003.

WEB LINKS

1. https://en.wikipedia.org/wiki/Digital_electronics
2. <http://www.electrical4u.com/digital-electronics/>
3. <http://www.asic-world.com/digital/tutorial.html>



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CO3	2	-	2	-	2	1	-	3	-	2	-	3	1	-
CO4	2	2	2	-	2	1	3	3	-	2	-	3	1	-
CO5	-	2	-	-	-	1	3	3	2	2	-	2	1	-

COURSE OBJECTIVES

- To inculcate knowledge about the basics of mechanisms and understand the geometry of motion at any point in a link of a mechanism.
- To examine students to understand the types of cam and follower, motion and profile drawing of cam.
- To construct students on the phenomenon of direction of rotation, speed and torque determination for simple, compound and planetary gear systems.
- To propose the effects of friction in motion transmission and in machine components.
- To the motion resulting from a specified set of linkages in a mechanism.

UNIT I BASICS OF MECHANISMS**15**

Introduction to Mechanisms – Degree of Freedom – Kutzbach criterion – Grashoff's law – Kinematic Inversions of Four bar chain, Slider, Double crank chains – Description of common Mechanisms– Single, double and offset slider mechanisms – Quick return mechanisms Ratchets and escapements – Indexing Mechanisms – Design of Crank and Rocker Mechanisms.

UNIT II KINEMATICS OF LINKAGES**15**

Displacement, velocity and acceleration and analysis in simple mechanisms – Graphical Method velocity and acceleration polygons – Vector Approach, Computer applications in the kinematic analysis of simple mechanisms – Coriolis Components of Acceleration.

UNIT III KINEMATICS OF CAM**15**

Classifications – Displacement diagrams – Parabolic, Simple harmonic, UAAR and Cycloidal motions – Layout of plate cam profiles – Derivatives of Follower motion – High speed cams – circular arc and tangent cams– Pressure angle and undercutting.

UNIT IV GEARS AND GEAR TRAINS**15**

Spur gear Terminology and definitions – Fundamental Law of toothed gearing and involute gearing – Inter changeable gears – gear tooth action - Contact ratio – Terminology – Helical, Bevel, Worm, Rack and Pinion Gears (Basics only) – Gear trains – Parallel axis gear trains – Epicyclic gear trains.

UNIT V FRICTION**15**

Surface contacts – Sliding and Rolling friction – Friction drives – Friction in screw threads – Friction clutches – Belt and rope drives, Friction aspects in Brakes.

TOTAL PERIODS 75**COURSE OUTCOMES**

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

- improve the basics of mechanisms and the geometry of motion at any point in a link of a mechanism.
- construct the profile of cam for any given combination and condition.
- determination the speed and torque for simple, compound and planetary gear systems.
- identify the effects of friction in motion transmission and in machine components.
- prioritize the sliding and rolling friction.

1. Khurmi, R.S., "Theory of Machines", 14th Edition, S Chand Publications, 2009.
2. Rattan S.S, "Theory of Machines", Tata McGraw – Hill Publishing Company Ltd., New Delhi, 2010.

1. Thomas Bevan, “Theory of Machines”, CBS Publishers and Distributors, 2001.
2. Ghosh A and A.K.Mallick, “Theory of Mechanisms and Machines”, Affiliated East – West Pvt. Ltd., New Delhi, 2005.
3. Rao J.S and Dukkupati R.V, “Mechanism and Machine Theory”, Wiley – Eastern Ltd., New Delhi, 2007.
4. John Hannah and Stephens R.C, “Mechanics of Machines”, Viva Low – Prices Student Edition, 2008.
5. Shigley J.E and Uicker J.J, “Theory of Machines and Mechanisms”, McGraw – Hill, Inc. 2008

1. www.asic-world.com/digital/tutorial.html
2. <https://www.britannica.com/science/friction>

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COURSE OBJECTIVES

- To design the understanding of the fundamentals of fluid mechanics and hydraulic machines
- To improve the classical experimental and diagnostic techniques, and the principles behind these techniques
- To invent the practice in making engineering judgments, estimates and assessing the reliability of the measurements and skills which are very important in all engineering disciplines.

LIST OF EXPERIMENTS

1. Determination of the Coefficient of discharge of given Orifice meter.
2. Determination of the Coefficient of discharge of given Venturi meter.
3. Study of Bernoulli's Theorem apparatus.
4. Study of Losses in Pipes.
5. Conducting experiments and drawing the characteristic curves of centrifugal pump.
6. Conducting experiments and drawing the characteristic curves of reciprocating pump.
7. Conducting experiments and drawing the characteristic curves of Gear oil pump.
8. Conducting experiments and drawing the characteristic curves of Pelton wheel.
9. Conducting experiments and drawing the characteristics curves of Francis turbine.
10. Conducting experiments and drawing the characteristic curves of Kaplan turbine.

TOTAL PERIODS 30**COURSE OUTCOMES**

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

- list the fundamentals of fluid mechanics and hydraulic machines.
- apply experimental knowledge on classical, experimental and diagnostic techniques.
- estimate and assess the reliability of measurements which are very important in all engineering disciplines.
- test venturi meter and orifice meter to determine the fluid flow parameters.

REFERENCES

1. P. N. Modi and S. M. Seth, "Hydraulics and Fluid Mechanics", Standard Book House, Delhi, (1991).
2. S. S. Rattan, "A Text Book of Fluid Mechanics", Khanna Publishers, Delhi, (1994)
3. Som, S.K. and Biswas, G., "Introduction to Fluid Mechanics and Fluid Machines", Second Edition, Tata McGraw-Hill, New Delhi, 2nd Edition, (2007).



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COURSE OBJECTIVES

- To design the specifications and symbols of standard machine components used in machine drawing.
- To formulate the concept of various tolerances and fits used for component design.
- To recommended and practice the drawing of machine components and simple assemblies using standard CAD packages.
- To improve and create drawings manually or using any one CAD packages for standard machine components and assemblies with tolerance.

LIST OF EXPERIMENTS

1. Introduction to Machine Drawing - Dimensioning, Sectional views, Welding symbols, surface finish Symbols.
2. Study of Limits, Fits and tolerances.
3. Free hand sketching of Machine Elements - Keys, Hexagonal and Square Head Bolts and Nuts, Conventional representation of Threads.
4. Converting given isometric view into orthographic views
5. Part and Assemble drawing of Universal coupling and Flange Coupling
6. Part and Assemble drawing of Bearings.
7. Part and Assemble drawing of Valves.
8. Part and Assemble drawing of Machine Elements – Tail Stock, Screw Jack and Connecting Rod Assembly.

TOTAL PERIODS 30**COURSE OUTCOMES**

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

- decide the dimensioning, sectional views, welding symbols.
- construct the various part and assemble drawing of bearings.
- examine the various part and assemble drawing of couplings.
- predict the various part and assemble drawing of valves.



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CO4	2	-	2	-	-	1	-	2	-	-	-	3	-	-

	SEMESTER IV	
	NUMERICAL METHODS	
MA16404	(COMMON TO AERO, CIVIL, EEE, MECH & MCT)	
		3 2 0 4

COURSE OBJECTIVES

- To analyse different methods to find solution for a large system of linear equations
- To find the intermediate values for a series of given data
- To develop efficient algorithms for solving problems in science, engineering and technology
- To solve the nonlinear differential equations that cannot be solved by regular conventional method.
- To apply finite element method to increase the accuracy of second order differential equations

UNIT I SOLUTION OF EQUATIONS AND EIGEN VALUE PROBLEMS 15

Solution of equation – Iteration method : **Newton Raphson method** – Solution of linear system by **Gauss-Jordan method** – Iterative method – Gauss-Seidel method – Inverse of a matrix by Gauss-Jordan method – Eigenvalue of a matrix by power method.

UNIT II INTERPOLATION AND APPROXIMATION 15

Lagrangian Polynomials – Divided differences – Newton's Divided Difference, Hermite Interpolation Polynomial and Interpolating with a cubic spline – **Newton's forward and backward difference formulas.**

UNIT III NUMERICAL DIFFERENTIATION AND INTEGRATION 15

Differentiation using interpolation formulae – Numerical integration by trapezoidal and Simpson's 1/3–Romberg's method – Two- and Three-point Gaussian quadrature formulas – Double integrals using trapezoidal and Simpson's rule.

UNIT IV INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS 15

Single step methods: Taylor series method – Modified Euler method for first order equation – Fourth order **Runge-Kutta method** for solving first and second order equations – Multistep methods: Milne's and Adam's predictor and corrector methods.

UNIT V BOUNDARY VALUE PROBLEMS IN ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS 15

Finite difference solution of second order ordinary differential equation – Finite difference solution of one dimensional heat equation by explicit and implicit methods – One dimensional wave equation and two-dimensional **Laplace and Poisson equations.**

TOTAL PERIODS 75

COURSE OUTCOMES

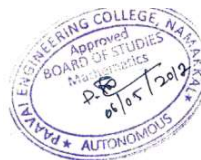
At the end of this course, the students will be able to

- comprehend the basics of linear equations.
- apply the interpolation methods for constructing approximate polynomials
- demonstrate the knowledge of numerical differential equations in computational and simulation process
- utilize the concept of initial value problems in the field of science and engineering
- describe the computational procedure of the amount of heat emitted or transferred from an object

1. Erwin Kreyszig., “Advanced Engineering Mathematics” 10th edition, Wiley Publications, 2010.
2. T. Veerarajan. and T .Ramachandran, “Numerical Methods with programming in C”, 2nd ed., Tata McGraw-Hill, 2006.
3. Sankar Rao K “Numerical Methods For Scientists And Engineers –3rd Edition Princtice Hall of India Private, New Delhi, 2007.

1. P. Kandasamy, K. Thilagavathy and K. Gunavathy, “Numerical Methods”, S.Chand Co. Ltd., New Delhi, 2003
2. Gerald C.F. and Wheatley, P.O., “Applied Numerical Analysis” 6th Edition, Pearson Education Asia, New Delhi, 2002.
3. M.K.Jain , S.R.K. Iyengar , R.K.Jain , “Numerical Methods For Scientific & Engineering Computation” New Age International (P) Ltd , New Delhi , 2005.
4. M.B.K. Moorthy and P.Geetha, “Numerical Methods”, Tata McGraw Hill Publications company, New Delhi, 2011.

1. <https://www.youtube.com/watch?v=QTQ8bO1F-Dg>
2. <https://www.youtube.com/watch?v=AT7Olelic8U>
3. <https://www.youtube.com/watch?v=TH06N7Q7FJw>
4. <https://www.youtube.com/watch?v=DnBJLpdVHCY>
5. <https://www.youtube.com/watch?v=5TccPEz2nB8>



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CO3	3	3	2	3	-	-	-	-	-	-	-	1	2	-
CO4	3	3	2	3	-	-	-	-	-	-	-	1	2	-
CO5	3	3	3	3	-	-	-	-	-	-	-	1	-	-

COURSE OBJECTIVES

- To invent the knowledge about the static and dynamic force analysis on various parts of reciprocating engine, the function of flywheel and to construct the various turning moment diagram.
- To propose the knowledge about balancing of various parts for different engine.
- To predict the causes of free vibration through analysis.
- To elaborate the analysis and causes of forced vibration.
- To advertise the effects of vibration in various beams under different load conditions and the basic concepts of governor and gyroscopes.

UNIT I FORCE ANALYSIS 15

Rigid Body dynamics in general plane motion – Equations of motion- Dynamic force analysis – Inertia force and Inertia torque – D. Alembert's principle – The principle of superposition –Dynamic Analysis in Reciprocating Engines – Turning moment diagrams – Fly wheels.

UNIT II BALANCING 15

Static and dynamic balancing – Balancing of rotating masses – Balancing a single cylinder Engine Balancing Multi – Cylinder Engines – Partial balancing in locomotive Engines – Balancing linkages.

UNIT III FREE VIBRATION 15

Basic features of vibratory systems – Degrees of freedom – Free vibration – Equations of motion – Types of Damping – Damped vibration critical speeds of simple shaft – Torsional systems; Natural frequency of two and three rotor systems

UNIT IV FORCED VIBRATION 15

Response to periodic forcing – Harmonic Forcing – Forcing caused by unbalance – Support motion – Force Transmissibility and amplitude transmissibility vibration isolation.

UNIT V MECHANISM FOR CONTROL 15

Governors – Types – Centrifugal governors – Gravity controlled and spring controlled centrifugal governors – Characteristics – Controlling Force - Other governor mechanisms. Gyroscope – Gyroscopic couple – Gyroscopic Stabilization - Gyroscopic effects in Automobiles, ships and airplanes.

TOTAL PERIODS 75**COURSE OUTCOMES**

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

- formulate static and dynamic force analysis on various parts of reciprocating engine and construct turning moment diagram of flywheel.
- judge the balancing of various parts for different engine.
- improve knowledge on analysis of free vibration.
- improve knowledge on analyze of forced vibration.
- design the basic concepts of Mechanism for Control of Centrifugal governors and gyroscopes.

TEXT BOOKS

1. Khurmi, R.S., “Theory of Machines”, 14th Edition, S Chand Publications, 2009.
2. Rattan. S. S, “Theory of Machines”, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2011.

REFERENCES

1. Thomas Bevan, “Theory of Machines”, CBS Publishers and distributors, 2010.
2. Ghosh A. and Mallick A.K., “Theory of Mechanisms and Machines”, Affiliated East- West Press Pvt.Ltd., New Delhi, 2010.
3. Shigley J.E. and Uicker J.J., “Theory of Machines and Mechanisms “, McGraw – Hill, Inc., 2009.
4. Rao J.S. and Duggipati R.V., “Mechanism of Machine Theory”, Wiley – Eastern Limited, New Delhi, 2008.
5. John Hannah and Stephens R.C., “Mechanics of Machines”, Viva low – Priced Student Edition, 2007.

WEB LINKS

1. <http://nptel.ac.in/courses/112104114/>
2. <http://freevideolectures.com/Course/2364/Dynamics-of-Machines>

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COURSE OBJECTIVES

- To describe the feedback control and basic components of control systems.
- To identify the various time domain and frequency domain tools for analysis and design of linear control systems.
- To discuss the methods to analyze the stability of systems using root locus technique.
- To describe the methods of designing compensators and applications of control systems.
- To compute knowledge in the basic concepts of linear control theory and design of Control system.

UNIT I BASIC CONCEPTS AND SYSTEM REPRESENTATION 9

Basic elements in control systems – Open and closed loop systems with example –Mathematical model of Translational, Rotational & Electrical systems – Transfer function – Block diagram reduction techniques – Signal flow graph.

UNIT II TIME RESPONSE ANALYSIS 9

Introduction – Time domain specifications – Types of test inputs I and II order system response– Steady state error – Error coefficients – Generalized error series – P, PI, PD, PID Controlled characteristics.

UNIT III FREQUENCY RESPONSE ANALYSIS AND DESIGN 9

Introduction – Frequency domain specifications – Bode plots and polar plots – Constant M and N circles and Nichols chart – Correlation between frequency domain and time domain specifications.

UNIT IV STABILITY OF CONTROL SYSTEMS 9

Characteristics equation – Location of roots in s-plane for stability – Routh Hurwitz criterion –Root locus Construction – Gain margin and phase margin – Nyquist stability criterion.

UNIT V COMPENSATION DESIGN & APPLICATIONS OF CONTROL SYSTEMS 9

Realization of basis compensation – Lag, Lead and Lag – lead networks – Compensator design using Bode plots. Stepper motors- AC & DC Servo Motor-Hydraulic Controller-Pneumatic Controller - Overview of Distributed Control system and PLC.

TOTAL PERIODS 45**COURSE OUTCOMES**

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

- construct the feedback control and basic components of control systems.
- explain the various time domain and frequency domain tools to analysis and design of linear control systems.
- conduct the analysis to stability of systems from transfer function and to define the methods of designing compensators.
- identify the application areas of control system.
- discover the compensation design processes.

TEXT BOOKS

1. J. Nagrath and M. Gopal, Control System Engineering, New Age International Publisher, New Delhi, 2011.

REFERENCES

1. Katsuhiko Ogata, “Modern Control Engineering”, 4th Edition, Pearson Education 2003.
2. I.J.Nagrath & M. Gopal, “Control Systems Engineering”, New Age International Publishers, 2003.
3. B.C.Kuo, “Automatic control systems”, Prentice Hall of India Ltd, New Delhi 1995.
4. Dorf R.C. and Bishop R.H., “Modern Control systems”, Addison – Wesley, 1995 (MATLAB reference).
5. Leonard N.E. and William Levine, “Using MATLAB to Analyze and Design Control Systems,”

WEB LINKS

1. <http://nptel.ac.in/courses/108101037/1>
2. https://en.wikipedia.org/wiki/Control_engineering



Mapping of Course Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	-	3	-	3	-	2		-	-	-	-	2
CO2	3	2	-	2	-	3	-	2		-	-	-	-	-
CO3	2	2	-	2	-	3	-	-	-	-	2	-	-	-
CO4	2	2	-	2	-	3	-	-	-	2	2	-	-	-
CO5	-	-	-	2	-	3	-	-	-	-	2	-	-	2

COURSE OBJECTIVES

- To construct the theoretical basis about the stress, strain and elastic modulus.
- To identify the concepts in various components with sound mathematical principles and to systematically solve engineering problems regardless of difficulty.
- To calculate the shear force, bending moment, deflection and slopes in various types of beams with different load conditions.
- To identify the concept of confidence and competence while solving problems related to the machine components like shafts, columns, springs and purposes.
- To explain the basic concept in torsion in shafts and springs.

UNIT I STRESS, STRAIN AND DEFORMATION OF SOLIDS 15

Properties of mild steel, cast iron, aluminum alloys, copper alloys and magnesium alloys - Mechanical properties of Materials - Stress and Strain - Stresses and strains due to axial force - Hooke's law - Factor of safety - Poisson's ratio - Elastic constants and their relationship Stress-Strain Curve for Ductile and Brittle Materials.

UNIT II ANALYSIS OF STRESSES IN TWO DIMENSIONS 15

State of stresses at a point - Normal and tangential stresses on inclined planes - Principal planes and stresses – Plane of maximum shear stress - Mohr's circle for biaxial stresses. Behavior of thick wall pressure vessels

UNIT III BEAMS 15

Types of beams: Supports and Loads - Theory of simple bending - Stresses in beams: bending and shear stress - Stress variation along the length and section of the beam, Slope and Deflection of beams: Double integration for Cantilever and simply supported beams Section modulus

UNIT IV COLUMNS 15

Columns - Buckling of long columns due to axial load - Equivalent length of a column - Euler's and Rankine's formulae for columns of different end conditions Deflection in overhanging beams

UNIT V SHAFTS 15

Analysis of torsion of circular bars - Shear stress distribution - Bars of Solid and hollow circular section – Compound shafts.

TOTAL PERIODS 75**COURSE OUTCOMES**

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

- examine the stress, strain and elastic moduli under given loading.
- construct the shear force and bending moment diagrams of standard beams.
- show the deflection and slopes in various types of beams with different load conditions.
- solve the problems related to the machine components like shafts, columns, springs and purposes.
- identify the application areas of springs.

TEXT BOOKS

1. R. K. Bansal, A text book of Strength of Materials, Laxmi Publications (P) Limited, New Delhi, 2010.
2. Egor P. Popov, Engineering Mechanics of Solids, Prentice Hall of India Learning. Ltd., New Delhi, 2010.

REFERENCES

1. R.K.Rajput, Engineering Materials, S. Chand and Company Ltd, New Delhi, 2007.
2. P. Purushothama Raj and V. Ramasamy, Strength of Materials, Pearson Education, India, 2013.
3. S. Rattan, Strength of Materials, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2011.
4. B. K. Sarkar, Strength of Materials, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2008.
5. Irwing H. Shames and James M. Pitarresi, Introduction to Solid Mechanics, Prentice Hall of India Learning. Ltd., New Delhi, 2009.
6. R. Subramaniam, Strength of Materials, Oxford University Press, New Delhi 2012.

WEB LINKS

1. www.engineersedge.com/strength_of_materials.html
2. www.me.mtu.edu/~mavable/MoM2nd.html



Mapping of Course Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	-	2	-	3	3	-	3	3	3	-	3	-
CO2	3	3	-	3	-	2	3	-	3	3	3	-	2	-
CO3	3	3	-	2	-	2	2	-	3	3	-	-	2	-
CO4	3	3	-	2	-	2	3	-	3	3	-	-	2	-
CO5	3	2	-	2	-	3	2	-	3	2	3	-	2	-

COURSE OBJECTIVES

- To understand the basics and working principle of various manufacturing processes.
- To distinguish conventional and non-conventional machining processes.
- To know the suitable metal removal processes for various application.
- To understand the principles of different metal finishing processes.
- To know the principles of different joining processes like welding, brazing, soldering and adhesive bonding.

UNIT I FOUNDRY TECHNOLOGY 9

Pattern and Core making: Pattern types, allowances, types of cores, core print - Moulding sand: types, properties, green sand moulding - Melting furnaces: Induction furnaces, CO₂ process, Centrifugal Castings, Shell Casing, Investment Casting, Die casting, Defects in casting.

UNIT II FORMING – PROCESSES 9

Hot Working and Cold Working. Rolling: Introduction – Rolling Mills – Rolling Operations – Production of Seamless Tubing and Pipe. Forging: Introduction – Related Forging Operations – Drop forging. Extrusion and Drawing: Extrusion Practice – Hot, Cold, Impact and Hydrostatic extrusion. Sheet metal operations – Blanking, Punching and Piercing.

UNIT III MATERIAL REMOVAL PROCESSES 9

Lathes and Lathe Operations, Drilling and Drilling Machines, Reaming and Reamers, Tapping and Taps- Tool nomenclature, cutting speed, feed, machining Time calculations.

UNIT IV SPECIAL MACHINES 9

Milling Machines and Operations, Planning and Shaping, Broaching, Gear Hobbing and Shaping. Grinding Process – Abrasives – Finishing operations –lapping, Honing Powder coating.

UNIT V PRINCIPLES AND APPLICATIONS OF JOINING PROCESSES 9

Gas welding, Basic Arc Welding Processes, Thermit Welding, Electron – Beam Welding, Laser– Beam Welding, Ultrasonic Welding, Friction Welding, Electro slag, Resistance welding, Principles and application of Brazing and Soldering.

TOTAL PERIODS 45**COURSE OUTCOMES**

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

- identify the basics and working principle of various casting processes.
- improve the knowledge on forming processes.
- explain the basic and working principle of conventional machining process.
- construct the basic and working principle of special machines.
- identify the basic application and principles of metal joining process.

TEXT BOOKS

1. Kalpakjian, S., “Manufacturing Engineering and Technology”, Pearson education India, 4th edition, 2001 (ISBN 81 78081 571)
2. Zainalabedin Navabhi, VHDL Analysis and Modeling of Digital Systems, McGraw-Hill, 1998. 2009.

REFERENCES

1. Hajra Choudhury, S.K., and Haqjra Choudhury, A.K., “Elements of Workshop Technology”, Volume I & II, Media Promoters and Publishers Private Limited, Mumbai, 1997.
2. Paul Degarma E, Black J.T. and Ronald A. Kosher, eighth edition, Materials and Processes in Manufacturing Prentice – Hall of India, 1997.
3. Sharma P.C. A Textbook of Production Technology, S. Chand and Co., Ltd., 1999.

WEB LINKS

1. <https://books.google.com/books?id=sT6jwN1LKTQC&printsec=frontcover&dq=Manufacturing+Technology&hl=en&sa=X&ei=NWUaVZfkNMyyogSG9YCACA&ved=0CDgQ6AEwAw#v=onepage&q=Manufacturing%20Technology&f=false>
2. <https://www.google.com/search?tbm=bks&hl=en&q=Manufacturing+Technology>

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COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	3		3		3	3		3	2	-
CO2	3	-	-	-	3		2		2	3		3	3	-
CO3	3	-	-	-	3		3		2	3		3	3	-
CO4	3	-	-	-	2		3		2	3		3	3	-
CO5	3	-	-	-	3		3		3	3		3	2	-



COURSE OBJECTIVES

- To study the architecture of 8085.
- To understand the addressing modes and instruction set of 8085.
- To impart knowledge of commonly used peripheral devices.
- To gain the knowledge of interrupt controller / interfacing ICs.
- To cognizant the applications of microprocessor.

UNIT I INTRODUCTION

9

Organization of Micro Computers – Organization of 8085: Architecture, Internal Register Organization and Pin Configuration – **Instruction Set of 8085** – addressing modes – instruction and machine cycles with states and timing diagram.

UNIT II MEMORY AND I/O DEVICES

9

Need for Interfacing – Memory Interfacing: address space partitioning – address map – Address decoding –Bus contention. **I/O Interfacing**: Data transfer schemes – programmed Synchronous and asynchronous – Interrupt driven Transfer – Multiple devices and multiple interrupt levels – enabling disabling and masking of interrupts.DMA transfer: Cycle stealing – Burst mode – Multiple DMA devices – DMA transfer in 8085 systems – serial data transfer.

UNIT III INTERFACING DEVICES

9

Programmable peripheral device – programmable interval timer (8253) – Programmable communication interface (USART) – **Programmable interrupt controller** – Programmable DMA Controller (8257), programmable peripheral interface (8255).

UNIT IV DESIGN USING PERIPHERAL DEVICES

9

Interfacing A/D and D/A converters – Matrix Keyboard design using 8255 using 8085 programs. Designing real time clock, detecting power failure, detecting presence of objects using 8253 -**Design of Keyboard and display interfacing using 8279.**

UNIT V MICROPROCESSOR APPLICATIONS

9

Temperature monitoring system – Automotive applications – Closed loop process control –**Stepper motor control.**

TOTAL PERIODS 45**COURSE OUTCOMES**

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

- understand the architecture of 8085, instruction set and addressing modes of 8085 and illustrate with simple programs.
- get knowledge about commonly used peripheral / interfacing ics.
- analyse the concepts of i/o interfacing, execution.
- design microprocessor-based systems using peripheral devices.
- device selection and the applications of microprocessor.

TEXT BOOKS

1. Ramesh Goankar, "Microprocessor Architecture, Programming and Applications with 8085",
2. Umashankar B.S., Udaya Kumar K, "The 8085 Microprocessor: Architecture, Programming and Interfacing", Publisher: Pearson Education, 2008.
3. R.Theagarajan, S.Dhanasekaran, S.Dhanapal, "Microprocessors and its applications", New Age International, 2004

REFERENCES

1. V. Douglas Hall, "Microprocessors and Interfacing Programming and Hardware", Tata McGraw - Hill Publishing Company Ltd., 2002.
2. K. Ray and K. M. Bhurchandi, "Advanced Microprocessor and Peripherals – Architecture, Programming and Interfacing", Tata McGraw - Hill Publishing Company Ltd., 2006.
3. Aditya P. Mathur, "Introduction to Microprocessor", Tata McGraw-Hill Publishing Company Ltd., 2003.
4. Rafiquzzaman M., "Microprocessors Theory and Applications: Intel and Motorola", Prentice Hall, 2003.
5. Krishnakant "Microprocessors and Microcontrollers Architecture Programming and System Design", 8085-8086- 8051- 8096", PHI, 2007.

WEB LINKS

1. <https://en.wikipedia.org/wiki/Microcontroller>
2. <http://www.zseries.in/embedded%20lab/8085%20microprocessor/other%20applications>.
3. <http://www.zseries.in/embedded%20lab/8085%20microprocessor/other%20applications>.
4. <http://www.nptel.ac.in/courses/Webcourse->

Mapping of Course Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	3	3	2	-	-	-	-	-	-	2	3	2
CO2	-	-	3	3	2	-	-	-	-	-	-	2	3	2
CO3	-	-	3	3	2	-	-	-	-	-	-	2	3	2
CO4	-	-	3	3	2	-	-	-	-	-	-	2	3	2
CO5	-	-	3	3	2	-	-	-	-	-	-	2	3	2



COURSE OBJECTIVES

- To able to write program using arithmetic operations of microprocessors.
- To understand various IC interfacing with 8085.
- To experimentally understand the operation of Intel 8085 microprocessor.
- To know about the Sorting of number series and Code conversion.

LIST OF EXPERIMENTS**I. Programming**

1. Addition and subtraction of two 8 bit numbers.
2. Addition and subtraction of two 16 bit numbers.
3. Decimal addition and subtraction of two 8 bit numbers
4. To arrange a series of numbers in ascending order.
5. To arrange a series of numbers in descending order
6. To find the largest and smallest number in given array.
7. Multiplication and Division of 8 bit numbers
8. Decimal to hexadecimal conversion and hexadecimal number to decimal number conversion.

II. Interfacing

1. Analog to digital conversion.
2. Digital to analog conversion.
3. Stepper motor controller.
4. Temperature controller.

**TOTAL PERIODS 30****COURSE OUTCOMES**

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

- execute programs for various arithmetic operations in 8085.
- transfer data to corresponding memory locations.
- convert analog and digital data for interfacing applications.
- implement programming for stepper motor and temperature control applications.

Mapping of Course Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	2	-	-	-	-	-	1	1	3	3
CO2	3	2	2	2	2	-	-	-	-	-	1	1	3	3
CO3	3	2	2	2	2	-	-	-	-	-	1	1	3	3
CO4	3	2	2	2	2	-	-	-	-	-	1	1	3	3

COURSE OBJECTIVES

- To impart knowledge and skill in the field of conventional machine tools used in the industries.
- To supplement the theory, course on machining processes.
- To demonstrate and to study of the following machines.
- To understand the machine capabilities and processes completely.

LIST OF EXPERIMENTS**UNIT I LATHE PRACTICE**

- a. Step Turning
- b. Taper Turning
- c. Thread Cutting

UNIT II DRILLING PRACTICE

- a. Drilling
- b. Tapping
- c. Reaming

UNIT III MILLING PRACTICE

- a. Surface Milling
- b. Gear Cutting
- c. Contour Milling

UNIT IV SHAPING PRACTICE

- a. Cutting Key Ways
- b. V-Block machining
- c. Round to Square shape

**TOTAL PERIODS 30****COURSE OUTCOMES**

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

- operate the lathe and make parts by performing step turning, taper turning and thread cutting operations.
- perform the drilling, tapping and reaming.
- ability to operate milling make parts by performing milling and cutting process.
- imagine the shaping and machining process.

REFERENCES

1. Central Machine Tool Institute (CMTI), Machine Tool Design Handbook, Tata McGraw-Hill Publishing Company Ltd, Bangalore, 2008
2. Geoffrey Boothroyd and Winston A. Knight, Fundamental of Machining and Machine Tools, CRC Press, Taylor and Francis Group, Indian Edition, 2006
3. Heinrich Gerling and Karl H. Heller, All About Machine Tools, New Age International (P) Limited Publishers, Noida, 2008
4. Steve F. Krar, Arthur R. Gill and Peter Smid, Technology of Machine Tools, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2008.

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COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	3	3	-	2	-	3	-	2	3	-
CO2	3	-	-	-	3	3	-	3	-	2	-	3	2	-
CO3	3	-	-	-	3	3	-	3	-	2	-	2	3	-
CO4	3	-	-	-	3	3	-	3	-	3	-	2	3	-

COURSE OBJECTIVES

- To list the various practical aspects of instrumentation with emphasis on mechanical domain.
- To explain the various types of governor, cam, balancing of rotating masses and to determine the M.I. of various systems.
- To discuss the concept of mechanical measurement and various methods used for measuring the
- To formulate the concept of vibrating system spring mass.

LIST OF EXPERIMENTS

1. Governor – Determination of sensitivity, effort, etc. for Watt, Porter, Proell, Hartnell Governors.
2. Cam – Study of jump phenomenon and drawing profile of the cam.
3. Motorized Gyroscope – Verification of law's – Determination of gyroscopic couple.
4. Whirling of shaft – Determination of critical speed of shaft with concentrated loads.
5. Balancing of reciprocating masses.
6. Balancing of rotating masses.
7. Determination of Moment of inertia by oscillation method for connecting rod and flywheel.
8. Vibrating system spring mass – system – Determination of damping co – efficient of single degree of Freedom system.
9. Determination of influence co – efficient for multi degree freedom suspension system.
10. Determination of transmissibility ratio – vibrating table.
11. Determination of torsional natural frequency of single and Double Rotor systems. - Undamped and Damped Natural frequencies.
12. Transverse vibration of Free and Fixed beam with and without concentrated masses.

TOTAL PERIODS 30**COURSE OUTCOMES**

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

- relate the different characteristics of governors and verify with gyroscopic relation.
- draw the cam profile with different followers and study of jump phenomenon.
- identify the system response, natural frequency and resonance for free, forced, torsional.
- know experimental verification of dynamic balancing of rotating masses, reciprocating masses.



[illegible]

COURSE OBJECTIVES

- To improve the skills to formulate a technical project.
- To explain the various tasks of the project and standard procedures.
- To Teach the use of new tools, algorithms and techniques required to carry out the projects.
- To analyze the various procedures for validation of the product and analyze the cost effectiveness.

GUIDELINE FOR REVIEW AND EVALUATION

The students may be grouped into 2 to 4 and work under a project supervisor. The Device/system/component to Be fabricated may be decided in consultation with the supervisor. A project report to be submitted by the group and the fabricated model, which will be reviewed and Evaluated for internal assessment by a Committee Constituted by the Head of the Department. At the end of the semester examination the project work is evaluated based on oral presentation and the Project report jointly by external and internal examiners constituted by the Head of the Department. It is highly desirable to publish their project in state/ national level conferences or Symposiums.

TOTAL PERIODS 30**COURSE OUTCOMES**

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

- formulate the real-world problem, identify the requirement and develop the design solutions.
- identify the technical ideas, strategies and methodologies and use the new tools, algorithms, techniques that contribute to obtain the solution of the project.
- analyze and validate through conformance of the developed prototype and analysis the cost effectiveness.
- explain the acquired knowledge through preparation of report and oral presentations.

Mapping of Course Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
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CO1	3	3	-	3	-	-	-	-	-	-	1	-	3	3
CO2	1	1	-	2	-	-	3	3	-	-	-	3	2	1
CO3	2	2	-	-	-	-	2	2	-	-	2	2	-	2
CO4	2	2	-	-	-	-	2	-	-	-	3	-	2	2



	SEMESTER V				
MT16501	DESIGN OF MACHINE ELEMENTS	3	2	0	4
	(Use of PSG Design Data Book is permitted)				

COURSE OBJECTIVES

To enable the students to

- describe the various steps involved in the design process.
- identify the principles involved in evaluating the shape and dimensions of a component and to satisfy functional and strength requirements.
- propose the standard practices and standard data.
- extend the uses of catalogues and standard machine components.
- design the simple machine elements shaft, coupling, joint, lever, spring, flywheel and bearing.

UNIT **STEADY STRESSES AND VARIABLE STRESSES IN MACHINE MEMBERS** **15**

Introduction to the design process - factor influencing machine design, selection of materials based on mechanical properties - Direct, Bending and Torsional stress equations - Impact loading - Calculation of principle stresses for various load combinations- **Design of curved Beams** - Crane hook and C frame - Factor of safety - The theories of failure.

UNIT II **DESIGN OF SHAFTS AND COUPLINGS** **15**

Design of solid and hollow shafts based on strength, rigidity and critical speed - Design of keys and key ways - Design of rigid and flexible couplings - **Muff, Clamp, Rigid Flange**, Bushed - pin flexible couplings.

UNIT III **DESIGN OF JOINTS** **15**

Threaded fasteners - Bolted joints including eccentric loading, Knuckle joints, Cotter joints - Welded joints, Riveted joints for structures - **theory of bonded joints.**

UNIT IV **DESIGN OF SPRINGS AND FLYWHEEL** **15**

Design of helical, multi- leaf and torsional springs under constant loads and varying loads - End conditions and length of springs - Stresses in Helical springs of circular wire - Wahl stress factor - **Design of flywheels involving Stresses in rim and arm.**

UNIT V **DESIGN OF BEARINGS** **15**

Sliding contact and rolling contact bearings - Hydrodynamic journal bearings - Somerfield Number - Raimondi and Boyd graphs - **Selection of Rolling Contact bearings.**

TOTAL PERIODS 75

COURSE OUTCOMES

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

- acquire knowledge about design process and the factors influencing it and design the simple components for static loading.
- categories the knowledge of life of the components subjected to varying loads.
- encompass grasped the concept the welded joints, threaded joints and springs subjected to static loads.
- formulate the design procedure for springs and flywheel.
- understand the rolling contact bearings for static and cyclic loads, select the lubricants and bearing dimensions for hydrodynamic lubrication.

TEXT BOOKS

1. Bhandari V, “Design of Machine Elements”, 3rd Edition, Tata McGraw-Hill Book Co, (2010).
2. Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett “Mechanical Engineering Design”, 8th Edition, Tata McGraw-Hill, (2008).

REFERENCES

1. Sundararajamoorthy T. V. Shanmugam .N, “Machine Design”, Anuradha Publications, Chennai, (2003).
2. Robert C. Juvinall and Kurt M. Marshek, “Fundamentals of Machine Design”, 4th Edition, Wiley, (2005).
3. Alfred Hall, Halowenko, A and Laughlin, H., “Machine Design”, Tata McGraw-Hill Book Co (2011).
4. Bernard Hamrock, Steven Schmid, Bo Jacobson, “Fundamentals of Machine Elements”, 2nd Edition, Tata McGraw-Hill Book Co., (2006).
5. Orthwein W, “Machine Component Design”, Jaico Publishing Co, (2003).

WEB LINKS

1. <https://mech.iitm.ac.in/meiitm/course/design-of-machine-elements/>
2. <http://www.readorrefer.in/article/Design-of-Shafts-and-Couplings-5901/>
3. <https://www.rroij.com/open-access/design-and-development-of-dual-mass-flywheel-system.php?aid=54289>



Mapping of Course Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
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CO3	3	3	-	-		2	-	1	-	2	2	-	-	-
CO4	3	2	-	-		2	-	-	-	2	1	-	2	-
CO5	3	3	-	-	-	3	-	2	-	2	2	-	-	-

COURSE OBJECTIVES

To enable the students to

- achieve a knowledge of the basic laws governing the operation of electrical instruments and the measurement techniques.
- discuss about units, standards, error analysis and characteristics of measurement systems.
- plan and purpose of this course is to make the students to get adequate knowledge about virtual instrumentation.
- learn a signal conditioning circuit and data acquisition system.
- understand the program for various applications of lab view and DAQ card.

UNIT I SCIENCE OF MEASUREMENT 9

Units and Standards; Calibration techniques; **Errors in Measurements**; Generalized Measurement System; Static and dynamic characteristics of transducers; Generalized Performance of Zero Order and First Order Systems; Response of transducers to different Time varying inputs. Classification of transducers.

UNIT II MECHANICAL MEASUREMENTS 9

Temperature measurement - **Filled thermometer; bimetallic thermometer**; Pressure measurement - Bourdon gauge; Bellows; diaphragm; Vacuum measurement - McLeod gauge; thermal conductivity gauge; Ionization gauge; Flow Measurement - **turbine flow Meter**, hot wire Anemometer; Float level sensor.

UNIT III ELECTRICAL MEASUREMENTS 9

Potentiometer; RTD, Thermistor, Thermocouple; Strain gauges; LVDT, RVDT; Capacitive transducers; Piezo electric transducer; **Pyrometers**; load cell; Hall effect Transducers; Photoelectric transducers; Fiber Optic transducers; hygrometer.

UNIT IV SIGNAL CONDITIONING AND DATA ACQUISITION 9

Amplification, Filtering; Level conversion Linearization ; Buffering; Sample and Hold circuit; Analog to Digital converter; Digital to Analog converter; Data Acquisition; Data Logging; Data conversion; **Introduction to Digital Transmission system.**

UNIT V VIRTUAL INSTRUMENTATION 9

Introduction to Lab VIEW; Graphical user interfaces; Data types; Data flow programming; Graphical programming; Palettes and tools Front panel objects; Functions and libraries; FOR Loops; WHILE Loops; Arrays and Clusters; **Data acquisition using DAQ card.**

TOTAL PERIODS 45

COURSE OUTCOMES

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

- identify the units and standards, their conversions, characteristics and error analysis of systems.
- describe the different devices available in mechanical measurements.
- classify and describe resistive, inductive and capacitive transducers which are used for measuring various parameters like displacement, temperature, humidity etc.
- design a signal conditioning circuit and data acquisition system.
- construct the lab view program for various applications and to know the use of lab view and DAQ card.

TEXT BOOKS

1. A.K.Sawhney and P.Sawhney, A Course on Mechanical Measurement Instrumentation and Control, Dhanpat Rai and Co, New Delhi, 2011.
2. Garry M. Johnson, Labview Graphical Programming, Tata McGraw; Hill Publishing Company Limited, New Delhi, 2006.

REFERENCES

1. D. Patranabis, "Sensors and Transducers", PHI, New Delhi, 2nd Edition, 2010.
2. Ernest O. Doebelin, "Measurement Systems - Applications and Design", Tata McGraw-Hill, 2009.
3. D. Patranabis, Principles of Industrial Instrumentation, Tata McGraw Hill Publishing Company Limited, New Delhi, 2011.

WEB LINKS

1. <http://www.mfg.mtu.edu/cyberman/machtool/machtool/sensors/fundamentals.html>
2. <http://sensorsandinstrumentation.co.uk/>



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CO1	2	3	1	-	2		2	-		2	2	-		2
CO2	3	3	-	-	-		2	1		2	2	-	-	0
CO3	-	3	2		1		-	2		-	2	1	-	2
CO4	3	3	2		1		2	1		3	2	1	-	2
CO5	-	3	2		1	-	-	1		-	2	2	-	2

COURSE OBJECTIVES

To enable the students to

- identify the evolution and principle of CNC machine tools.
- describe the constructional features of CNC machine tools.
- construct the simple programs for CNC turning and machining centers.
- describe the tooling and work holding devices for CNC machine tools.
- explain the CNC programs for popular CNC controllers.

UNIT I INTRODUCTION TO CNC MACHINE TOOLS 9

Evolution of CNC Technology, principles, features, advantages, applications - CNC and DNC concept, systems - classification of CNC Machines turning center, machining center, grinding machine, EDM - Types of control CNC controllers, characteristics, interpolators - Computer Aided Inspection.

UNIT II STRUCTURE OF CNC MACHINE TOOL 9

CNC Machine building, structural details, configuration and design - Guide ways Friction - Anti friction and other types of guide ways - Elements used to convert the rotary motion to a linear motion Screw and nut, recirculating ball screw, planetary roller screw, rack and pinion - spindle assembly - torque transmission Elements gears, timing belts.

UNIT III DRIVES AND CONTROLS 9

Spindle drives - DC shunt motor, 3 phase - AC induction motor - Feed drives - Stepper motor - Servo principle - DC and AC servomotors - Open loop and closed loop control - Axis measuring system - synchro, synchro- resolver, gratings, moiré fringe gratings, encoders.

UNIT IV CNC PROGRAMMING 9

Coordinate system - Structure of a part program - G & M Codes - Tool length compensation - Cutter radius and tool nose radius compensation - Do loops, subroutines, canned cycles, mirror image, parametric programming - Machining cycles and programming for machining - Generation of CNC codes from CAM packages.

UNIT V TOOLING AND WORK HOLDING DEVICES 9

Introduction to cutting tool materials: Carbides, Ceramics, CBN, PCD inserts classification - PMK, NSH, holding qualified, semi qualified and preset tooling - Tooling system for machining center and turning center - Work Devices for rotating and fixed work parts - Economics of CNC - maintenance of CNC machines.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- identify the evolution, principles, classification and applications of CNC machine tools.
- define the basic structure, construction, working and control of CNC machines.
- identify the fundamentals of drive system and control modules of CNC technology.
- expand the program for CNC machines.
- propose the knowledge about different tooling and working holding devices of CNC.

TEXT BOOKS

1. P. Radhakrishnan, Computer Numerical Control Machine & Computer Aided Manufacturing, New Academic Science Limited.
2. Tilak Raj, CNC Technology & Programming, Dhanpat Rai publishing company(p) ltd., New Delhi.

REFERENCES

1. P. N. Rao and N. K. Tiwari, Numerical Control and Computer Aided Manufacturing, Tata McGraw-Hill Publishing company, New Delhi.
2. M. Adithan & B. S. Pabla, CNC Machines, New Age International Publishers, New Delhi.
3. HMT Limited, "Mechatronics", Tata McGraw-Hill Publishing Company Limited, New Delhi, 2005.

WEB LINKS

1. <http://www.brighthubengineering.com/manufacturing-technology>
2. <https://www.scribd.com/doc/29051586/Introduction-of-CNC-Machine>



Mapping of Course Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	1		2	-	-	-	2	-	2	3
CO2	2	-	1	-	-		2	1	-	-	2	-	1	2
CO3	1	-	2	-	1		-	1	-	-	2	-	-	1
CO4	3	-	2	-	1		2	2	-	-	2	-	1	2
CO5	1	-	2	-	1		2	1	-	-	2	-	-	2

COURSE OBJECTIVES

To enable the students to

- know the constituents of the environment and the precious resources in the environment.
- conserve all biological resources.
- understand the role of human being in maintaining a clean environment and useful environment for the future generations.
- acquire knowledge about ecological balance and preserve bio-diversity.
- understand the role of government and non-government organizations in environment management.

UNIT I INTRODUCTION TO ENVIRONMENTAL STUDIES AND NATURAL RESOURCES 9

Environment: Definition - scope - importance - need for public awareness. Forest resources: Use - over exploitation - deforestation - case studies - mining - effects on forests and tribal people. Water resources: Use - over utilization of surface and ground water - floods - drought - conflicts over water. Mineral resources: Use - exploitation - environmental effects of extracting and using mineral resources - case studies. Food resources: world food problems - changes caused by agriculture and overgrazing - effects of modern agriculture- fertilizer -pesticide problems - water logging - salinity - case studies. Energy resources: Growing energy needs - renewable and non - renewable energy sources. Land resources: Land as resource - land degradation - soil erosion. Role of an individual in conservation of natural resources.

UNIT II ECOSYSTEMS AND BIODIVERSITY 9

Concept of an ecosystem: Structure and function of an ecosystem - producers - consumers - decomposers - energy flow in the ecosystem - ecological succession - food chains - food webs and ecological pyramids. Types of ecosystem: Introduction - characteristic features - forest ecosystem - grassland ecosystem - desert ecosystem - aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries). Biodiversity: Introduction - definition (genetic - species -ecosystem) diversity. Value of biodiversity: Consumptive use - productive use - social values - ethical values - aesthetic values. Biodiversity level: Global - national - local levels - India as a mega diversity nation - hotspots of biodiversity. Threats to biodiversity: Habitat loss - poaching of wildlife - man wildlife conflicts - endangered and endemic species of India. Conservation of biodiversity: In-situ and ex-situ conservation of biodiversity - field study.

UNIT III POLLUTION

9

Pollution : Definition - air pollution - water pollution - soil pollution - marine pollution - noise pollution - thermal pollution - nuclear hazards. Solid waste management: Causes - effects - control measures of urban and industrial wastes. Role of an individual in prevention of pollution - pollution case studies. Disaster management: Floods - earthquake - cyclone - landslides. Electronic waste - sources - causes and its effects.

UNIT IV SOCIAL ISSUES AND ENVIRONMENT

9

Sustainable development: Unsustainable to sustainable development - urban problems related to energy. Water conservation - rain water harvesting - watershed management. Resettlement and rehabilitation of people. Environmental ethics: Issues - possible solutions - climate change - global warming and its effects on flora and fauna - acid rain - ozone layer depletion - nuclear accidents - nuclear holocaust - wasteland reclamation - consumerism and waste products. Environment protection act: Air (Prevention and Control of Pollution) act -water (Prevention and control of Pollution) act - wildlife protection act - forest conservation act - issues involved in enforcement of environmental legislation.

UNIT V HUMAN POPULATION AND ENVIRONMENT

9

Human population: Population growth - variation among nations - population explosion - family welfare programme and family planning - environment and human health - Human rights - value education - HIV/ AIDS, Swine flu - women and child welfare. Role of information technology in environment and human health.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- explain the relationship between the human population and environment.
- elaborate the basic concepts of environment studies and natural resources.
- gain the knowledge about ecosystem and biodiversity.
- have knowledge about causes, effects and control measures of various types of pollution.
- understand the social issues and various environmental acts.

TEXT BOOKS

1. Raman Sivakumar, Introduction to Environmental Science and Engineering, 2nd Edn, Tata McGraw Hill Education Private Limited, New Delhi, (2010).
2. Benny Joseph, "Environmental Science and Engineering", Tata McGraw Hill, (2010).

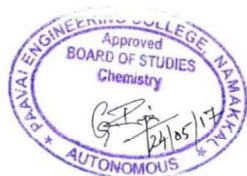
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1. Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad India, 2010.
2. S. Divan, Environmental Law and Policy in India, Oxford University Press, New Delhi, 2001.
3. K.D. Wager, Environmental Management, W.B. Saunders Co., Philadelphia, USA, 1998.
4. W.P. Cunningham, Environmental Encyclopaedia, Jaico Publishing House, Mumbai, 2004.

5. Clair Nathan Sawyer, Perry L. McCarty, Gene F. Parkin, "Chemistry for Environmental Engineering and Science", McGraw-Hill Education; 5 edition, 2002.

WEB LINKS

1. www.chegg.com
2. www.vidhyarathiplus.com



Mapping of Course Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-		3		2	-	-	2		-
CO2	-	-	2	-	-		-		-	2	-	2		2
CO3	2	-	2	-	2		-		-	2	-	2		-
CO4	2		2	-	2		3		-	2	-	2		2
CO5	-		-	-	-		3		2	2	-	2		-

COURSE OBJECTIVES

To enable the students to

- develop the analysis and design skills needed in PC based acquisition and controlsystems.
- measure voltage, current, temperature, displacement, power and torque.
- provide hands on experience on measuring instruments.
- understand the concept of controlling the parameters based on measurement.

LIST OF EXPERIMENTS

1. Measurement of temperature using thermocouple.
2. Measurement of temperature using thermistor.
3. Measurement of temperature using RTD.
4. Measurement of linear and rotary displacement using potentiometer.
5. Measurement of displacement using LVDT.
6. Strain measurement using strain gauge.
7. Torque measurement using torque sensor.
8. Speed and position control of D.C servo motor.
9. Digital comparator.
10. Voltage to frequency and frequency to voltage converter.
11. Study on the application of data acquisition system for industrial purposes.

TOTAL PERIODS 30

COURSE OUTCOMES

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

- choose the sensors for the measurement of different signals.
- analyze the servomotor position control using photo electric pickup.
- create the appropriate design procedure to obtain a required measurement data.
- identify the signal processing techniques to convert them to usefultsignal.



Mapping of Course Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	1	-	2		1		3	2	1	-	2	3
CO2	3	-	-	-	-		1		3	2	1	-	-	2
CO3	3	-	2	-	3		-		3	-	1	-	2	1
CO4	2	-	1	-	1		1		3	3	2	-	2	2

COURSE OBJECTIVES

To enable the students to

- design problems in a systematic manner.
- instruct the manual and computer assisted part programming, tool path generation operation and control of CNC machines tools.
- use the CNC machines efficiently for manufacturing desired products and knowledge of programming and use of CNC tooling.
- implement CNC programs for milling and turning machining operations.

LIST OF EXPERIMENTS

1. Study of G codes and M codes for machining center and turning center.
2. Manual part programming using G and M codes for Turning, step turning, Taper turning, thread cutting and radius turning on cylindrical components.
3. Given a component drawing to write the manual part programming and execute on CNC Lathe and Milling Machine.
4. Programming and Simulation of machining using the following features.
 - (i) Linear and Circular interpolation.
 - (ii) Pocket milling, slotting, peck drilling and other fixed canned cycles.

TOTAL PERIODS 30

COURSE OUTCOMES

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

- program in the CNC machines to generate any contour/profile.
- use an understanding of General and Machine (G & M) code to generate or edit a program which will operate a CNC Lathe.
- develop the CNC program for machining center.
- develop the CNC program for pocket milling, slotting, peck drilling and other fixed canned cycles.

REFERENCES

1. T. William W. Lugges, CNC A First Look Primer, Delmar Publishers, New York, (1997).
2. Alan Overby, CNC Machining Handbooks: Building, Programming and Implementation, McGraw-Hill Publishing Company Ltd, New York, (2011).

WEB LINKS

1. <http://www.sosmath.com/matrix/matrix.html>



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PROGRAMME ELECTIVE COURSES (PE)

PROGRAMME ELECTIVE - I

MT16151

ADVANCED MANUFACTURING PROCESSES

3 0 0 3

COURSE OBJECTIVES

To enable the students to

- identify the several non-traditional machining process in micro and precision manufacturing field.
- select the suitable electro chemical machining process for materials considering their merits and demerits.
- study the various process parameters and their effect on the component machined on various thermo electrical machining processes.
- build broad understanding of laser based physical processes and their implications in material processing and manufacturing processes.
- provide the students with an understanding of the basic fundamentals of rapid prototyping, its fabrication techniques, materials and various areas of defects and improvements in Rapid Prototyping.

UNIT I ADVANCED MACHINING PROCESSES

9

Introduction - Classification - process economy - Mechanical machining - Types - Ultrasonic machining (USM) - Abrasive Jet Machining (AJM) - Abrasive Flow Machining (AFM) - Water Jet Machining (WJM) - Operating principle - Process parameters - Applications - Limitations.

UNIT II ELECTRO CHEMICAL MACHINING

9

Electro chemical machining - Chemical material removal - Types - Electro chemical machining (ECM) - Electro chemical drilling (ECD) - Electro chemical grinding (ECG) - Electro chemical honing (ECH) - Shaped tube electrolytic machining - Operating principle - Process parameters - Applications - Limitations.

UNIT III THERMO ELECTRICAL MACHINING

9

Thermo electrical machining - Types - Electrical discharge machining (EDM) - Electrical discharge wire cutting (EDWC) - Electron beam machining (EBM) - Ion Beam Machining (IBM) - Plasma Arc Machining (PAM) - Operating principle - Process parameters - Applications - Limitations.

UNIT IV LASER MATERIALS PROCESSING

9

Laser materials processing - Laser types - Processes - Laser beam machining (LBM) - Laser cutting (LC) - Laser drilling (LD) - Laser marking and engraving (LM) - Laser micromachining (LMM) - Laser engineered net shaping (LENS) - Applications - Limitations.

UNIT V SPECIAL PROCESSING TECHNOLOGIES**9**

Special processing technologies - Rapid Prototyping - Methods - Fused Deposition Modeling (FDM) - Laminated Object Manufacturing (LOM) - Selective laser sintering (SLA) - Solid Ground curing (SGC) - 3D printing (3DP) - Processing of integrated circuits - Micro and nano fabrication technologies.

TOTAL PERIODS 45**COURSE OUTCOMES**

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

- identify the contribution of non-traditional machining process in micro and precision.
- select the most appropriate process for a given product design, application requirements and constraint.
- summarize the merits and demerits of the non-traditional manufacturing process.
- to identify, select, and optimize laser materials processes through case studies of practical problems and probable solutions for innovative and potential next generation manufacturing.
- invent subtractive and additive (3D-Printing) manufacturing for rapid prototyping.

TEXT BOOKS

1. Abdel, H. and El-Hofy, G. "Advanced Machining Processes", McGraw-Hill, USA, 2005.
2. Wellar, E.J. "Non-Traditional Machining Processes", Society of Manufacturing Engineers Publications, 2nd edition, Michigan, 1984.

REFERENCES

1. Steen, W.M. and Watkins, K. "Laser Materials Processing", Springer London Ltd, 2003.
2. Groover, M.P. "Fundamentals of modern manufacturing processes - Materials, Processes and Systems.

WEB LINKS

1. nptel.ac.in/courses/112107077/
2. <https://www.iitk.ac.in/me/advanced-manufacturing-processes>
3. <https://www.nhti.edu/.../course.../advanced-manufacturing-processes-course-descriptio>



Mapping of Course Outcomes with Programme Outcomes:
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	-	-	-	-	-	1	-	-	1	2	-	3	-
CO2	1	-	-	-	2	2	-	2	-	2	2	-	2	-
CO3	1	-	-	-	1	2	1	2	-	-	2	-	3	-
CO4	1	-	-	-	2	1	-	2	-	2	2	-	2	-
CO5	1	-	-	-	-	1	1	-	-	-	3	-	2	-

COURSE OBJECTIVES

To enable the students to

- introduce discrete fourier transform and its applications.
- list signal processing concepts in systems having more than one sampling frequency.
- define structure and techniques of IIR filter.
- define structure and techniques of FIR filter.
- teach the design of infinite and finite impulse response filters for filtering undesired signals.

UNIT I SIGNALS AND SYSTEMS 9

Basic elements of DSP - concepts of frequency in Analog and Digital Signals - sampling theorem - discrete - time signals, systems - analysis of discrete time LTI systems - Z transform - convolution - correlation.

UNIT II FREQUENCY TRANSFORMATIONS 9

Introduction to DFT - properties of DFT - circular convolution - filtering methods based on DFT - FFT algorithms - decimation - in - time algorithms, Decimation - in - frequency algorithms - Use of FFT in linear filtering - DCT - use and application of DCT.

UNIT III IIR FILTER DESIGN 9

Structures of IIR - analog filter design - discrete time IIR filter from analog filter - IIR filter design by impulse invariance, Bilinear transformation, Approximation of derivatives - (LPF, HPF, BPF, BRN) filter design using frequency translation.

UNIT IV FIR FILTER DESIGN 9

Structures of FIR - linear phase FIR filter - fourier series - Filter design using windowing techniques (Rectangular Window, Hamming Window, Hanning Window), Frequency sampling techniques.

UNIT V FINITE WORD LENGTH EFFECTS IN DIGITAL FILTERS 9

Binary fixed point and floating point number representations - comparison - quantization noise - truncation and rounding - quantization noise power - input quantization error - coefficient quantization error - limit cycle oscillations - dead band - overflow error - signal scaling.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- know the discrete Fourier transform and its applications.
- perform frequency transforms for the signals.
- design IIR filters.
- design FIR filters.
- construct finite word length effects in digital filters.

TEXT BOOKS

1. John G. Proakis and Dimitris G.Manolakis, “Digital Signal Processing - Principles, Algorithms & applications”, Fourth Edition, Pearson Education, Prentice Hall, (2015).

REFERENCES

1. Emmanuel C.Ifearchor, and Barrie.W.Jervis, “Digital Signal Processing”, Second Edition, Pearson Education, Prentice Hall, (2012).
2. Sanjit K. Mitra, “Digital Signal Processing - A Computer Based Approach”, Third Edition, Tata McGraw Hill, (2012).
3. A.V.Oppenheim, R.W. Schafer and J.R. Buck, Discrete-Time Signal Processing, 8th Indian Reprint, Pearson, (2014).
4. Andreas Antoniou, “Digital Signal Processing”, Tata McGraw Hill, (2015).

WEB LINKS

1. [http://www. signals and systems .html](http://www.signalsandsystems.html)
2. [http://www. filter design.html](http://www.filterdesign.html)
3. [http://www.digital filters.html](http://www.digitalfilters.html)
4. [http://www. signal Processing.html](http://www.signalProcessing.html)

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COURSE OBJECTIVES

To enable the students to

- identify with various types of maintenance, their procedure and defects analysis commonly adopted in manufacturing industries.
- discriminate preventive, predictive and failure maintenance.
- describe procedures and guidelines on work permit system to carry out jobs of inspection, testing, maintenance, alternation, repair, upkeepment and construction in safest possible manner.
- distinguish about usage of computers for maintenance management.
- understand how condition monitoring techniques can be used to detect and analyse some common machinery problems.

UNIT I DEFECTS AND FAILURE ANALYSIS 9

Maintenance Concept, Maintenance objective, Challenges in maintenance. Defect generation - types of failures - defect reporting and recording - defect analysis - failure analysis - equipment down time analysis - breakdown analysis - FTA - FMEA - FMECA.

UNIT II MAINTENANCE SYSTEMS 9

Planned and un-planned maintenance - breakdown maintenance - corrective maintenance - opportunistic maintenance - routine maintenance - preventive maintenance - predictive maintenance - condition based maintenance system - design out maintenance - maintenance by objectives - selection of maintenance system.

UNIT III SYSTEMATIC MAINTENANCE 9

Codification and Cataloguing - instruction manual and operating manual - maintenance manual and departmental manual - maintenance time standard - maintenance work order and work permit - job monitoring - feedback and control - maintenance records and documentation. Introduction to Total Productive Maintenance (TPM).

UNIT IV COMPUTER MANAGED MAINTENANCE SYSTEM 9

Selection and scope of computerization - equipment classification - codification of breakdown, material and facilities - job sequencing - material management module - captive engineering module. Decision making in maintenance. Economic aspects of maintenance.

UNIT V CONDITION MONITORING 9

Condition monitoring techniques - visual monitoring - temperature monitoring - vibration monitoring - lubricant monitoring - cracks monitoring - thickness monitoring - noise and sound monitoring - condition monitoring of hydraulic system. Machine diagnostics - objectives - monitoring strategies.

TOTAL PERIODS 45

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

- classify the maintenance system and select suitable one based on requirement.
- identify the documentation and record updating involved in maintenancesystems.
- prepare the maintenance plan and explain the cost benefit analysis.
- analyze the defects and failures encountered in manufacturing system.
- establish the monitoring strategies according to system characteristics.

1. Keith Mobley, Lindley Higgins and Darrin Wikoff, "Maintenance Engineering Handbook", McGraw-Hill, 2008.
2. Sushil Kumar Srivastava, Industrial Maintenance Management, S. Chand and Company Ltd, New Delhi, 2006.

1. Manfred, H. "Bibring, Handbook of Machine Tools", Vol.3, John Wiley & Sons.
2. Mishra R.C., Pathak K. "Maintenance Engineering and Management", Prentice Hall of India Private Ltd., New Delhi, 2002.
3. R. Keith Mobley, Maintenance Fundamentals, Butterworth Heinemann Publications, USA, 2004.

1. <https://www.lce.com/Whats-the-role-of-the-Reliability-Engineer-1227.html>
2. <http://www.defectsandfailureanalysis.com/>
3. <https://www.hon.ch/HONselect/Selection/E01.370.html>

[illegible]

COURSE OBJECTIVES

To enable the students to

- define the basics of simulation modeling and replicating the practical situations in organizations.
- generate random numbers and random variates using different techniques.
- develop simulation model using heuristic methods.
- analysis of simulation models using input analyzer, and output analyzer.
- get elaborate knowledge on system identification and decision making.

UNIT I SYSTEM AND SYSTEM ENVIRONMENT 9

Component of a system - continuous and discrete systems - types of model; Steps in simulation study; Simulation of an event occurrence using random number table - single server queue -two server queues - inventory system.

UNIT II RANDOM NUMBER GENERATION 9

Properties of random numbers - generation of pseudo - random numbers - techniques of generating pseudo random numbers; test for random numbers: the chi-square test-the Kolmogorov smirnov test - runs test - gap test - poker test.

UNIT III RANDOM - VARIATE GENERATION 9

Inverse transform technique for exponential, uniform, triangular, weibull, empirical, uniform and discrete distribution, acceptance rejection method for poisson and gamma distribution; direct transformation for normal distribution.

UNIT IV ANALYSIS OF DATA 9

Analysis of simulated data - data collection, identifying the distribution, parameter estimation, goodness of fit tests, verification and validation of simulation models.

UNIT V SYSTEM IDENTIFICATION 9

Concepts of system identification - identification using normal operating records (integration method) - identifiability conditions - system order determination.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- describe the simulation and its importance in creation of models for real time systems.
- describe the different types of systems.
- simulate the real time systems by generating the random numbers and variables.
- design and analyze the model using simulation software packages.
- identify system using integration method.

TEXT BOOKS

1. Banks J., Carson J.S. and Nelson B.L., “Discrete - Event System Simulation”, 3rd Edition, Pearson Education, Inc 2004 (ISBN 81-7808-505-4).

REFERENCES

1. Geoffrey Gorden, “System Simulation”, Prentice Hall of India, 2003.
2. Narsingh Deo., “System Simulation with Digital Computer”, Prentice Hall of India, 2003.
3. Birta, "Modelling and Simulation: Exploring Dynamic System Behaviour", Springer, Indian Reprint, 2010.

WEB LINKS

1. https://web.stanford.edu/class/archive/ee/ee392m/ee392m.../Lecture9_ModelSim.pdf
2. <https://computational-eng.llnl.gov/>
3. aimday.se/modelling-simulation/modelling-simulation/

[illegible]

COURSE OBJECTIVES

To enable the students to

- identify the several aspects of the design process.
- study the concept of product costing, patenting and manufacturing economics in product design.
- identify with the relationship between customer desires.
- propose the functional requirements, product materials and product design.
- investigate the knowledge about manufacturing process selection.

UNIT I PRODUCT DESIGN AND PLANNING 9

Product planning - identifying opportunities - allocating resources and timing - pre-project planning - reflect on the results and the process - identifying customer needs - raw data from customers - interpreting raw data in terms of customer needs - organizing the needs into a hierarchy - establishing the relative importance of the needs -reflecting on the results and the process.

UNIT II PRODUCT SPECIFICATIONS AND CONCEPT GENERATION 9

Specifications - specifications established - establishing target specifications - setting the final specifications - concept generation - the activity of concept generation - clarify the problem - external search - internal search - systematic exploration - reflect on the results and the process.

UNIT III PRODUCT DEVELOPMENT ECONOMICS 9

Elements of economic analysis - quantitative analysis, qualitative analysis - building a base - case financial model - sensitivity analysis - development cost and time with examples - project trade-offs - six potential, trade off rules, limitations - influence of qualitative factor on project success - qualitative analysis.

UNIT IV COST ESTIMATION 9

DFM Cross functional team - estimate the manufacturing cost, reduce the cost of components, reduce the cost of assembly, rescue the cost of supporting production - impact of DFM decisions - development time, development cost, product quality, external factors.

UNIT V PATENTS AND INTELLECTUAL PROPERTY 9

Overview of patents, utility patents, preparing a disclosure - formulate strategy plan- study of prior invention- outline claims - description of inventions - refine claims - pursue application - reflect of result and process.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- identify the customer requirements to start new project and carryout product planning.
- generate and select suitable ideas to pursue successful design.
- quantify and access the manufacturing process and cost to make well defined component.
- express the process of patenting the intellectual property.
- apply the economic reasoning to analysis the contemporary problem for newly developed product.

TEXT BOOKS

1. Karl T. Ulrich and Stephen D. Eppinger, “Product Design and Development”, McGraw- Hill Book Company, New Delhi, (2009).
2. Benjamin W. Niebel and Alanb. Draper, “Product Design and Process Engineering”, Tata Publishing Company Ltd, New Delhi, (1976).

REFERENCES

1. George E. Dieter, “Engineering Design - Materials and Process Approach”, Tata McGraw- Hill Publishing Company Limited, New Delhi, (2008).
2. S. Dalela and Mansoor Ali, “Industrial Engineering and Management Systems”, Standard Publishers Distributors Pvt. Ltd., New Delhi, (2006).
3. Harry Nystrom, “Creativity and Innovation”, John Wiley and Sons Pvt. Ltd., Singapore, McGraw-Hill, (1988).
4. S. B. Srivastava, "Industrial Management", I. K. International Publishing House Pvt. Ltd., New Delhi, (2012).

WEB LINKS

1. <https://help.sap.com/doc/.../3.6/en-US/1c9acf535b804808e10000000a174cb4.html>
2. <https://www.diva-portal.org/smash/get/diva2:621113/FULLTEXT01.pdf>
3. productdesignmanagement.com/design-to-cost/



Mapping of Course Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
	Programme Outcomes (POs)													
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
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CO3	1	-	-	-	1	2	2	1	-	-	2	1	-	1
CO4	1	-	-	-	1	2	1	2	2	-	1	-	2	2
CO5	1	-	-	-	1	2	2	1	2	-	1	-	-	3

COURSE OBJECTIVES

To enable the students to

- provide a clear view on Programmable Logic Controllers (PLC).
- propose the various methods involved in automatic control and monitoring.
- develop the PLC program for various applications.
- familiarize with the communication protocols.
- learn the use of Supervisory Control and Data Acquisition (SCADA).

UNIT I PROGRAMMABLE LOGIC CONTROLLERS 9

Introduction - Parts of PLC - Principles of operation - PLC sizes - PLC hardware components - I/O section - Analog I/O modules - digital I/O modules; PLC programming Simple instructions - output control devices; latching relays, converting simple relay diagram into PLC ladder diagram.

UNIT II INSTRUCTIONS 9

Timer instructions - ON delay, OFF delay and retentive Timers; UP counter, DOWN Counter and cascading counters, Program control instructions; Data manipulating instructions; math Instructions.

UNIT III APPLICATIONS OF PLC 9

Simple materials handling applications, Automatic control of warehouse door, Automatic lubrication of supplier conveyor belt, Automatic car washing machine, Bottle Label detection and process control application.

UNIT IV PLC MAINTENANCE AND CASE STUDIES 9

PLC maintenance - internal PLC faults - faults external to PLC - watch dogs - safety; Hardware safety circuits - troubleshooting; Case Studies: PLC as robot controller and FMS - PLC to factory automation

UNIT V INTRODUCTION TO SCADA AND DCS 9

Supervisory Control and Data Acquisition Systems: Introduction - Evolution of SCADA - features of SCADA - SCADA Architecture - Components of SCADA - Master Terminal Unit - Remote terminal Unit - SCADA Communications; Distributed Control System: Evolution - Architectures - Local control unit - Process interfacing issues - Communication facilities

TOTAL PERIODS **45**

COURSE OUTCOMES

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

- identify the different parts of PLC and its functions.
- analyze the use of timers and counters in PLC.
- develop the PLC program for various applications.
- know about the maintenance of PLC.
- realize the use of Supervisory Control and Data Acquisition

TEXT BOOKS

1. Petruzella Frank D, Programmable Logic Controllers, Tata McGraw-Hill Publishing (P) Ltd., New Delhi, 2017.
2. Stuart A. Boyer, SCADA: Supervisory Control and Data Acquisition, (4e), ISA Publication, 2009.

REFERENCES

1. Lukcas M.P., "Distributed Control Systems", Van Nostrand Reinhold Co., New York, 1986.
2. Bolton , "Programmable Logic Controllers 5th Edition Newnes,2009.

WEB LINKS

1. <http://electrical;engineering;portal.com/basic;steps;in;plc;programming>
2. www.control.com
3. www.automation;info.com



Mapping of Course Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	-	-	2	2			3	-	1	-	2	-
CO2	2	2	-	-	-	3			3	-	1	-	1	-
CO3	1	2	-	-	2	1			3	-	3	-	-	-
CO4	3	2	-	-	2	2			-	-	2	-	3	-
CO5	2	2	-	-	2	2			3	-	2	-	2	-

COURSE OBJECTIVES

To enable the students to

- identify the concepts of fluid power.
- examine the fundamental knowledge of hydraulic and pneumatic system.
- design and operation of hydraulic and pneumatic components and systems.
- use application in manufacturing and mechanical systems.
- identify the design of hydraulic and pneumatic circuits applied in industries.

UNIT I FLUID POWER SYSTEMS 9

Introduction to Fluid power - Advantages and Applications - Fluid Power ANSI Symbols - Types of fluids - Properties of fluids - Pascal's law and Applications - Basics of Hydraulics - Principles of flow - Pump Classification - Pump characteristics - Construction, Working, Performance, Selection criteria of pumps, Advantages, Disadvantages.

UNIT II HYDRAULIC ACTUATORS AND VALVES 9

Hydraulic Actuators: Cylinders - Types and construction, Application, Hydraulic cushioning - Hydraulic motors Control Components: Direction control, Flow control and Pressure control valves - Types, Construction and Operation - Servo and Proportional valves - Applications.

UNIT III HYDRAULIC SYSTEMS 9

Intensifiers, Industrial hydraulic circuits - Regenerative, Pump Unloading, Double-pump, Pressure Intensifier, Air - over oil, Reciprocation, Synchronization, Sequencing, Fail-safe, Speed Control, Hydrostatic transmission, Electro Hydraulic circuits.

UNIT IV PNEUMATIC SYSTEMS 9

Properties of air - Perfect Gas Laws - Filter, Regulator, Lubricator - Pneumatic actuators, Design of pneumatic Circuit cascade method - Electro pneumatic circuits. Accumulators: types and applications.

UNIT V TROUBLE SHOOTING AND APPLICATIONS 9

Installation, Selection, Maintenance, Trouble Shooting and Remedies in Hydraulic and Pneumatic Systems - Case studies and Design of hydraulic circuits for Drilling, Planning, Shaping, Surface grinding, Press and Forklift Applications. Design of Pneumatic circuits for a Pick and Place application - Case studies.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- illustrate symbols used in hydraulic and pneumatic systems.
- identify the appropriate components for hydraulic and pneumatic circuits.
- operate and maintain various pneumatic and hydraulic systems in industrial environments.
- design the hydraulic and pneumatic circuits for simple application.
- construct the fluid power circuits applied in industries.

TEXT BOOKS

1. Anthony Esposito, “Fluid Power with Applications”, Pearson, (2009).
2. S. R. Majumdar, “Pneumatic systems - Principles and maintenance”, Tata McGraw Hill, (2014).

REFERENCES

1. James L. Johnson, “Introduction to Fluid Power”, Delmar Thomson Learning, (2013).
2. Andrew Parr, “Hydraulics and Pneumatics”, Jaico Publishing House, (2015).
3. Illangov Soundarrajan, “Introduction to Hydraulics and Pneumatics, Prentice hall of India, New Delhi, (2015).
4. S. R. Majumdar, “Oil Hydraulics”, Tata McGraw Hill Publishing Company Pvt Ltd., New Delhi, (2014).
5. Pinches, “Industrial Fluid Power”, Prentice hall, New Delhi, (2008).

WEB LINKS

1. <http://www.jmpeng.com/wp-content/uploads/2014/03/PickFlex-CaseStudy.pdf>
2. <http://www.arozone.com/en/products/diaphragm-pumps.html>
3. <http://hydraulicspneumatics.com/datasheet/bluetooth-and-smartphones-configure-hard-reach-hydraulic-valves-pdf-download>



Mapping of Course Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	2	1	3	2	2	-	-	3	1	-
CO2	1	-	-	-	2	1	-	2	-	2	-	3	1	-
CO3	1	-	-	-	2	1	-	2	-	2	-	3	1	-
CO4	1	-	-	-	1	1	3	2	-	2	-	3	1	2
CO5	2	-	-	-	3	1	3	2	2	2	2	2	1	-

COURSE OBJECTIVES

To enable the students to

- access the knowledge on laws of thermodynamics concepts, principles and mechanism for physical systems.
- identify the applications of air standard cycles.
- solve one dimensional conduction heat transfer problems.
- apply empirical correlations for both forced and free convection to determine values for the convection heat transfer coefficient.
- understand the basic concepts of radiation heat transfer to include both black body radiation and gray body radiation.

UNIT I LAWS OF THERMODYNAMICS 15

Systems - closed and open systems - properties, processes and cycles - equilibrium - work and heat transfers - first law for a closed system and flow processes - enthalpy - second law - entropy - entropy change.

UNIT II AIR STANDARD CYCLES 15

Air standard cycles: Carnot cycle - Otto cycle - Diesel cycle - Brayton cycle - Rankine cycle - cycle efficiency - IC Engine: two stroke and four stroke engines.

UNIT III HEAT TRANSFER: CONDUCTION 15

Basic Concepts - Mechanism of Heat Transfer - Conduction, Convection and Radiation - Fourier Law of Conduction - General Differential equation of Heat Conduction - Cartesian and Cylindrical Coordinates - One Dimensional Steady State Heat Conduction.

UNIT IV CONVECTION 15

Convection: Basic Concepts - Heat Transfer Coefficients - Boundary Layer Concept - Types of Convection - Forced Convection - External Flow and Internal Flow - Flow over Plates, Cylinders and Spheres.

UNIT V RADIATION 15

Basic Concepts, Laws of Radiation - Stefan Boltzmann Law, Kirchhoff's Law - Black Body Radiation and Radiation Between different surfaces.

TOTAL PERIODS 75

COURSE OUTCOMES

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

- examine the laws and basic concept of thermodynamics.
- draw PV diagram and obtain the performance of air standard cycles.
- examine the one dimensional heat transfer through conduction for a given system.
- explain the types of convection and determine heat transfer coefficient.
- justify the radiation effect among different surfaces.

TEXT BOOKS

1. P. K. Nag, Engineering Thermodynamics, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2008.
2. C. P. Kothandaraman, Fundamentals of Heat and Mass Transfer, 3rd edition, New Age International publishers, New Delhi, 2006.

REFERENCES

1. Yunus A. Cengel and Michael A. Boles, Thermodynamics - An Engineering Approach in SI McGraw Hill Publishing Company, New Delhi, 2010.
2. T. D. Eastop and McConkey, Applied Thermodynamics for Engineering Technologists, 2004.
3. C. P. Kothandaraman and S. Subramanya, 8th Edition Heat and Mass Transfer Data Book, New International publishers, New Delhi, 2014.

WEB LINKS

1. <https://www.grc.nasa.gov/www/BGH/heat.html>
2. www.cdeep.iitb.ac.in/.../Heat%20and%20Mass%20Transfer/Conduction/.../1.2.html
3. npTEL.ac.in/courses/112108149/pdf/M1/Student_Slides_M1.pdf



Mapping of Course Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	1	2	2	1	3	-	1	3	2	3
CO2	2	2	1	2	-	3	2	1	3	1	1	2	1	1
CO3	2	3	3	1	2	1	-	3	2	-	3	2	-	2
CO4	3	2	2	-	1	2	3	2	-	1	2	1	1	2
CO5	2	2	1	1	2	2	1	2	2	-	2	2	2	1

COURSE OBJECTIVES

To enable the students to

- learn the basic concepts of Object Oriented Programming.
- learn the basics of C++ language.
- know about C++ data types, access modifiers, classes and objects.
- work on identifying the relationship between classes.
- know about master of Object Oriented Programming using C++.

UNIT I INTRODUCTION TO C++ 9

Object oriented programming concepts - Introduction to C++ - Tokens - Keywords - Identifiers and constants- Basic data types- User defined data types - Derived data types - Symbolic constants - Declaration of variables - Dynamic initialization of variables - Reference variables - Operators in C++ - Scope resolution operator - Manipulators - Expressions and their types - Control structures - The main function - Function prototyping - Call by reference - Return by reference - Inline functions - Default arguments - Function overloading.

UNIT II CLASSES AND OBJECTS 9

Specifying a class - Defining member functions - Private member functions -Arrays within a class - Memory allocation for objects - Static data members - Static member functions - Arrays of objects - Objects as function arguments -Friendly functions - Returning objects. Constructors: Parameterized constructors - Multiple constructors in a class - Constructors with default arguments - Dynamic initialization of objects - Copy constructor - Dynamic constructors - Destructors.

UNIT III OPERATOR OVERLOADING AND INHERITANCE 9

Defining operator overloading: Overloading unary, binary operators. Manipulation of strings using operators - Rules for overloading operators - Type Conversions - Defining derived classes - Single inheritance - Multilevel Inheritance - Multiple inheritance -Hierarchical inheritance - Hybrid inheritance - Virtual base classes - Abstract classes.

UNIT IV POLYMORPHISM AND TEMPLATES 9

Introduction to pointers to objects: This pointer - Pointers to derived classes - Virtual functions - Pure virtual functions. Function templates, user defined template arguments, class templates.

UNIT V EXCEPTION HANDLING AND GENERIC PROGRAMMING 9

Exception Handling: Exception handling mechanism, multiple catch, nested try, rethrowing the exception - Namespaces - std namespace- Standard Template Library.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- identify and apply object oriented concepts like abstraction, encapsulation, modularity, hierarchy, typing, concurrency and persistence.
- relate real world object into entity.
- create reusable system components.
- estimate various metrics specific to object oriented development.
- predict runtime error using exception handling technology.

TEXT BOOKS

1. E.Balagurusamy, “Object Oriented Programming with C++”, Tata McGraw Hill, Sixth Edition, 2013.

REFERENCES

1. Ira Pohl, “Object Oriented Programming using C++”, Pearson Education, Second Edition.
2. S. B. Lippman, JoseeLajoie, Barbara E. Moo, “C++ Primer”, Fourth Edition, Pearson.
3. B. Stroustrup, “The C++ Programming language”, Third edition, Pearson Education, 2004.

WEB LINKS

1. <http://nptel.ac.in/courses/106105151/>
2. <https://www.tutorialspoint.com/cplusplus/cpp-object-oriented.htm>
3. <http://www.studytonight.com/cpp/cpp-and-oops-concepts.php>



Mapping of Course Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	2	2	1	-	2	-	-	-	1	1	-	-
CO2	-	1	3	-	1	-	2	-	-	-	-	-	-	2
CO3	-	1	3	2	-	-	-	-	-	-	-	-	-	-
CO4	-	2	2	-	1	-	-	-	-	-	-	1	-	-
CO5	1	2	2	1	-	-	1	-	-	-	-	-	-	-

COURSE OBJECTIVES

To enable the students to

- provide a clear view on Programmable Logic Controllers (PLC).
- facilitate knowledge on PLC control principles and applications with field devices.
- train the students to create ladder diagrams for automatic control and monitoring.
- impart knowledge on configure microcontroller with stepper motor.

LIST OF EXPERIMENTS

1. Study of Programmable Logic Controllers.
2. Sequential operation of pneumatic cylinders using PLC.
3. Hydraulic motor with timer using PLC.
4. Automate the tank water level control using PLC.
5. Automatic bottle filling process using PLC.
6. Traffic light controller.
7. Programming the material handling system.
8. Programming the control the lamp by timer.
9. Programming the linear actuation of hydraulic cylinder.
10. 8051 / 8031 Programming (addition and subtraction).
11. 8051 / 8031 Programming (multiplication and division).
12. Stepper motor interface.



TOTAL PERIODS 30

COURSE OUTCOMES

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

- understand the use of software in PLC.
- develop the PLC program for various applications like bottle filling, cylinder actuation and control.
- implement traffic control using PLC.
- compose the microcontroller interface.

Mapping of Course Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	-	1	-	-	-	-	1	-	2	-	-	2
CO2	3	-	-	2	-	-	2	-	1	1	2	-	-	1
CO3	3	-	-	1	-	-	-	-	1	-	-	-	-	2
CO4	3	3	-	-	-	-	3	-	-	-	2	-	-	2

LABORATORY**COURSE OBJECTIVES**

To enable the students to

- know fundamental knowledge of object oriented programming.
- demonstrate C++ syntax and semantics.
- solve simple engineering problems.
- know the development of solution for complex problems in the real world.

LIST OF EXPERIMENTS

1. Write C++ Programs using Classes and Objects.
2. Design C++ Classes with static members, methods with default arguments, friend functions.
3. Develop C++ Programs using Operator Overloading.
4. Develop C++ Programs using constructor, destructor, and copy constructor.
5. Develop C++ Programs Overload the new and delete operators.
6. Develop C++ Programs using Inheritance, Polymorphism and its types.
7. Develop C++ Programs using Arrays and Pointers.
8. Develop C++ Programs using Dynamic memory allocation.
9. Develop C++ Programs using Function Templates.
10. Develop C++ Programs using Exceptions Handling.
11. Write C++ Programs using Classes and Objects.
12. Design C++ Classes with static members, methods with default arguments, friend functions.

**TOTAL PERIODS 60****COURSE OUTCOMES**

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

- understand object-oriented concepts and how they are supported by C++.
- demonstrate the ability to analyze, use, and create functions, classes, to overload operators.
- create and initialize real world entities using constructors.
- apply the concepts of data encapsulation, inheritance, and polymorphism to develop large scale software.

RECOMMENDED SYSTEM/SOFTWARE REQUIREMENTS

Software: Turbo C++.

Hardware: Flavor of any WINDOWS or LINUX and Standalone desktops 30 Nos.

Mapping of Course Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	-	3	-	2	-	1	-	2	-	1	-	-	-
CO2	-		-		-		-	-	-		-	-	2	-
CO3	-	-	-	-	2	-	2	-	-	-	-	-	2	-
CO4	1	-	3	-	-	-	1	-	-	-	-	-	-	-

COURSE OBJECTIVES

To enable the students to

- understand the role of pneumatic and hydraulic systems in a complex mechatronics system.
- analyze pneumatic and hydraulic circuits, and identify basic components.
- invent and provide hand on experience to students to design and test hydraulic circuit to control press.
- design and test hydraulic, pneumatic circuits to perform basic operations.

LIST OF EXPERIMENTS

1. Fluid power standards.
2. Study of hydraulics systems components.
3. Study of pneumatic systems components.
4. Design of pressure control of pneumatic circuit.
5. Design of meter in circuit.
6. Design of meter out circuit.
7. Design of speed control circuit for double acting pneumatic cylinder.
8. Design of hydraulic press circuit.
9. Design of hand operated pneumatic double acting cylinder using fluid power simulation software.
10. Design of hydraulic cylinder reciprocating system using fluid power simulation software.
11. Design and testing of pneumatic double acting cylinder sequencing circuit (A+ B+ B- A-) using fluid power simulation software.
12. Design and testing of pneumatic double acting cylinder synchronization circuits. (cylinders connected in series and parallel) using fluid power simulation software.

TOTAL PERIODS 30**COURSE OUTCOMES**

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

- find the experience of common hydraulic and pneumatic machine used in the industries.
- construct the fluid system for various applications.
- compare hydraulic, pneumatic and mechanical systems.
- design a hydraulic or pneumatic system circuit by using related software and make simulations.



Mapping of Course Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	3	-	-	2	-	-	-	3	-	3	-	1	-
CO2	1	2	-	-	2	-	-	3	3	-	2	-	1	1
CO3	2	2	-	-	1	-	-	1	-		2	-	-	2
CO4	1	2	-	-	3	-	-	-	3		2	-	1	3

COURSE OBJECTIVES

To enable the students to

- identify the use of forecasting, control of inventory, process of routing and scheduling for improving productivity.
- construct and solve linear programming problem.
- investigate deterministic and probabilistic models of problems related to networks and queuing.
- understand the concepts of linear programming technique.
- know decision theory and game theory techniques.

UNIT I PRODUCTION PLANNING AND CONTROL 9

Productivity - productivity index - productivity measurement - job design - job standard - work study - method - study - operation process chart - motion study - motion economy - SIMO chart - work measurement - PMTS ergonomics; **Industrial safety** - losses due to accidents, causes, preventive measures; Forecasting - types - accuracy of forecast - sales forecasting techniques; Time series method - simple moving average, weighted moving average, exponential smoothing.

UNIT II INVENTORY CONTROL 9

Inventory control - purpose - inventory costs - EOQ - deterministic models - shortage model; Classification - **ABC analysis, FSN analysis**; Material Requirement Planning (MRP).

UNIT III SCHEDULING AND QUEUING 9

Introduction - rules - factors affecting - master schedule - Gantt chart; Sequencing problem - models with n jobs with 2 machines, models with n jobs with 3 machines; Queuing models - basic queuing systems and models - notation - parameter - poisson arrival - exponential service - constant rate service - infinite population.

UNIT IV LINEAR PROGRAMMING 9

Introduction - formulation - graphical method, simplex method artificial variable techniques: Big M and Two phase method; Transportation Problems - North West corner method, least cost method, Vogel's approximation Method - MODI method - **assignment problems with Hungarian algorithm.**

UNIT V NETWORK MODELS 9

Network models - shortest route - minimal spanning tree - maximum flow models - project network - **CPM and PERT networks** - critical path scheduling.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- explain the ways of improving productivity by job design, work study, ergonomics, forecasting techniques and following safety.
- explain the inventory control techniques and the need for material requirement planning.
- solve the sequencing of 'n' jobs with two and more machines and also compute the characteristics of single server queuing models.
- formulate the linear programming problems and find the optimum solution.
- construct the network model and identify the critical path of deterministic and probabilistic models.

TEXT BOOKS

1. Prem Kumar Gupta and D. S. Hira, "Operations Research", S. Chand and Co., New Delhi, 2014.
2. S. B. Srivastava, "Industrial Management", I. K. International Publishing House Pvt. Ltd., New Delhi, 2012.
3. T. R. Banga, N. K. Agarwal and S. C. Sharma, "Industrial Engineering and Management Science", Khanna Publishers, Delhi.

REFERENCES

1. Hamdy A. Taha, "Operation Research: An introduction", Pearson Publications., New Delhi, (2010).
2. Frederick S. Hiller and Gerald J. Liberman, Operations Research: Concepts and cases, Tata McGraw-Hill Publishing Company Pvt Ltd., New Delhi, 2010.

WEB LINKS

1. <http://www.industrial management.html>
2. <http://www.operation research.html>
3. mime.oregonstate.edu/what-do-industrial-engineers-do



Mapping of Course Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
	Programme Outcomes (POs)													
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	-	-	-	1	2	3	1	2	-	3	2	1	2
CO2	2	-	-	-	1	2	2	2	2	-	2	2	-	2
CO3	1	-	-	-	1	2	2	1	-	-	2	1	-	1
CO4	1	-	-	-	1	2	1	2	2	-	1	-	2	2
CO5	1	-	-	-	1	2	2	1	2	-	1	-	-	3

COURSE OUTCOMES

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

- design components and systems to integrate computers, sensors and transducers in mechanical system to meet desired needs.
- design electrically controlled fluid power circuits for various industrial applications.
- develop PLC ladder program for industrial automation and control.
- model different kinds of system and identify a suitable control.
- design a mechatronics system for a given application.

TEXT BOOKS

1. W. Bolton, Mechatronics: Electronic control systems in Mechanical and Electrical Engineering, Pearson Education, New Delhi, 6th Edition, 2015.
2. Nitaigour Premchand Mahalik, Mechatronics: Principles, Concepts and Applications, Tata McGraw Hill Publishing Company Pvt Ltd., New Delhi, 2017.

REFERENCES

1. David G. Alciature and Michael B. Histan, Introduction to Mechatronics and Measurement Systems, Tata McGraw Hill Publishing Company Pvt Ltd., New Delhi, 2007.
2. M. D. Singh, and J. G. Joshi, Mechatronics, Prentice Hall of India, New Delhi, 2009.
3. Rolf Isermann, "Mechatronic Systems Fundamentals", Springer, 2003.
4. Robert H Bishop, "Mechatronics: Introduction", Taylor and Franics, 2006.

WEB LINK

1. <http://nptel.ac.in/courses/112103174/3>
2. www.eng.um.edu.my/dme/students/MFE3004AdditionalPT5
3. me.sabanciuniv.edu/en/research/research-areas/design-of-mechatronic-systems



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	Programme Outcomes (POs)													
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CO3	-	3	2	1	2	-	-	3	2	-	2	2	-	1
CO4	2	3	2	-	1	2	2	1	-	3	2	1	-	2
CO5	-	2	2	1	2	-	-	3	2	-	2	2	-	1

COURSE OBJECTIVES

To enable the students to

- analyse the different materials used for MEMS.
- identify and understand the various sensors and actuators.
- understand the rudiments of microfabrication techniques.
- learn about the various micromachining process.
- gain knowledge about design considerations and various packaging technologies.

UNIT I INTRODUCTION TO MICROSYSTEMS 9

Overview of microelectronics manufacture and microsystems technology; Definition - MEMS materials; Laws of scaling; The multi-disciplinary nature of MEMS; Survey of materials central to micro engineering; Applications of MEMS in various industries.

UNIT II MICRO SENSORS AND ACTUATORS 9

Working principle of Microsystems - micro actuation techniques - micro sensors - types - Microactuators - types - micropump - micromotors - microvalves - microgrippers - microaccelerometers.

UNIT III FABRICATION PROCESS 9

Substrates - single crystal silicon wafer formation - Photolithography - Ion implantation - Diffusion - Oxidation - CVD - Physical vapor deposition - Deposition epitaxy - etching process.

UNIT IV MICROMACHINING 9

Silicon Anisotropic Etching - Anisotropic Wet Etching - Dry Etching of Silicon - Plasma Etching - Deep Reaction Ion Etching (DRIE) - Isotropic Wet Etching - Gas Phase Etchants - case studies; Basic surface micromachining processes - structural and sacrificial materials - acceleration of sacrificial Etch - striction and antistiction methods - LIGA Process; Assembly of 3D MEMS - Foundry process.

UNIT V MICROSYSTEMS DESIGN AND PACKAGING 9

Design considerations - Mechanical Design - process design - realization of MEMS components using intellisuite; Micro system packaging - packing technologies - assembly of microsystems - reliability in MEMS.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- understand the applications of MEMS in various industries.
- evaluate the techniques used in micro sensors and actuators.
- design the micro devices, micro systems using the MEMS fabrication process.
- analyze the drawbacks in etchings and micromachining processes.
- create new designs on microsystems and packaging.

TEXT BOOKS

1. Tai Ran Hsu, “MEMS & Micro systems Design and Manufacture” Tata McGraw Hill, New Delhi, 2002.
2. Chang Liu, ‘Foundations of MEMS’, Pearson Education Inc., 2006.

REFERENCES

1. Maluf, Nadim, “An introduction to Micro electro mechanical Systems Engineering”, AR Tech house, Boston, 2000.
2. Mohamed Gad - el - Hak, “MEMS Handbook”, CRC Press, 2002.
3. Julian W.Gardner, Vijay K.Varadan, Osama O. Awadel Karim, “Micro sensors MEMS and Smart Devices”, John Wiley & sons Ltd., 2002.
4. James J.Allen, Micro Electro Mechanical System Design, CRC Press Publisher, 2005.

WEB LINK

1. <http://nptel.ac.in/courses/112101098/download/lecture-37.pdf>
2. <https://internetofthingsagenda.techtarget.com/definition/micro-electromechanical-systems-MEMS>
3. <https://compliantmechanisms.byu.edu/content/introduction-microelectromechanical-systems-MEMS>



Mapping of Course Outcomes with Programme Outcomes:
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12	PSO1	PSO2
CO1	2	3	1	3	2	2	2	-	2	-	3	2	1	1
CO2	1	2	2	1	2	2	-	3	2	2	2	2	2	1
CO3	2	3	2	-	-	2	2	1	-	-	2	1	-	2
CO4	3	2	2	2	2	1	1	2	3	-	1	-	2	3
CO5	2	2	1	-	1	3	2	1	3	2	2	1	-	-

COURSE OBJECTIVES

To enable the students to

- make the students to understand the role of instrumentation in bio medical applications.
- gain adequate knowledge on ECG, EEG and EMG.
- introduce the methods for conditioning.
- analyse parameters of medical imaging and its measurements.
- introduce the basis of signal conversion.

UNIT I INTRODUCTION**9**

Cell structure - electrode - electrolyte interface - electrode potential - resting and action potential - electrodes for their measurement - ECG, EEG, EMG and EOG - machine description - methods of measurement - stem cells.

UNIT II BIO MEDICAL SENSORS AND TRANSDUCERS**9**

Basic transducer principles - types - source of bio electric potentials - resistive, inductive, capacitive, fiber - optic, photoelectric, chemical; Active and passive transducers and their description and feature applicable for biomedical instrumentation.

UNIT III SIGNAL CONDITIONING, RECORDING AND DISPLAY**9**

Input isolation - D.C amplifier - charge amplifier - power amplifier and differential amplifier - feedback Op-amp - electrometer amplifier - carrier amplifier - instrument power supply - oscillography - galvanometric - XY magnetic recorder - storage oscilloscopes - electron microscope - PMMC writing systems - telemetry principles.

UNIT IV MEDICAL MEASUREMENT AND MONITORING SYSTEMS**9**

Blood pressure measurement - ultrasonic method - plethysmography - blood flow measurement - electromagnetic flow meter - cardiac output measurement - dilution method - phonocardiography - vector cardiograph; Heart lung machine - artificial ventilator - Anesthetic machine - Basic ideas of CT scanner - MRI - ultrasonic scanner laser equipment and application - cardiac pacemaker - DC - defibrillator patient safety - electrical shock hazards.

UNIT V BIO MEDICAL DIAGNOSTIC INSTRUMENTATION**9**

Introduction - computers in medicine - basis of signal conversion and digital filtering - data reduction technique - time and frequency domain technique - Biomatics.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- gain adequate knowledge on ECG, EEG and EMG.
- acquire knowledge on characteristics and applications of a variety of signal transducers.
- understand the various recording and display devices.
- distinguish between various health measurement and monitoring system.
- familiarize various medical equipment's and their technical aspects.

TEXT BOOKS

1. R. S. Khandpur, Handbook of Biomedical Instrumentation, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2014.
2. Cromwell, Weibell and Pfeiffer, Biomedical Instrumentation and Measurements, Prentice Hall of India Learning Ltd., New Delhi, 2011.

REFERENCES

1. R. Ananda Natarajan, Biomedical Instrumentation and Measurements, Prentice-Hall of India Pvt.Ltd; 2nd revised edition, 1995.
2. L. A. Geddes and Baker, L.E., Principles of Applied Bio-medical Instrumentation, John Wiley and Sons Publishing Company, New York, 1995.
3. W. J. Tompkins, Biomedical Digital Signal Processing, Prentice Hall of India Learning. Ltd., New Delhi, 2000.

WEB LINK

1. <https://study.com/articles/Biomedical-Instrumentation-Courses-and-Training-Programs.html>
2. <http://www.tankonyvtar.hu/en/tartalom/tamop412A/2011-0079-jobbagy-biomedical/ch02.html>
3. <https://www.igi-global.com/article/biomedical-instrumentation/148682>



Mapping of Course Outcomes with Programme Outcomes:
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	3	3	1	3	-	2	1	1	3	3	1	2	3	3
CO2	1	1	3	-	1	1	3	3	2	1	1	3	-	1
CO3	2	1	-	1	-	-	-	2	3	2	1	-	3	2
CO4	-	-	2	2	3	3	2	1	-	-	3	2	-	3
CO5	1	1	-	-	1	3	-	-	1	1	-	1	2	-

COURSE OBJECTIVES

To enable the students to

- explain the concept of non-destructive evaluation.
- access knowledge on various types of non-destructive evaluation methods.
- identify the principles and working of different NDT methods.
- compose knowledge on selection of such different methods for testing and evaluation of various components minimum values.
- identify the concept of ultrasonic testing methods.

UNIT I INTRODUCTION AND LIQUID PENETRANTS TESTING 9

Non-destructive testing (NDT) and its importance - **NDT vs Destructive Testing** - Visual Examination - Basic Principles, optical aids used and applications. Liquid Penetrants - Principles, Procedure for penetrants testing, Penetrants testing methods, Post emulsification, properties of liquid penetrants, sensitivity, applications and Limitations - Standards.

UNIT II MAGNETIC PARTICLE TESTING 9

Magnetic Particle Testing - Principles, Magnetizing techniques, Procedures, Equipment, Sensitivity, Applications and Limitations- Standards. Case studies.

UNIT III ULTRASONIC TESTING 9

Properties of sound beam, Transducers, inspection methods, Techniques for Normal and angle beam inspection, Flaw characterization-equipment, and methods of display - A - Scan, B - Scan, C - **Scan**, **Immersion testing** - application, advantages and limitations - standards.

UNIT IV RADIOGRAPHY 9

Electromagnetic radiation sources - X-ray production and gamma ray sources, properties, radiation - attenuation and effects in film, Exposure charts - radiographic imaging - inspection techniques - applications and limitations - safety in industrial radiography - neutron radiography - standards. Case studies.

UNIT V EDDY CURRENT 9

Principles, Instrumentation, Techniques, Probe, Sensitivity, Advanced Test Methods, applications & limitations standards. Other Techniques: **Acoustic Emission Testing** Principle, Techniques, Instrumentations, Applications and Standards, Homography Thermography - Principles, Equipment, Techniques, Applications and Standards, Leak testing - methods, detection and Standards. Selection of NDT Methods: Defects in material - Selection of NDT and Instrumentation - Some Case studies.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- access the knowledge about working liquid penetrants testing.
- identify the non-destructive evaluation methods for magnetic particle testing.
- identify the ultrasonic testing methods and working processes.
- relate the knowledge about the sources, process and safety precautions of x-ray radiography.
- locate the test performance on eddy current techniques.

TEXT BOOKS

1. Baldev Raj, T. Jayakumar and M. Thavsimuthu, “Practical Non-Destructive Testing” 3rd Edition, Narosa Publishing House, New Delhi, 2009.
2. Shull Peter J, Non Destructive Evaluation: Theory-Techniques and Applications, Marcel Dekkar Inc., New York, USA, 2002.

REFERENCES

1. Baldev Raj and Venkatraman B., Practical Radiology, Narosa Publishing House, New Delhi, 2004.
2. Hull Barry and John Vernon, Non Destructive Testing, 1st Edition, Macmillan, London, 1988.
3. Brichan D., Non Destructive Testing, Oxford Press, 1975.
4. ASM Handbook, Non Destructive Evaluation and Quality Control, Vol.17, 9th Edition, 1989.

WEB LINKS

1. <http://www.asnt.org/MinorSiteSections/AboutASNT/Intro-to-NDT>
2. <http://www.trainingndt.com/what-is-nondestructive-testing>
3. <http://www.twi-global.com/capabilities/integrity-management/non-destructive-testing/ndt-techniques>



Mapping of Course Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
	Programme Outcomes (POs)													
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	3	-	2		-	2	-	3	-	1	-
CO2	-	-	-	1	-	-		3	2	-	2	-	-	-
CO3	3	-	-	-	-	2		1	-	-	2	-	-	-
CO4	3	-	-	-	-	2		-	3	-	1	-	2	-
CO5	3	-	-	-	-	3		1	3	-	1	-	-	-

SEMESTER VII

MT16701

COMPUTER INTEGRATED MANUFACTURING

3 0 0 3

COURSE OBJECTIVES

To enable the students to

- understand the concept of automation and rapid prototyping processes.
- classify the different types of material handling & storage system with principles and applications.
- know the importance of group technology and cellular manufacturing.
- summarize the fundamentals of flexible manufacturing systems.
- make use of computers to prepare the product and process plan.

UNIT I INTRODUCTION 9

Brief introduction to CAD and CAM - Manufacturing Planning, Manufacturing control; CIM Definition - CIM wheel - CIM components - Evolution of CIM - needs of CIM - Benefits of CIM; Automation in Production Systems - Automation Principles and Strategies - Basic Elements of an Automated system - Advanced Automation Functions - Levels of Automation.

UNIT II MATERIAL HANDLING SYSTEMS 9

Introduction - material handling systems - principles and design - material transport system - transfer mechanisms automated feed cut of components - performance analysis; types of handling systems - Automated Guided Vehicles and its various guiding technologies.

UNIT III AUTOMATED MANUFACTURING SYSTEMS 9

Group technology (GT) - classification - components - an overview; Part families - parts classification and coding - product flow analysis - cellular manufacturing - composite part concept - machine cell design and layout; Flexible Manufacturing Systems - introduction - components - planning and implementation - application.

UNIT IV MONITORING AND QUALITY CONTROL 9

Types of production monitoring system, process control and strategies, direct digital control - Supervisory computer control - computer aided quality control - QC and CIM - inspection and testing - objectives of CAQC - role of computer in QC - post process metrology - computer aided inspection using robots - integration of CAD/CAM with inspection system - Flexible Inspection System (FIS).

UNIT V MANUFACTURING SUPPORT SYSTEMS 9

Process planning and Concurrent Engineering - Computer Aided Process Planning (CAPP) - design for manufacturing - advanced manufacturing planning - production planning and control system - master production schedule - capacity planning; Shop floor control - inventory control - MRP - MRP-II – ERP - J.I.T production systems; Agile manufacturing.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- select a suitable production system.
- associate the production system with manufacturing operations.
- infer the concepts of group technology.
- apply the basic concepts of machine tools and computer control systems.
- understand automated production planning and control.

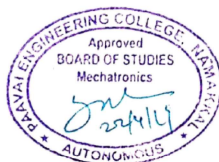
TEXT BOOKS

1. M.P. Groover, Automation, “Production Systems and Computer Integrated manufacturing”, 4th Edition, Pearson Education, 2016.
2. Radhakrishnan P, Subramanyan S, And Raju V., “CAD/CAM/CIM”, 4th Edition New Age International (P) Ltd., New Delhi, 2018.

REFERENCES

1. Yoremkoren, “Computer Integrated Manufacturing System”, McGraw-Hill, 2007.
2. Pham D.T & Dimov.S.S, “Rapid manufacturing”, Springer-Verlag, London, 2011.
3. Chua C.K, K F Leong, C S Lim, “Rapid Prototyping: Principles and Applications” World Scientific Pub Co Inc; 3rd edition, 2010.
4. Zeid I., “CAD/CAM: Theory & Practice”, McGraw Hill India, 2nd edition, 2006.

Mapping of Course Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	1		-	-	-	1	-	-	1	2	3	3
CO2	1	-	3		1	-	-	3	-	-	1	3	-	1
CO3	2	-	-		-	-	-	2	-	-	1	-	3	2
CO4	-	-	2		3	-	-	1	-	-	3	2	-	3
CO5	1	-	-		1	-	-	-	-	-	-	1	2	-



COURSE OBJECTIVES

To enable the students to

- learn the fundamentals of robotics and components of robots.
- impart knowledge on end effectors and its design.
- familiarize with the robot kinematic equations.
- impart knowledge on machine vision and its fundamentals.
- learn about basics of robot programming and applications in robots.

UNIT I INTRODUCTION AND ROBOT COMPONENTS 9

Introduction; Basic components of robot; Laws of robotics; Classifications of robot; Specifications of robot; Power transmission system - rotary to rotary motion - rotary to linear motion; Harmonics drives.

UNIT II ROBOT END EFFECTORS 9

Introduction; Types of End effectors - Mechanical gripper; Types of gripper mechanism; Gripper force analysis; Other types of gripper; Special purpose grippers.

UNIT III KINEMATICS OF ROBOT 9

Introduction; Matrix representation; Homogeneous transformation matrices; Representation of transformations; Inverse of transformation matrices; Forward and inverse kinematics of robots.

UNIT IV MACHINE VISION SYSTEM 9

Machine vision; Image acquisition - digital images - sampling and quantization; Levels of computation feature extraction - windowing techniques - segmentation - thresholding - edge detection; Binary morphology and grey morphology.

UNIT V ROBOT PROGRAMMING AND APPLICATIONS 9

Robot programming; Generations of languages - classification of robot language; VAL system and languages; Robot software; Applications of robots.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- understand the different types of robots and its various components.
- develop the basic design selection of robot grippers.
- solve the homogeneous transformation matrix for different types of robots.
- summarize the image processing techniques.
- apply the basic engineering knowledge for the design of robots.

TEXT BOOKS

1. M.P.Groover, M.Weiss, R.N. Nagal, N.G.Odrey, Ashish Dutta, "Industrial Robotics Technology, Programming and Applications" Tata , McGraw-Hill Education Pvt Limited, 2nd edition, 2012.
2. S. R. Deb, Sankha Deb, "Robotics Technology and flexible Automation" 2nd edition, Tata McGraw - Hill Publication, 2009.

REFERENCES

1. Saeed B. Niku, "Introduction to Robotics: Analysis, Systems, Applications", 2nd edition, Pearson Education India, 2013.
2. K.S.Fu, R.C.Gonzalez, C.S.G.Lee, "Robotics: Control, Sensing, Vision and Intelligence", Tata McGraw-Hill Publication, 1st edition, 2008.
3. John.J.Craig, "Introduction to Robotics: Mechanics & control", Second edition, 2002.
4. S K Saha, "Introduction to Robotics", Tata McGraw-Hill Publication, 2nd edition, 2014.

Mapping of Course Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	2	-	3	2	1	-	-	3
CO2	2	1	2	-	-	-	2	-	3	2	3	-	-	1
CO3	1	3	2	-	-	-	-	-	3	-	2	-	-	2
CO4	3	2	2	-	-	-	2	-	-	3	2	-	-	2
CO5	1	2	2	-	-	-	2	-	3	-	2	-	-	2



COURSE OBJECTIVES

To enable the students to

- understand the construction and working principle of various parts of an automobile.
- study the different types of ignition systems, injection systems used in automobiles.
- impart knowledge of assembling and dismantling of engine parts and transmission system.
- learn the principles of operation and constructional details of the steering system.
- enhance the knowledge in the field of alternative fuel sources.

UNIT I VEHICLE STRUCTURE AND ENGINES 9

Types of automobiles - vehicle construction and different layouts - chassis - frame and body; Vehicle aerodynamics (various resistances and moments involved); IC engines - components - functions and materials - Variable Valve Timing (VVT).

UNIT II ENGINE AUXILIARY SYSTEMS 9

Electronically controlled gasoline injection system for SI engines - Electronically controlled diesel injection system (Unit injector system, Rotary distributor type and common rail direct injection system); Electronic ignition system (Transistorized coil ignition system, capacitive discharge ignition system); Turbochargers (WGT, VGT); Engine emission control by three - way catalytic converter system - emission norms (Euro and BS).

UNIT III TRANSMISSION SYSTEMS 9

Clutch - types and construction; Gearboxes- manual and automatic - gear shift mechanisms; Overdrive; Transfer box; Fluid flywheel; Torque converter; Propeller shaft; Slip joints; Universal joints; Differential and rear axle - Hotchkiss drive and torque tube drive.

UNIT IV STEERING, BRAKES AND SUSPENSION SYSTEMS 9

Steering geometry and types of steering gear box - power steering; Types of front axle; Types of suspension Systems; Pneumatic and Hydraulic Braking Systems - Antilock Braking System (ABS) - Electronic Brake Force distribution (EBD) and Traction Control.

UNIT V ALTERNATIVE ENERGY SOURCES 9

Use of natural gas - Liquefied Petroleum Gas - Bio-diesel - Bio-ethanol - Gasohol and Hydrogen in automobiles; Engine modifications required - performance - combustion and emission characteristics of SI engines and CI engines using alternate fuels; Electric and Hybrid Vehicles; Fuel Cell.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- learn about the principles of operation and constructional details of various automobile components and subsystems.
- demonstrate the starting systems, ignition systems and an engine control systems.
- understand the various components in the transmission system.
- classify various steering systems, brake systems and an engine control systems.
- acquire knowledge in the field of alternative fuel sources.

TEXT BOOKS

1. Kirpal Singh, “Automobile Engineering”, Vol 1 and 2, Seventh Edition, Standard Publishes, New Delhi, 13th Edition, 2014.
2. R.K. Rajput, “A Textbook of Automobile Engineering” Laxmi Publications, 1st edition, 2015.

REFERENCES

1. F. K. Sully, “Motor Vehicle Mechanic's Textbook”, Butterworth-Heinemann, 5th edition, 2014.
2. William Crouse and Donald Anglin, “Automotive Mechanics,” 10th Edition, McGraw Hill Education, 2017.
3. Martin W Stockel, Martin T Stockle and Chris Johanson, “Auto Fundamentals,” Goodheart-Wilcox Publisher, 12th Edition, 2018.
4. Heinz Heisler, " Advanced Vehicle Technology,” 2nd Edition, SAE International Publications USA, 2018.
5. Ganesan V. “Internal Combustion Engines”, 4th Edition, Tata McGraw-Hill, 2017.

Mapping of Course Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	2	2	3	-	2	-	-	-	1	-
CO2	-	-	-	-	2	1	-	3	3	2	-	-	2	1
CO3	2	2	-	-	-	2	3	2	-	-	-	-	-	2
CO4	2	3	-	-	2	-	2	-	1	-	-	-	1	1
CO5	2	2	-	-	2	3	1	1	2	2	-	-	-	-



COURSE OBJECTIVES

To enable the students to

- provide an overview of how computers are being used in design.
- know the usage of G codes and M codes.
- do manual part programming.
- gain practical experience in computer assisted part programming.

LIST OF EXPERIMENTS

1. Modeling of a given part using design software.
2. Modeling the component of flange coupling using design software.
3. Assembly the component of screw jack using design software.
4. Assembly the component of universal coupling using design software.
5. Study the specification of CNC machines.
6. Study the functions of G codes, M codes and procedures for manual part programming.
7. Milling - manual part programs and simulation verification - linear and circular interpolation and contour motions.
8. Lathe - manual part programs and simulation verification - peck drilling, chamfering, grooving, canned cycle turning, and canned cycle facing, taper turning, thread turning cycle, turning linear and circular interpolation.

TOTAL PERIODS 30

COURSE OUTCOMES

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

- assemble the various modelled components.
- familiar about the functions of G and M codes.
- generate code for lathe and milling operations.
- verify the programming through simulation.



Mapping of Course Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	2	-	-	-	3	2	-	-	3	-	2
CO2	3	-	-	2	-	-	-	3	-	-	-	3	-	1
CO3	3	-	-	-	2	-	-	3	1	-	-	3	-	-
CO4	3	-	-	2	2	-	-	3	-	-	-	3	-	-

COURSE OBJECTIVES

To enable the students to

- understand the different types of robots and its applications.
- learn the different types of links, drives, joints and end effectors used in robots.
- verify transformation with respect to gripper.
- program point to point and continuous path robots.

LIST OF EXPERIMENTS

1. Study of robots configuration and application.
2. Study of different types of robots links and joints.
3. Study of components of robots with drive system and end effectors.
4. Verification of transformation (position and orientation) with respect to gripper and world coordinate system.
5. Determination of maximum and minimum position of links.
6. Robot programming for point to point path and continuous path.
7. Estimation of accuracy, repeatability and resolution of robot performance.
8. Programming a pick and place robot using point to point for palletizing.
9. Programming a pick and place robot using continuous path for palletizing.
10. Programming the robot for a drilling application.

TOTAL PERIODS 30

COURSE OUTCOMES

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

- control mobile robots using different sensors and actuators.
- manipulate an industrial robot using a machine vision system and HMI's.
- handle a robot model using the robotics simulation software.
- analyze and present the findings of experimental observations in both written and oral format.



Mapping of Course Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	3	-	-	-		3	2	-	-	3	-	2
CO2	3	-	2	-	-	-		3	-	-	-	3	-	1
CO3	3	-	2	-	2	-		3	1	-	-	3	-	-
CO4	3	-	2	-	2	-		3	-	-	-	3	-	-

COURSE OBJECTIVES

To enable the students to

- design, analyze, realize / simulate a physical system by using the technology they learnt during the program.
- integrate various systems into one mechatronics product.
- work in a team with confined time duration.
- disseminate his work both in oral and written format.

GUIDELINE FOR REVIEW AND EVALUATION

- Students in the form of group, not exceeding 3 members in a group to carry out their main project.
- It should be a mechatronics project. However, special considerations can be given for interdisciplinary measurement and computer-based simulation projects. This exception should be recorded and approved by the department committee.
- Management related projects will not be allowed.
- The interdisciplinary projects will carry more weightage.
- It is mandatory to publish their main project in national/international level conferences to appear in the viva-voce exam.

TOTAL PERIODS 60

COURSE OUTCOMES

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

- identify feasible problems to solve through project works.
- collect literature through research journals and identify the gap in selected area.
- devise the methodology to find solution through gathering complete knowledge on materials/design procedure/analysis and optimization techniques/ availability of experimental setup/ company permission and other documentation procedures to execute the project.
- prepare project report as per format and confidently face viva voce with proper PPT for presentation.



Mapping of Course Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	2	-	-	-	-	-	3	3	-	-	2	2
CO2	3	-	2	-	-	-	-	-	3	3	-	-	2	2
CO3	3	-	2	-	-	-	-	-	3	3	-	-	2	2
CO4	3	-	2	-	-	-	-	-	3	3	-	-	2	2

SEMESTER VIII

MT16801

AUTOTRONICS

3 0 0 3

COURSE OBJECTIVES

To enable the students to

- learn basics of electronics, emission standards in automobiles.
- identify the fundamentals of ignition and injection system.
- select and use various sensors and actuators in automobiles.
- understand the different control modes of engine management, networking in vehicles.
- know the comfort and safety systems in automobiles.

UNIT I INTRODUCTION 9

Evolution of electronics in automobiles; Emission laws - introduction to Euro I, Euro II, Euro III, Euro IV, Euro V standards; Equivalent Bharat Standards. Charging systems - charging circuit diagram; Alternators; Starting system - starter motors and starter circuits.

UNIT II IGNITION AND INJECTION SYSTEM 9

Ignition systems - Ignition fundamentals - Electronic and Programmed Ignition - Distribution less ignition - Direct ignition - Spark plugs; Electronic fuel control - basics of combustion - Engine fueling and exhaust emissions; Electronic control of carburetion; Petrol fuel injection; Diesel fuel injection.

UNIT III SENSORS AND ACTUATORS 9

Working principle and characteristics of airflow rate; Engine crankshaft angular position - Hall effect; Automobile sensors - throttle angle, temperature and exhaust gas oxygen sensors; Study of the fuel injector; Actuators - exhaust gas recirculation actuators - stepper motor actuator - vacuum operated actuator.

UNIT IV ENGINE CONTROL SYSTEM 9

Control modes for fuel control - Engine control subsystems; Ignition control methodologies; Engine management system - different ECU's used in the engine management; In-vehicle networks - CAN standard - CAN standard format; Diagnostics systems in modern automobiles.

UNIT V CHASSIS AND SAFETY SYSTEM 9

Traction control system; Cruise control system; Electronic control of automatic transmission; Electronic suspension system; Power Train Control; Safety System Control - Antilock braking system - Airbag system - Seat Belt Tensioners; Steering System Control.

TOTAL PERIODS 45

COURSE OUTCOMES

Upon the completion of the course, students should be able to

- describe the importance of emission standards in automobiles.
- discuss the electronic fuel injection/ignition components and their function.
- choose equipment for measuring mechanical quantities, temperature and appropriate actuators.
- diagnose electronic engine control systems problems with appropriate diagnostic tools.
- illustrate the chassis and vehicle safety system.

TEXT BOOKS

1. Tom Denton, "Automobile Electrical and Electronics Systems", 5 edition, Routledge, 2017.
2. Barry Hollembeak, "Automotive Electricity and Electronics", 6th edition, Delmar Publishers, 2014.

REFERENCES

1. James D. Halderman "Automotive Fuel and Emissions Control Systems", Pearson, 4th edition, 2015.
2. A. K. Babu, "Automotive Electrical and Electronics", 1st edition, Khanna Publishing, 2018.
3. William Ribbens, " Understanding Automotive Electronics: An Engineering Perspective ", 8th Edition, Butterworth-Heinemann, 2017.

Mapping of Course Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	3	-	2	-	-		3	-	-	-	3
CO2	1	-	3	2	-	1	-	3		1	-	3	-	-
CO3	2	-	2	-	-	2	-	2		-	-	2	-	2
CO4	2	-	2	-	-	-	-	-		-	-	-	-	1
CO5	-	-	2	2	-	3	-	1		1	-	1	-	2



COURSE OBJECTIVES

To enable the students to

- design, analyze, realize / simulate a physical system by using the technology they learnt during the program.
- integrate various systems into one mechatronics product.
- work in a team with confined time duration.
- disseminate his work both in oral and written format.

GUIDELINE FOR REVIEW AND EVALUATION

- Students in the form of group, not exceeding 3 members in a group to carry out their main project.
- It should be a mechatronics project. However, special considerations can be given for interdisciplinary measurement and computer-based simulation projects. This exception should be recorded and approved by the department committee.
- Management related projects will not be allowed.
- The interdisciplinary projects will carry more weightage.
- It is mandatory to publish their main project in national/international level conferences to appear in the viva-voce exam.

TOTAL PERIODS 180

COURSE OUTCOMES

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

- identify feasible problems to solve through project works.
- collect literature through research journals and identify the gap in selected area.
- devise the methodology to find solution through gathering complete knowledge on materials/design procedure/analysis and optimization techniques/ availability of experimental setup/ company permission and other documentation procedures to execute the project.
- prepare project report as per format and confidently face viva voce with proper PPT for presentation.



Mapping of Course Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	2	-	-	-	-	-	3	3	3	2	2	2
CO2	3	-	2	-	-	-	-	-	3	3	3	2	2	2
CO3	3	-	2	-	-	-	-	-	3	3	3	2	2	2
CO4	3	-	2	-	-	-	-	-	3	3	3	2	2	2

PROGRAMME ELECTIVE - II

MT16251

ENGINEERING ECONOMICS AND COST ANALYSIS

3 0 0 3

COURSE OBJECTIVES

To enable the students to

- learn the fundamentals of demand and supply.
- understand and apply methods of cost analysis.
- know the types of banking and its functions.
- compute the depreciation methods.
- the method adopted for capital budgeting.

UNIT I DEMAND AND SUPPLY ANALYSIS

9

Definition and scope of study - importance of economic analysis - demand and supply analysis - demand determinants - Law of demand - elasticity of demand - Law of supply - elasticity of supply - demand forecasting Methods.

UNIT II COST ANALYSIS

9

Types of cost - Fixed cost- variable cost - marginal cost - pricing decisions - pricing techniques in practice - full cost - pricing - marginal cost pricing - going rate pricing - bid pricing - price fixing for a rate of return.

UNIT III MONEY AND BANKING

9

Value of money - inflation, deflation; Banking - commercial bank and its functions - central bank and its functions; New economic environment - globalization - liberalization and privatization.

UNIT IV DEPRECIATION AND COST ANALYSIS

9

Causes of depreciation - objectives - methods of computing depreciation - simple problems; Breakeven analysis - breakeven point - breakeven chart - uses of breakeven analysis; Balance sheet.

UNIT V CAPITAL BUDGETING

9

Need for capital budgeting - rate of return method - payback period method - present value comparisons method - cost benefit analysis; Preparation of feasibility report - economic and commercial feasibility - financial feasibility - technical feasibility.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- acquire knowledge to the major concepts and techniques of engineering economic analysis.
- carryout the supply of material and demand of products in their management profession.
- gain adequate knowledge on banking system.
- perform demand forecasting, cost analysis, pricing and financial accounting for an engineering

industry.

- carryout cost analysis for capital subjecting based on depreciation money available.

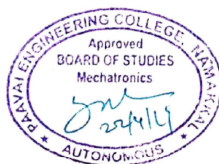
TEXT BOOKS

1. Panneerselvam R, "Engineering Economics", Prentice Hall India Learning Private Limited; 2nd Revised edition, 2013.
2. Anjali Bagad, "Engineering Economics and Financial Accounting", Technical Publications, 2012.

REFERENCES

1. Donald.G. Newman, Jerome.P.Lavelle, "Engineering Economics and Analysis" Engg. Press, Texas, 2010.
2. Patel Bhavesh. M, "Project Management: Financial Evaluation with Strategic Planning, Networking and Control ", 2nd edition, Vikas Publishing House, New Delhi, 2010.
3. Michael Baye and Jeff Prince, " Managerial Economics and Business Strategy ", Tata McGraw Hill, 2013.
4. Paul Samuelson and William Nordhaus, "Economics", Tata McGraw Hill, 19th edition, 2010.

Mapping of Course Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
	Programme Outcomes (POs)													
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12	PSO1	PSO2
CO1	2	3	1	3	2	2	3	-	2	-	3	2	1	-
CO2	-	3	2	1	2	-	-	3	2	-	2	2	-	1
CO3	3	3	2	-	1	2	2	1	-	3	2	1	-	2
CO4	3	2	1	-	2	2	1	-	3	2	1	-	2	3
CO5	2	1	-	-	-	3	2	1	3	2	1	-	-	-



COURSE OBJECTIVES

To enable the students to

- understand the need, history, growth and classification of RP system.
- convert CAD models in to real life engineering components.
- know the principle, process parameters, applications of SLA, SLS and EBM.
- learn the principle, process parameters, applications of FDM and LOM.
- illustrate the principle, process parameters, applications of 3D printing and LENS.

UNIT I INTRODUCTION 9

Overview - Need - Development of Additive Manufacturing Technology - Principle - AM Process Chain - Classification - **Rapid Prototyping - Rapid Tooling** - Rapid Manufacturing - Applications - Benefits - Case studies.

UNIT II DESIGN FOR ADDITIVE MANUFACTURING 9

Design tools: Data processing - CAD model preparation - Part orientation and support structure generation - Model slicing - Tool path generation - Design for Additive Manufacturing: Concepts and objectives - AM unique capabilities - **DFAM for part quality improvement** - Customised design and fabrication for medical applications.

UNIT III PHOTO POLYMERIZATION AND POWDER BED FUSION PROCESSES 9

Photo polymerization: SLA - Photo curable materials - Process - Advantages and Applications. Powder Bed Fusion: **SLS** - Process description - powder fusion mechanism - Process Parameters - Typical Materials and Application. Electron Beam Melting.

UNIT IV EXTRUSION BASED AND SHEET LAMINATION PROCESSES 9

Extrusion Based System: FDM-Introduction - Basic Principle - Materials - Applications and Limitations - Bio extrusion. Sheet Lamination Process: **LOM** - Gluing or Adhesive bonding - Thermal bonding.

UNIT V PRINTING PROCESSES AND BEAM DEPOSITION PROCESSES 9

Droplet formation technologies - Continuous mode - Drop on Demand mode - Three Dimensional Printing - Advantages - Bioplotter - **Beam Deposition Process**: LENS - Process description - Material delivery - Process parameters - Materials - Benefits - Applications.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- apply RP tools using additive manufacturing techniques.
- design a prototype the models of real world engineering parts.
- access the principle and effect of process parameters in RP process.

- learn about a working principle and construction of FDM and LOM process.
- develop the various printer models using RP process.

TEXT BOOKS

1. Chua C.K., Leong K.F., and Lim C.S., “Rapid prototyping: Principles and applications”, 3rd edition, World Scientific Publishers, 2010.
2. Ian Gibson, David W.Rosen, Brent Stucker “Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing” Springer, 2nd edition , 2015.

REFERENCES

1. Andreas Gebhardt “Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing” Hanser Gardner Publication, 1st edition, 2012.
2. Kamrani A.K. and Nasr E.A., “Rapid Prototyping: Theory and practice”, Springer, 2006.
3. Fuewen Frank Liou, “Rapid Prototyping and Engineering applications :A tool box for prototype development”, CRC Press, 2nd edition, 2019.
4. Tom Page “Design for Additive Manufacturing” LAP Lambert Academic Publishing, 2012.

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COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12	PSO1	PSO2
CO1	2	-	3	3	-	-	2	-	2	-	-	-	1	-
CO2	2	-	2	1	-	-	-	-	2	2	-	-	1	1
CO3	1	-	-	-	-	-	2		-	-	-	-	-	2
CO4	-	-	1	2	-	-	1		3	-	-	-	2	1
CO5	1	-	3	-	-	-	2		3	2	-	-	-	-



COURSE OBJECTIVES

To enable the students to

- provide the overview of embedded system design principles.
- understand the need and importance of networking in an embedded system.
- study the concepts of real time operating systems.
- define hardware and software communication and control requirements.
- get an idea of the latest trends in the embedded systems field.

UNIT I INTRODUCTION TO EMBEDDED SYSTEMS 9

Embedded systems - Processor embedded into a system - Embedded hardware units and devices in a system - Embedded software in a system - Examples of embedded systems - Complex systems design and processors - Design process in embedded system - Formalization of system design - Classification of embedded systems.

UNIT II DEVICES AND COMMUNICATION BUSES FOR DEVICES NETWORK 9

IO Types and Examples - Serial communication devices - Parallel device ports - Wireless devices - Timer and counting devices - Watchdog timer - Real time clock - Network embedded systems - Serial bus communication bus protocols - Parallel bus device protocols - Internet enabled systems - Wireless and mobile system protocols.

UNIT III REAL TIME OPERATING SYSTEM 9

Basic design using an RTOS - Tasks and Task states - Tasks and Data - Semaphore functions and shared data - Message queues functions - mailbox functions - pipe functions - Encapsulating using the semaphores and queues - interrupt routines in an RTOS environment - Introduction to RTOS Vx Works, RT Linux.

UNIT IV EMBEDDED SOFTWARE DEVELOPMENT PROCESS AND TOOLS 9

Introduction - Host and target machines - Linking and locating software - Getting embedded software into the target systems - Issues in hardware and software design and Co-design.

UNIT V PIC MICROCONTROLLER 9

Microcontrollers and embedded processors - Overview of the PIC18 family - PIC file register - Using instructions with the default access bank - Addressing modes - Standard and enhanced CCP modules - Compare mode programming - ADC characteristics - ADC programming in the PIC18.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- explain the need of embedded systems and their development procedures.
- understand interfacing of IO devices and other peripherals.
- summaries the concepts involved in real time operating systems.
- use various tools for developing embedded applications.
- explain the construction, addressing modes and instructions sets of PIC micro controller.

TEXT BOOKS

1. Rajkamal, 'Embedded System - Architecture, Programming, Design', Tata McGraw Hill, 3rd edition, 2017.
2. Muhammad Ali Mazidi, Danny Causey, Rolin McKinlay, "PIC Microcontroller and Embedded Systems: Using Assembly and C for PIC18", Microdigital; 2nd edition, 2016.

REFERENCES

1. Muhammad Ali Mazidi, Janice G. Mazidi, Rolin D. McKinlay, "The 8051 Microcontroller and Embedded Systems", Pearson, 2nd edition, 2018.
2. Muhammad Ali Mazidi, Janice G. Mazidi, Rolin D. McKinlay, "The 8051 Microcontroller and Embedded Systems: Using Assembly and C", Pearson Education India, 2nd edition, 2008.
3. Chattopadhyay, 'Embedded System Design', Prentice Hall India Learning Private Limited, 2nd edition, 2013.

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	Programme Outcomes (POs)													
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12	PSO1	PSO2
CO1	1	-	2	2	-	-	2	-	2	-	-	-	1	-
CO2	1	-	-	1	-	-	-	-	2	2	-	-	1	1
CO3	1	-	-	-	-	-	2		-	-	-	-	-	1
CO4	-	-	2	2	-	-	1		3	-	-	-	1	1
CO5	1	-	2	-	-	-	2		3	2	-	-	-	-



COURSE OBJECTIVES

To enable the students to

- understand the division of network functionalities into layers.
- explain the following terms: computer network, LAN, WAN, MAN, internet, protocol, topology, media, peer-to-peer network, and server-based network.
- familiar with the components required to build different types of networks.
- exposed to the required functionality at each layer.
- learn the flow control and congestion control algorithms.

UNIT I FUNDAMENTALS AND PHYSICAL LAYER 9

Data communication - Networks - Network models - Layer tasks - The OSI Model - Layers in the OSI model - TCP/IP protocol suit - Data and signals - Transmission media - Switching.

UNIT II DATA LINK LAYER 9

Error detection and correction - Data link control - Framing - HDLC - Multiple access - Wireless LAN's: Standard Ethernet - Fast Ethernet - Gigabit Ethernet - 802.11 - Bluetooth.

UNIT III NETWORK LAYER 9

The Logical address (IP4, IP6) - Internet protocol: Internetworking (IP4, IP6) - Transitions from IP4 to IP6 - ICMP - IGMP - Forwarding - Unicasting routing protocol (Distance Vector Routing, Link State Routing) - Multicasting routing protocol.

UNIT IV TRANSPORT LAYER 9

Duties of Transport Layer - UDP - TCP - Congestion control and Quality of Service - Techniques to Improve QoS.

UNIT V APPLICATION LAYER 9

Electronic Mail (SMTP, POP3, IMAP, MIME) - File Transfer Protocol - WWW - HTTP - DNS.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- have a good understanding of the OSI reference model.
- have experience in designing communication protocols.
- analyze the requirements for a given organizational structure and select the most appropriate networking architecture and technologies.
- expose TCP/IP protocol suite.
- design and build a network using routers.

TEXT BOOKS

1. Behrouz A. Forouzan, “Data Communication and Networking”, Fifth Edition, Tata McGraw - Hill, 2012.

REFERENCES

1. Larry L. Peterson, Bruce S. Davie, “Computer Networks: A Systems Approach”, Fifth Edition, Morgan Kaufmann Publishers, 2011.
2. James F. Kurose, Keith W. Ross, “Computer Networking - A Top-Down Approach Featuring the Internet”, Fifth Edition, Pearson Education, 2009.
3. Nader. F. Mir, “Computer and Communication Networks”, Pearson Prentice Hall Publishers, 2010.
4. William Stallings, “Data and Computer Communication “Tenth Edition, Pearson Education, 2014.

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CO1	3	2	3	2	-	-	-	-	-	-	-	-	3	2
CO2	2	2	3	3	-	-	-	-	-	2	-	-	2	3
CO3	3	3	3	2	3	-	-	-	-	-	-	2	2	3
CO4	3	3	3	2	3	-	-	-	-	-	-	2	3	3
CO5	3	3	3	2	-	-	-	2	-	-	-	-	-	3



COURSE OBJECTIVES

To enable the students to

- understand the principles, functions and design practices of jigs, fixtures and dies.
- acquire the knowledge about locating and clamping devices.
- calculate press tonnage requirements.
- gain knowledge on progressive, compound and combination dies.
- select and sketch a suitable jig/fixture/die for a given work piece.

UNIT I PURPOSE TYPES AND FUNCTIONS OF JIGS AND FIXTURES 9

Objectives of tool design - introduction to jigs and fixtures - principle in design of jigs and fixtures;

Materials used in jigs and fixtures; Location and clamping - types; Analysis of clamping; Tolerance and error analysis.

UNIT II JIGS 9

Types of jigs - Template jig - plate jig - latch jigs - channel jigs - box jigs - post jigs - angle plate jigs - angular post jigs - turnover jigs - pot jigs - indexing jigs - Automatic drill jigs; Rack and pinion operated; Air operated jigs components; Design and sketching of Jigs for given work piece.

UNIT III FIXTURES 9

General principles of boring - lathe - milling and broaching fixtures; Grinding - planning and shaping fixtures - assembly - inspection and welding fixtures; Modular fixtures; Design and sketching of fixtures for given component.

UNIT IV PRESS WORKING TERMINOLOGIES AND ELEMENTS OF DIES AND STRIP LAYOUT 9

Press working terminology; Presses and press accessories; Computation of press capacities; Elements of progressive compound and combination dies; Economic strip layout; Punch-die clearance; Die block - die shoe; Bolster plate - punch plate - holder - guide pins and bushes – strippers – knockouts – stops – pilots; Selection of standard die sets.

UNIT V DESIGN OF DIES 9

Design and sketching of progressive and compound dies for Blanking and piercing operations; Bending dies - Deep drawing and wire drawing dies; Design considerations in forging and extrusion.

Note: (Use of P S G Design Data Book is permitted in the University examination)

TOTAL PERIODS 45

COURSE OUTCOMES

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

- understand the basics of Jigs and fixtures and location of clamping.
- demonstrate the working of pneumatic and hydraulic actuation.
- understand the different types of fixtures.
- understand the capacities and tonnage requirements and elements of progressive combination and compound dies.
- apply design and development of progressive and compound dies for blanking and piercing operations.

TEXT BOOKS

1. Edward Hoffman, “Jigs and Fixture Design”, Cengage India, 5th edition, 2008.
2. Joshi, P.H., “Jigs and Fixtures”, McGraw Hill Education; 3rd edition, 2017.

REFERENCES

1. K. Venkataraman, “Design of Jigs, Fixtures and Press Tools”, Wiley-Blackwell, 2nd edition, 2015.
2. Cyril Donaldson, George H. Lecain and VC Goold “Tool Design”, McGraw Hill Education, 4th edition, 2012.
3. V.Balachandran, “Design of Jigs, Fixtures and Press Tools” Notion Press, 1st edition, 2015.
4. John Nee, “Fundamentals of Tool Design”, Society of Manufacturing Engineers, 6th edition, 2010.
5. Roop Lal, “Jig and Fixtures Design”, Vayu Education of India, 2015.

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CO1	2	3	1	3	2	2	2	-	2	-	3	2	1	1
CO2	1	2	2	1	2	2	-	2	2	2	2	2	2	1
CO3	2	3	2	1	-	1	2	1	-	1	2	1	-	2
CO4	3	2	2	2	1	1	1	2	3	-	1	-	2	3
CO5	2	2	1	-	1	3	2	1	3	2	2	1	-	-



PROGRAMME ELECTIVE - III

MT16351

MECHATRONICS SYSTEM DESIGN

3 0 0 3

COURSE OBJECTIVES

To enable the students to

- know the basic system design procedure.
- design a system with the aid of mechanical and electronic components.
- learn about mechatronics design process.
- understand the data acquisition and control methodologies.
- illustrate the application of mechatronics system.

UNIT I INTRODUCTION 9

Key elements - mechatronics design process - design parameters - traditional and mechatronics designs - advanced approaches in mechatronics - industrial design - ergonomics and safety.

UNIT II SYSTEM MODELLING 9

Introduction - model categories - fields of application - model development - model verification-model validation - model simulation - design of mixed systems - electro mechanics design - model transformation domain - independent description forms - simulator coupling.

UNIT III REAL TIME INTERFACING 9

Introduction - selection of interfacing standards; Elements of data acquisition and control systems - over view of I/O process - general purpose I/O card and its installation - data conversion process - application software - LabVIEW environment and its applications; Vim - Sim Environment and its applications; Man Machine Interface.

UNIT IV CASE STUDIES ON MECHATRONIC SYSTEM 9

Introduction - fuzzy based washing machine - PH control system - autofocus camera - exposure control - motion control using D.C. motor and solenoids - engine management systems - controlling temperature of a hot/cold reservoir using PID - control of pick and place robot - part identification and tracking using RFID - online surface measurement using image processing.

UNIT V MICRO MECHATRONIC SYSTEM 9

Introduction - system principle - component design - system design - scaling laws - micro actuation - micro robot - micro pump - applications of micro mechatronics components.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- identify various mechatronics elements.
- categorize the different system models.
- obtain knowledge about of real time interface.
- apply mechatronics design process for new product development.
- outline the importance of micro mechatronics system.

TEXT BOOKS

1. Devdas shetty, Richard A. Kolk, "Mechatronics System Design", 2nd Edition, Cengage Learning, 2012.
2. Georg pelz, "Mechatronics Systems: Modeling and simulation" with HDL's, John Wiley and son Ltd, 2003.

REFERENCES

1. Bishop, Robert H, "Mechatronics Hand book", 2nd Edition, CRC Press, 2018.
2. Bradley, D.Dawson, N.C. Burd and A.J. Loader, "Mechatronics: Electronics in Products and Processes", CRC Press 1993, First Indian print 2010.
3. De Silva, "Mechatronics: A Foundation Course", Taylor and Francis, Indian Reprint, 2013.

Mapping of Course Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
	Programme Outcomes (POs)													
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12	PSO1	PSO2
CO1	2	2	-	-	-	2	-	-	-	2	-	-	-	1
CO2	-	2	-	-	1	3	-	1	-	2	-	-	-	3
CO3	2	-	-	-	3	-	-	3	-	-	-	2	-	2
CO4	2	2	-	-	1	2	-	1	-	3	-	2	-	3
CO5	2	-	-	-	3	-	-	3	-	-	-	2	-	1



COURSE OBJECTIVES

To enable the students to

- understand the concepts of mathematical modeling of engineering problems.
- study the methods to assemble finite element equations, boundary conditions and post processing.
- learn about the triangular element, load vectors and applications to heat transfer.
- study about plane stress, plane strain and plate and shell elements.
- gain knowledge on iso- parametric formulation, shape functions, numerical integration and matrix solution techniques.

UNIT I INTRODUCTION 9

Historical Background - Mathematical Modeling of field problems in Engineering - Governing Equations - Discrete and continuous models - Boundary, Initial and Eigen Value problems - Weighted Residual Methods - Variational Formulation of Boundary Value Problems - Ritz Technique - Basic concepts of the Finite Element Method.

UNIT II ONE-DIMENSIONAL PROBLEMS 9

One Dimensional Second Order Equations - Discretization - Element types - Linear and Higher Order Elements - Derivation of Shape functions and Stiffness matrices and force vectors - Assembly of Matrices - Solution of problems from solid mechanics and heat transfer. Longitudinal vibration frequencies and mode shapes. Fourth Order Beam Equation - Transverse deflections and Natural frequencies of beams.

UNIT III TWO DIMENSIONAL SCALAR VARIABLE PROBLEMS 9

Second Order 2D Equations involving Scalar Variable Functions - Variational formulation - Finite Element formulation - Triangular elements - Shape functions and element matrices and vectors. Application to Field Problems - Thermal problems - Torsion of Non-circular shafts - Quadrilateral elements - Higher Order Elements.

UNIT IV TWO DIMENSIONAL VECTOR VARIABLE PROBLEMS 9

Equations of elasticity - Plane stress, plane strain and axisymmetric problems - Body forces and temperature effects - Stress calculations - Plate and shell elements.

UNIT V ISOPARAMETRIC FORMULATION 9

Natural co-ordinate systems - Isoparametric elements - Shape functions for iso parametric elements - One and two dimensions - Serendipity elements - Numerical integration and application to plane stress problems - Matrix solution techniques - Solutions Techniques to Dynamic problems - Introduction to Analysis Software.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- understand different mathematical techniques used in FEM analysis.
- understand methods to assemble finite element equation of structural problems and non-structural problems.
- attain knowledge of basic idea about triangular element, plane stress, plane strain conditions and application to heat transfer problems.
- acquire knowledge on basic idea about axisymmetric element, plane stress conditions with different boundary conditions.
- understand the concept in mapping of elements from natural to local coordinate system, displacement and stress calculations with numerical integration.

TEXT BOOKS

1. Seshu, P, “Text Book of Finite Element Analysis”, Prentice-Hall of India Pvt. Ltd., New Delhi, 2013.
2. Reddy. J.N., “An Introduction to the Finite Element Method”, 3rd Edition, Tata McGraw-Hill, 2017.

REFERENCES

1. Rao, S.S., “The Finite Element Method in Engineering”, 5th Edition, ButterworthHeinemann, 2010.
2. Daryl L. Logan , “A First Course in the Finite Element Method”, Cengage Learning Custom Publishing, 6th edition, 2016.
3. Malkus, Plesha, Witt Robert D. Cook, “Concepts and Applications of Finite Element Analysis”, 4th Edition, Wiley, 2007.
4. Tirupathi R. Chandrupatla and Ashok D. Belugundu, “Introduction to Finite Elements in Engineering”, Pearson Education India, 4th edition, 2015.

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
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CO2	-	3	-	1		-	-	3	-	-	2	-	-	-
CO3	3	3	-	-		2	-	1	-	2	2	-	-	-
CO4	3	2	-	-		2	-	-	-	2	1	-	2	-
CO5	3	3	-	-	-	3	-	2	-	2	2	-	-	-



COURSE OBJECTIVES

To enable the students to

- learn about various non-traditional machining processes, the various process parameters and their influence on performance and their applications.
- access knowledge on various types of mechanical energy-based processes.
- identify the principles and working of electrical energy-based processes.
- gain the knowledge of chemical and electro- chemical energy-based processes.
- acquire the concept of thermal energy-based processes.

UNIT I INTRODUCTION 9

Introduction to Non-traditional machining processes, need for non-traditional machining, classification of non-traditional machining processes, their applications, advantages, limitations, Comparison of non-traditional machining processes.

UNIT II MECHANICAL ENERGY BASED PROCESSES 9

Abrasive Jet Machining - Water Jet Machining - Abrasive Water Jet Machining - Ultrasonic Machining (AJM, WJM, AWJM and USM) - working principles - equipment used - process parameters - MRR - applications.

UNIT III ELECTRICAL ENERGY BASED PROCESSES 9

Electric Discharge Machining (EDM) - Wire cut EDM tool - working principles - equipment - Surface finish - power and control Circuits - tool wear - process parameters - MRR - applications.

UNIT IV CHEMICAL AND ELECTRO - CHEMICAL ENERGY BASED PROCESSES 9

Chemical Machining and Electro Chemical Machining (CHM and ECM) - working principles - equipment used - process parameters - surface finish and MRR - Applications - ECG and ECH - applications.

UNIT V THERMAL ENERGY BASED PROCESSES 9

Laser Beam machining (LBM) - Plasma Arc Machining (PAM) - Electron Beam Machining (EBM) - Ion Beam Machining (IBM) - working principles - equipment used - types - beam control techniques - applications.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- demonstrate different non-traditional machining processes and know the influence of difference process parameters on the performance and their applications.
- understand the knowledge on various types of mechanical energy-based processes.
- identify a problem and apply the fundamental concepts and enable to solve problems arising in metal removal process.
- interpret Electro Chemical Machining process, economic aspects of ECM and problems on estimation.
- relate generation and control of Electron Beam for Machining, Laser Beam Machining and comparison.

TEXT BOOKS

1. Jagadeesha T. “Unconventional Machining Processes”, I K International Publishing House Pvt. Ltd, 2016.
2. V. K. Jain, “Advanced Machining Processes”, 26th Reprint, Allied Publishers Pvt. Ltd., 2016.

REFERENCES

1. Angelos P. Markopoulos and J. Paulo Davim, “Advanced Machining Processes: Innovative Modeling Techniques”, CRC Press, 1st edition, 2017.
2. J.A. McGeough, “Advanced Methods of Machining”, Springer, 2011.
3. Paul De Garmo, J.T.Black, and Ronald.A.Kohser, “Material and Processes in Manufacturing” John Wiley and Sons, 10th Edition, 2010.

Mapping of Course Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
	Programme Outcomes (POs)													
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	-	3	-	-	2	-	-	-	-	2	-	2
CO2	1	-	-	1	-	-	-	-	-	2	-	2	-	2
CO3	-	-	-	-	-	-	2	-	-	3	-	2	-	2
CO4	3	-	-	2	-	-	2	-	-	2	-	-	-	2
CO5	2	-	-	-	-	-	2	-	-	2	-	2	-	-



COURSE OBJECTIVES

To enable the students to

- understand the fundamentals of Industrial control.
- impart students with analysis of converters and inverters.
- introduce the method of controlling speed.
- outline the formal procedures for relays, heating and welding control.
- introduce the concept of process control.

UNIT I INTRODUCTION**9**

Industrial control classification - motion and process control - feed forward control - interfacing devices - amplifier - review of thyristor - SCR - TRIAC - phototransistor.

UNIT II CONVERTERS AND INVERTERS**9**

Analysis of controlled and fully controlled converters - dual converters - analysis of voltage source and current source - current source and series converters.

UNIT III INDUSTRIAL MOTOR CONTROL**9**

Method of controlling speed - basic control circuit - DC motor control, AC motor control - Servo motor control - Stepper motor control - micro controller based speed control - solid state motor control - PLL control of a DC motor control

UNIT IV HEATING AND WELDING CONTROL**9**

Introduction - principle of relays - electromechanical relay - solid state relays - latching relays timing relays - induction heating - dielectric heating - controls for welding.

UNIT V PROCESS AND MOTION CONTROL**9**

Elements of process control - temperature control - flow control, level control - methods of motion control - feedback control - direct digital control.

TOTAL PERIODS 45**COURSE OUTCOMES**

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

- solve the fundamentals of Industrial control applications.
- design analysis of voltage source and current source.
- acquire knowledge on the basics about principle of relays.
- understand the principle of relays used in welding process.
- design the process control of elements.

TEXT BOOKS

1. Bogdan M. Wilamowski , J. David Irwin “Fundamentals of Industrial Electronics “CRC Press, 2017.
2. Kissell T.E, “Industrial Electronics: Applications for Programmable Controllers, Instrumentation and Process Control and Electrical Machines and Motor Controls”, Prentice Hall India Learning Private Limited; 3rd edition, 2003.

REFERENCES-

1. Terry L.M. Bartelt, "Industrial electronics, devices, systems and applications", Cengage Learning, 2005.
2. Stephen L. Herman, "Industrial Motor Control", 7th edition, Delmar publishers, 2013.
3. Biswanath Paul, "Industrial Electronics and Control" PHI Learning publisher;2014.
4. Jean-Pierre Corriou; "Process Control"; Springer;2017.

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	Programme Outcomes (POs)													
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	-	-	-	-	-	-	-	-	3	2
CO2	2	3	3	3	-	-	-	-	-	-	-	-	2	3
CO3	2	3	3	3	2	-	-	-	-	-	-	-	3	3
CO4	2	3	3	3	2	-	-	-	-	-	-	-	2	3
CO5	2	3	3	2	3	-	-	-	-	-	-	-	2	3



COURSE OBJECTIVES

To enable the students to

- learn the fundamentals of Database Management Systems.
- make the students understand the relational model.
- familiarize the students with ER diagrams.
- expose the students to SQL.
- familiarize the students with the different types of databases.

UNIT I INTRODUCTION 9

Purpose of Database System -Views of data - Data Models - Database Languages - Database System Architecture - Database users and Administrator - Entity - Relationship model (E-R model) - E-R Diagrams - Introduction to relational databases.

UNIT II RELATIONAL MODEL 9

The relational Model - The catalog - Types - Keys - Relational Algebra - Domain Relational Calculus - Tuple Relational Calculus - Fundamental operations - Additional I/O operations - SQL fundamentals - Integrity - Triggers - Security - **Advanced SQL features** - Embedded SQL - Dynamic SQL - Missing Information -Views - Introduction to Distributed Databases and Client/Server Databases.

UNIT III DATABASE DESIGN 9

Functional Dependencies - Non-Loss Decomposition - Functional Dependencies - First, Second, Third Normal Forms, Dependency Preservation - **Boyce/ Code Normal Form**-Multi-Valued Dependencies and Fourth Normal Form - Join Dependencies and Fifth Normal Form.

UNIT IV TRANSACTIONS 9

Transaction Concepts - Transaction Recovery - ACID Properties -System Recovery - Media Recovery - Two Phase Commit - Save Points - SQL Facilities for recovery - Concurrency - Need for Concurrency - Locking Protocols –Two -Phase Locking - Intent Locking - Deadlock- Serializability - Recovery Isolation Levels - **SQL Facilities for Concurrency**.

UNIT V IMPLEMENTATION TECHNIQUES 9

Overview of Physical Storage Media - Magnetic Disks - RAID -Tertiary storage - File Organization - Organization of Records in Files - Indexing and Hashing - Ordered Indices - B+ tree Index Files -B tree Index Files - Static Hashing - Dynamic Hashing - Query Processing Overview - Catalog Information for Cost Estimation - Selection Operation -Sorting - Join Operation -Database Tuning.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- describe basic concepts of a database system.
- design a data model and schemas in RDBMS.
- analyze functional dependencies for designing a robust database.
- apply SQL for business - related problems.
- implement transactions, Concurrency control, and be able to do a database recovery

TEXT BOOKS

1. Abraham Silberschatz, Henry F. Korth and S. Sudharshan, “Database System Concepts”, Sixth Edition, Tata Mc Graw Hill, 2011.
2. C.J.Date, A.Kannan, S.Swamynathan, “An Introduction to Database Systems”, Eighth Edition, Pearson Education, 2006.

REFERENCES

1. Elmasri R. and Shamkant B. Navathe, “Fundamentals of Database Systems”, 6th Edition, Addison Wesley, 2011.
2. Atul Kahate, “Introduction to Database Management Systems”, Pearson Education, New Delhi, 2006.
3. Raghu Ramakrishnan, “Database Management Systems”, Fourth Edition, Tata Mc Graw Hill, 2010.
4. G.K.Gupta, “Database Management Systems”, Tata Mc Graw Hill, 2011.
5. Hector Garcia-Molina, Jeff Ullman, and Jennifer Widom, “Database Systems: The Complete Book”, Pearson Education, Second Edition, 2008.

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COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	-	-	-	-	-	-	-	-	3	2
CO2	2	3	3	3	-	-	-	-	-	-	-	-	2	3
CO3	2	3	3	3	2	-	-	-	-	-	-	-	3	3
CO4	2	3	3	3	2	-	-	-	-	-	-	-	2	3
CO5	2	3	3	2	3	-	-	-	-	-	-	-	2	3



PROGRAMME ELECTIVE - IV

MT16451

COMPUTATIONAL FLUID DYNAMICS

3 0 0 3

COURSE OBJECTIVES

To enable the students to

- understand the fundamental concepts of computational fluid dynamics.
- study the various techniques involved in the discretization of fluid elements.
- acquire knowledge about grid generation.
- impart knowledge in analysis techniques used in computational solutions of fluid mechanics and heat transfer problems.
- discuss the applications of CFD.

UNIT I INTRODUCTION 9

Impact and applications of CFD in diverse fields; governing equations of fluid dynamics; continuity; momentum and energy; generic integral form for governing equations; Initial and Boundary conditions; Classification of partial differential equations; Hyperbolic - Parabolic - Elliptic and Mixed.

UNIT II BASIC ASPECTS OF DISCRETIZATION 9

Discretization techniques; Finite difference - Finite volume and Finite element method; Comparison of Discretization by the three methods; Introduction to finite differences - difference equations; Uniform and Non-uniform grids - numerical errors - **grid independence test and optimum step size.**

UNIT III GRID GENERATION 9

Transformation of non-uniform grids to uniform grids - the general transformation of the equations; Form of the governing equations suitable for CFD; Compressed grids - boundary fitted coordinate systems - elliptic grid generation - **adaptive grids; Modern developments in grid generation.**

UNIT IV CONDUCTION AND CONVECTION 9

Steady One - dimensional conduction - two and three - dimensional conduction; Steady one - dimensional convection and Diffusion; Transient one - dimensional and two - dimensional conduction; **Explicit, Implicit, Crank Nicolson.**

UNIT V INCOMPRESSIBLE FLUID FLOW AND APPLICATIONS OF CFD 9

Gradient term and continuity equation - staggered grid - momentum equations - pressure and velocity corrections - pressure correction equation - numerical procedure for SIMPLE algorithm - boundary conditions for the pressure correction method - stream function - vorticity method; Discussion of case studies; **Applications of CFD fluent software** - drying - sterilization - mixing - refrigeration; Other applications - heat exchanger - clean room condition - future of CFD in the food industry.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- apply the fundamental concepts of computational fluid dynamics.
- evaluate the important classes of numerical discretization scheme.
- demonstrate the importance of grid generation in fluid dynamics problems
- solve numerical equations related to fluid flow and heat transfer problems.
- identify CFD software to solve fluid flow problems.

TEXT BOOKS

1. J. D. Anderson., Jr. “Computational Fluid Dynamics; The Basic with Applications”, Tata McGraw Hill Publishing Company Pvt Ltd., New Delhi, 2017.
2. John F. Wendt, “Computational Fluid Dynamics: An Introduction”, Springer; 3rd edition, 2012.

REFERENCES

1. P.S. Ghoshdastidar, “Computational Fluid Dynamics and Heat Transfer”, Cengage India Private Limited, 1st edition, 2017.
2. Muralidhar and T. Sundarajan, “Computational Fluid Flow and Heat Transfer”, Narosa Publishing House, New Delhi 2009.
3. S. V. Patankar, “Numerical Heat Transfer and Fluid Flow”, CRC Press, 2017.
4. Jiyuan Tu, Guan Heng Yeoh, Chaoqun Liu, “Computational Fluid Dynamics: A Practical Approach”, Butterworth-Heinemann, 3rd edition, 2018.

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COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	3	3	1	3	-	2	1	1	3	3	1	2	3	3
CO2	1	1	3	-	1	1	3	3	2	1	1	3	-	1
CO3	2	1	-	1	-	-	-	2	3	2	1	-	3	2
CO4	-	-	2	2	3	3	2	1	-	-	3	2	-	3
CO5	1	1	-	-	1	3	-	-	1	1	-	1	2	-



COURSE OBJECTIVES

To enable the students to

- identify the concepts of sensor technology.
- know the fundamental knowledge of biomedical sensors.
- understand the principle and operation of electrodes
- design advanced sensors.
- troubleshoot and calibrate the medical equipment.

UNIT I INTRODUCTION TO SENSORS 9

Chemical Sensors - Blood, Gas and Acid, base physiology Electrochemical sensors - Chemical Fibro sensors; Ion Selective Field Effect Transistor (ISFET); Immunologically Sensitive Field Effect Transistor (IMFET); Integrated flow sensor and Blood Glucose sensors; Optical Sensors - Fiber optic light propagation - Graded index Fibers - Fiber optic communication driver circuits; Laser classifications - driver circuits for solid state laser diodes; Radiation sensors and Optical combinations.

UNIT II BIOMEDICAL SENSORS 9

Biomedical Sensors - introduction - sensors terminology in the human body - Body fluids musculoskeletal system; Bioelectric amplifiers - bioelectric Amplifiers for Multiple input Circuits - differential amplifiers; Physiological pressure and other cardiovascular measurements and devices.

UNIT III ELECTRODES 9

Electrodes - Electrodes for Biophysical sensing - Electrode model circuits - Microelectrodes - ECG and EEG Electrodes; ECG signals - waveforms - Standard lead system - Polarization Polarizable and Non polarizable Electrodes - body surface recording electrodes; Ultrasonic Transducers for Measurement and therapy; Radiation detectors; NIR spectroscopy.

UNIT IV ADVANCED SENSOR DESIGN 9

Advanced Sensor Design - Fluoroscopic machines design - Nuclear medical systems - EMI to biomedical sensors - types and sources of EMI - fields and EMI effects; Computer systems used in X-ray and nuclear medical equipment.

UNIT V TROUBLESHOOTING AND MAINTENANCE 9

Troubleshooting - typical faults - calibration; Maintenance procedure for medical equipment; Design of 2 and 4 wire transmitters with 4-20 mA output; Aerospace Sensor - Laser Gyroscope and accelerometers; Sensors used in space and environmental applications.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- illustrate the basic concepts and principles of sensors.
- describe the fundamentals of biomedical sensors.
- define the operation and principle of electrodes.
- design advanced sensor for the required applications.
- Troubleshoot, calibrate and maintenance of medical equipment.

TEXT BOOKS

1. Jacob Fraden , “Handbook of Modern Sensors”, Springer Nature, 5th edition, 2015.
2. Martin J. Richardson, John D. Wiltshire “The Hologram: Principles and Techniques”, Wiley IEEE Press, 1st edition, 2017.
3. John G. Webster and Halit Eren, “Measurement, Instrumentation, and Sensors Handbook: Electromagnetic, Optical, Radiation, Chemical, and Biomedical Measurement”, CRC Press, 2nd edition, 2017.

REFERENCES

1. Laurence J. Street, “Introduction to Biomedical Engineering Technology”, CRC Press, 3rd edition, 2016.
2. Arthur H. Hartog, “An Introduction to Distributed Optical Fibre Sensors”, CRC Press, 1st edition, 2017.
3. P. Garnell, “Guided Weapon Control Systems”, Pergamon Press, 2nd edition, 1980.

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CO2	-	-	3	1	3	1	3	3	2	2	-	2	2	1
CO3	2	3	1	-	-	2	1	2	3	-	2	2	-	2
CO4	2	2	2	3	2	-	1	-	-	-	1	3	3	2
CO5	1	1	1	-	2	3	2	1	2	2	2	-	-	-



COURSE OBJECTIVES

To enable the students to

- know the utilization of renewable energy sources.
- identify the availability of solar energy and solar cells.
- acquire knowledge of the wind energy resources and wind turbine design.
- understand the bioenergy and biomass process.
- learn other sources of energy such as tidal and geothermal energy.

UNIT I INTRODUCTION 9

World energy use - reserves of energy resources - environmental aspects of energy utilization - renewable energy scenario in Tamil Nadu, India and around the world - potentials - achievements/applications - economics of renewable energy systems.

UNIT II SOLAR ENERGY 9

Solar radiation - measurements of solar radiation - flat plate and concentrating collectors - solar direct thermal applications - solar thermal power generation - fundamentals of solar photovoltaic conversion - solar cells – solar PV power generation - solar PV applications.

UNIT III WIND ENERGY 9

Wind data and energy estimation - types of wind energy systems - performance - site selection - details of wind turbine generator - safety and environmental aspects.

UNIT IV BIOENERGY 9

Biomass direct combustion - biomass gasifiers - biogas plants - digesters - ethanol production - bio diesel - cogeneration - biomass applications.

UNIT V OTHER RENEWABLE ENERGY SOURCES 9

Tidal energy - wave energy - open and closed OTEC cycles - small hydro-geothermal energy - hydrogen and storage - fuel cell systems - hybrid systems.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- describe the availability of renewable energy sources.
- discuss the solar energy and the current solar energy cells.
- gather wind energy resources and techniques to utilize them effectively.
- categorize the availability and the conversion method of bioenergy and biofuels.
- summarize the significance of hydrogen and fuel cells principles, storage and uses.

TEXT BOOKS

1. Rai. G.D., "Non-Conventional Energy Sources", Khanna Publishers, New Delhi, 2018.
2. N.K. Bansal, "Non-Convention Energy Resources", Vikas, 2018.

REFERENCES

1. Garg.H. P and Prakash. J., "Solar Energy - Fundamentals and applications", McGraw Hill Education, 2017.
2. Mohd. Hasan Ali, "Wind Energy Systems: Solutions for Power Quality and Stabilization", CRC Press, 2017.
3. Vaughn C. Nelson, Kenneth L. Starcher, "Introduction to Bioenergy", CRC Press, 2017.
4. Sukhatme, S.P., J. K. Nayak, "Solar Energy, Principles of Thermal Collection and Storage", Tata MCGraw Hill, 2009.
6. John Twidell, Tony Weir, "Renewable Energy Sources", Routledge, 2015.

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CO1	2	3	-	1	-	-	-	3	-	2	-	2	3	-
CO2	3	3	-	-	-	-	3	-	-	2	-	-	3	3
CO3	2	-	-	3	-	-	2	1	-	-	-	3	3	2
CO4	-	3	-	2	-	-	2	3	-	2	-	-	-	1
CO5	2	-	-	2	-	-	-	1	-	2	-	2	3	2



PROGRAMME ELECTIVE - V

MT16551

INTELLECTUAL PROPERTY RIGHTS

3 0 0 3

COURSE OBJECTIVES

To enable the students to

- understand the importance of IPR.
- provide knowledge of Patents, Copyrights and Trademarks.
- understand the international convention relating to IPR.
- learn various levels of policies.
- study the different case studies related to IPR.

UNIT I INTRODUCTION 9

Introduction - invention and creativity - Intellectual Property (IP) - importance - protection of IPR - basic types of property (movable property, immovable property and intellectual property).

UNIT II PATENTS, COPYRIGHTS AND TRADEMARKS 9

IP - Patents - Copyrights and related rights - Trade Marks and rights arising from trademark registration - definitions - industrial designs and integrated circuits - protection of geographical indications at national and international levels - application procedures.

UNIT III INTERNATIONAL IPR CONVENTION 9

Introduction - establishment of WIPO - mission and activities - history - General Agreement on Trade and Tariff (GATT).

UNIT IV IPR STRATEGIES 9

Indian position vs WTO and strategies - Indian IPR legislations - commitments to WTO - patent ordinance and the bill - draft of a national intellectual property policy - present against unfair competition.

UNIT V CASE STUDIES 9

Case studies on - patents (basmati rice, turmeric, neem, etc.) - copyright and related rights - trade marks - industrial design and integrated circuits - geographic indications - protection against unfair competition.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- distinguish various property rights.
- acquire knowledge of patents, copyrights and trademarks.
- describe the procedures to obtain Intellectual Property Rights.
- demonstrate the Indian position with WTO.

- explain and choose on the effective usage of IPR's with some case studies.

TEXT BOOK

1. K.C. Kankanala, A.K. Narasani, V. Radhakrishnan, "Indian Patent Law and Practice", Oxford University Press, UK ed. Edition, 2012.
2. Neeraj Pandey and Khushdeep Dharni, "Intellectual Property Rights", PHI Learning, 2014.

REFERENCES

1. M. K. Bhandari, "Law Relating to Intellectual Property Rights", Central Law Publications, 4th edition, 2015.
2. Anil Kumar H S and Ramakrishna B, "Fundamentals of Intellectual Property Rights: For Students, Industrialist and Patent Lawyers", Notion Press, 1st edition, 2017.
3. Editorial Board of Professional Book Publishers, "Intellectual Property Laws", Professional Book Publishers, 1st edition, 2018.

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CO2	-	-	1	1	2	1	-	3	3	2	-	2	2	3
CO3	3	1	2	-	-	2	1	1	-	-	3	1	-	2
CO4	1	3	2	2	2	-	1	-	1	-	1	-	1	1
CO5	3	2	1	-	1	3	2	1	2	2	2	-	-	-



COURSE OBJECTIVES

To enable the students to

- present the concepts of intelligent agents and searching.
- illustrate the concepts of intelligent knowledge and reasoning.
- categorize the concepts of intelligent planning and learning.
- choose the applications of AI in robot vision.
- familiarize with different AI techniques and learning the expert systems.

UNIT I INTRODUCTION TO AI AND PRODUCTION SYSTEMS 9

Introduction to AI; Criteria for success; Problem defining - production systems characteristics - specialized system characteristics; Problem solving methods - problem graphs - matching and indexing - heuristic search techniques; **Generate and Test - hill climbing** - first search; Problem reduction.

UNIT II KNOWLEDGE REPRESENTATION 9

Representations and mappings - approaches - issues - representing simple facts in logic - instance and ISA Relationships; Computable functions and predicates - resolution - natural deduction - procedural versus declarative knowledge - **logic programming**; Knowledge based agents; The Wumpus World.

UNIT III PLANNING AND LEARNING 9

Planning - components of planning system - goal stack planning - nonlinear planning - hierarchical planning - and Conditional Planning; **Reactive systems**; Learning - rote learning - learning by taking advice - explanation based learning - formal learning theory - genetic learning- logical formulation of learning - inductive learning.

UNIT IV AI IN ROBOT VISION 9

Introduction - steering an automobile; Two stages of robot vision; Image processing - averaging - **edge enhancement** - **combining edge enhancement with averaging** - region finding - scene analysis - interpreting lines and curves in the image - model based vision; Stereo vision and depth analysis.

UNIT V EXPERT SYSTEMS 9

Definition; Features of an expert system - organization - characteristics - representing and using domain knowledge; Expert system - architecture - typical ES- MYCIN, PIP, INTERNIST, DART, XOON - Shells; Knowledge acquisition; Perception and action; Real time search - perception and action.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- create the level of the model in design an AI system.
- interpret the knowledge about representations and mappings.
- describe about planning and components of planning.
- identify the various stages of robot vision.
- summarize the features of expert system.

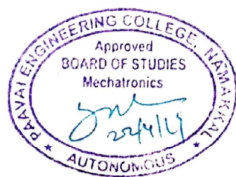
TEXT BOOKS

1. Kevin Knight, Elaine Rich and B. Nair, “Artificial Intelligence”, 3rd edition, McGraw Hill Education, 2017.
2. Nils J. Nilsson, “Principles of Artificial Intelligence”, Springer publishers, 2014.

REFERENCES

1. Russell, “Artificial Intelligence, A Modern Approach”, 3rd edition, Pearson Publisher, 2017.
2. Patterson, “Introduction to Artificial Intelligence”, 1st edition, Pearson Education India, 2015.
3. Gopalkrishnan P, “Handbook of Materials Management”, 2nd edition, Prentice Hall India Learning Private Limited, 2015.
4. Peter Baily, Barry Crocker, David Farmer, David Jessop and David Jones, “Procurement and Principles Management”, 11th edition, Pearson Education, 2018.

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CO3	-	3	2	1	2	-	-	3	2	-	2	2	-	1
CO4	2	3	2	-	1	2	2	1	-	3	2	1	-	2
CO5	-	2	2	1	2	-	-	3	2	-	2	2	-	1



COURSE OBJECTIVES

To enable the students to

- impart the importance of design in today's context of global competition, environmental awareness and customer oriented market.
- learn the basic concepts and various aspects of design using simple examples and case studies.
- acquire ideas on legal and ethical domains, codes of ethics.
- gain knowledge about rapid prototyping finite element analysis.
- understand about reliability centered maintenance.

UNIT I DESIGN FUNDAMENTALS 9

Importance of design - design process - considerations of good design - morphology of design - organization for design; Computer Aided Engineering; Designing to codes and standards; Concurrent Engineering; Product and process cycles; Technological forecasting; Market Identification; Competition bench marking.

UNIT II CUSTOMER ORIENTED DESIGN AND SOCIETAL CONSIDERATIONS 9

Identification of customer needs - customer requirements; Quality Function Deployment; Product design specifications - human factors in design - ergonomics and aesthetics; Societal consideration - contracts - Product Liability - protecting intellectual property - legal and ethical domains; Codes of ethics - ethical conflicts; Environment responsible design - future trends in interaction of engineering with society.

UNIT III DESIGN METHODS 9

Creativity and Problem Solving - creativity methods - theory of Inventive Problem Solving (TRIZ); Conceptual Decomposition; Generating design concepts - axiomatic design - evaluation methods embodiment design - product architecture - configuration design - parametric design; Role of models in design - mathematical modeling - simulation - geometric modeling; Rapid prototyping Finite Element Analysis; Optimization - search methods.

UNIT IV MATERIAL SELECTION PROCESSING AND DESIGN 9

Material selection process; Economics - cost vs performance - weighted property index - Value Analysis; Role of processing in design - classification of manufacturing process - design for manufacture; Design for assembly; Designing for castings - forging - metal forming - machining and welding; Residual stresses - Fatigue - fracture and failure.

UNIT V PROBABILITY CONCEPTS IN DESIGN FOR RELIABILITY 9

Probability; Distributions; Test of hypothesis; Design of experiments; Reliability theory; Design for reliability - reliability centered maintenance; Robust design; Failure Mode Effect Analysis.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- appreciate the aspects of need for design, design process, materials and processes used for designing various components.
- acquainted with the knowledge of designing creative components and legal, human and marketing factors during the design of products.
- equipped with tools for improving quality, reliability and performance of a product.
- self-assured of the technique to promote innovative and successful designs.
- identify the problems in which random variables and distribution concepts are used.

TEXT BOOK

1. Linda C. Schmidt and George Dieter, “Engineering Design”, 4th edition, McGraw Hill Education, 2017.
2. Richard G Budynas and J Keith Nisbett, “Shigley's Mechanical Engineering Design”, 1st edition, McGraw Hill Education, 2017.

REFERENCES

1. Gerhard Pahl, W. Beitz, Jörg Feldhusen and Karl-Heinrich Grote, “Engineering Design: A Systematic Approach”, 3rd edition, Springer, 2014.
2. Shuchen B. Thakore and Bharat I. Bhatt, “Introduction to Process Engineering and Design”, 2nd edition, McGraw Hill Education, 2017.
3. Karl T. Ulrich and Steven D. Eppinger “Product Design and Development”, 5th edition, McGraw Hill Education, 2017.

Mapping of Course Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
	Programme Outcomes (POs)													
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	2	3	1	3	2	2	2	-	2	-	3	2	1	1
CO2	1	2	2	1	2	2	-	3	1	2	2	3	1	1
CO3	-	3	2	-	-	2	3	1	-	-	2	1	-	3
CO4	3	2	2	2	2	1	1	2	3	-	1	-	2	3
CO5	2	2	1	-	1	3	-	1	3	2	1	1	1	2



COURSE OBJECTIVES

To enable the students to

- gain knowledge on working of spark ignition engines.
- impart knowledge of combustion aspects of C.I engines.
- evaluate the pollution formation and control.
- understand the engineering issues and perspectives affecting fuel and engine development.
- develop the knowledge on HCCI combustion and its benefits and applications.

UNIT I SPARK IGNITION ENGINES 9

Mixture requirements - fuel injection systems - monopoint, multipoint and direct injection - stages of combustion - normal and abnormal combustion - knock - factors affecting knock - combustion chambers.

UNIT II COMPRESSION IGNITION ENGINES 9

Diesel fuel injection systems - stages of combustion - knocking - factors affecting knock - direct and indirect injection systems - combustion chambers - fuel spray behaviour - spray structure and spray penetration - air motion - introduction to turbocharging.

UNIT III POLLUTANT FORMATION AND CONTROL 9

Pollutant - sources - formation of carbon monoxide, unburnt hydrocarbon, oxides of nitrogen, smoke and particulate matter - methods of controlling emissions - catalytic converters, selective catalytic reduction and particulate traps - methods of measurement - emission norms and driving cycles.

UNIT IV ALTERNATIVE FUELS 9

Alcohol, Hydrogen, Compressed Natural Gas, Liquefied Petroleum Gas and Bio Diesel - properties, suitability, merits and demerits - Engine Modifications.

UNIT V RECENT TRENDS 9

Air assisted combustion, Homogeneous charge compression ignition engines - variable geometry turbochargers - common rail direct injection systems - hybrid electric vehicles - NO_x adsorbers - onboard diagnostics.

TOTAL PERIODS 45

COURSE OUTCOMES

Upon completing the course, the student should be able to

- demonstrate the construction and working of SI engines and to identify the advantages and disadvantages of the operation and efficiency of SI engines.
- classify the various stages of combustion in C.I engines and Features and design considerations of combustion.

- identify the nature and extent of the problem of pollutant formation and control in internal combustion engines.
- examine the various alternative fuel options available for conventional fuels and their performance and emission characteristics.
- understand the concept of HCCI, its benefits and challenges.

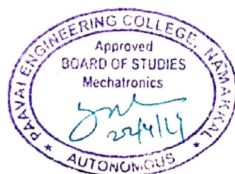
TEXT BOOKS

1. Ramalingam. K.K, "Internal Combustion Engines", 3rd edition, Scitech Publications, 2016.
2. Ganesan. V, "Internal Combustion Engines", Tata McGraw Hill Education, 4th edition, 2017.

REFERENCES

1. Mathur. M.L and R.P. Sharma, "Internal Combustion Engines", Dhanpat Rai Publications, 2014.
2. James E Duffy, "Modern Automotive Technology for Maintenance and Light Repair", 9th edition, Goodheart-Wilcox Publisher, 2019.
3. A. K. Babu, "Automotive Electrical and Electronics", 1st edition, Khanna Publishing, 2018.

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CO2	-	-	1	1	2	1	-	3	3	2	-	2	2	1
CO3	3	1	2	-	-	3	3	2	-	-	1	1	-	2
CO4	3	2	3	2	2	-	3	-	3	-	3	-	1	3
CO5	3	1	2	-	2	2	3	1	3	2	3	-	-	-



COURSE OBJECTIVES

To enable the students to

- learn the modern manufacturing systems.
- understand the concepts and applications of flexible manufacturing systems.
- familiarize with planning for FMS database.
- impart knowledge on economic justification of FMS.
- gain knowledge about FMS development towards factories of the future.

UNIT I PLANNING, SCHEDULING AND CONTROL OF FLEXIBLE MANUFACTURING SYSTEMS 9

Introduction to FMS - development of manufacturing systems - benefits - major elements - types of flexibility; FMS application and flexibility - single product - single batch - n - batch scheduling problem - knowledge based scheduling system.

UNIT II COMPUTER CONTROL AND SOFTWARE FOR FLEXIBLE MANUFACTURING SYSTEMS 9

Introduction - composition of FMS - hierarchy of computer control - computer control of work center and assembly lines - FMS supervisory computer control - types of software specification and selection - trends.

UNIT III FMS SIMULATION AND DATA BASE 9

Application of simulation - model of FMS - simulation software – limitation - manufacturing data systems – data Flow - FMS database systems - planning for FMS database.

UNIT IV GROUP TECHNOLOGY AND JUSTIFICATION OF FMS 9

Introduction; Matrix formulation - mathematical programming formulation - graph formulation; Knowledge based system for group technology; Economic justification of FMS - application of possibility distributions in FMS systems justification.

UNIT V APPLICATIONS OF FMS AND FACTORY OF THE FUTURE 9

FMS application in machining - sheet metal fabrication - prismatic component production - aerospace application; FMS development towards factories of the future - artificial intelligence and expert systems in FMS; Design philosophy and characteristics for future - unmanned factories.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- perform planning, scheduling and control of flexible manufacturing systems.
- exhibits the basic hierarchy of computer control.
- acquaintance the perform simulation on software's use of group technology to product classification.
- exposure of artificial intelligence and expert systems in FMS.
- apply the possibility distributions in FMS systems justification.

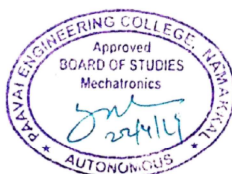
TEXT BOOK

1. Ioan Constantin Dima, "Industrial Production Management in Flexible Manufacturing Systems", 1st edition, Idea Group, U.S, 2013.

REFERENCES

1. Radhakrishnan.P, Subramanyan. S and Raju.V, "CAD/CAM/CIM", 4th edition, New Age International Pvt Ltd, 2018.
2. Nand K. Jha, "Handbook of Flexible Manufacturing Systems", Academic Press Inc., 2012.
3. Groover M.P., "Automation, Production Systems and Computer Integrated Manufacturing ", 5th edition, Pearson College Div, 2018.
4. Serope Kalpakjian and Steven R. Schmid, "Manufacturing Engineering and Technology", 7th edition, Pearson Education, 2018.
5. Taiichi Ohno, "Evolution of Toyota Production System", Kindle Edition, Amazon Asia-Pacific Holdings Private Limited, 2017.

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CO3	2	3	2	-	-	2	2	1	-	-	2	1	-	2
CO4	3	2	2	2	2	1	1	2	3	-	1	-	2	3
CO5	2	2	1	-	1	3	2	1	3	2	2	1	-	-



OPEN ELECTIVE –II (OE)

MT16906

VETRONICS

3 0 0 3

COURSE OBJECTIVES

To enable the students to

- understand the role of vetronics in defense applications.
- gain adequate knowledge on engine control, fuel delivery systems and MPFI.
- introduce the methods for transmission control and safety systems.
- understand the components of an airplane and their functions.
- introduce the basics of marine engineering.

UNIT I FUNDAMENTALS OF VEHICLE ENGINEERING 9

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

UNIT II AUTOMOTIVE ENGINE CONTROL, MONITORING AND DIAGNOSTICS SYSTEMS 9

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

UNIT III AUTOMOTIVE TRANSMISSION AND SAFETY SYSTEMS 9

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

UNIT IV AIRCRAFT MECHATRONICS 9

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

UNIT V MARINE MECHATRONIC SYSTEMS 9

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

TOTAL PERIODS 45

COURSE OUTCOMES

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

- gather the knowledge in particularly of automotive engines.
- acquire knowledge on engine controls and fuel delivery systems.
- understand the various transmission control systems, electromagnetic interference and electronic dashboard instruments in automobiles, aircraft and marine applications.
- distinguish between various components of an airplane and their functions.
- familiarize various marine propulsion mechatronics and their technical aspects.

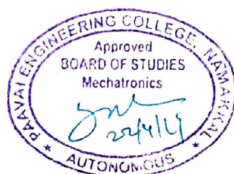
TEXT BOOKS

1. William B. Ribbens, "Understanding Automotive Electronics: An Engineering Perspective", - 8th Edition, Butterworth - Heinemann, 2017.
2. A. Galip Ulsoy, Huei Peng, and Melih Çakmakci, "Automotive Control Systems", Cambridge University Press, 2014.

REFERENCES

1. Tom Denton, "Automobile Electrical and Electronic Systems", 5th edition, Routledge, 2107.
2. Robert Bosch GmbH, "Bosch Automotive Electrics and Automotive Electronics", 5th edition, Springer Nature, 2014.
3. Amir Almslmany, "Recent Advancements in Airborne Radar Signal Processing: Emerging Research and Opportunities", 1st edition, IGI Global, 2018.
4. Hamid Reza Karimi, "Offshore Mechatronics Systems Engineering", 1st edition, CRC Press, 2018.

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CO1	2	2	-	-	-	2	-	-	-	2	-	-	-	1
CO2	-	1	-	-	1	1	-	1	-	2	-	-	-	2
CO3	2	-	-	-	2	-	-	3	-	-	-	2	-	2
CO4	2	1	-	-	2	1	-	1	-	2	-	2	-	2
CO5	2	-	-	-	2	-	-	3	-	-	-	1	-	1



COURSE OBJECTIVES

To enable the students to

- understand the basic objectives of a manufacturing industry and explain how automation and control technologies relate to control system.
- study the criteria in selecting a transducer for particular application.
- know the signal flow in a signal transmission system.
- outline the importance of PLC and SCADA in industrial automation.
- write PLC program using ladder diagram for simple applications.

UNIT I INTRODUCTION TO AUTOMATION 9

Introduction - automation principles and strategies - levels of automation - advanced automation functions - reasons for automation; industrial control system : continuous control system - discrete control systems - robot control system.

UNIT II HARDWARE COMPONENTS FOR AUTOMATION 9

Transducers - capacitive transducer - piezo electric transducer - hall effect transducer - thermo electric transducer - photo electric transducer.

UNIT III SIGNAL CONDUCTION AND DATA TRANSMISSION 9

Functions of signal conditioning equipment - amplification - types of amplifier; mechanical - fluid - optical - electrical and electronics. Signal transmission - converters.

UNIT IV PROGRAMMABLE LOGIC CONTROLLER 9

Introduction - parts of PLC - PLC hardware components - output control devices - timers; ON delay, OFF delay - counters; UP counter, DOWN counter - introduction about SCADA

UNIT V APPLICATION OF PLC 9

Simple material handling application - automatic control of ware house door - automatic lubrication of supplier conveyor belt - automatic car washing system - bottle label detection and process control application.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- describe working of various blocks of basic industrial automation system.
- learn the various types of transducers, basic principle of working and their applications.
- perform the frequency domain analysis of the signals in a signal transmission system.
- ability to apply PLC timers and counters for the control of industrial processes.
- develop PLC ladder program for a given application.

TEXT BOOKS

1. A.K. Sawhney and Puneet Sawhney, “A Course in Mechanical Measurements and Instrumentation and Control”, Dhanpat Rai and Co. (P) Limited, 2017.
2. Frank D. Petruzella, “Programmable Logic Controllers”, 4th edition, McGraw Hill Education India Private Limited, 2017.

REFERENCES

1. John W. Webb and Ronald A. Reis, “Programmable Logic Controllers: Principles and Applications”, 5th edition, Pearson Education India, 2015.
2. Stuart A Boyer, “SCADA: Supervisory Control and Data Acquisition”, International Society of Automation; 4th edition, 2016.
3. Mikell P. Groover, “Automation, Production Systems, and Computer-Integrated Manufacturing”, 5th edition, Pearson College Div, 2018.

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CO2	2	2	-	-	-	3			3	-	1	-	1	-
CO3	1	2	-	-	2	1			3	-	3	-	-	-
CO4	3	2	-	-	2	2			-	-	2	-	3	-
CO5	2	2	-	-	2	2			3	-	2	-	2	-



COURSE OUTCOMES

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

- demonstrate an understanding of competitive manufacturing environment.
- understand the principles of Group technology and FMS.
- study in detail about the software and database role FMS.
- understand the principles of Lean Manufacturing and ability to implement in organization.
- demonstrate the concept of JIT principle in a manufacturing system.

TEXT BOOKS

1. Groover M.P., "Automation, Production Systems and Computer Integrated Manufacturing ", 5th edition, Pearson College Div, 2018.

REFERENCES

1. Serop Kalpakjian and Steven R. Schmid, "Manufacturing Engineering and Technology", 7th edition, Pearson Education, 2018.
2. Taiichi Ohno, "Evolution of Toyota Production System", Kindle Edition, Amazon Asia-Pacific Holdings Private Limited, 2017.
3. John Nicholas, "Lean Production for Competitive Advantage: A Comprehensive Guide to Lean Methodologies and Management Practices", 2nd edition, Productivity Press, 2018.
4. Pascal Dennis, "Lean Production Simplified: A Plain-Language Guide to the World's Most Powerful Production System", 3rd edition, Productivity Press, New York, 2016.

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CO4	1	-	-	-	2	1	-	2	-	2	2	-	2	-
CO5	1	-	-	-	-	1	1	-	-	-	3	-	2	-



COURSE OBJECTIVES

To enable the students to

- understand the basics of sensors in manufacturing.
- gain knowledge on different types of sensors in manufacturing.
- explain the sensors for process monitoring.
- know the concept of condition monitoring and selection of sensors.
- learn about the various automatic identification techniques.

UNIT I INTRODUCTION 9

Introduction - Role of sensors in manufacturing automation-operation principles of different sensors - electrical, optical, acoustic, pneumatic, magnetic, electro optical, photo - electric, vision, proximity, tactile, range sensors.

UNIT II SENSORS IN MANUFACTURING 9

Sensors in manufacturing - Temperature sensors in process control - Pressure sensors - Fiber optic sensors and their principles and applications - Displacement sensor for robotic application - Sensors for CNC machine tools - Linear and angular position sensors, velocity sensors. Sensors in Robotics - encoder, resolver, potentiometers, range, proximity, touch sensors.

UNIT III PROCESS MONITORING 9

Principle, Sensors for Process Monitoring - online and off line quality control, Quality parameter design Direct monitoring of fault based on process signals.

UNIT IV CONDITION MONITORING 9

Condition monitoring of manufacturing systems - principles - sensors for monitoring force, vibration and noise. Selection of sensors and monitoring techniques. Acoustics emission sensors - principles and applications - online tool wear monitoring.

UNIT V AUTOMATIC IDENTIFICATION TECHNIQUES 9

MRP - MRPII - Shop floor control - Factory data collection systems - Automatic identification methods - Bar code technology, automated data collection system - agile manufacturing - flexible manufacturing - Enterprise integration and factory information system.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- recognize role of sensors in manufacturing automation, including operation principles.
- evaluate the performance of sensors measurement and management in modern day manufacturing systems.
- analyze the process monitoring systems to improve performance of online and off line quality

control.

- illustrate principles of automatic identification techniques.
- illustrate concepts and applications of MRP, shop floor control, agile manufacturing, flexible manufacturing and factory information system.

TEXT BOOKS

1. Sabrie Salomon, "Sensors and Control Systems in Manufacturing", 2nd edition, McGraw-Hill Education, 2010.
2. Groover M.P., "Automation, Production Systems and Computer Integrated Manufacturing ", 5th edition, Pearson College Div, 2018.

REFERENCES

1. Laurent A. Francis and Krzysztof Iniewski, "Novel Advances in Microsystems Technologies and Their Applications", 1st edition, CRC Press, 2017.
2. Randy Frank, "Understanding Smart Sensors", 3rd edition, Artech House, 2013.
3. Nicholas Odrey, Mitchell Weiss, Mikell Groover, Roger Nagel and Ashish Dutta, "Industrial Robotics - SIE: Technology - Programming and Applications", 2nd edition, McGraw Hill Education, 2017.

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CO4	1	-	-	-	1	1	-	1	-	2	2	-	2	-
CO5	1	-	-	-	-	1	1	-	-	-	-	-	-	-



COURSE OBJECTIVES

To enable the students to

- understand the need of nano technology and its physical scale nature.
- know characterization synthesis method of nanotechnology.
- understand the various sensor used in nano sensing.
- understand the need of molecular nano machines and nano tribology.
- understand the application of various industrial nano technology.

UNIT I INTRODUCTION TO NANO 9

Nano and nature - physical scales of nano technology - Genealogy and Philosophy of nano technology - Methods of measuring properties - structure - Microscopy - Spectroscopy.

UNIT II CHARACTERIZATION METHODS 9

Electron microscope - image collection in electron microscopes - scanning electron microscopy (SEM) - scanning transmission electron microscopy (STEM) - scanning probe microscopes - scanning tunnelling microscopy - scanning probe lithography - optical microscopes for nano science and technology - x ray diffraction.

UNIT III NANO SENSORS 9

Introduction - nano scale organization for sensors characterization - nano sensors based on optical properties - nano sensors based on quantum size effects - electrochemical sensors - sensors based on physical properties - nano biosensors - smart dust.

UNIT IV MOLECULAR NANOMACHINES AND NANOTRIBOLOGY 9

Introduction - covalent and non-covalent approaches - molecular motors and machines - molecular devices - single molecule devices - tribology at nanoscale - Nano tribology applications.

UNIT V INDUSTRIAL NANO TECHNOLOGY 9

Nano particles and microorganism - nano materials in bone substitutes and dentistry, food and cosmetic applications - textiles, paints, catalysis, drug delivery and its applications.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- demonstrate the understanding of length scales concepts, nanostructures and nanotechnology.
- discuss and evaluate state-of-the-art characterization methods for nanomaterials, and determine nanomaterial safety and handling methods required during characterization.
- demonstrate knowledge in design and structuring of nano interfaces for sensors.

- illustrate the principles involved in a nano machine and applications of studying nano tribology.
- explain the fundamental principles of nanotechnology and their application to biomedical engineering.

TEXT BOOKS

1. Pradeep. T , “NANO: The Essentials: Understanding Nanoscience and Nanotechnology” , 1st edition, McGraw Hill Education, 2017.
2. Joseph Natowitz and Christian Ngo, “Our Nanotechnology Future (Atlantis Advances in Nanotechnology, Material Science and Energy Technologies)”, Amsterdam University Press, 2017.

REFERENCES

1. Wesley C. Sanders, “Basic Principles of Nanotechnology”, 1st edition, CRC Press, 2018.
2. M. A. Shah and K. A. Shah, “Nanotechnology: The Science of Small”, 2nd edition, Wiley, 2019.

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