115EDT01	ADVANCED MATHEMATICS	L	T	P	C
		3	1	0	4

OBJECTIVES:

- To solve linear systems by methods of elimination, triangularisation and iteration, method of finite differences and Rayleigh Ritz methods.
- To know the methods for solving numerically partial differential equations of parabolic, elliptic and hyperbolic types with appropriate boundary and initial conditions encountered in engineering design.

UNIT I SIMULTANEOUS EQUATIONS AND NUMRICAL INTEGRATION 12

Solution of system of equations, Direct methods: Gauss elimination method, Choleski method, Iterative methods: Relaxation method. System of non-linear equations – Newton Raphson method – Newton-Cotes integration formulae - Trapezoidal rule, Simpson's rule, Gaussian quadrature.

UNIT II BOUNDARY VALUE & EIGENVALUE PROBLEMS 12

Shooting method, solution through a set of equations, derivative boundary conditions, Characteristic value problems and solution using characteristic polynomial method, Jacobi method, power method and Inverse of a matrix by power method.

UNIT III CALCULUS OF VARIATIONS 12

Variation and its properties – Euler's equation – Functional dependent of first and higher order derivatives – Functionals dependent of functions of several independent variables – Rayleigh Ritz method – Galerkin method.

UNIT IV PARTIAL DIFFERENTIAL EQUATIONS – NUMERICAL SOLUTIONS 12

Laplace equations, representations as a difference equation, Iterative methods for Laplace's equations. Poisson equation, derivative boundary conditions, irregular and non-rectangular grids. Matrix patterns, Sparseness, ADI method, Applications to heat flow problems.

UNIT V PARABOLIC PARTIAL DIFFERENTIAL EQUATIONS 12

Explicit method, Crank-Nicholson method, derivative boundary condition, stability and convergence criteria. Parabolic equations in two or more dimensions, applications to heat flow problems.

TOTAL : 60 Hours

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COURSE OUTCOMES:

Students will be able to

- Understand the basic concepts of mechanics of materials.
- Calculate the stresses and deflection in unsymmetrical beams.
- Calculate the stresses and strains associated with thick-wall cylindrical pressure vessels and rotating disks, non circular rotating shafts.
- Calculate the stresses and strains in flat plates and torsion of noncircular cross section members.
- Solve problems related to boundary conditions.

REFERENCE BOOKS:

1. Richard L.Burden, J.Dougles Faires and Annette M. Burden, "Numerical Analysis", Tenth Edition, Cengage, 2016.
2. Curis F Gerald and Patrick O Wheatley, "Applied Numerical Analysis", Pearson Education, 2002.
3. Gupta, A.S., "Calculus of Variations with Applications", Prentice Hall of India Pvt. Ltd., New Delhi, 2010.
4. Elsgolc, L.E., "Calculus of Variations", Dover Pub., 2007.
5. Steven C Chapra and Raymond P Canale, "Numerical Methods for Engineers with software and programming Applications", Tata McGraw Hill Edition, 2004.
6. Ward Cheney and David Kincaid, "Numerical Mathematics and Computing", Brooks/Cole Publishing company, Fourth Edition, 1999.
7. Sankara Rao, K., "Introduction to Partial Differential Equations", Prentice Hall of India Pvt. Ltd., New Delhi, 2012.
8. Jain M K, Iyengar S R K, and Jain R K, "Computational Methods For Partial Differential Equations", New age International (P) Ltd, 1994.

Course Outcome		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
Co1	Understand the basic concepts of mechanics of materials.	3	3	3	3	-	-	-	-	-	-	-	1	3	3	1
Co2	Calculate the stresses and deflection in unsymmetrical beams.	3	3	3	3	-	-	-	-	-	-	-	1	3	3	-
Co3	Calculate the stresses and strains associated with thick-wall cylindrical pressure vessels and rotating disks, non circular rotating shafts.	3	3	3	3	-	-	-	-	-	-	-	1	3	3	-
Co4	Calculate the stresses and strains in flat plates and torsion of noncircular cross section members.	3	3	3	3	-	-	-	-	-	-	-	2	3	3	2
Co5	Solve problems related to boundary conditions.	3	3	3	3	-	-	-	-	-	-	-	2	3	3	2

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115EDT02	ADVANCED MECHANICS OF MATERIALS	L	T	P	C
		3	1	0	4

OBJECTIVES:

- To understand the basic concepts of mechanics of materials.
- To calculate the stresses and deflection in unsymmetrical beams.
- To calculate the stresses and strains associated with thick-wall cylindrical pressure vessels and rotating disks, non circular rotating shafts.
- To calculate the stresses and strains in flat plates and torsion of noncircular cross section members.

PREREQUISITE: Knowledge of Strength of Materials is required.

UNIT I ELASTICITY **11**

Stress and Strain relation, General equation of elasticity in cartesian, polar and spherical coordinates, Differential equation of equilibrium, Compact ability, Boundary conditions, Representations of three dimensional stress of a tension, Generalized Hooke's law, St.Vennant's principle, Plane strain, plane stress, Airy's stress function, Shear Centre, Location of shear centre for various sections, shear flow.

UNIT II UNSYMMETRICAL BENDING **13**

Stresses and deflection in beams subjected to unsymmetrical loading – Kern of a section, Curved flexural members, circumferential and radial stresses, Deflection and radial curved beam with re-strained ends, Closed ring subjected to concentrated load & uniform load, Chain link & Crane hooks.

UNIT III THICK CYLINDERS AND ROTATING DISCS **13**

Thick walled cylinder subjected to internal and external pressures, Shrink fit joints, Stresses due to rotation, Radial and tangential stresses in solid disc and ring of uniform thickness and varying thickness, Allowable speed, Rotating shafts and cylinders.

UNIT IV TORSION OF NON CIRCULAR SECTIONS **11**

Torsion of rectangular cross section, St.Vennant Theory, Elastic membrane analogy, Prandtl's stress function, Torsional stresses in hollow thin walled tubes.

UNIT V STRESSES IN FLAT PLATES **12**

Stresses in circular and rectangular plates due to various types of loading and end conditions, Buckling of plates, Theory of contact stresses – methods of computing contact stresses, Deflection of bodies in point and line contact – applications.

TOTAL : 60 Hours

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COURSE OUTCOMES:

Students will be able to

- Understand the basic concepts of mechanics of materials.
- Calculate the stresses and deflection in unsymmetrical beams.
- Calculate the stresses and strains associated with thick-wall cylindrical pressure vessels and rotating disks, non circular rotating shafts.
- Calculate the torsion of noncircular cross section members.
- Calculate the stresses and strains in flat plates.

TEXT BOOKS:

1. Arthur P.Boresi and Richard J.Schmidt, "Advanced Mechanics of Materials", John Willey & Sons Inc., 6th Edition, 2009.
2. Antony E. Armenakas, "Advanced Mechanics of Materials and Applied Elasticity", Taylor & Francis, 2013.

REFERENCE BOOKS:

1. Robert D.Cook, Wareen.C.Yound, "Advanced Mechanics of Materials", Macmillon Publishers Company, 2nd Edition, 1999.
2. Srinath.L.S., "Advanced Mechanics of Solids", Tata McGraw Hill Publishing Company Ltd., 3rd Edition, 2010.
3. Krishna Raju, N. and Gururaja.D.R., "Advanced Mechanics of Solids and Structures", Narosa Publishing House, 1997.

Course Outcome		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
Co1	Understand the basic concepts of mechanics of materials.	3	2	-	1	2	-	-	-	-	-	-	2	1	-	-
Co2	Calculate the stresses and deflection in unsymmetrical beams.	2	1	-	1	-	-	-	-	-	-	-	2	1	1	-
Co3	Calculate the stresses and strains associated with thick-wall cylindrical pressure vessels and rotating disks, non circular rotating shafts.	2	2	-	2	1	-	-	-	-	-	-	2	1	-	-
Co4	Calculate the torsion of noncircular cross section members.	2	1	-	2	2	-	-	-	-	-	-	2	-	-	-
Co5	Calculate the stresses and strains in flat plates.	2	1	-	3	2	-	-	-	-	-	-	2	-	-	1

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115EDT03	CONCEPTS OF ENGINEERING DESIGN	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand about the design process and various tools used in engineering design.
- To gain the knowledge about the selection of material for design and their processing.
- To known the role of environmental issues in design.

UNIT I THE DESIGN PROCESS **08**

The Design Process - Need identification – Design requirements – Product Life Cycle – Morphology of Design steps of Product Design – Conceptual Design, Embodiment Design, Detailed Design – Concurrent Engineering – CAD & CAM, Human factors in Design.

UNIT II TOOLS IN ENGINEERING DESIGN **09**

Creativity and Problem solving, Decision Theory, Modeling – Role of models in Engineering Design, Mathematical Modeling, Geometric modeling, Finite Element Modeling, Rapid Prototyping – Simulation Finite Difference method, Monte Carlo method – Optimization – Search Methods, Geometric programming, Structural and Shape optimization.

UNIT III MATERIAL SELECTION AND MATERIALS IN DESIGN **09**

Classification and Properties of Engineering materials, Material Standards and specifications – Methods of material selection – Ashby Chart and method of weight factors, Derivation of material indices, Use of material selection Chart, Pugh selection method, Selection with computed aided databases – Design for brittle fracture, Design for fatigue failure, Design for corrosion resistance, Designing with plastics.

UNIT IV MATERIAL PROCESSING AND DESIGN **09**

Classification of manufacturing processes and their role in design, Factors determining the process selection, Use of process selection chart and computerized database – Design for manufacturing, Design for forging and sheet metal forming, Design for casting, Design for machining, welding and assembly, Design for residual stresses and heat treatment

UNIT V LEGAL, ETHICAL ENVIRONMENTAL AND SAFETY ISSUES IN DESIGN AND QUALITY ENGINEERING **10**

Origin of laws, Contracts, Liability, Tort Law, Product Liability , Design aspects of product liability, Codes of ethics, Solving ethical conflicts, Design for environment – Life Cycle assessment, Material recycling and remanufacture, Design for safety – Potential Dangers and Guidelines for design for safety, Design for reliability failure mode effect analysis, Robust Design.

TOTAL : 45 Hours

COURSE OUTCOMES:

Students will be able to

- Implement the design process and various tools for product design.
- Make the decision about the tools for product design and their processing.
- Incorporate the issues material selection.
- Know about material processing and design
- Know about legal and ethical issues in design.

TEXT BOOKS:

1. Dieter George E, “Engineering Design – A Materials and Processing Approach”, McGraw Hill, International Edition, Singapore 2012.
1. Karl T. Ulrich and Steven D. Eppinger, “Product Design and Development”, McGraw Hill, International Edition, 2011.

REFERENCE BOOKS:

1. Gerhard Pahl and Beitz W, “Engineering Design: A Systematic Approach”, Springer, Verlag, London, 3rd Edition, 2007.
2. Ray M.S., “Elements of Engineering Design: An Integrated Approach”, Prentice Hall Inc. 1985.
1. Suh. N. P., “The Principles of Design”, Oxford University Press, New York, 1990.

Course Outcome		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
Co1	Implement the design process and various tools for product design.	2	3	-	-	2	-	-	-	1	1	1	-	2	-	-
Co2	Make the decision about the tools for product design and their processing.	2	2	-	-	2	-	-	-	1	1	1	-	2	-	-
Co3	Incorporate the issues material selection.	2	2	-	-	2	-	-	-	1	1	1	-	2	-	1
Co4	Know about material processing and design	1	2	-	-	2	-	-	-	1	1	1	-	2	-	-
Co5	Know about legal and ethical issues in design.	1	1	2	2	2	-	-	-	1	1	1	-	2	-	2

115EDT04	COMPUTER APPLICATIONS IN DESIGN	L	T	P	C
		3	0	0	3

OBJECTIVE:

- To understand about the application of computer graphics in design.
- To understand the concepts of geometrical modeling and reverse engineering of components.
- To understand computer tools in tool design and design productivity.
- To gain knowledge about managing product design data using computer.

PREREQUISITE: Fundamentals of Computer and Programming, Design of Machine Elements , Design of Transmission Systems.

UNIT I INTRODUCTION TO COMPUTER APPLICATIONS IN NEW PRODUCT DESIGN **09**

Concept design, Parametric sketching, Constraints, Computer graphics, Principles- 2D transformation, scaling, rotation, windowing, view ports, clipping, data exchange formats.

UNIT II COMPUTERS IN DESIGN **09**

Solid modeling of Mechanical components, Associative features, Sheet metal components, Nesting and development, Plastic parts with draft and shrinkage allowance, Reverse engineering of components, Assembly of parts, Tolerance analysis, Mass property calculations.

UNIT III COMPUTERS IN TOOLING DESIGN **09**

Mould design, jigs and fixtures design, Check for interferences, Mechanism design and analysis, Rapid tooling.

UNIT IV COMPUTERS IN DESIGN PRODUCTIVITY **09**

Customizing various software by using visual basic, pro/program, script, LISP etc to write applications like design of shafts, gears etc.,

UNIT V MANAGING PRODUCT DESIGN DATA **09**

Version control, Library creation, catalog making, standardization for design, collaborative design among peer groups, Design optimization for geometry, Design check, approval and validation.

TOTAL : 45 Hours

COURSE OUTCOMES:

- Students will be familiarized with the computer graphics application in design.
- Students will be able to solve CAE problems that arise in engineering.
- Students will be able to write program functions to implement graphics primitives, geometrical transformations and the use of object hierarchy in graphics applications.
- Students will be able to write program by using languages like visual basic, LISP, etc
- Students will be able to know about library creation, catalog making, etc

TEXT BOOKS:

1. William M. Neumann and Robert Sproul, “Principles of Interactive Computer Graphics” McGraw Hill Book Co., Singapore, 1989.
2. Ibrahim Zeid, “CAD/CAM – Theory and Practice”, McGraw Hill International Edition, 2010.

REFERENCE BOOKS:

1. P N Rao, “CAD/CAM: Principles and Applications” Tata McGraw Hill, Second Edition, 2011.
2. Schlechtendahl E. G, “CAD – Data transfer for Solid Models”, Springer, Verlag, Berlin, 1989.
3. Donald Hearn and M Pauline Baker, “Computer Graphics”, Prentice Hall Inc, 2004.

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Course Outcome		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
Co1	Students will be familiarized with the computer graphics application in design.	1	-	-	1	-	-	2	1	1	-	3	3	2	3	-
Co2	Students will be able to solve CAE problems that arise in engineering.	3	-	-	-	-	-	3	-	-	-	3	2	-	3	-
Co3	Students will be able to write program functions to implement graphics primitives, geometrical transformations and the use of object hierarchy in graphics applications.	3	2	-	-	2	3	-	2	-	2	1	3	1	3	-
Co4	Students will be able to write program by using languages like visual basic, LISP, etc	2	1	1	-	-	-	-	-	-	-	1	2	1	3	-
Co5	Students will be able to know about library creation, catalog making, etc	1	-	-	-	-	-	-	1	3	-	1	3	-	3	-

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115EDT05	ADVANCED FINITE ELEMENT ANALYSIS	L	T	P	C
		3	1	0	4

OBJECTIVES:

- To formulate and analysis of 1D, 2D, 3D analysis arising in engineering design.
- Provide further Advanced FEA knowledge and techniques for solving Dynamic analysis
- To understand the thermal and fluid flow problems by FEA.

PREREQUISITE - Knowledge of Numerical Methods and Strength of Materials are required.

UNIT I ONE DIMENSIONAL ANALYSIS **12**

Relevance of finite element analysis in design, Modeling and discretization, Interpolation, elements, nodes and Degrees of Freedom, Applications of FEA, Variational methods, Potential energy method – Weighted residual methods, Galerkin method, One Dimensional Elements and Computational Procedures: Bar element, Beam element, Truss element, Shape functions, Element matrices and vectors - Assembly of elements – Boundary conditions - Solution of equations, Mechanical loads and stresses, Example problems.

UNIT II TWO AND THREE DIMENSIONAL ANALYSIS **12**

Basic Boundary Value Problems in two-dimensions – Triangular, quadrilateral, higher order elements, Poisson's and Laplace's Equation, Weak Formulation, Introduction to Theory of Elasticity – Plane Stress – Plane Strain and Axisymmetric Formulation, Principle of virtual work – Element matrices and vectors, Three dimensional stress and strain – Tetrahedral Element – Hexahedral Element, Finite Element formulation, Example problems.

UNIT III ISOPARAMETRIC FORMULATION **12**

Natural Co-ordinate Systems – Lagrangian Interpolation Polynomials – Isoparametric Elements, Bilinear Isoparametric quadrilateral elements – shape function, Jacobian matrix, strain displacement matrix, stress-strain relationship matrix, force vector, Isoparametric Formulation - triangular element – rectangular elements – Serendipity elements, Numerical Integration - Gauss quadrature – Stress calculations, Examples problems.

UNIT IV DYNAMIC ANALYSIS **12**

Introduction, Equations of motion, Axial vibration of rod, Transverse Vibration of beam, Formulation of element stiffness, Mass and force matrices, Lumped and consistent mass matrices, Natural frequencies, Eigen Values and Eigen Vectors, Mode shapes, Vector iteration methods, Transient vibration, Example problems.

UNIT V THERMAL AND FLUID FLOW ANALYSIS **12**

Steady state heat transfer, Heat transfer with convection, One Dimensional Finite Element Formulation, Two Dimensional Finite Element Formulation, Basic differential equations of fluid flow, One Dimensional Finite Element Formulation, Two Dimensional Finite Element Formulation, Example problems.

TOTAL : 60 Hours

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COURSE OUTCOMES:

- Students will capable of formulate and analysis of 1D, 2D and 3D Problems.
- Students will able to solve dynamic analysis problem using FEA
- Students will have the ability to apply finite element to formulate and solve fluid, thermal and vibration problems.
- Students will have the ability to derive element matrices and vectors by different methods by applying basic laws in mechanics and integration by parts**.**
- Students will have the ability to solve problems related to thermal and fluid flow.

TEXT BOOKS:

1. Daryl L Logan, "A First course in the finite element method", Cengage learning, 6th Edition, 2017.
2. Seshu P, "A Text book on Finite Element Analysis", Prentice Hall of India, New Jersey, 2003.

REFERENCE BOOKS:

1. Robert D. Cook, David S. Malkus, Michael E. Plesha, Robert J. Witt, "Concepts and Applications of Finite Element Analysis", Wiley Student Edition, 4th Edition, 2008.
2. David V Hutton, "Fundamentals of Finite Element Analysis", McGraw Hill Int. Ed., New Delhi, 2004.
3. Chandrupatla T R and Belegundu A D, "Introduction to Finite Elements in Engineering", Third Edition, Prentice Hall, 2002.
4. S.S.Rao, "The Finite Element Method in Engineering", Butterworth-Heinemann, 2010.
5. Bathe K.J., "Finite Element Procedures in Engineering Analysis", Prentice Hall, 1996.
6. J. N.Reddy, "An Introduction to the Finite Element Method", McGraw Hill International, 2005.

Course Outcome		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
Co1	Students will capable of formulate and analysis of 1D, 2D and 3D Problems.	2	-	1	-	-	-	3	-	-	-	1	1	-	2	-
Co2	Students will able to solve dynamic analysis problem using FEA	-	1	1	-	-	2	-	-	-	-	-	1	3	-	1
Co3	Students will have the ability to apply finite element to formulate and solve fluid, thermal and vibration problems.	-	2	-	-	-	1	-	-	-	-	1	1	2	-	-
Co4	Students will have the ability to derive element matrices and vectors by different methods by applying basic laws in mechanics and integration by parts**.**	-	3	-	-	-	2	-	-	1	-	-	-	-	2	-
Co5	Students will have the ability to solve problems related to thermal and fluid flow.	-	2	-	-	-	1	-	-	-	2	-	-	-	-	3

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115EDP07	CAE LAB - 1	L	T	P	C
		0	0	4	2

OBJECTIVES:

- To impart knowledge on simulation of different mechanisms like 4-bar, slider and cam mechanisms using the simulation softwares.
- To understand the types of element used type of analysis done, interpretation of results, method of solving and analyzing the problem.
- To have better knowledge in finite element analysis software, applied to structural, thermal, dynamic analysis.

Simulation of mechanisms using simulation software like MATLAB/ADAMS etc. **15**

Simulation of mechanism: Simple pendulum, Four bar mechanism, Slider crank mechanism, Cam and Follower mechanism, Spur gear drive, Piston and Cylinder.

Analysis of mechanical machine components using analysis software like ANSYS/ NASTRAN etc. **30**

Static Structural analysis: Truss, Bar, Beam, Axisymmetric analysis.

Dynamic analysis: Modal, Harmonic, Transient analysis, Buckling analysis, Non linear analysis

Thermal analysis: Conduction heat transfer, Heat transfer with Conduction and Convection, Transient heat conduction analysis.

Coupled field analysis, Contact analysis, Fluid flow analysis and Design optimization.

COURSE OUTCOMES:

- Students will have the ability to apply the concepts of simulations in various mechanical engineering applications.
- Student will able to solve the structural, thermal, fluid analysis
- Students will be familiarized with the analysis packages which are necessary to solve the engineering problems numerically.
- Students will have the ability to solve real time problem based on FEA techniques.
- Students will know more about design optimization.

TOTAL : 45 Hours

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Course Outcome		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
Co1	Students will have the ability to apply the concepts of simulations in various mechanical engineering applications.	2	1	-	-	-	-	-	-	-	1	-	-	2	-	-
Co2	Student will able to solve the structural, thermal, fluid analysis	2	1	1	-	-	1	1	-	-	1	-	-	2	-	-
Co3	Students will be familiarized with the analysis packages which are necessary to solve the engineering problems numerically.	2	1	1	-	-	1	1	-	-	1	1	-	2	-	-
Co4	Students will have the ability to solve real time problem based on FEA techniques.	2	1	2	-	-	2	2	-	-	1	2	2	2	-	1
Co5	Students will know more about design optimization.	2	1	1	-	-	2	2	-	-	1	2	2	2	-	1

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115EDE02	ADDITIVE MANUFACTURING AND TOOLING	L	T	P	C
		3	0	0	3

OBJECTIVE:

- To understand the concepts of the rapid prototyping methods.
- To know the applications of rapid prototype areas in industries.
- Able to know about rapid tooling techniques and its advantages.

PREREQUISITE: Knowledge of Manufacturing Technology - I is required.

UNIT I INTRODUCTION OF RAPID PROTOTYPING **08**

Need for the compression in product development, History of RP systems, Survey of applications, Growth of RP industry and classification of RP systems

UNIT II STEREO LITHOGRAPHY SYSTEMS AND SELECTIVE LASER SINTERING **09**

Stereo lithography Systems, Principle, Process parameters, Process details, Data preparation, Data files and Machine details, Applications. Selective Laser Sintering, Types of machines, Principle of operation, Process parameters, Data preparation for SLS, Applications.

UNIT III FUSION DEPOSITION MODELING & SOLID GROUND CURING **09**

Fusion Deposition Modeling: Principle, Process parameters, Path generation, Applications. Solid Ground Curing: Principle of operation, Machine details, Applications.

UNIT IV LAMINATED OBJECT MANUFACTURING, CONCEPT MODELERS & LENS **09**

Laminated Object Manufacturing, Principle of operation, LOM materials, Process details, Applications. Concept Modelers, Principle, Thermo jet printer, Sander's model market, 3-D printer, GenisysXs printer, JP system 5, Object Quadra System, Laser Engineered Net Shaping (LENS), principle, applications.

UNIT V RAPID TOOLING **10**

Indirect Rapid Tooling, Silicone rubber tooling, Aluminum filled epoxy tooling, Spray metal tooling, etc. Direct Rapid Tooling, Direct AIM, Quick cast process, Copper polyamide, Rapid Tool, DMILS, ProMetal, Sand casting tooling, Laminate tooling, soft tooling vs hard tooling, Case Studies: Automotive and Aerospace Industries

TOTAL : 45 Hours

COURSE OUTCOMES:

- Students will be familiarized with the various methods of rapid prototyping technologies and rapid tooling.
- Students will be competently use the tools to explore digital manufacturing techniques and CAD modelling software.
- Students will have an idea about different techniques available for additive manufacturing.
- Students will be familiar with various additive techniques.
- Students will be familiar with rapid tooling techniques.

TEXT BOOKS:

1. Paul. F. Jacobs, "Stereo lithography and other RP & M Technologies", SME, New York, 2000.
2. Hague R.J. M and Reever P.E., "Rapid Prototyping, Tooling and Manufacturing", Rapra Technology Ltd, 2000.

REFERENCE BOOKS:

1. Pham. D. T. & Dimov. S. S., "Rapid Manufacturing", Verlag, London, 2012.
2. Terry Wohlers, "Wohlers Report 2006", Wohlers Associates, 2006.
3. Kennath G Cooper, "Rapid Prototyping Technology", Marcel Deccer, Inc, New York, 2005.
4. Serope Kalpak Jain and Steven R Schmid, "Manufacturing Engineering and Technology", Pearson Edition, 6th Edition, 2009.

Course Outcome		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
Co1	Students will be familiarized with the various methods of rapid prototyping technologies and rapid tooling.	1	-	3	-	-	3	3	1	-	-	1	1	2	-	2
Co2	Students will be competently use the tools to explore digital manufacturing techniques and CAD modelling software.	2	-	3	-	-	3	3	2	-	-	-	1	2	-	2
Co3	Students will have an idea about different techniques available for additive manufacturing.	2	-	3	-	-	3	3	2	-	-	-	1	2	-	2
Co4	Students will be familiar with various additive techniques.	1	-	3	-	3	3	3	1	-	-	1	1	2	-	2
Co5	Students will be familiar with rapid tooling techniques.	1	-	3	-	-	3	3	1	-	-	1	1	2	-	2

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215EDT01	MECHANICS OF COMPOSITE MATERIALS	L	T	P	C
		3	0	0	3

OBJECTIVES:

The student will able to

1. Understand general characteristics of composite materials.
2. Understand manufacturing process of composite materials.
3. Understand mechanics of composite materials.
4. Perform various tests on composite materials to know its effect.
5. Develop the equations based on laminates.

PREREQUISITE: Knowledge of Composite Materials is required.

UNIT I INTRODUCTION OF COMPOSITE MATERIALS **11**

Definition, Need, General Characteristics, Applications, Fibers – Glass, Carbon, Ceramic and Aramid fibers, Matrices – Polymer, Graphite, Ceramic and Metal Matrices, Fiber surface treatments, Fillers and Additives.

UNIT II MANUFACTURING OF COMPOSITES **12**

Bag Moulding, Compression Moulding, Pultrusion, Filament Winding, Other Manufacturing Processes, Processing of MMC, Diffusion bonding, Stir casting, Squeeze casting, Quality Inspection methods.

UNIT III MECHANICS OF COMPOSITES **13**

Rule of mixture, volume and mass fractions, density, void content, Evaluation of four elastic moduli based on strength of materials approach and Semi-Empirical model, Longitudinal Young's modulus, transverse Young's modulus, major Poisson's ratio, In-plane shear modulus, Ultimate strengths of a unidirectional lamina, Characteristics of Fiber-reinforced lamina, laminates, Lamination theory, Interlaminar stresses

UNIT IV PROPERTIES OF COMPOSITES **12**

Static Mechanical Properties, Fatigue and Impact Properties, Environmental effects, Long term properties, Fracture Behavior and Damage Tolerance

UNIT V LAMINA CONSTITUTIVE EQUATIONS **12**

Lamina Constitutive Equations: Lamina Assumptions – Macroscopic Viewpoint. Generalized Hooke's Law. Reduction to Homogeneous Orthotropic Lamina – Isotropic limit case, Orthotropic Stiffness matrix (Qij), Definition of stress and Moment Resultants. Strain Displacement relations. Basic Assumptions of Laminated anisotropic plates. Laminate Constitutive Equations – Coupling Interactions, Balanced Laminates, Symmetric Laminates, Angle Ply Laminates, Cross Ply Laminates. Laminate Structural Moduli. Evaluation of Lamina Properties from Laminate Tests. Quasi-Isotropic Laminates. Determination of Lamina stresses within Laminates.

TOTAL : 60 HOURS

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COURSE OUTCOMES:

- The students will have ability to identify the properties of composite materials.
- The students will have knowledge of manufacturing composite materials by using various methods.
- The students can analyse the mechanism of composite materials.
- The students can perform various tests on composite materials.
- The students can able to develop the equations based on laminates and to determine lamina stress within laminates.

TEXT BOOKS:

1. Robert M Jones, "Mechanics of composite materials (Materials science and Engineering Series)", Taylor and Francis, Second Edition, 2015.
2. Mallick, P.K., "Fiber Reinforced Composites: Materials, Manufacturing and Design", Maneel Dekker Inc, 3rd Edition, 2007.

REFERENCE BOOKS:

1. Ronald Gibson, "Principles of Composite Material Mechanics", 4th Edition, Tata McGraw Hill, 2015.
2. Autar K. Kaw, "Mechanics of Composite Materials" CRC Press, NY, 2nd Edition, 2006.
3. Agarwal, B.D., and Broutman L.J., "Analysis and Performance of Fiber Composites", 3rd Edition, John Wiley and Sons, New York, 2006.
4. Halpin J.C, "Primer on Composite Materials, Analysis", Techomic Publishing Co, 2006.
5. Mallick P K and Newman S, "Composite Materials Technology: Processes and Properties", Hansen Publisher, Munish, 2006.
6. Chawla K.K., "Composite Materials", Springer – Verlag, 1998.

Course Outcome		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
Co1	The students will have ability to identify the properties of composite materials.	3	1	-	-	-	1	1	-	1	1	-	-	2	-	-
Co2	The students will have knowledge of manufacturing composite materials by using various methods.	3	1	-	-	-	1	1	-	1	1	-	-	2	-	-
Co3	The students can analyse the mechanism of composite materials.	3	1	-	-	-	1	1	-	1	1	-	-	2	-	-
Co4	The students can perform various tests on composite materials.	3	1	-	-	-	1	1	-	1	1	-	-	2	-	-
Co5	The students can able to develop the equations based on laminates and to determine lamina stress within laminates.	3	1	-	-	-	1	1	-	1	1	-	-	2	-	-

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215EDT02	MECHANICAL VIBRATIONS	L	T	P	C
		3	1	0	4

OBJECTIVES:

1. To gain the knowledge on basic aspects of vibrations of Single degree of freedom system.
2. To gain the knowledge on vibration of two degree of freedom system and Forced vibration.
3. To understand modes of vibration, Eigen values and Eigen vectors, Numerical methods of fundamental frequencies including Multi-degree of freedom system.
4. To gain the knowledge on continuous system systems governed by wave equations and Euler equation.
5. To understand concepts of designing systems to achieve the vibratory response, analyze and predict vibratory behavior of mechanical systems.

PREREQUISITE: Knowledge of Kinematics of Machines, Dynamics of Machinery are required.

UNIT - I FUNDAMENTALS OF VIBRATION **12**

Introduction to Single degree freedom system - free vibration systems, Damped vibrations, Single degree freedom - forced vibration with elastically coupled viscous dampers, System Identification from frequency response, Support motion, Duhamel's Integral, Impulse Response function, Virtual work, Lagrange's equation, Transient Vibration.

UNIT - II TWO DEGREE FREEDOM SYSTEM **12**

Free vibration of spring-coupled system, Mass coupled system, Vibration of two degree freedom system, Forced vibration, Vibration Absorber, Vibration isolation.

UNIT- III MULTI-DEGREE FREEDOM SYSTEM **12**

Normal mode of vibration, Flexibility Matrix and Stiffness matrix, Eigen values and eigen vectors, Orthogonal properties, Modal matrix-Modal Analysis, Forced Vibration by matrix inversion, Modal damping in forced vibration, Numerical methods for fundamental frequencies.

UNIT- IV VIBRATION OF CONTINUOUS SYSTEMS **12**

Systems governed by wave equations, Vibration of strings, Vibration of rods, Euler Equation for Beams, Effect of Rotary inertia and shear deformation, Vibration of plates.

UNIT - V EXPERIMENTAL METHODS IN VIBRATION ANALYSIS **12**

Vibration instruments, Vibration exciters Measuring Devices, Analysis, Vibration Tests – Free and Forced Vibration tests, Examples of Vibration tests – Industrial, case studies.

TOTAL : 60 HOURS

COURSE OUTCOMES:

The students will be able to

- Solve for the motion and the natural frequency of a freely vibrating single degree of freedom un-damped motion and a freely vibrating single degree of freedom damped motion.
- Construct the governing differential equation and its solution for a vibrating mass subjected to an arbitrary force.
- Solve vibration problems that contain multiple degrees of freedom.
- Solve vibration problems for the system governed by wave equations. Identify the effect of Rotary inertia and Sheer deformation for Continuous system.
- Perform vibration tests for systems subjected to forced and free vibrations, also to analyse and solve the problems arising in Industry due to vibrations by proper case study

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TEXT BOOKS:

1. Rao, J.S. and Gupta, K., "Introductory Course on Theory and Practice Mechanical Vibration", 2nd Edition, New Age International (P) Ltd., New Delhi, 2014.
2. William T. Thomson, Marie Dillon Dahleh., "Theory of Vibration with Applications", 5th Edition, CBS Publishers and Distributors, New Delhi, 2014.

REFERENCE BOOKS:

1. Den Hartog, J.P, "Mechanical Vibrations," Dover Publications, New York, 2013.
2. Rao V Dukkipatti, "Mechanical Vibrations", PHI Learning Pvt Ltd, 2nd Edition, 2012.
3. Rao, S.S., "Mechanical Vibrations", 6th Edition, Pearson Edition, 2011.
4. Iyengar R.N, "Elements of Mechanical Vibration", I K International Publishing House Pvt. Ltd., New Delhi, 2010.
5. A G Ambekar, "Mechanical Vibration and Noise Engineering", Prentice Hall of India, 2006.
6. Rao, J. S., Advanced Theory of Vibration: Nonlinear Vibration and One-dimensional Structures, New Age International, 1993.

Course Outcome		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
Co1	Solve for the motion and the natural frequency of a freely vibrating single degree of freedom un-damped motion and a freely vibrating single degree of freedom damped motion.	2	3	2	1	2	-	-	-	-	-	-	-	2	-	3
Co2	Construct the governing differential equation and its solution for a vibrating mass subjected to an arbitrary force.	2	1	3	1	-	-	-	-	-	-	-	-	2	-	2
Co3	Solve vibration problems that contain multiple degrees of freedom.	2	3	2	2	2	-	-	-	-	-	-	-	2	-	3
Co4	Solve vibration problems for the system governed by wave equations. Identify the effect of Rotary inertia and Sheer deformation for Continuous system.	1	2	3	2	2	-	-	-	-	-	-	-	2	-	3
Co5	Perform vibration tests for systems subjected to forced and free vibrations, also to analyse and solve the problems arising in Industry due to vibrations by proper case study	1	1	2	-	2	-	1	-	-	-	-	-	2	-	2

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215EDT03	ADVANCED MECHANISMS DESIGN	L	T	P	C
		3	1	0	4

OBJECTIVES:

1. To provide a foundation for the study of machine design.
2. To understand the advanced kinematics and synthesis of mechanisms to achieve desired motion.
3. To develop skills for designing and analyzing linkages, coupler curves.
4. To gain knowledge on the principles of advanced computer-based tools for analysis and synthesis of mechanisms.
5. To understand theory and application tools through a major mechanism design project.

PREREQUISITE: Knowledge of Kinematics of Machines is required.

UNIT I INTRODUCTION **12**

Review of fundamentals of kinematics-classifications of mechanisms-components of mechanisms – mobility analysis – formation of one D.O.F. multi loop kinematic chains, Network formula – Gross motion concepts-Basic kinematic structures of serial and parallel robot manipulators-Compliant mechanisms-Equivalent mechanisms.

UNIT II KINEMATIC ANALYSIS **12**

Position Analysis – Vector loop equations for four bar, slider crank, inverted slider crank, geared five four bar linkage jerk analysis. Plane complex mechanisms-auxiliary point method. Spatial RSSR bar and six bar linkages. Analytical methods for velocity and acceleration Analysis–mechanism-Denavit-Hartenberg Parameters – Forward and inverse kinematics of robot manipulators.

UNIT III PATH CURVATURE THEORY AND COUPLER CURVE **12**

Fixed and moving centrodes, inflection points and inflection circle. Euler Savary equation, graphical constructions – cubic of stationary curvature. Four bar coupler curve-cusp-crunode coupler driven six-bar mechanisms-straight line mechanisms.

UNIT IV SYNTHESIS OF FOUR BAR MECHANISMS **12**

Type synthesis – Number synthesis – Associated Linkage Concept. Dimensional synthesis – function generation, path generation, motion generation. Graphical methods-Pole technique inversion technique-point position reduction-two, three and four position synthesis of four- bar mechanisms. Analytical methods- Freudenstein's Equation-Bloch's Synthesis.

UNIT V SYNTHESIS OF MECHANISMS **12**

Cognate Lingages-parallel motion Linkages. Design of six bar mechanisms-single dwell-double dwell-double stroke. Geared five bar mechanism-multi-dwell. Cam Mechanisms-determination of optimum size of cams. Mechanism defects.

Study and use of Mechanism using Simulation Soft-ware packages. Students should design and fabricate a mechanism model as term project.

TOTAL : 60 HOURS

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COURSE OUTCOMES:

- The student will be able to identify the kinematic chain in a given machine.
- The student will be able to analyze a complex mechanism for displacement velocity and acceleration.
- Students will be familiar with basic concepts of path curvature and coupler curves.
- Students will have a solid theoretical background in kinematics and in the analysis and synthesis of mechanisms.
- Students will have the ability to apply theory and the use of practical engineering tools in a substantial mechanism design project.

TEXT BOOKS:

1. Uicker, J.J., Pennock, G. R. and Shigley, J.E., "Theory of Machines and Mechanisms", Oxford University Press, 2016.
2. Sandor G.N., and Erdman A.G., "Advanced Mechanism Design Analysis and Synthesis", Prentice Hall, 2001.

REFERENCE BOOKS:

1. Kenneth J, Waldron, Gary L. Kinzel, "Kinematics, Dynamics and Design of Machinery", John Wiley-sons, 2016.
2. William Cleghorn and Nikolai Dechev, "Mechanics of Machines", Oxford University Press, Second Edition, 2014.
3. Robert L.Norton., "Design of Machinery", Tata McGraw Hill, 2011.
4. Ramamurti, V., "Mechanics of Machines", Narosa, 2010.
5. Amitabha Ghosh and Ashok Kumar Mallik, "Theory of Mechanism and Machines", EWLP, Delhi, 2006.

Course Outcome		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
Co1	The student will be able to identify the kinematic chain in a given machine.	-	-	1	-	1	2	2	1	1	1	2	2	1	-	-
Co2	The student will be able to analyze a complex mechanism for displacement velocity and acceleration.	-	-	1	-	1	2	2	1	1	1	1	2	1	-	-
Co3	Students will be familiar with basic concepts of path curvature and coupler curves.	-	-	1	-	1	2	1	1	1	1	1	2	1	-	-
Co4	Students will have a solid theoretical background in kinematics and in the analysis and synthesis of mechanisms.	-	-	1	-	1	2	2	1	1	1	2	2	1	-	-
Co5	Students will have the ability to apply theory and the use of practical engineering tools in a substantial mechanism design project.	-	-	1	-	1	1	2	1	1	1	1	1	1	-	-

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215EDT04	ADVANCED MACHINE DESIGN	L	T	P	C
		3	1	0	4

OBJECTIVES:

1. To study design concepts in order to enhance the fatigue of materials.
2. To study the systematic engineering design based on S-N and ε-N approach.
3. To study about the formation of crack and effect of crack growth life estimation.
4. To study behaviour of mechanical components under fatigue.
5. To study about the surface failure of machine parts due to wear.

PREREQUISITE: Knowledge of Engineering Materials and Metallurgy is required.

UNIT I INTRODUCTION **12**

Role of failure prevention analysis in mechanical design, Modes of mechanical failure, Review of failure theories for ductile and brittle materials including Mohr's theory and modified Mohr's theory. Numerical examples.

Fatigue of Materials: Introductory concepts, High cycle and low cycle fatigue, Fatigue design models, Fatigue design methods, Fatigue design criteria, Fatigue testing, Test methods and standard test specimens, Fatigue fracture surfaces and macroscopic features, Fatigue mechanisms and microscopic features.

UNIT II STRESS-LIFE AND STRAIN-LIFE APPROACH **12**

Stress-Life (S-N) Approach: S-N curves, Statistical nature of fatigue test data, General S-N behavior, Mean stress effects, Different factors influencing S-N behaviour, S-N curve representation and approximations, Constant life diagrams, Fatigue life estimation using S- N approach.

Strain-Life (ε-N) Approach: Monotonic stress-strain behavior, Strain controlled test methods, Cyclic stress-strain behavior, Strain based approach to life estimation, Determination of strain life fatigue properties, Mean stress effects, Effect of surface finish, Life estimation by ε-N approach.

UNIT III LEFM APPROACH **12**

LEFM concepts, Crack tip plastic zone, Fracture toughness, Fatigue crack growth, Mean stress effects, Crack growth life estimation.

Notches and their effects: Concentrations and gradients in stress and strain, S-N approach for notched membranes, mean Stress effects and Haigh diagrams, Numerical examples

UNIT IV FATIGUE FROM VARIABLE AMPLITUDE LOADING **12**

Spectrum loads and cumulative damage, Damage quantification and the concepts of damage fraction and accumulation, Cumulative damage theories, Load interaction and sequence effects, Cycle counting methods, Life estimation using stress life approach. Numerical examples.

Notch strain analysis: Strain – life approach, Neuber's rule, Glinka's rule, applications of fracture mechanics to crack growth at notches. Numerical examples.

UNIT V SURFACE FAILURE AND SURFACE FATIGUE **12**

Surface Failure: Introduction, Surface geometry, Mating surface, Friction, Adhesive wear, Abrasive wear, Corrosion wear.

Surface fatigue: spherical contact, Cylindrical contact, General contact, Dynamic contact stresses, Surface fatigue strength, Surface fatigue failure modes, Design to avoid Surface failures.

Total: 60 HOURS

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COURSE OUTCOMES:

Students will have an ability to

- Design machine parts by considering fatigue failure.
- Reduce the failure of components based on stress - strain to life relationships.
- Analyze the formation of crack, notches and their effects.
- Analyze behaviour of mechanical elements under fatigue from variable amplitude loading conditions.
- Analyze the wear behaviour of mechanical components.

TEXT BOOKS:

1. Ralph I. Stephens, Ali Fatemi, Robert, Henry o. Fuchs, "Metal Fatigue in engineering", John Wiley, New York, Second Edition. 2001.
2. Jack. A. Collins, "Failure of Materials in Mechanical Design", John Wiley, New York, 1992.

REFERENCE BOOKS:

1. Robert L Norton, "Machine Design", Prentice Hall, 5th Edition, 2014.
2. Fatigue and Fracture, ASM Hand Book, Vol 19, 2002.
3. S.Suresh, "Fatigue of Materials", Cambridge University Press, 1998.
4. Julie.A.Benantine, "Fundamentals of Metal Fatigue Analysis", Prentice Hall, 1990.

Course Outcome		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
Co1	Design machine parts by considering fatigue failure.	3	2	-	2	2	-	-	-	-	-	2	2	2	1	1
Co2	Reduce the failure of components based on stress - strain to life relationships.	3	2	-	2	2	-	-	-	-	-	2	2	1	1	-
Co3	Analyze the formation of crack, notches and their effects.	2	2	-	2	3	-	-	-	-	-	3	1	1	2	1
Co4	Analyze behaviour of mechanical elements under fatigue from variable amplitude loading conditions.	2	2	-	2	2	-	-	-	-	-	2	2	1	-	-
Co5	Analyze the wear behaviour of mechanical components.	2	2	2	2	3	-	-	-	-	-	2	2	2	1	1

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215EDP07	CAE LABORATORY - II	L	T	P	C
		0	0	4	2

OBJECTIVES:

1. To understand and practice the drawings of machine components and simple assemblies using modeling packages.
2. To provide the fundamental concepts of the theory of the finite element method through software.
3. To develop proficiency in the application of the finite element method (modeling, analysis, and interpretation of results) to realistic engineering problems through the use of a major commercial general-purpose finite element code.
4. To understand the concepts of Structural and thermal stress analysis on components.
5. To gain knowledge about the Failure analysis of various joints.

Modeling and Assembling of mechanical machine components using modeling software **15**

Modeling and Assembling of Machine Vice, Tailstock, Connecting rod, Shaper tool head assembly etc.

Analysis of mechanical machine components using analysis software **30**

Stress analysis in Curved beam.
Single edge notched beam in four point bending.
Torsion of Prismatic bar with rectangular cross section.
Contact Stress Analysis of Circular Disc under diametrical compression.
Vibration Characteristics of a Spring Mass Damper System.
Buckling, Bending and Modal analysis of stiffened Panels.
Design Optimization problems (shape and weight optimization).
Thermal Stress Analysis a thick walled cylinder filled with a fluid at high temperature.
FE Modeling and Failure Analysis of welded joints, bolted joints and adhesive bonded joints.

Total: 45 HOURS

COURSE OUTCOME:

The students will have ability to

- Model and assemble the drawings of any mechanical products using modeling software.
- Select the method, meshing, analysis and optimize the real time problems using finite element analysis software.
- Evaluate and interpret FEA analysis results for design and evaluation purposes
- Develop a basic understanding of the limitations of the FE method and understand the possible error sources in its use.
- Use analysis software for the application and use of the FE method for heat transfer and structural problems.

Course Outcome		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
Co1	Model and assemble the drawings of any mechanical products using modeling software.	3	1	-	-	-	-	-	-	-	-	-	3	2	-	-
Co2	Select the method, meshing, analysis and optimize the real time problems using finite element analysis software.	1	2	-	-	-	-	-	-	-	1	-	-	2	1	-
Co3	Evaluate and interpret FEA analysis results for design and evaluation purposes	2	2	-	-	-	-	-	-	-	-	-	2	2	2	-
Co4	Develop a basic understanding of the limitations of the FE method and understand the possible error sources in its use.	3	2	-	-	-	-	-	-	-	-	-	-	2	1	1
Co5	Use analysis software for the application and use of the FE method for heat transfer and structural problems.	2	2	-	-	-	-	-	-	-	-	-	-	1	-	-

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215EDE02	INTEGRATED MANUFACTURING SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

1. To understand the production systems.
2. To gain knowledge on group technology, computer aided process planning and integrated manufacturing systems in modern manufacturing.
3. To gain the knowledge on computer aided planning and control.
4. To gain the knowledge of computer monitoring.
5. To know the concepts of integrated manufacturing system.

PREREQUISITE: Knowledge of CAD/CAM/CIM is required.

UNIT I INTRODUCTION **8**

Objectives of a manufacturing system-identifying business opportunities and problems-classification of production systems-linking manufacturing strategy and systems analysis of manufacturing operations.

UNIT II GROUP TECHNOLOGY AND COMPUTER AIDED PROCESS PLANNING **9**

Introduction-part families-parts classification and coding - group technology machine cells-benefits of group technology. Process planning function CAPP – Computer generated time standards.

UNIT III COMPUTER AIDED PLANNING AND CONTROL **9**

Production planning and control-cost planning and control-inventory management- Material requirements planning (MRP)-shop floor control-Factory data collection system-Automatic identification system-barcode technology- automated data collection system.

UNIT IV COMPUTER MONITORING **9**

Types of production monitoring systems-structure model of manufacturing process, process control & strategies- direct digital control-supervisory computer control computer in QC - contact inspection methods non-contact inspection method – computer aided testing - integration of CAQC with CAD/CAM.

UNIT V INTEGRATED MANUFACTURING SYSTEM **10**

Definition - application - features - types of manufacturing systems- machine tools materials handling system- computer control system - DNC systems manufacturing cell. Flexible Manufacturing Systems (FMS) - the FMS concept transfer systems - head changing FMS - variable mission manufacturing system - CAD/CAM system - human labor in the manufacturing system-computer integrated manufacturing system benefits. Rapid prototyping - Artificial Intelligence and Expert system in CIM.

TOTAL : 45 HOURS

COURSE OUTCOMES:

Students will be able to

- Get good exposure on manufacturing systems.
- Get good exposure on CAPP systems for rotational and prismatic parts and GT.
- Understand the effect of manufacturing automation strategies and derive production metrics with computer monitoring and control of manufacturing.
- Understand the production monitoring system.
- Understand the applications of FMS and Rapid prototyping concepts.

TEXT BOOKS:

1. Mikell P Groover, "Automation, Production System and Computer Integrated Manufacturing", Pearson/Prentice-Hall of India, 2012.
2. James A Rehg and Henry W Kroebber, “Computer Integrated Manufacturing”, Pearson/Prentice-Hall of India, 2005.

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REFERENCE BOOKS:

1. Yorem Koren, "Computer Integrated Manufacturing Systems", McGraw Hill, 2010.
2. David Bedworth, "Computer Integrated Design and Manufacturing", TMH, New Delhi, 1998.
3. Ranky, Paul G., "Computer Integrated Manufacturing", Prentice Hall International, 1st Edition, 1986.
4. R.W. Yeomans, A. Choudry and P.J.W. Ten Hagen, "Design rules for a CIM system", North Holland Amsterdam, 1986.

Course Outcome		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
Co1	Get good exposure on manufacturing systems.	-	-	2	-	-	1	1	-	-	-	1	1	2	-	1
Co2	Get good exposure on CAPP systems for rotational and prismatic parts and GT.	-	3	-	1	1	2	2	-	-	-	-	1	-	3	-
Co3	Understand the effect of manufacturing automation strategies and derive production metrics with computer monitoring and control of manufacturing.	-	2	1	-	1	-	-	-	-	-	1	1	-	3	-
Co4	Understand the production monitoring system.	3	1	-	2	-	-	1	-	-	-	-	2	-	-	2
Co5	Understand the applications of FMS and Rapid prototyping concepts.	2	-	-	-	1	-	-	-	2	-	2	-	2	-	3

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215EDE03	DESIGN FOR MANUFACTURE, ASSEMBLY AND ENVIRONMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:

1. To aquire knowledge on process capability and tolerances, form design.
2. To know about the factors influencing form design.
3. To gain the knowledge on component design for machining consideration, casting consideration in component design and design for the environment.
4. To gain the knowledge on group technology concepts.
5. To know about the environmental objectives and global issues.

PREREQUISITE: Knowledge of Machine drawing is required.

UNIT I PROCESS CAPABILITY AND TOLERANCES **8**

General design principles for manufacturability - strength and mechanical factors, mechanisms selection, Evaluation method, Process capability - Feature tolerances, Geometric tolerances. Worst case method - Assembly limits, Datum features, Tolerance stacks**.**

UNIT II FACTORS INFLUENCING FORM DESIGN **9**

Influence of materials on form design - form design of grey iron, malleable iron, steel and aluminium castings - form design of welded members, forgings.

UNIT III COMPONENT DESIGN - MACHINING CONSIDERATION **10**

Design features to facilitate machining – drills, milling cutters, keyways, Doweling procedures, Counter sunk screws - Reduction of machined area, simplification by separation, simplification by amalgamation. Design for machinability - Design for economy, Design for clampability, Design for accessibility, Design for assembly.

UNIT IV COMPONENT DESIGN - CASTING CONSIDERATION **9**

Redesign of castings based on Parting line considerations - Minimizing core requirements, machined holes, redesign of cast members to obviate cores. Identification of uneconomical design - Modifying the design - Group technology, Computer Applications for DFMA.

UNIT V DESIGN FOR THE ENVIRONMENT **9**

Introduction – Environmental objectives, Global issues, Regional and local issues. Basic DFE methods – Design guide lines, Example application. Lifecycle assessment – Basic method, AT&T's environmentally responsible product assessment. Weighted sum assessment method – Lifecycle assessment method, Techniques to reduce environmental impact, Design to minimize material usage. Design for disassembly, Design for recyclability, Design for remanufacture, Design for energy efficiency, Design to regulations and standards.

TOTAL : 45 HOURS

COURSE OUTCOMES:

The students will be able to

- Understand the complex interrelationships between design and manufacturing.
- Explore and understand basic manufacturing processes and the design for manufacturing (DFM) implications of design choices for specific manufacturing processes.
- Understand the role of components design with machining consideration.
- Understand approaches and practices related to CAD model building and model checking for specific manufacturing processes such as models for sheet metal and models for casts and molds.
- To know about environmental issues with case study.

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TEXT BOOKS:

1. Bralla, "Design for Manufacture Handbook", Second Edition, McGraw-Hill, New York, 1999.
2. Peck, Harry, "Design for Manufacture", Pitman Publications, 1983.

REFERENCE BOOKS:

1. George E Dieter, "Engineering Design- Material and processing approach", McGraw Hill Intl., 2nd Edition, 2000.
2. Boothroyd, G, Heartz and Nike, "Product Design for Manufacture", Second Edition, Marcel Dekker Inc., London, 2002.
3. Kevien Otto and Kristin Wood, "Product Design", Pearson Publication, New Delhi, 2004.
4. Matousek, "Engineering Design- A Systematic Approach", Blackie & Son Ltd, London, 1974.

Course Outcome		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
Co1	Understand the complex interrelationships between design and manufacturing.	3	-	2	-	2	1	1	-	-	-	-	-	3	-	1
Co2	Explore and understand basic manufacturing processes and the design for manufacturing (DFM) implications of design choices for specific manufacturing processes.	2	-	2	-	1	1	-	-	1	-	-	-	1	-	1
Co3	Understand the role of components design with machining consideration.	2	-	2	-	1	1	-	-	1	-	-	-	1	-	1
Co4	Understand approaches and practices related to CAD model building and model checking for specific manufacturing processes such as models for sheet metal and models for casts and molds.	2	-	2	-	1	1	-	-	1	-	-	-	1	-	1
Co5	To know about environmental issues with case study.	2	-	2	-	1	1	-	-	1	-	-	-	1	-	1

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315EDE01	MICRO ELECTRO MECHANICAL SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

1. To know the principles and processes involved in MEMS devices.
2. To know about the methods of device construction, materials and their characterization.
3. To know about micromechanics and micro manufacturing.
4. To educate the basics of micro fabrication and packaging techniques.
5. To gain the basic understanding of modeling & to apply in various applications.

UNIT I INTRODUCTION **9**

Overview, Microsystems and microelectronics, Working principle of Microsystems, micro actuation techniques-micro sensors-types, microactuators-types, micropump- micromotors-micro-valves-microgrippers, scaling laws-scaling in geomentry, scaling in rigid body dynamics, scaling in electrostatic forces, scaling in electricity, scaling in fluid mechanics, scaling in heat transfer.

UNIT II MATERIALS AND FABRICATION PROCESS **9**

Substrates and wafer-single crystal silicon wafer formation, ideal substrates - mechanical properties, silicon compounds - Sio_2, SiC, Si_3N_4 and polycrystalline silicon, Silicon piezoresistors - Gallium arsenide, Quartz-piezoelectric crystals, polymers for MEMS -conductive polymers, Photolithography, Ion implantation, Diffusion, Oxidation, CVD, Physical vapor deposition, Deposition by epitaxy, etching process.

UNIT III MICROMECHANICS **9**

Introduction-static bending of thin plates-circular plates with edge fixed, rectangular plate with all edges fixed and square plate with all edges fixed, Mechanical vibration-resonant vibration, micro accelerometers-design theory and damping coefficients, thermo mechanics, thermal stresses, fracture mechanics, stress intensity factors, fracture toughness and interfacial fracture mechanics.

UNIT IV MICRO SYSTEM MANUFACTURING AND PACKAGING **9**

Clean room technology, Bulk Micro manufacturing- surface micro machining –LIGA-SLIGA-Micro system packaging-materials-die level-device level-system, level-packaging techniques-die preparation, surface bonding, wire bonding, sealing.

UNIT V MICRO SYSTEM DESIGN **9**

Design considerations-process design, mask layout design, mechanical design-applications of micro system in automotive industry, bio medical, aero space-telecommunications.

TOTAL : 45 Hours

COURSE OUTCOMES:

The student should be able to

- Understand the basic principles involved in MEMS.
- Become familiar with micro fabrication techniques.
- Analyze the mechanics involved in the product before manufacturing.
- Select the suitable manufacturing & packaging techniques.
- Assess whether using a MEMS based solution is the relevant and best approach for suitable applications.

TEXT BOOKS:

1. Tai-Ran Hsu, "MEMS & Microsystems Design and Manufacture and Nanoscale Engineering", John Wiley and Sons Inc, 2008.
2. Rai –choudhury P, "MEMS and MOEMS Technology and Applications", PHI learning Private Limited, 2009.

REFERENCE BOOKS:

1. James J Allen, Dekker, "Micro Electro Mechanical System Design", CRC Press, 2010.
2. Mohamed Gad-el-Hak, "The MEMS Hand book", CRC press, 2002.
3. Francis E.H Tay and W.O Choong, "Microfludics and BioMEMS Applications", Springer, 2002.
4. Julian W. Gardner, Vijay K.Varadan, Osama O.Awadel Karim, "Microsensors MEMS and Smart Devices", John Wiley & sons Ltd., 2001.
5. S.Fatikow, U.Rembold, "Microsystem Technology and Microrobotics", Springer- Verlag Berlin Heidelberg, 1997.

Course Outcome		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
Co1	Understand the basic principles involved in MEMS.	2	1	-	-	-	-	-	-	-	1	-	-	1	2	-
Co2	Become familiar with micro fabrication techniques.	1	2	-	-	-	-	-	-	-	-	-	-	1	1	-
Co3	Analyze the mechanics involved in the product before manufacturing.	1	1	-	-	3	-	-	-	-	-	-	-	1	-	3
Co4	Select the suitable manufacturing & packaging techniques.	1	1	-	-	-	-	-	-	-	-	-	-	1	1	1
Co5	Assess whether using a MEMS based solution is the relevant and best approach for suitable applications.	3	2	1	-	2	-	-	-	-	-	-	-	2	1	3

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315EDE03	PRODUCT LIFE CYCLE MANAGEMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:

1. To know the concept of PLM and its impact on the organization.
2. To provide an overview of the current thinking on the principles, strategies and application of PLM, followed by an in-depth look at specific areas of PLM that are the focus of today's innovative organizations.
3. To understand the conceptual of PLM, along with the latest industry views on PLM applications.
4. To know the present frame works which provide economic justification for PLM projects and explain the pit falls of a piecemeal approach to PLM.
5. To know integration of PLM/PDM with other application.

UNIT I INTRODUCTION AND PRODUCT LIFE CYCLE ENVIRONMENT 9

Background, Overview, Need, Benefits, Concept of Product Life Cycle. Components / Elements of PLM, Emergence of PLM, Significance of PLM, Customer Involvement.
Product Data and Product Workflow, Company's PLM vision, The PLM Strategy, Principles for PLM strategy, Preparing for the PLM strategy, Developing a PLM strategy, Strategy identification and selection, Change Management for PLM.

UNIT II PRODUCT DEVELOPMENT PROCESS & METHODOLOGIES 9

Integrated Product development process - Conceive – Specification, Concept design, Design - Detailed design, Validation and analysis (simulation), Tool design, Realize – Plan manufacturing , Manufacture, Build/Assemble , Test (quality check) , Service - Sell and Deliver , Use , Maintain and Support, Dispose. Bottom-up design, Top-down design, Front loading design workflow, Design in context, Modular design. Concurrent engineering - work structuring and team Deployment - Product and process systemization - problem, identification and solving methodologies. Product Reliability, Mortality Curve. Design for Manufacturing, Design for Assembly. Design for Six Sigma.

UNIT III PRODUCT MODELLING AND TYPES OF ANALYSIS TOOLS 9

Product Modeling - Definition of concepts - Fundamental issues - Role of Process chains and product models -Types of product models - model standardization efforts-types of process chains - Industrial demands.
Design for manufacturing - machining - casting and metal forming - optimum design - Design for assembly and disassembly - probabilistic design concepts - FMEA - QFD - Taguchi Method for design of experiments -Design for product life cycle. Estimation of Manufacturing costs, Reducing the component costs and assembly costs, Minimize system complexity.

UNIT IV PRODUCT DATA MANAGEMENT (PDM) TECHNOLOGY 9

Product Data Management – An Introduction to Concepts, Benefits and Terminology, CIM Data. PDM functions, definition and architectures of PDM systems, product data interchange, portal integration, PDM acquisition and implementation.

UNIT V RECENT ADVANCES 9

Intelligent Information Systems - Knowledge based product and process models - Applications of soft computing in product development process - Advanced database design for integrated manufacturing.

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COURSE OUTCOMES:

The student shall be able to

- Understand product data, information, structures and PLM concepts.
- Apply PLM systems in organization verticals including production, after sales, sales and marketing, and subcontracting.
- Measure benefits of PLM implementation in daily operations, material costs, productivity of labor and quality costs.
- Apply PLM concepts for service industry and E-Business.
- Recognize tools and standards in PLM.

TEXT BOOKS:

1. Grieves Michael, "Product Lifecycle Management", McGraw-Hill, 2006.
2. Antti Saaksvuori, Anselmi Immonen, "Product Life Cycle Management", Springer, 3rd Edition, 2008.

REFERENCE BOOKS:

1. Kari Ulrich and Steven D. Eppinger, "Product Design & Development", McGraw Hill International Edns, 5th Edition, 2011.
2. Stark, John "Product Lifecycle Management: Paradigm for 21st Century Product Realisation", Springer-Verlag, 2005.
3. Burden, Rodger PDM: "Product Data Management", Resource Pub, 2003.
4. Crnkovic, Ivica; Asklund, Ulf; & Dahlqvist, Annita Persson. "Implementing and Integrating Product Data Management and Software Configuration Management", Artech House Publishers, 2003.
5. Jerry Clement, Andy Coldrick, & John Sari, "Manufacturing Data Structures", John Wiley & Sons, 1992.

Course Outcome		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
Co1	Understand product data, information, structures and PLM concepts.	1	1	-	3	3	-	-	-	-	2	-	-	1	-	3
Co2	Apply PLM systems in organization verticals including production, after sales, sales and marketing, and subcontracting.	1	1	-	3	3	-	-	-	-	2	-	-	1	-	3
Co3	Measure benefits of PLM implementation in daily operations, material costs, productivity of labor and quality costs.	1	1	-	3	3	-	-	-	-	2	-	-	1	-	3
Co4	Apply PLM concepts for service industry and E-Business.	1	1	-	3	3	-	-	-	-	2	-	2	1	-	3
Co5	Recognize tools and standards in PLM.	1	1	-	3	3	-	-	-	-	2	-	-	1	-	3

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315EDE04	DESIGN OF MATERIALS HANDLING SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

1. To learn fundamental principles of material handling systems. To understand the design of hoist in material handling.
2. To impart knowledge on various drives used for material handling equipment's.
3. To familiarize on transfer mechanism, conveyors, part feeding devices in material handling system.
4. To develop knowledge on the construction &working of elevators, escalators and improve presentation and team work skills.
5. To understand specific requirements of material handling systems and their design.

UNIT I MATERIALS HANDLING EQUIPMENT **6**

Types of material handling equipments, selection of material handling equipments and applications of material handling equipments.

UNIT II DESIGN OF HOISTS **10**

Design of hoisting elements - Welded and roller chains, Hemp and wire ropes, Design of ropes, pulleys, pulley systems, sprockets and drums, Load handling attachments. Design of forged hooks and eye hooks - crane grabs, lifting magnets, Grabbing attachments. Design of arresting gear. Brakes - shoe, band and cone types.

UNIT III DRIVES OF HOISTING GEAR **10**

Hand and power drives - Traveling gear, Rail traveling mechanism, cantilever and monorail cranes, slewing. Jib and luffing gear - cogwheel drive, selecting the motor ratings.

UNIT IV CONVEYORS **10**

Types – description, design and applications of Belt conveyors, apron conveyors and escalators, Pneumatic conveyors, Screw conveyors and vibratory conveyors.

UNIT V ELEVATORS **9**

Bucket elevators – design, loading and bucket arrangements. Cage elevators - shaft way, guides, counter weights, hoisting machine, safety devices, Design of fork lift trucks.

TOTAL : 45 Hours

COURSE OUTCOMES:

- The students will be able to understand the concepts and benefits of better material handling systems.
- The students will be able to understand the proper selection, use and care through work area hazard assessments and training.
- The course would familiarize the student on the technique to select suitable material handling equipment and design them based on the need.
- The Student will be able to design material handling equipments such as drives of hoisting gears, conveyors, elevators.
- To demonstrate knowledge of the safe shifting of materials in a diary processing operation.

TEXT BOOKS:

1. Rudenko, N, "Materials handling equipment", ELnvee Publishers, 1970.
2. Spivakovsy, A.O. and Dyachkov, V.K, "Conveying Machines", Volumes I and II, MIR Publishers, 1985.

REFERENCE BOOKS:

1. Alan Mulemann, John Oakland, Keith Locker, "Production and Operations Management" Macmillan India Ltd, 2015.
2. Datta A.K, "Materials Management: Procedures, Text and Cases", Prentice Hall of India, 2008.
3. Everett E. Adam Jr & Ronald J. Ebert, "Production and Operations Management", Prentice Hall of India, 2003 (Digitized 2008).
4. Alexandrov, M., 'Materials Handling Equipments', MIR Publishers, 1981.

Course Outcome		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
Co1	The students will be able to understand the concepts and benefits of better material handling systems.	2	2	1	3	-	-	-	-	2	1	1	1	2	-	1
Co2	The students will be able to understand the proper selection, use and care through work area hazard assessments and training.	2	2	1	3	-	-	-	-	2	1	1	1	2	-	1
Co3	The course would familiarize the student on the technique to select suitable material handling equipment and design them based on the need.	2	2	1	2	-	-	-	-	1	1	1	1	2	-	1
Co4	The Student will be able to design material handling equipments such as drives of hoisting gears, conveyors, elevators.	2	3	-	1	-	-	-	-	2	1	-	-	2	-	1
Co5	To demonstrate knowledge of the safe shifting of materials in a diary processing operation.	1	2	1	3	1	-	-	-	2	1	1	1	2	-	1

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315EDP01	PROJECT WORK (PHASE – I)	L	T	P	C
		0	0	12	6

OBJECTIVES:

1. To strengthens the students to carry out the project on their own and to implement their innovative ideas.
2. To deepen comprehension of principles by applying them to a new problem which may be the design and manufacture of a device, a research investigation or an analysis.
3. To create innovative learning environments aimed at increasing the value of the training pathways perception and at the rise of self confidence.
4. To the development of a virtual reflecting learning approach to foster the real involvement of all the students, included those students coming from less favoured environments.
5. To investigate the development of the student innovation ideas.

GUIDELINES

1. The project work is to enable the individual student to work on a project involving theoretical and experimental studies related to the branch of study.
2. Every project work shall have a guide who is the member of the faculty of the institution.
3. Each student shall finally produce a comprehensive report covering background information, literature survey, problem statement and methodology. The final report shall be typewritten form as specified in the guidelines.

EVALUATION

1. The progress of the project is evaluated by a review committee consisting of a minimum of three members.
2. The review committee may be constituted by the Head of the Department.
3. The continuous assessment shall be made by conducting three reviews.
4. Final review will be done by the committee that consists of minimum of three members one of which should be the guide. (If possible include one external expert examiner within the college)

TOTAL : 150 Hours

COURSE OUTCOMES:

The students will have

- Ability to make links across different areas of knowledge and to generate, develop and evaluate ideas and information so as to apply these skills to the project task.
- Skills to communicate effectively and to present ideas clearly and coherently to specific audience in both the written and oral forms
- Collaborative skills through working in a team to achieve common goals.
- Ability to learn on their own, reflect on their learning and take appropriate actions to improve it.
- Ability to estimate and cost the human and physical resources required, and make plans to obtain the necessary resources

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Course Outcome		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
Co1	Ability to make links across different areas of knowledge and to generate, develop and evaluate ideas and information so as to apply these skills to the project task.	2	2	2	-	-	-	-	-	-	1	-	-	3	-	2
Co2	Skills to communicate effectively and to present ideas clearly and coherently to specific audience in both the written and oral forms	2	2	-	-	-	-	-	-	-	1	-	-	3	-	2
Co3	Collaborative skills through working in a team to achieve common goals.	3	2	-	-	2	-	-	-	-	1	-	-	3	-	-
Co4	Ability to learn on their own, reflect on their learning and take appropriate actions to improve it.	2	2	3	3	2	-	-	-	-	1	-	-	3	- -	1
Co5	Ability to estimate and cost the human and physical resources required, and make plans to obtain the necessary resources	2	2	3	3	2	-	-	-	-	1	-	-	3	-	1

315EDP02	INTERNSHIP & TECHNICAL SEMINAR	L	T	P	C
		0	0	2	1

OBJECTIVES:

1. To make the students to get practical exposure and learn about various activities happening in the industries.
2. To make the students to learn about effective communication, presentation skills and report preparation.
3. To build the strength, team work spirit and self confidence in students life.
4. To develop skills in the application of theory to practical work situations.
5. To increase a student's strength of responsibility and good work habits.

GUIDELINES

- It is mandatory that each student should undergo internship / in-plant training in reputed industries for the duration of 2-3 weeks after second semester end examination. Then the student has to submit a hard copy of the training report not less than 10 pages. Also he / she has to give presentation on the training report for about 30 minutes.
- Students are encouraged to use various teaching aids such as over head projectors, power point presentation and demonstrative models.

EVALUATION

- The training report will be evaluated by the faculty in-charge.
- There is internal assessment and end examination.

TOTAL : 30 Hours

COURSE OUTCOMES:

- The students will have practical knowledge about various activities like process design, quality control that are takes place in industries.
- The students will have the skills about effective communication, presentation and report preparation.
- The students are able to improve their problem solving and critical thinking skills.
- The students are able to identify the professional standards.
- The students are able to create or modify the new technology policies.

Course Outcome		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
Co1	The students will have practical knowledge about various activities like process design, quality control that are takes place in industries.	2	3	-	-	-	-	-	-	-	1	1	-	2	-	-
Co2	The students will have the skills about effective communication, presentation and report preparation.	2	1	2	-	-	-	-	-	-	1	1	-	2	-	-
Co3	The students are able to improve their problem solving and critical thinking skills.	2	1	1	-	-	-	-	-	-	1	1	-	2	-	-
Co4	The students are able to identify the professional standards.	2	2	1	-	-	-	-	-	-	1	1	-	2	-	-
Co5	The students are able to create or modify the new technology policies.	3	2	1	-	-	-	-	-	-	1	1	-	3	-	-

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415EDP01	Project Work (Phase – II)	L	T	P	C
		0	0	30	15

OBJECTIVES:

The objectives of the project are

1. To get an opportunity to synthesize knowledge from various areas of learning, and critically and creatively apply it to real life situations.
2. To acquire skills like collaboration, communication and independent learning, prepares them for lifelong learning and the challenges ahead.
3. To deepen comprehension of principles by applying them to a new problem which may be the design and manufacture of a device, a research investigation or an analysis.
4. To use the engineering technical skills and modern engineering tools necessary for practical applications.
5. To document and present one's own research work, with strict requirements on structure, format, and language usage for publication.

GUIDELINES

1. The project work is to enable the individual student on a project involving theoretical and experimental studies related to the branch of study.
2. Every project work shall have a guide who is the member of the faculty of the institution.
3. They should publish the papers in the journals / conferences.
4. Each student shall finally produce a comprehensive report covering background information, literature survey, problem statement, project work details and conclusion. The final report shall be typewritten form as specified in the guidelines.

EVALUATION

1. The progress of the project is evaluated by a review committee consisting of a minimum of three members.
2. The review committee may be constituted by the Head of the Department.
3. The continuous assessment shall be made by conducting three reviews.
4. Final review will be done by the committee that consists of minimum of three members one of which should be the guide. (If possible include one external expert examiner within the college)

TOTAL : 90 HOURS

COURSE OUTCOMES:

The students will be able to

- Use the engineering technical skills and modern engineering tools necessary for practical applications.
- Use design principles and develop conceptual, engineering design and fabrication of various components.
- Take up any challenging practical problems and find solution by formulating proper methodology by attending different conferences.
- Create the document for research article with correct format and structure.
- Gain Practical knowledge about various activities like processes, design, quality control that are taking place in industries.

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Course Outcome		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
Co1	Use the engineering technical skills and modern engineering tools necessary for practical applications.	-	2	-	1	-	-	-	-	-	-	-	1	1	-	1
Co2	Use design principles and develop conceptual, engineering design and fabrication of various components.	2	1	-	1	-	-	-	-	-	-	-	1	-	2	-
Co3	Take up any challenging practical problems and find solution by formulating proper methodology by attending different conferences.	2	2	-	2	-	-	-	-	-	-	-	1	-	3	-
Co4	Create the document for research article with correct format and structure.	-	1	-	2	-	-	-	-	-	-	-	2	-	-	2
Co5	Gain Practical knowledge about various activities like processes, design, quality control that are taking place in industries.	-	1	-	2	-	-	-	-	-	-	-	2	-	-	2

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