118EDT01 **ADVANCED NUMERICAL METHODS** **L T P C**
3 1 0 4

COURSE OBJECTIVES:

- To solve equations using direct and iterative methods.
- To learn Eigen value problems.
- To introduce the concept of calculus of variations.
- To learn numerical methods to solve partial differential equations – Elliptic.
- To learn numerical methods to solve partial differential equations – Parabolic.

UNIT I SIMULTANEOUS EQUATIONS AND NUM ERICAL INTEGRATION 9

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 9

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 9

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 NUMERICAL SOLUTIONS PARTIAL DIFFERENTIAL EQUATIONS 9

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 methods

UNIT V PARABOLIC PARTIAL DIFFERENTIAL EQUATIONS 9

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 HOURS:60 PERIODS

COURSE OUTCOMES

At the end of the course the student will be able to

CO1: Apply numerical methods such as direct, iterative to solve system of equations and to solve integrals.
CO2: Solve the boundary value problems and Eigen value problems.
CO3: Compute maxima and minima of a functional dependent of functions using different methods.
CO4: Solve Elliptic type of partial differential equations using iterative methods.
CO5: Evaluate numerically the solutions of parabolic equations using initial and boundary conditions.

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REFERENCE BOOKS

1. Richard L.Burden, J.Dougles Faires and Annette M. Burden, "Numerical Analysis", Tenth Edition, Cengage, 2016. www.cengage.com/international.
2. Gupta, A.S., "Calculus of Variations with Applications", Prentice Hall of India Pvt. Ltd., New Delhi, 2010.
3. Elsgolc, L.E., "Calculus of Variations", Dover Pub., 2007.
4. Ward Cheney and David Kincaid, "Numerical Mathematics and Computing", Brooks/Cole Publishing company, Fourth Edition, 1999.
5. Sankara Rao, K., "Introduction to Partial Differential Equations", Prentice Hall of India Pvt. Ltd., New Delhi, 2012.
6. 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	Apply numerical methods such as direct, iterative to solve system of equations and to solve integrals.	3	3											3		
Co2	Solve the boundary value problems and Eigen value problems.	3	3											3		
Co3	Compute maxima and minima of a functional dependent of functions using different methods.	3	3											3		
Co4	Solve Elliptic type of partial differential equations using iterative methods.	3	3											3		
Co5	Evaluate numerically the solutions of parabolic equations using initial and boundary conditions.	3	3											3		

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118EDT02 **CONCEPTS OF ENGINEERING DESIGN** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To introduce basic concepts in design process.
- To provide knowledge on tools in engineering design.
- To learn material selection and materials in designing to machine members.
- To impart basic knowledge in material processing for designing machine members.
- To identify legal, ethical environmental and safety issue in design and quality Engineering.

UNIT I THE DESIGN PROCESS **8**

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 **9**

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 **9**

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 **9**

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 HOURS:45 PERIODS

COURSE OUTCOMES

Student will be able to

CO1: Perform design process for developing new machine members.
CO2: Notice tools in engineering design
CO3: Find the solution in materials selection and materials in designing a new machine member.
CO4: Conduct designing machine members using materials processing.
CO5: Apply knowledge to select material basing on legal, ethical environmental and safety issues in design and quality engineering.

TEXT BOOKS

1. Dieter George E, "Engineering Design – A Materials and Processing Approach", McGraw Hill, International Edition, Singapore 2012.
2. Karl T. Ulrich and Steven D. Eppinger, "Product Design and Development", McGraw Hill, International Edition, 6th Edition, 2011.

REFERENCE BOOKS

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

Course Outcome		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
Co1	Perform design process for developing new machine members.	3	3	3	3	3	2	1	1	2	1	1	1	3	3	3
Co2	Notice tools in engineering design	2	2	2	2	2	2	1	1	2	1	1	1	3	2	2
Co3	Find the solution in materials selection and materials in designing a new machine member.	2	2	2	2	2	2	1	1	2	1	1	1	2	2	2
Co4	Conduct designing machine members using materials processing.	3	3	3	3	3	2	1	1	2	1	1	1	3	2	2
Co5	Apply knowledge to select material basing on legal, ethical environmental and safety issues in design and quality engineering.	2	2	2	2	2	2	1	1	2	1	1	1	2	2	2

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118EDT03 **COMPUTER APPLICATION IN DESIGN** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To know about the application of computer graphics in design.
- To comprehend with the concepts of geometrical modeling and reverse engineering of components.
- To study about computer tools in mould design, jigs and fixtures design.
- To impart knowledge on design productivity using computers.
- 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 9

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

UNIT II COMPUTERS IN DESIGN 9

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 9

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

UNIT IV COMPUTERS IN DESIGN PRODUCTIVITY 9

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 9

Version control, Library creation, Catalog making, Standardization for design, Collaborative design among peer groups, Design optimization for geometry, Design check, approval and validation.

TOTAL HOURS:45 PERIODS

COURSE OUTCOMES

Students will be able to

CO1: Familiarized with the computer graphics application in design.
CO2: Perform design of machine tools using computers
CO3: Find the solution in programming the tool design
CO4: Apply computer knowledge in development of product design
CO5: Manage design data for producing new tools.

TEXT BOOKS

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

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REFERENCE BOOKS

1. P N Rao, "CAD/CAM: Principles and Applications" Tata McGraw Hill, 3rd Edition, 2010.
2. Donald D. Hearn and M Pauline Baker, "Computer Graphics", Prentice Hall Inc, 2004.
3. Schlechtendahl E. G, "CAD – Data transfer for Solid Models", Springer, Verlag, Berlin, 1989.

Course Outcome		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
Co1	Familiarized with the computer graphics application in design.	3	3	3	3	3	2	1	1	2	1	1	1	3	3	3
Co2	Perform design of machine tools using computers	3	3	3	3	3	2	1	1	2	1	1	1	3	3	3
Co3	Find the solution in programming the tool design	3	3	3	3	3	2	1	1	2	1	1	1	3	3	3
Co4	Apply computer knowledge in development of product design	3	3	3	3	3	2	1	1	2	1	1	1	3	3	3
Co5	Manage design data for producing new tools.	3	3	3	3	3	2	1	1	2	1	1	1	3	3	3

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118EDT04 **FINITE ELEMENT ANALYSIS** **L T P C**
3 1 0 4

COURSE OBJECTIVES:

- To formulate and analysis of 1D analysis arising in engineering design.
- To formulate and analysis of 2D, 3D analysis arising in engineering design.
- To know about the isoparametric formulation of triangular and rectangular elements.
- To provide further advanced FEA knowledge and techniques for solving Dynamic analysis
- To analyze 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 HOURS:60 PERIODS

COURSE OUTCOMES

CO1: Students will capable of formulate and analysis of 1D Problems.
CO2: Students will capable of formulate and analysis of 2D and 3D Problems.
CO3: Students will have the ability to solve isoparametric problems using FEA.
CO4: Students will able to solve dynamic analysis problem using FEA
CO5: Students will have the ability to apply finite element to formulate and solve thermal and fluid

flow problems.

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. S.S.Rao, “The Finite Element Method in Engineering”, Butterworth-Heinemann, 5th Edition, 2010.
2. *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.
3. J. N.Reddy, “An Introduction to the Finite Element Method”, McGraw Hill International, 2005.
4. David V Hutton, “Fundamentals of Finite Element Analysis”, McGraw Hill Int. Ed., New Delhi, 2004.
5. Chandrupatla T R and Belegundu A D, “Introduction to Finite Elements in Engineering”, Third Edition, Prentice Hall, 2002.
6. Bathe K.J., “Finite Element Procedures in Engineering Analysis”, Prentice Hall, 1996.

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 Problems.	1	2	2	1	1					1			2		1
Co2	Students will capable of formulate and analysis of 2D and 3D Problems.	1	2	2	1	1					1			2		1
Co3	Students will have the ability to solve isoparametric problems using FEA.	1	2	2	1	1					1			2		1
Co4	Students will able to solve dynamic analysis problem using FEA	1	2	2	1	1					1			2		1
Co5	Students will have the ability to apply finite element to formulate and solve thermal and fluid flow problems.	2	1	2	1	2								3		2

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118EDT05 **OPTIMIZATION TECHNIQUES IN DESIGN** **L T P C**
3 1 0 4

COURSE OBJECTIVES:

- To impart knowledge on various categories of existing engineering problems and solutions to such problems through different optimization techniques and approaches.
- To learn the engineering optimization fundamentals and applications.
- To understand the different optimization techniques and approaches for various categories of existing engineering problems and to formulate the optimization problems.
- To know about the design concepts for manufacturing industries.
- To study about the computational procedure in dynamic programming.

PREREQUISITE: Knowledge of Design of Machine Elements is required.

UNIT I ENGINEERING DESIGN PRACTICE 12

Evolution of Design Technology, Introduction to Design and the Design Process, Design versus Analysis, Role of Computers in Design Cycle, Impact of CAE on Design, Numerical Modeling with FEA and Correlation with Physical Tests.

Applications of Optimization in Engineering Design: Automotive, Aerospace and General Industry Applications, Optimization of Metallic and Composite Structures, Minimization and Maximization Problems, Multidisciplinary Design Optimization (MDO) and Multi Objective Optimization (MOO).

UNIT II OPTIMUM DESIGN PROBLEM FORMULATION 12

Types of Optimization Problems, The Mathematics of Optimization, Design Variables and Design Constraints, Feasible and Infeasible Designs, Equality and Inequality Constraints, Discrete and Continuous Optimization, Linear and Non Linear Optimization.

Optimization Theory, Fundamental Concepts, Global and Local Minimum, Gradient Vector and Hessian Matrix, Concept of Necessary and Sufficient Conditions, Constrained and Unconstrained Problems, Lagrange Multipliers and Kuhn Tucker Conditions

UNIT III SENSITIVITY ANALYSIS, OPTIMIZATION DISCIPLINES 12

Sensitivity Analysis, Linear and Non Linear Approximations. Gradient Based Optimization Methods, Dual and Direct.

Optimization Disciplines: Conceptual Design Optimization and Design Fine Tuning, Combined Optimization, Optimization of Multiple Static and Dynamic Loads, Transient Simulations, Equivalent Static Load Methods, Internal and External Responses, Design Variables in Each Discipline.

UNIT IV MANUFACTURABILITY IN OPTIMIZATION PROBLEMS 12

Design For Manufacturing, Manufacturing Methods and Rules, Applying Manufacturing Constraints to Optimization Problems.

Design Interpretation: Unbound Problems, Over Constrained Problems, Problems with numerical of Multiple Solutions, Active and Inactive Constraints, Constraint Violations and Constraint Screening, Design Move Limits, Local and Global Optimum.

UNIT V DYNAMIC PROGRAMMING 12

Introduction, Multistage decision processes, Principle of optimality, Computational Procedure in dynamic programming, Initial value problem, Examples.

TOTAL HOURS:60 PERIODS

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COURSE OUTCOMES

CO1: Students will be familiarized with different approaches of optimizing an engineering problem or a function which is essentially required in industries today.

CO2: Students acquire knowledge to optimize an existing design with single or multiple objective functions.

CO3: Students will get familiarized with the different approaches of optimizing disciplines in engineering problem or a function.

CO4: Students will able to solve the optimization problems in manufacturability using various optimization methods.

CO5: Students will able to write the procedure for dynamic programming using computational process.

TEXT BOOKS

1. Rao S.S, "Engineering Optimization: Theory and Practice", Newage Publisher, 3rd Edition, 2013.
2. Jasbir Arora, "Introduction to Optimum Design", McGraw Hill, 2011.

REFERENCE BOOKS

1. Fox R.L, Addison, "Optimization methods for Engg. Design", Wesley, 2004.
2. Mital K. V. and C. Mohan, "Optimization methods in Operations Research and Systems Analysis", New age International Publishers, 1996.

Course Outcome		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
Co1	Students will be familiarized with different approaches of optimizing an engineering problem or a function which is essentially required in industries today.	3	3	3	3	3	2	1	1	2	1	1	1	3	3	3
Co2	Students acquire knowledge to optimize an existing design with single or multiple objective functions.	3	3	3	3	3	2	1	1	2	1	1	1	3	3	3
Co3	Students will get familiarized with the different approaches of optimizing disciplines in engineering problem or a function.	3	3	3	3	3	2	1	1	2	1	1	1	3	3	3
Co4	Students will able to solve the optimization problems in manufacturability using various optimization methods.	3	3	3	3	3	2	1	1	2	1	1	1	3	3	3
Co5	Students will able to write the procedure for dynamic programming using computational process.	3	3	3	3	3	2	1	1	2	1	1	1	3	3	3

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118EDP07 **CAE LABORATORY - 1** **L T P C**
0 0 2 1

COURSE OBJECTIVES:

- To know about design concepts, to use the Finite Element Method software correctly and efficiently.
- To know about the types of element used, type of analysis done, interpretation of results, method of solving and analyzing a given problem.
- To acquire the basic skills in using professional level finite element software, applied to structural, heat transfer and fluid flow components at various loading conditions.
- To analyze a physical problem, develop experimental procedures for accurately investigating the problem, and effectively perform and document findings.
- To simulate simple mechanisms using simulation software.

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.

TOTAL HOURS:45 PERIODS

COURSE OUTCOMES

Student will be able to

CO1: Select the method, meshing, analysis and optimize the given problem for structural and thermal applications.
CO2: Conduct structural analyses and selected other analysis like normal modes/natural frequency analysis, harmonic analysis, steady-state heat conduction analysis
CO3: Use professional level finite element software to solve engineering problems in solid mechanics and heat transfer
CO4: Simulate simple kinematic mechanisms using simulation software.
CO5: Recognize sources of errors in FEA.

Course Outcome		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
Co1	Select the method, meshing, analysis and optimize the given problem for structural and thermal applications.		2		1								1	1		1
Co2	Conduct structural analyses and selected other analysis like normal modes/natural frequency analysis, harmonic analysis, steady-state heat conduction analysis	2	1		1								1			2
Co3	Use professional level finite element software to solve engineering problems in solid mechanics and heat transfer	2	2		2								1			3
Co4	Simulate simple kinematic mechanisms using simulation software.		1		2								2			2
Co5	Recognize sources of errors in FEA.	1	1		1									1		1

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118EDE02 **ADDITIVE MANUFACTURING** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To know about the concepts of the rapid prototyping methods.
- To know the principle and process details of stereo lithography system.
- To comprehend the concepts and process details of fusion deposition modeling.
- To gain the knowledge on laminated object manufacturing.
- To know about rapid tooling techniques and its advantages.

PREREQUISITE: Knowledge of Manufacturing Technology - I is required.

UNIT I INTRODUCTION OF RAPID PROTOTYPING 8

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 9

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 9

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 9

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 5system, 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, 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 HOURS:45 PERIODS

COURSE OUTCOMES

CO1: The students will able to gain knowledge about the various rapid prototyping technologies.
CO2: The students will able to gain knowledge about stereo lithography process and selective laser sintering.
CO3: The students will have sound knowledge on processes like fusion deposition modeling and solid ground curing.
CO4: The students will have sound knowledge on processes includes laminated object manufacturing concept modeler and laser engineered net shaping.
CO5: The students can enhance the knowledge in rapid tooling and different softwares used for rapid prototyping like solid view.

TEXT BOOKS

1. Pham. D. T. & Dimov. S. S., "Rapid Manufacturing", Verlag, London, 2012.
2. Paul. F. Jacobs, "Stereo lithography and other RP & M Technologies", SME, New York, 2010.

REFERENCE BOOKS

1. Hari Prasad & K.S. Badrinarayanan, “Rapid Prototyping and Tooling”, SIP Pageturners, 2013.
2. Chee Kai Chua, Kah Fai Leong, Chu Sing Lim, “Rapid Prototyping Principles and Applications”, World Scientific Publishing Company, 2010.
3. Serope Kalpakjian and Steven R Schmid, “Manufacturing Engineering and Technology”, Prentice Hall, 6th Edition, 2009.
4. Frank W Lioli, “Rapid Prototyping and Engineering Applications”, CRC Press, 2008.
5. Terry Wohlers, “Wohlers Report 2006”, Wohlers Associates, 2006.
6. N. Hopkinson, RJM Hague, P.M.Dickens, “Rapid Manufacturing: An Industrial Revolution for the Digital Age”, Wiley, 2005.

Course Outcome		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
Co1	The students will able to gain knowledge about the various rapid prototyping technologies.	2		2									1	2		1
Co2	The students will able to gain knowledge about stereo lithography process and selective laser sintering.	1		2										1		1
Co3	The students will have sound knowledge on processes like fusion deposition modeling and solid ground curing.	1		1										1		2
Co4	The students will have sound knowledge on processes includes laminated object manufacturing concept modeler and laser engineered net shaping.						3							1		1
Co5	The students can enhance the knowledge in rapid tooling and different softwares used for rapid prototyping like solid view.	1		1			2							1		1

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218EDT01 **TRIBOLOGY IN DESIGN** **L T P C**
3 1 0 4

COURSE OBJECTIVES:

- To understand the principles for selecting compatible materials for minimizing friction and wear in machinery.
- To understand the principles of hydrodynamic and hydrostatic lubrication and their design and applications.
- To understand the principles of bearing selection and bearing arrangement in machines.
- To understand the factors influencing the design and selection of Porous bearings.
- To learn about space and automotive tribology.

UNIT I INTRODUCTION TO TRIBOLOGY **12**

Introduction, Friction, Wear, Wear Characterization, Regimes of lubrication Classification of contacts, lubrication theories, Effect of pressure and temperature on viscosity. Newton's Law of viscous forces, Flow through stationary parallel plates. Hagen's Poiseuille's theory, viscometers. Numerical problems, Concept of lightly loaded bearings, Petroff's equation, Numerical problems.

UNIT II HYDRODYNAMIC LUBRICATION **12**

Pressure development mechanism. Converging and diverging films and pressure induced flow. Reynold's equation in two dimensions with assumptions. Introduction to idealized slide bearing with fixed shoe and Pivoted shoes. Expression for load carrying capacity. Location of center of pressure, effect of end leakage on performance, Numerical problems

Journal Bearings: Introduction to idealized full journal bearings. Load carrying capacity of idealized full journal bearings, Sommerfeld number and its significance, short and partial bearings, Comparison between lightly loaded and heavily loaded bearings, effects of end leakage on performance, Numerical problems.

UNIT III HYDROSTATIC BEARINGS **12**

Hydrostatic thrust bearings, hydrostatic circular pad, annular pad, rectangular pad bearings, types of flow restrictors, expression for discharge, load carrying capacity and condition for minimum power loss, numerical problems, and hydrostatic journal bearings. **EHL Contacts:** Introduction to Elasto - hydrodynamic lubricated bearings. Introduction to 'EHL' constant. Grubin type solution.

UNIT IV ANTIFRICTION BEARINGS **12**

Advantages, selection, nominal life, static and dynamic load bearing capacity, probability of survival, equivalent load, cubic mean load, bearing Mountings.

Porous Bearings: Introduction to porous and gas lubricated bearings. Governing differential equation for gas lubricated bearings, Equations for porous bearings and working principal, Fretting phenomenon and its stages.

UNIT V SPACE AND AUTOMOTIVE TRIBOLOGY **12**

Introduction - Mechanism, components, liquid and solid lubricants, accelerated testing and life testing of space mechanism. Principles of Aerospace eccentric bearing test mechanism. Engine Tribology - importance, engine bearings, wheel bearings, tire. Mechanics of load transfer - contact area and normal pressure distribution, brakes, effects of service on engine oil properties. Tribology in manufacturing - macro and micro tribology of MEMS materials. Technologies for machinery diagnosis and prognosis.

TOTAL HOURS:60 PERIODS

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COURSE OUTCOMES

The students will be able to

CO1: Select compatible materials for minimizing friction and wear in machinery.

CO2: Design or choose efficient tribological systems such as rolling element bearings, hydrodynamic bearings, and dry sliding bearings, for the needs of a specific application.

CO3: Design bearings under Hydrostatic condition.

CO4: Explain the concepts advanced bearings like porous bearings and gas lubricated bearings.

CO5: Performs space and automotive tribology related study.

TEXT BOOKS

1. Majumdar.B.C, “Introduction to Tribology of Bearing”, Wheeler Publishing, New Delhi, 2001.
2. Radzimovsky, “Lubrication of Bearings – Theoretical Principles and Design”, Oxford Press Company, 2000.

REFERENCE BOOKS

1. Dudley D.Fulier, "Theory and Practice of Lubrication for Engineers", New York Company, 1998
2. Moore "Principles and Applications of Tribology", Pergamon Press, 1975.
3. Oscar Pinkus, BenoSternlicht, “Theory of Hydrodynamic Lubrication”, McGraw-Hill, 1961.
4. G W Stachowiak, A W Batchelor, “Engineering Tribology”, Elsevier Publication 1993.
5. F. M. Stansfield, “Hydrostatic Bearings for Machine Tools and Similar Applications”, Machinery Publishing, 1970.

Course Outcome		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
Co1	Select compatible materials for minimizing friction and wear in machinery.	3	1	1										1	2	1
Co2	Design or choose efficient tribological systems such as rolling element bearings, hydrodynamic bearings, and dry sliding bearings, for the needs of a specific application.	2	2	1										2	2	1
Co3	Design bearings under Hydrostatic condition.	1	1	2										1	1	2
Co4	Explain the concepts advanced bearings like porous bearings and gas lubricated bearings.	2	2	2										2	1	2
Co5	Performs space and automotive tribology related study.	3	2	2										1	1	2

218EDT02 **VIBRATION ANALYSIS AND CONTROL** **L T P C**
3 1 0 4

COURSE OBJECTIVES:

- To fully understand and appreciate the importance of vibrations in mechanical design of machine parts that operates in vibratory conditions.
- To obtain linear vibratory models of dynamic systems with changing complexities (SDOF, MDOF).
- To write the differential equation of motion of vibratory systems.
- To make free and forced (harmonic, periodic, non-periodic) vibration analysis of single and multi degree of freedom linear systems.
- To understand working principles of vibration measurement devices.

UNIT I FUNDAMENTALS OF VIBRATION 12

Introduction -Sources of Vibration-Mathematical Models- Displacement, velocity and Acceleration-Review Of Single Degree Freedom Systems -Vibration isolation Vibrometers and accelerometers - Response To Arbitrary and non- harmonic Excitations – Transient Vibration –Impulse loads- Critical Speed Of Shaft-Rotor systems.

UNIT II TWO DEGREE FREEDOM SYSTEM 12

Introduction-Free Vibration Of Undamped And Damped - Forced Vibration With Harmonic Excitation System –Coordinate Couplings And Principal Coordinates

UNIT III MULTI-DEGREE FREEDOM SYSTEM AND CONTINUOUS SYSTEM 12

Multi Degree Freedom System –Influence Coefficients and stiffness coefficients- Flexibility Matrix and Stiffness Matrix – Eigen Values and Eigen Vectors-Matrix Iteration Method –Approximate Methods: Dunkerley, Rayleigh's, and Holzer Method -Geared Systems-Eigen Values & Eigen vectors for large system of equations using sub space, Lanczos method - Continuous System: Vibration of String, Shafts and Beams

UNIT IV VIBRATION CONTROL 12

Specification of Vibration Limits –Vibration severity standards- Vibration as condition Monitoring tool-Vibration Isolation methods- -Dynamic Vibration Absorber, Torsional and Pendulum Type Absorber-Damped Vibration absorbers-Static and Dynamic Balancing-Balancing machines-Field balancing – Vibration Control by Design Modification- - Active Vibration Control

UNIT V EXPERIMENTAL METHODS IN VIBRATION ANALYSIS 12

Vibration Analysis Overview - Experimental Methods in Vibration Analysis.-Vibration Measuring Instruments - Selection of Sensors- Accelerometer Mountings. -Vibration Exciters-Mechanical, Hydraulic, Electromagnetic And Electrodynamics –Frequency Measuring Instruments-. System Identification from Frequency Response -Testing for resonance and mode shapes

TOTAL HOURS:60 PERIODS

COURSE OUTCOMES

The student will have an ability to

CO1: Analyze the mathematical model of a linear vibratory system to determine its response.
CO2: Obtain linear mathematical models of real life engineering systems.
CO3: Use Lagrange's equations for linear and nonlinear vibratory systems.
CO4: Determine vibratory responses of SDOF and MDOF systems to harmonic, periodic and non-periodic excitation.
CO5: Conduct test by using different vibration measuring device.

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TEXT BOOKS

1. Rao, S.S.," Mechanical Vibrations," Prentice Hall, 2011.
2. Ramamurti. V, "Mechanical Vibration Practice with Basic Theory", Narosa, New Delhi, 2000.

REFERENCE BOOKS

1. V. P. Singh, "Mechanical Vibrations Mechanical Engineering; a Modern Approach", Dhanpat Rai Publication, 2009.
2. S. Graham Kelly & Shashidar K. Kudari, "Mechanical Vibrations", Tata McGraw –Hill Publishing Com. Ltd New Delhi, 2007.
3. S Graham Kelly, "Schaum's Outline of Mechanical Vibrations", McGraw Hill Education, 1996.
4. Thomson, W.T., "Theory of Vibration with Applications", CBS Publishers and Distributors, New Delhi, 1990.

Course Outcome		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
Co1	Analyze the mathematical model of a linear vibratory system to determine its response.	1	1	2										1	1	1
Co2	Obtain linear mathematical models of real life engineering systems.	2	1	2										3	2	2
Co3	Use Lagrange's equations for linear and nonlinear vibratory systems.	3	1	1										2	1	3
Co4	Determine vibratory responses of SDOF and MDOF systems to harmonic, periodic and non-periodic excitation.	1	1	2										1	2	1
Co5	Conduct test by using different vibration measuring device.	2	1	2										2	1	2

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218EDT03 **INTEGRATED MECHANICAL DESIGN** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To understand the fundamentals of design procedure of shafts and phase of design.
- To understand the design procedure for developing the shafts.
- To understand the design procedure for developing gears and gear boxes.
- To understand the design procedure for developing brakes and clutches.
- To understand the fundamentals and design procedure of different machine elements for mechanical design.

UNIT I FUNDAMENTALS OF DESIGN 9

Phases of design – Standardization and interchangeability of machine elements - Process and Function Tolerances – Individual and group tolerances – Selection of fits for different design situations – Design for assembly and modular constructions – Concepts of integration –BIS, ISO, DIN, BS, ASTM Standards. Oblique stresses – Transformation Matrix – Principal stresses – Maximum shear stress - Theories of Failure – Ductile vs. brittle component design.

UNIT II DESIGN OF SHAFTS 9

Analysis and Design of shafts for different applications – integrated design of shaft, bearing and casing – Design for rigidity

UNIT III DESIGN OF GEARS AND GEAR BOXES 9

Principles of gear tooth action – Gear correction – Gear tooth failure modes – Stresses and loads – Component design of spur, helical, bevel and worm gears – Design for sub assembly – Integrated design of speed reducers and multi-speed gear boxes – application of software packages.

UNIT IV BRAKES & CLUTCHES 9

Dynamics and thermal aspects of brakes and clutches – Integrated design of brakes and clutches for machine tools, automobiles and mechanical handling equipments.

UNIT V INTEGRATED DESIGN 9

Integrated Design of systems consisting of shaft, bearings, springs, motor, gears, belt, rope, chain, pulleys, Cam & Follower, flywheel etc. Example - Design of Elevators, Escalators, Gear Box, Valve gear Mechanisms, Machine Tools

TOTAL HOURS:45 PERIODS

(Use of Approved Data Book Is Permitted)

COURSE OUTCOMES

The student will have an ability to

CO1: Design components based on process and function tolerances.
CO2: Design shafts for different applications.
CO3: Design different types of gears and gear boxes.
CO4: Solve the problems in brakes and clutches.
CO5: Understand the basics procedure of design of machine in engineering field.

TEXT BOOKS

1. Norton L. R., “Machine Design – An Integrated Approach”, Pearson Education, 2005.
2. Shigley, J.E., “Mechanical Engineering Design”, McGraw Hill, 1986.

REFERENCE BOOKS

1. Prasad. L. V., "Machine Design", Tata McGraw Hill, New Delhi, 1992.
2. Maitra G.M., "Hand Book of Gear Design", Tata McGraw Hill, 1985.
3. Alexandrov, M., "Materials Handling Equipments", MIR Publishers, 1981.
4. Newcomb, T.P. and Spur, R.T., "Automobile Brakes and Braking Systems", Chapman and Hall, 2nd Edition, 1975.
5. Boltzharol, A., "Materials Handling Handbook", The Ronald Press Company, 1958.

APPROVED DATA BOOKS

1. P.S.G. Tech., "Design Data Book", Kalaikathir Achchagam, Coimbatore, 2003.
2. Lingaiah. K. and Narayana Iyengar, "Machine Design Data Hand Book", Vol. 1 & 2, Suma Publishers, Bangalore, 1983.

Course Outcome		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
Co1	Design components based on process and function tolerances.	1	2	2	1	1					1			2		1
Co2	Design shafts for different applications.	1	2	2	1	1					1			1		1
Co3	Design different types of gears and gear boxes.	1	1	2	1	1					1			2		1
Co4	Solve the problems in brakes and clutches.	1	3	1	1	1					1			2		1
Co5	Understand the basics procedure of design of machine in engineering field.	1	1		1	1	1	1				1	1	1	1	

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218EDT04 **MECHANISMS DESIGN AND SIMULATION** **L T P C**
3 1 0 4

COURSE OBJECTIVES:

- To learn the basic concepts of mechanism and analysis of kinematic structures.
- To learn the analytical methods for velocity and acceleration analysis of mechanism.
- To learn the various path curvature theory.
- To understand the synthesis of four bar mechanism.
- To learn the concept of coupler curve for cam mechanism.

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 bar and six bar linkages. Analytical methods for velocity and acceleration Analysis– four bar linkage jerk analysis. Plane complex mechanisms-auxiliary point method. Spatial RSSR mechanism-Denavit-Hartenberg Parameters – Forward and inverse kinematics of robot manipulators.

UNIT III PATH CURVATURE THEORY, 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-cuspcrunode 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 COUPLER CURVE BASED MECHANISMS & CAM 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 HOURS:60 PERIODS

COURSE OUTCOMES

The students will be able to

CO1: Use the concept of analysis for different kinematic mechanism.
CO2: Use the position analysis method to determine the velocity and acceleration.
CO3: Formulate the coupler curve for straight line and six bar mechanism.
CO4: Perform the dimensional synthesis of four bar mechanism.
CO5: Synthesis the coupler curve for cam mechanism.

TEXT BOOKS

1. Robert L.Norton., "Design of Machinery",Tata McGraw Hill, 2005.
2. Sandor G.N., and Erdman A.G., "Advanced Mechanism Design Analysis and Synthesis", Prentice Hall, 1984.

REFERENCE BOOKS

1. Uicker, J.J., Pennock, G. R. and Shigley, J.E., "Theory of Machines and Mechanisms", Oxford University Press, 2005.
2. Amitabha Ghosh and Asok Kumar Mallik, "Theory of Mechanism and Machines", EWLP, Delhi, 1999.
3. Kenneth J, Waldron, Gary L. Kinzel, "Kinematics, Dynamics and Design of Machinery", John Wiley-sons, 1999.
4. Ramamurti, V., "Mechanics of Machines", Narosa, 2005.

Course Outcome		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
Co1	Use the concept of analysis for different kinematic mechanism.	1	2	2										1		1
Co2	Use the position analysis method to determine the velocity and acceleration.	1	2	2										1		1
Co3	Formulate the coupler curve for straight line and six bar mechanism.	1	2	2	1									1		1
Co4	Perform the dimensional synthesis of four bar mechanism.	1	2	2	1									1		1
Co5	Synthesis the coupler curve for cam mechanism.	1	2	1	1						1			2		1

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218EDP07	CAE LABORATORY – II	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES:

- To understand and practice the drawings of machine components and simple assemblies using modeling packages.
- To provide the fundamental concepts of the theory of the finite element method through software.
- 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.
- To understand the concepts of Structural and thermal stress analysis on components.
- 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 HOURS:45 PERIODS

COURSE OUTCOMES

The students will have ability to

CO1: Model and assemble the drawings of any mechanical products using modeling software.
CO2: Select the method, meshing, analysis and optimize the real time problems using finite element analysis software.
CO3: Evaluate and interpret FEA analysis results for design and evaluation purposes
CO4: Develop a basic understanding of the limitations of the FE method and understand the possible error sources in its use.
CO5: Use analysis software for the application and use of the FE method for heat transfer and structural problems.

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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.	1	1	2	1	2					1			2		2
Co2	Select the method, meshing, analysis and optimize the real time problems using finite element analysis software.	1	1	2	1	2					1			2		2
Co3	Evaluate and interpret FEA analysis results for design and evaluation purposes	1	1	2	1	2					1			2		2
Co4	Develop a basic understanding of the limitations of the FE method and understand the possible error sources in its use.	1	1		1								1	1		1
Co5	Use analysis software for the application and use of the FE method for heat transfer and structural problems.	1	1	2	1	1					1			1		1

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218EDE03 DESIGN FOR MANUFACTURE AND ASSEMBLY

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To aquire knowledge on process capability and tolerances, form design.
- To know about the factors influencing form design.
- To gain the knowledge on component design for machining consideration, casting consideration in component design and design for the environment.
- To gain the knowledge on group technology concepts.
- 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 HOURS:45 PERIODS

COURSE OUTCOMES

The students will be able to

CO1: Understand the complex interrelationships between design and manufacturing.

CO2: Explore and understand basic manufacturing processes and the design for manufacturing (DFM) implications of design choices for specific manufacturing processes.

CO3: Understand the role of components design with machining consideration.

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.

CO5: Know about the environmental issues with case study.

TEXT BOOKS

1. Peck, Harry, "Designing for Manufacture", Pitman Publications, 2010.
2. James Bralla, "Design for Manufacturability Handbook", Second Edition, McGraw-Hill, New York, 1999.

REFERENCE BOOKS

1. George E Dieter, "Engineering Design- Material and processing approach", McGraw Hill Intl., 2nd Edition, 2013.
2. Matousek, "Engineering Design- A Systematic Approach", Blackie & Son Ltd, London, 2013.
3. Kevien Otto and Kristin Wood, "Product Design", Pearson Publication, New Delhi, 2011.
4. Boothroyd, G, Heartz and Nike, "Product Design for Manufacture", Second Edition, Marcel Dekker Inc., London, 2010.

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.	2	1	2			1							2		1
Co2	Explore and understand basic manufacturing processes and the design for manufacturing (DFM) implications of design choices for specific manufacturing processes.	2		1	1									2		
Co3	Understand the role of components design with machining consideration.	1	1	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.	1		2			1							1		
Co5	Know about the environmental issues with case study.	1		1									1	1		

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218EDE04 **ENGINEERING FRACTURE MECHANICS** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To understand the basic concepts of solid mechanics.
- To get knowledge on stationary crack, crack growth and fatigue crack growth.
- To analyze dynamic energy balance.
- To understand the concepts of fatigue crack growth curve.
- To analyze crack Growth for cyclic loading and crack initiation under large scale.

PREREQUISITE: Knowledge of Engineering Materials and Metallurgy is required.

UNIT I ELEMENTS OF SOLID MECHANICS 9

The geometry of stress and strain, elastic deformation, plastic and elasto-plastic deformation - Limit analysis.

UNIT II STATIONARY CRACK UNDER STATIC LOADING 9

Two dimensional elastic fields - Analytical solutions yielding near a crack front - Irwin's approximation - Plastic zone size - Dugdale model - J integral and its relation to crack opening displacement.

UNIT III ENERGY BALANCE AND CRACK GROWTH 9

Griffith analysis - Linear Fracture Mechanics-Crack opening displacement - Dynamic energy balance – R Curves - Crack arrest.

UNIT IV FATIGUE CRACK GROWTH CURVE 9

Empirical relation describing crack growth by fatigue - Life calculations for a given load amplitude - Effects of changing the load spectrum - Effects of Environment.

UNIT V APPLICATION OF FRACTURE MECHANICS 9

Crack Initiation under large scale yielding – Thickness as a design parameter – Mixed mode fractures - Crack instability in thermal and residual stress fields - Numerical methods

TOTAL HOURS:45 PERIODS

COURSE OUTCOMES

The students will be able to

CO1: Calculate the stress-strain and load-displacement fields around a crack tip.
CO2: It helps the engineers to get familiarized with the design of components that contain crack under static load condition.
CO3: It helps the engineers to get familiarized with the design of components that contain crack and its growth under fatigue load condition.
CO4: Design materials and structures using fracture mechanics approaches.
CO5: Know different application of fracture mechanics.

TEXT BOOKS

1. David Broek, "Elementary Engineering Fracture Mechanics ", 4th Edition, Kluwer Academic Publishers, 2005.
2. George E.Dieter,"Mechanical Metallurgy", 3rd Edition, Tata McGraw Hill, 1986.
3. Preshant Kumar, "Elements of Fracture Mechanics", Tata McGraw Hill, 2009.

REFERENCE BOOKS

1. Anderson T L, “Fracture Mechanics: Fundamentals and Applications”, CRC Press, 4th Edition, 2017.
2. Janssen M, Zuidema J, Wanhill R J H, “Fracture Mechanics”, VSSD, 2nd Edition, 2006.
3. Sanfard R J, “Principles of Fracture Mechanics”, Pearson Education Inc., Upper Saddle River, 2003.
4. Kare Hellan, "Introduction of Fracture Mechanics", McGraw-Hill Book Company, 2000.

Course Outcome		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
Co1	Calculate the stress-strain and load-displacement fields around a crack tip.		2		1								1	1		1
Co2	It helps the engineers to get familiarized with the design of components that contain crack under static load condition.	2	1	2	1								1	2		2
Co3	It helps the engineers to get familiarized with the design of components that contain crack and its growth under fatigue load condition.	1	2		1	1					1			2		
Co4	Design materials and structures using fracture mechanics approaches.	1	1		1	2					1			1		2
Co5	Know different application of fracture mechanics.	1	2	1		1								1		1

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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.

TOTAL : 45 Hours

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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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315EDE08	INDUSTRIAL ROBOTICS & EXPERTS SYSTEM	L	T	P	C
		3	0	0	3

OBJECTIVES:

1. To understand the importance of robots in modern industries and lifestyle.
2. To analyze various robot kinematics, motion and control.
3. To designing of various robot components, robot shell and robot programming.
4. To understand the concept of robot work cell design and robot cycle time analysis.
5. To understand robot programming and artificial intelligence.

UNIT I INTRODUCTION AND ROBOT KINEMATICS **9**

Definition need and scope of Industrial robots, Robot anatomy, Work volume, Precision movement, Classifications of Robots, Robot Kinematics, Direct and inverse kinematics, Robot trajectories, Control of robot manipulators, Robot dynamics, Methods for orientation and location of objects.

UNIT II ROBOT DRIVES AND CONTROL **9**

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

UNIT III ROBOT SENSORS **9**

Transducers and Sensors, Sensors in Robot, Tactile sensor, Proximity and range sensors, Sensing joint forces, Robotic vision system, Image Gribbing, Image processing and analysis, Image segmentation, Pattern recognition, Training of vision system.

UNIT IV ROBOT CELL DESIGN AND APPLICATION **9**

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

UNIT V Robot programming, artificial intelligence and expert systems **9**

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

TOTAL : 45 Hours

COURSE OUTCOMES:

The students will be able to

- Analysis the robotic kinematics
- Acquire the knowledge of robot sensors and vision system.
- Acquire the knowledge of robot cell design.
- Apply artificial intelligence and expect systems in robotics
- Design robotics and write program for controlling the robotics

TEXT BOOKS:

1. Yoram Koren," Robotics for Engineers' Mc Graw-Hill, 1987 (Digitized 2007).
2. John J Craig, “Introduction to Robotics – Mechanics and Control”, Pearson, 3rd Edition, 2012.

REFERENCE BOOKS:

1. Kozyrey, Yu. "Industrial Robots", MIR Publishers Moscow, third edition, 2008.
2. Deb, S.R." Robotics Technology and Flexible Automation", Tata Mc Graw-Hill, 2001.
3. Mikell, P. Groover, Mitchell Weis, Roger, N. Nagel, Nicholas G. Odrey," Industrial Robotics Technology, Programming and Applications", Mc Graw-Hill, Int. 2000.
4. Timothy Jordanides et al, "Expert Systems and Robotics ", Springer -Verlag, New York, May 1991.

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Course Outcome		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
Co1	Analysis the robotic kinematics	3	2	2	-	-	-	1	-	-	-	-	-	3	-	2
Co2	Acquire the knowledge of robot sensors and vision system.	3	3	1	-	-	-	-	-	-	1	-	-	2	-	2
Co3	Acquire the knowledge of robot cell design.	3	3	1	1	-	-	-	-	-	-	1	-	1	-	2
Co4	Apply artificial intelligence and expect systems in robotics	3	2	2	1	-	-	-	-	-	-	2	-	2	-	2
Co5	Design robotics and write program for controlling the robotics	2	2	-	1	-	-	-	-	-	-	-	-	2	-	2

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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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