ANNA UNIVERSITY, CHENNAI

UNIVERSITY DEPARTMENTS

CHOICE BASED CREDIT SYSTEM

REGULATIONS – 2023

M.E. ENGINEERING DESIGN

(FULL – TIME MODE)

VISION OF THE DEPARTMENT

Department of Mechanical Engineering strives to be recognized globally for excelling in Engineering education and research leading to innovative, entrepreneurial and competent Graduates in Mechanical Engineering and allied disciplines.

MISSION OF THE DEPARTMENT

Department of Mechanical Engineering shall contribute to the educational, economic and social development by:

- Providing world class education by fostering effective teaching learning process that is supported through pioneering and cutting-edge research to make impactful contribution to the society.
- Attracting highly motivated students with enthusiasm, aptitude, and interest in the field of Mechanical and allied Engineering disciplines.
- Expanding the frontiers of Engineering and science in technological innovation while ensuring academic excellence and scholarly learning in a collegial environment.
- Excelling in industrial consultancy and research leading to innovative technology development and transfer.
- Serving the society with innovative and entrepreneurially competent graduates for the national and international community towards achieving the sustainable development goals.

PROGRAM EDUCATIONAL OBJECTIVES (PEOS)

The following are the Program Educational Objectives of Engineering Design:

- **PEO 1**: To develop an aptitude to use engineering principles to conceptualize, create, model, test and evaluate designs within the context of local and global needs.
- **PEO 2**: To become effective and excellent collaborators and innovators, participating in efforts to address and provide solutions to social and technical challenges.
- **PEO 3**: To develop innovative technologies and find solutions to contemporary issues in Engineering Design using fundamental principles in combination with modern engineering tools and methods.
- **PEO 4**: To pursue advanced education, research and development and other creative/innovative efforts in their professional career.

PROGRAM OUTCOMES (POS)

The following are the Program Outcomes of Engineering Design:

- **PO 1**: An ability to independently carry out research/investigation and development work to solve practical problems.
- **PO 2**: An ability to write and present a substantial technical report/document.
- **PO 3**: An ability to demonstrate a degree of mastery in Engineering Design. The mastery should be at a level higher than the requirements in the appropriate bachelor programme.
- **PO 4**: Provide optimized solutions during product design using advanced Computer Aided
Engineering tools and mathematical models.

- **PO 5:** Identify the societal needs and industrial problems in different domains of research including inter-disciplinary fields and provide innovative solutions using design paradigms.
- **PO 6:** Become a successful professional with acquired creative design skills and knowledge through which impetus would be provided to develop solutions that would lead to next generation technologies.

Mapping of PEO with PO & PSO:

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## EMPLOYABILITY ENHANCEMENT COURSES (EEC)

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OBJECTIVES:
- To impart knowledge in understanding the advantages of various solution procedures of solving the system of linear and nonlinear equations.
- To give a clear picture about the solution methods for solving the BVPs and the system of IVPs.
- To acquire knowledge in solving time dependent one and two dimensional parabolic PDEs by using various methodologies.
- To strengthen the knowledge of finite difference methods for solving elliptic equations.
- To get exposed to the ideas of solving PDEs by finite element method.

UNIT I  ALGEBRAIC EQUATIONS  12

UNIT II  ORDINARY DIFFERENTIAL EQUATIONS  12
Runge Kutta Methods for system of IVPs, numerical stability, Adams-Bashforth multistep method, solution of stiff ODEs, shooting method, BVP: Finite difference method, collocation method, orthogonal collocation method, Galerkin finite element method.

UNIT III  FINITE DIFFERENCE METHOD FOR TIME DEPENDENT PARTIAL
DIFFERENTIAL EQUATION  12

UNIT IV  FINITE DIFFERENCE METHODS FOR ELLIPTIC EQUATIONS  12
Laplace and Poisson’s equations in a rectangular region: Five point finite difference schemes, Leibmann’s iterative methods, Dirichlet and Neumann conditions – Laplace equation in polar coordinates: finite difference schemes – approximation of derivatives near a curved boundary while using a square mesh.

UNIT V  FINITE ELEMENT METHOD  12

TOTAL: 60 PERIODS

OUTCOMES:
At the end of the course, students will be able to
CO1 Get familiarized with the methods which are required for solving system of linear, nonlinear equations and eigenvalue problems.
CO2 Solve the BVPs and the system of IVPs by appropriate methods discussed.
CO3 Solve time dependent parabolic PDEs by using various methodologies up to dimension two.
CO4 Solve elliptic equations by finite difference methods.
CO5 Use the ideas of solving PDEs by finite element method.

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ED3101 ADVANCED MECHANICS OF DEFORMABLE BODIES

COURSE OBJECTIVES:
The main learning objective of this course is to prepare the students for acquiring the knowledge on the mechanics of materials under various loading conditions.

UNIT I Elasticity

UNIT II SHEAR CENTRE AND UNSYMMETRICAL BENDING
Location of shear centre for various thin sections - shear flows. Stresses and Deflections in beams subjected to unsymmetrical loading-kern of a section

UNIT III STRESSES IN FLAT PLATES AND CURVED MEMBERS
Circumference and radial stresses – deflections - curved beam with restrained ends - closed ring subjected to concentrated load and uniform load - chain links and crane hooks. Solution of rectangular plates – pure bending of plates – deflection – uniformly distributed load – various end conditions

UNIT IV TORSION OF NON-CIRCULAR SECTIONS
General Torsional equation - Torsion of rectangular cross section - St.Venants theory - elastic membrane analogy - Prandtl's stress function - torsional stress in hollow thin walled tubes and multi-walled sections

UNIT V STRESSES IN ROTATING MEMBERS AND CONTACT STRESSES
Radial and tangential stresses in solid disc and ring of uniform thickness and varying thickness allowable speeds. Methods of computing contact stress-deflection of bodies in point and line contact applications

COURSE OUTCOMES: Upon completion of this course, the students will be able to:

CO1 apply the concepts of theory of elasticity in three-dimensional stress system.
CO2 determine the shear centre of various cross-sections and deflections in beams subjected to unsymmetrical bending.
CO3 evaluate the stresses in flat plates and curved members
CO4 calculate torsional stress of non-circular sections.
CO5 determine the stresses in rotating members, contact stresses in point and line contact applications.

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ED3151 DESIGN WITH ADVANCED MATERIALS

COURSE OBJECTIVES:
The main learning objective of this course is to prepare the students for acquiring the knowledge on the mechanical behaviour of both metallic and non-metallic materials under different loading and temperature conditions.

UNIT I BASIC CONCEPTS OF MATERIAL BEHAVIOR 9
Engineering Design process and the role of materials; materials classification and their properties, Strengthening mechanisms-grain size reduction, solid solution strengthening, strain hardening, grain boundary strengthening, precipitation, particle, fibre and dispersion strengthening, Effect of temperature, strain and strain rate on plastic behavior – Super plasticity – Failure of metals.

UNIT II BEHAVIOUR UNDER CYCLIC LOADS AND DESIGN APPROACHES 9

UNIT III SELECTION OF MATERIALS 9
Selection of materials based on function, Objective, Constraints, free variables and service requirements – Relationship between materials selection and processing – Case studies in advanced materials selection with relevance to aero, auto, marine, machinery and nuclear applications.

UNIT IV MODERN METALLIC MATERIALS 9

UNIT V NON METALLIC MATERIALS 9

TOTAL: 45 PERIODS

COURSE OUTCOMES: Upon completion of this course, the students will be able to:

CO1 Analyze the different strengthening and failure mechanism of the metals
CO2 Apply the effects of metallurgical parameters in the materials design
CO3 Analyze the relationship between the selection of materials and processing
CO4 Develop the novel material through understanding the properties of the existing metallic materials
CO5 Analyze the different materials used in the engineering applications

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COURSE OBJECTIVES:
The main learning objective of this course is to prepare the students for acquiring the knowledge on various mechanisms and its design and simulation.

UNIT I INTRODUCTION

UNIT II KINEMATIC ANALYSIS

UNIT III PATH CURVATURE THEORY, COUPLER CURVE
Fixed and moving centrodes, inflection points and inflection circle. Euler Savary equation, graphical constructions – cubic of stationary curvature. Four bar coupler curve-cusp -cunode - coupler driven six-bar mechanisms-straight line mechanisms.

UNIT IV SYNTHESIS OF FOUR BAR MECHANISMS
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 AND CAM MECHANISMS

COURSE OUTCOMES: Upon completion of this course, the students will be able to:
CO1 Apply concepts of gross motion capability and develop multi loop kinematic chains and equivalent mechanisms
CO2 Determine velocity and acceleration of complex mechanisms
CO3 Evaluate inflection points and draw the inflection circle
CO4 Synthesize planar mechanisms
CO5 Design of six bar coupler driven mechanisms and cam mechanisms

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COURSE OBJECTIVES:
To understand and apply the principles and concepts in Integrated Product Design and Development.

UNIT I   **INTRODUCTION TO PRODUCT DEVELOPMENT**  9

UNIT II   **PRODUCT PLANNING, CUSTOMER NEEDS IDENTIFICATION AND PRODUCT SPECIFICATION**  9

UNIT III   **PRODUCT CONCEPT GENERATION, SELECTION AND TESTING**  9
Activity of Concept Generation – Concept Selection – Concept Screening – Concept Scoring – Caveats – Concept Testing.

UNIT IV   **PRODUCT ARCHITECTURE, INDUSTRIAL DESIGN, DESIGN FOR MANUFACTURING**  9

UNIT V   **PROTOTYPING, PRODUCT DEVELOPMENT ECONOMICS AND MANAGEMENT**  9

TOTAL: 45 PERIODS

COURSE OUTCOMES: Upon completion of this course, the students will be able to:

**CO1** Apply the principles of concept development process and opportunity identification process.

**CO2** Apply the principle of product planning; customer needs analysis and set product specifications for new product design and development.

**CO3** Generate, select, screen, test concepts for new product design and development.

**CO4** Apply the principles of product architecture, industrial design and design for manufacturing in new product development.

**CO5** Apply the principles of prototyping techniques. Apply the concepts of economics principles; project management practices in accelerating the new product development activity.

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OBJECTIVES:
To impart knowledge on
- Formulation of research problems, design of experiment, collection of data, interpretation and presentation of result
- Intellectual property rights, patenting and licensing

UNIT I  RESEARCH PROBLEM FORMULATION  9
Objectives of research, types of research, research process, approaches to research; conducting literature review- information sources, information retrieval, tools for identifying literature, Indexing and abstracting services, Citation indexes, summarizing the review, critical review, identifying research gap, conceptualizing and hypothesizing the research gap

UNIT II  RESEARCH DESIGN AND DATA COLLECTION  9
Statistical design of experiments- types and principles; data types & classification; data collection - methods and tools

UNIT III  DATA ANALYSIS, INTERPRETATION AND REPORTING  9
Sampling, sampling error, measures of central tendency and variation.; test of hypothesis- concepts; data presentation- types of tables and illustrations; guidelines for writing the abstract, introduction, methodology, results and discussion, conclusion sections of a manuscript; guidelines for writing thesis, research proposal; References – Styles and methods, Citation and listing system of documents; plagiarism, ethical considerations in research

UNIT IV  INTELLECTUAL PROPERTY RIGHTS  9
Concept of IPR, types of IPR – Patent, Designs, Trademarks and Trade secrets, Geographical indications, Copy rights, applicability of these IPR; IPR & biodiversity; IPR development process, role of WIPO and WTO in IPR establishments, common rules of IPR practices, types and features of IPR agreement, functions of UNESCO in IPR maintenance.

UNIT V  PATENTS  9
Patents – objectives and benefits of patent, concept, features of patent, inventive steps, specifications, types of patent application; patenting process - patent filling, examination of patent, grant of patent, revocation; equitable assignments; Licenses, licensing of patents; patent agents, registration of patent agents.

TOTAL: 45 PERIODS

COURSE OUTCOMES
Upon completion of the course, the student can
CO1: Describe different types of research; identify, review and define the research problem
CO2: Select suitable design of experiment s; describe types of data and the tools for collection of data
CO3: Explain the process of data analysis; interpret and present the result in suitable form
CO4: Explain about Intellectual property rights, types and procedures
CO5: Execute patent filing and licensing

REFERENCES:
2. Soumitro Banerjee, “Research methodology for natural sciences”, IISc Press, Kolkata, 2022,
COURSE OBJECTIVES:
The main learning objective of this course is to prepare the students to generate the geometric model using commercial CAD tools.

List of Experiments
- CAD Introduction.
- Sketcher
- Solid modeling – Extrude, Revolve, Sweep, etc. and Variational sweep, Loft, etc.
- Surface modeling – Extrude, Sweep, Trim etc. and Mesh of curves, Free form etc.
- Feature manipulation – Copy, Edit, Pattern, Suppress, History operations etc.
- Assembly-Constraints, Exploded Views, Interference check, Mass and CG.
- Drafting-Layouts, Standard & Sectional Views, Detailing & Plotting

TOTAL: 60 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:

CO1 Utilize CAD software to create Geometric Constructions and apply principles of technical drawings to create different 3D models

CO2 construct solid models, assemblies, and detail drawings using a feature-based parametric design CAD program, while capturing design intent in the models

CO3 solve design problems in parts and assemblies at the intermediate level.

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COURSE OBJECTIVES:
The main learning objective of this course is to prepare the students for understanding the forces and torques that come into action in various kinds of mechanical systems.

List of Experiments:
1. Free fall of rigid body
2. Projectile motion
3. Simulation of simple Pendulum
4. Simulation of Compound Pendulum
5. Kinematic Analysis four bar and slider crack mechanism and its inversions
6. Dynamic Analysis four bar and slider crack mechanism and its inversions
7. Design of cam Profile for various follower output motion
8. Kinematic & Dynamic Analysis of Gear Tracks
9. Vibration Analysis SDOF and MDOF
10. Project on virtual product design using Commercial Software Package

TOTAL: 60 PERIODS

COURSE OUTCOMES: Upon completion of this course, the students will be able to:

CO1 Model different systems and import them into the multi body dynamic software
CO2 Conduct multi body dynamic tests and obtain required dynamic properties by
CO3 Use the above data in additional stress analysis software

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COURSE OBJECTIVES:
To develop a thorough understanding of the basic principles of the finite element analysis techniques with an ability to effectively use the tools of the analysis for solving practical problems arising in engineering design.

UNIT I    FINITE ELEMENT ANALYSIS OF ONE DIMENSIONAL PROBLEMS   9
Historical Background – Weighted Residual Methods - Basic Concept of FEM – Variational Formulation of B.V.P. – Ritz Method – Finite Element Modelling – Element Equations – Linear and Higher order Shape functions – Bar, Beam Elements –Applications to Heat Transfer problems

UNIT II    FINITE ELEMENT ANALYSIS OF TWO DIMENSIONAL PROBLEMS   9

UNIT III    ISO-PARAMETRIC FORMULATION   9

UNIT IV    EIGEN VALUE PROBLEMS   9
Dynamic Analysis – Equations of Motion – Consistent and lumped mass matrices – Free Vibration analysis – Natural frequencies of Longitudinal, Transverse and torsional vibration – Solution of Eigenvalue problems - Introduction to transient field problems.

UNIT V    NON-LINEAR ANALYSIS   9
Introduction to Non-linear problems - some solution techniques- computational procedure material non-linearity-Plasticity and viscoplasticity, stress stiffening, contact interfaces- problems of gaps and contact - geometric non-linearity - modeling considerations - Free and Mapped meshing -Mesh quality- Error estimate.

TOTAL:45 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
CO1 Develop mathematical models for one dimensional problems and their numerical solutions.
CO2 Determine field variables for two dimensional scalar and vector variable problems.
CO3 Apply Isoparametric transformation and numerical integration for evaluation of element matrices.
CO4 Apply various solution techniques to solve Eigen value problems.
CO5 Formulate solution techniques to solve non-linear problems.

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COURSE OBJECTIVES:
The main learning objective of this course is to prepare the students to acquire knowledge on Vibration, and its control strategies for practical applications.

UNIT I  FUNDAMENTALS OF VIBRATION

UNIT II  TWO-DEGREE FREEDOM SYSTEM

UNIT III  MULTI-DEGREE FREEDOM SYSTEM AND CONTINUOUS SYSTEM

UNIT IV  VIBRATION AND NOISE CONTROL

UNIT V  EXPERIMENTAL METHODS IN VIBRATION ANALYSIS

Laboratory Experiments
List of Experiments:
1. Verification of law of springs in an undamped spring-mass system arranged in series, parallel and series-parallel fashions
2. Determination of stiffness and natural frequency of undamped spring-mass systems arranged in series, parallel and series-parallel fashions
3. Determination of natural frequency a single rotor shaft system
4. Determination of critical speed of shaft
5. Dynamic balancing of a rotor
6. Determination of natural frequency, damping coefficient and mode shapes of specimens supported at its ends
7. Forced vibration of a component vibrated through sine and random profiles – Determination of natural frequency and durability

COURSE OUTCOMES: Upon completion of this course, the students will be able to:
CO1 Apply the basic concepts of vibration in damped and undamped systems and the concepts of dynamic balancing technique to balance various components
CO2 Determine the natural frequencies and mode shapes of the two-degree freedom systems.
CO3 Calculate the natural frequencies and mode shapes of the multi-degree freedom and continuous systems
CO4 Control the vibration and noise levels in a body
CO5 Measure and analyze the vibration levels in a body

TOTAL 60 PERIODS
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COURSE OBJECTIVES:
The main learning objective of this course is to prepare the students to acquire knowledge on mechanics of cracked components of different modes by which these components fail under static and fatigue load conditions.

UNIT I  ELEMENTS OF SOLID MECHANICS

UNIT II  STRESS AND DISPLACEMENT AROUND THE CRACK TIP FOR DIFFERENT MODES OF FRACTURE

UNIT III  STATIONARY CRACK UNDER STATIC LOADING

UNIT IV  FATIGUE FAILURE AND ENVIRONMENTAL-ASSISTED FRACTURE

UNIT V  APPLICATIONS OF FRACTURE MECHANICS
J-integral, Mixed-mode fracture, Crack arrest methodologies – Case studies: Analysis on failed components and design for the extension of its life.

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:

1. CO1 Formulate the governing equations for elastic problems.
2. CO2 Evaluate the stresses/displacements around the crack tip for different modes of fracture.
3. CO3 Estimate the $K_{1c}$/SIF/critical flaws/failure stresses for different crack geometries.
4. CO4 Assess the life of the cracked components under different types of repeated/variable fatigue loads and for designing for its life extension.
5. CO5 Analyze the failed engineering components under different modes of fracture.

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COURSE OBJECTIVES:
The main learning objective of this course is to prepare the students for effectively using analysis tools for solving practical problems.

List of Experiments:
1. Force and Stress analysis using link elements in Trusses.
2. Stress and deflection analysis in beams with different support conditions.
5. Thermal stress and heat transfer analysis of plates.
7. Vibration analysis of spring-mass systems.
8. Modal analysis of Beams.
9. Harmonic, transient and spectrum analysis of simple systems.
10. Analysis of machine elements under dynamic loads
11. Analysis of non-linear systems

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
CO1 Solve the engineering problems numerically with Computer Aided Finite Element Analysis packages
CO2 Create Finite Element Model to accurately simulate the physical behaviour.
CO3 Demonstrate problem-solving skills by Result and Post-Processing the solution

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TOTAL: 60 PERIODS
ED3311 Technical Seminar

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COURSE OBJECTIVES:
The main learning objective of this course is to prepare the students for acquiring skills of oral presentation in seminars and conferences and technical writing abilities for journal publications.

The students will work for two hours per week guided by a group of staff members. They will be asked to talk on any topic of their choice related to Engineering design topics and to engage in dialogue with the audience. A brief copy of their talk also should be submitted. Similarly, the students will have to present a seminar of not less than fifteen minutes and not more than thirty minutes on the technical topic. They will also answer the queries on the topic. The students as audience also should interact. Evaluation will be based on the technical presentation and the report and also on the interaction during the seminar.

TOTAL: 30 PERIODS

COURSE OUTCOMES: Upon completion of this course, the students will be able to:

- **CO1** Comprehend concepts and methods for inductive and deductive reasoning of technical contents.
- **CO2** Develop report writing skills.
- **CO3** Develop oral presentation skills.

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ED3312 PROJECT WORK – I

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COURSE OBJECTIVES:
The main learning objective of this course is to prepare the students for identifying a specific problem for the current need of the society and or industry, through detailed review of relevant literature, developing an efficient methodology to solve the identified specific problem.

Each PG student shall work individually on a selected specific topic in the area of Product Design & Development which shall be approved by the Head of the Division under the supervision of a Faculty Member (Guide / Supervisor) who is familiar in the selected specific topic. The selected specific topic maybe theoretical and or experimental and or simulation and or case study. The students’ Project Work – I shall be evaluated through Internal Examination and End Semester Examination.

The Internal Examination must be conducted periodically (Zeroth, First, Second and Third) through Project Work Review Presentation Meetings followed by questions from the panel of Review Committee Members comprising of two expert faculty members and a project coordinator.

At the end of the semester, a detailed report on the work done by the PG student must be submitted with the approval from the Guide/Supervisor and the Review Committee Members. The Project Work – I Report must contain the Introduction with clear definition along with detailed review of relevant literature on the selected specific problem; an efficient methodology to solve the selected specific problem along with necessary hypothesis and or experimental setup and or simulation and or case study for carrying out the research project work along with preliminary results; discussions, relevant conclusions and future direction along with specified references.

The End Semester Examination must be conducted through Project Work Presentation followed by questions from the panel of Examiners comprising an External Examiner and Project Coordinator as Internal Examiner.

TOTAL: 180 PERIODS
COURSE OUTCOMES: Upon completion of this course, the students will be able to:

CO1 Demonstrate a sound technical knowledge in their selected project topic.
CO2 Select and identify the problem statement along with scope and boundary; assimilate detailed review of relevant literature; formulate an efficient methodology to solve the selected specific problem.
CO3 Propose engineering design solutions to complex problems using a systematic approach.

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ED3411 PROJECT WORK – II

COURSE OBJECTIVES:
The main learning objective of this course is to prepare the students for solving the specific problem for the current need of the society and or industry, through the formulated efficient methodology, and to develop necessary skills to critically analyse and discuss in detail regarding the project results and making relevant conclusions.

The student may continue to work on the Project Work – I’s selected topic as per the formulated efficient methodology under the same Faculty Member (Guide/Supervisor). The students’ Project Work – II shall be evaluated through Internal Examination and End Semester Examination.

The Internal Examination must be conducted periodically (First, Second and Third) through Project Work Review Presentation Meetings followed by questions from the panel of Review Committee Members comprising of two expert faculty members and a project coordinator.

At the end of the semester, a detailed report on the work done by the PG student must be submitted with the approval from the Guide/Supervisor and the Review Committee Members. The Thesis (Project Work – II Report) must contain the Introduction with clear definition along with detailed review of relevant literature on the selected specific problem; an efficient methodology to solve the selected specific problem along with necessary theoretical hypothesis and or experimentation and or simulation and or case study for carrying out the research project work along with complete results with critical analysis and detail discussions, followed by relevant conclusions, along with specified references.

The End Semester Examination must be conducted through Project Work Presentation followed by questions from the panel of Examiners comprising an External Examiner and Project Coordinator as Internal Examiner.

TOTAL: 360 PERIODS

COURSE OUTCOMES: Upon completion of this course, the students will be able to:

CO1 Demonstrate a sound technical knowledge of their selected project topic.
CO2 Propose product design & development solutions to complex problems using a systematic approach.
CO3 Demonstrate the knowledge, skills and attitudes of a professional engineer to take up any challenging practical problem in the field of engineering design and find optimum solutions to it.

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COURSE OBJECTIVES:
The main learning objective of this course is to prepare the students for understanding the design for sustainable behaviour and design practices.

UNIT I  INTRODUCTION  9

UNIT II   DESIGN FOR SUSTAINABLE BEHAVIOUR  9

UNIT III  DESIGN FOR ENVIRONMENT  9

UNIT IV  PRODUCT SERVICE DESIGN FOR SUSTAINABILITY  9
Design of individual products to integrated set of products and services – Categories – Need to implement – Design practice – PSS design for sustainability examples – Methods and tools – Benefits and limitations – Future research direction – Case studies.

UNIT V  SYSTEMIC DESIGN AND FUTURE OF DESIGN FOR SUSTAINABILITY  9

TOTAL:  45 PERIODS

COURSE OUTCOMES: Upon completion of this course, the students will be able to:
CO1   Address the need, challenges and impact the need for sustainable design
CO2   Understand the design for sustainable behaviour and design practices
CO3   Evaluate design considerations for environmental issues
CO4   Know the design categories in the product service design and future research directions
CO5   Understand the evolution of Design for sustainability and its framework

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COURSE OBJECTIVES:
The main learning objective of this course is to prepare the students for understanding the design for sustainable behaviour and design practices.

UNIT I  INTRODUCTION TO COMPOSITE MATERIALS  9

UNIT II  MANUFACTURING OF COMPOSITES  9
Manufacturing process of Epoxy resins and Fibers - Manufacturing of Polymer Matrix Composites (PMCs) - hand lay-up, spray technique, filament winding, Pultrusion, Resin Transfer Moulding (RTM), bag moulding, injection moulding, Sandwich Mould Composites (SMC) - Manufacturing of Metal Matrix Composites (MMCs) - Solid state, liquid state, vapour state processing, Manufacturing of Ceramic Matrix Composites (CMCs) – Hot pressing reaction bonding process - infiltration technique, direct oxidation - interfaces.

UNIT III  LAMINA CONSTITUTIVE EQUATIONS  9

UNIT IV  LAMINA STRENGTH ANALYSIS AND ANALYSIS OF LAMINATED FLAT PLATES  9

UNIT V  THERMO-STRUCTURAL ANALYSIS  9
Fabrication stresses/Residual stresses in FRP laminated composites- Co-efficient of Thermal Expansion (C.T.E.) - Modification of Hooke’s Law. Modification of Laminate Constitutive Equations. Orthotropic Lamina C.T.E’s -Stress and Moment Resultants due cooling of the laminates during fabrication-Calculations for thermo-mechanical stresses in FRP laminates - Thermally Quasi-Isotropic Laminates. Case studies: Implementation of CLT for evaluating residual stresses in the components made with different isotropic layers such as electronic packages etc.

TOTAL: 45 PERIODS

COURSE OUTCOMES: Upon completion of this course, the students will be able to:
CO1 calculate for mechanical strength of the composite material
CO2 fabricate the FRP and other composites by different manufacturing methods
CO3 analyze fiber reinforced Laminates for different combinations of plies with different orientations of the fiber
evaluate the stresses in the lamina of the laminate using different failure theories
analyze thermo-mechanical behaviour and evaluate residual stresses in different types of laminates using the Classical Laminate Theory

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COURSE OBJECTIVES:
The main learning objective of this course is to prepare the students for imparting knowledge on various concepts in engineering design and principles of implementing quality in a product or service.

UNIT I  DESIGN FUNDAMENTALS, METHODS AND MATERIAL SELECTION  9

UNIT II  DESIGN FOR QUALITY  9
Quality Function Deployment -House of Quality-Objectives and functions-Targets-Stakeholders- Measures and Matrices-Design of Experiments –design process-Identification of control factors, noise factors, and performance metrics - developing the experimental plan- experimental design – testing noise factors-Running the experiments –Conducting the analysis-Selecting and conforming factor-Set points-reflecting and repeating

UNIT III  FAILURE MODE EFFECTS ANALYSIS, DESIGN FOR SIX SIGMA AND DESIGN FOR SAFETY  9

UNIT IV  DESIGN OF EXPERIMENTS  9
Importance of Experiments, Experimental Strategies, Basic principles of Design, Terminology, ANOVA, Steps in Experimentation, Sample size, Single Factor experiments – Completely Randomized design, Randomized Block design, Statistical Analysis, Multifactor experiments - Two and three factor full Factorial experiments, 2K factorial Experiments, Confounding and Blocking designs, Fractional factorial design, Taguchi’s approach - Steps in experimentation, Design using Orthogonal Arrays, Data Analysis, Robust Design- Control and Noise factors, S/N ratios

UNIT V  STATISTICAL CONSIDERATION AND RELIABILITY  9
Frequency distributions and Histograms- Run charts –stem and leaf plots- Pareto diagrams- Cause and Effect diagrams-Box plots- Probability distribution-Statistical Process control–Scatter diagrams – Multivariable charts –Matrix plots and 3-D plots.-Reliability-Survival and Failure- Series and parallel systems-Mean time between failure-Weibull distribution

COURSE OUTCOMES: Upon completion of this course, the students will be able to:
CO1 apply fundamentals of design process and material selection for developing a quality product
CO2 apply the quality concepts to develop a robust product
CO3 perform Failure Mode Effect Analysis on a product and use six sigma principles to enhance its quality
CO4 apply different experimental design methods in product development
CO5 implement various statistical tools to improve its quality and reliability

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COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for knowing about different types of bearings available for machine design and their operating principles and acquiring research knowledge in the developing area of the rotor dynamics such as identification of rotor bearing system parameters and its use in futuristic model-based condition monitoring and fault diagnostic.

UNIT I  CLASSIFICATION AND SELECTION OF BEARINGS  
Selection criteria-Dry and Boundary Lubrication Bearings-Hydrodynamic and Hydrostatic bearings- Electro Magnetic bearings-Dry bearings-Rolling Element bearings- Bearings for Precision Applications-Foil Bearings-Special bearings- Selection of plain Bearing materials –Metallic and Non metallic bearings

UNIT II  SELECTION AND DESIGN OF ROLLING BEARINGS  
Design and performance analysis of Thrust and Journal bearings – Full, partial, fixed and pivoted journal bearings design procedure-Design and performance analysis of Rolling bearings- Contact Stresses and Centrifugal stresses-Elasto hydrodynamic lubrication- Fatigue life calculations- dynamics of hydro dynamic bearings -Squeeze film effects in journal bearings and thrust bearings -Rotating loads, alternating and impulse loads in journal bearings

UNIT III  TORSIONAL VIBRATION OF ROTATING MEMBERS AND THEIR INSTABILITY  
Flexural and torsional vibrations, critical speeds of shafts using Rayleigh’s method, matrix iteration methods, Prohal and Myklested method, equivalent discrete systems, geared and branched systems. - Instability of rotors mounted on fluid film bearings, rigid rotor instability, instability of a flexible rotor, instability threshold by transfer matrix methods, internal hysteresis of shafts, instability in torsional vibrations

UNIT IV  BALANCING OF ROTORS  
Balancing of rotors, Concepts and principles of Single-plane balancing, Two-plane balancing, balancing criteria for flexible rotors, bearing dynamic parameters estimation, measurement & digital processing techniques

UNIT V  CONDITIONING MONITORING  
Introduction to rotary machinery maintenance, fundamentals of data acquisition, principles of condition monitoring, transducers for condition monitoring, fault diagnosis in rotating machines, NDT methods in condition monitoring, wear and debris analysis, case studies in condition monitoring

TOTAL: 45 PERIODS

COURSE OUTCOMES: Upon completion of this course, the students will be able to:

CO1 acquisition of knowledge in the analysis of all types of bearings.
CO2 ability to make specifications of all types of bearings
CO3 ability to develop the vibration models of rotor bearing systems with changing complexities for real engineering systems.
CO4 ability to formulate the response due to unbalance and instability in practical rotor systems.
CO5 ability to identify rotor bearing system parameters and capability to carry out research in condition monitoring and fault identification in rotors

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OBJECTIVES:
- To gain knowledge on evolution of Solid Freeform Manufacturing (SFM) and the importance of DfAM in improving the quality.
- To acquaint with various SFM Technologies and hybrid processes, along with their material science and applications in different fields.

UNIT I  INTRODUCTION
Introduction to solid freeform manufacturing (SFM) - Need- SFM evolution, Distinction between SFM & CNC machining- Development of SFM systems — Hierarchical structure of SFM - SFM process chain — Classification. SFM Supply chain - Economics aspect: Strategic aspect- Operative aspect

UNIT II  DESIGN FOR ADDITIVE MANUFACTURING (DfAM)

UNIT III  VAT POLYMERIZATION, MATERIAL EXTRUSION & SHEET LAMINATION TECHNOLOGIES

UNIT IV  POWDER BED FUSION, BINDER JETTING, MATERIAL JETTING & DIRECT ENERGY DEPOSITION TECHNOLOGIES

UNIT V  MATERIALS AND APPLICATIONS OF SFM

TOTAL: 45 PERIODS
COURSE OUTCOMES:
At the end of the course, students will be able to
CO 1: Explore the importance in the evolution of SFM/AM, proliferation into the various fields and its effects on supply chain
CO 2: Recognize the importance of DfAM in improving the quality of fabricated parts and understand the guidelines of DfAM
CO 3: Acquire knowledge on principles and applications of vat polymerization, material extrusion and sheet lamination processes with case studies.
CO 4: Acquire knowledge on principles of powder bed fusion, jetting, direct energy deposition and hybrid processes
CO 5: Understand the properties and characteristics of materials used in SFM/AM and explore the applications in various fields.

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COURSE OBJECTIVES:
To understand and apply the principles and concepts in Product Life-Cycle Management for Product Design and Development.

UNIT I  INTRODUCTION TO PLM

UNIT II  PLM ENVIRONMENT: BUSINESS PROCESS

UNIT III  PLM ENVIRONMENT: PRODUCT DATA

UNIT IV  PLM ENVIRONMENT: INFORMATION SYSTEMS

UNIT V  PLM ENVIRONMENT: PROJECT MANAGEMENT

Laboratory Experiments
List of Experiments:
1. Getting Started with PLM software’s Engineering BOM
2. Working with CAD Parts
3. Creating and Attaching Specifications
4. Creating Engineering Bill of Materials
5. Releasing Parts Using the ECM Process
6. Use Matrix Query Language (MQL) to fetch the info from Database (DB) and test queries on PLM.

TOTAL: 60 PERIODS

COURSE OUTCOMES: Upon completion of this course, the students will be able to:
CO1  Apply the fundamental concepts and principles behind PLM in Product Design & Development.
CO2  Apply the business process concept of PLM in Product Design & Development.
CO3  Apply the product data concept of PLM in Product Design & Development.
CO4  Apply the information systems concept of PLM in Product Design & Development.
CO5  Apply the project management concept of PLM in Product Design & Development.

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COURSE OBJECTIVES:
The main learning objective of this course is to prepare the students for imparting knowledge on various categories of existing engineering problems and solutions to such problems through different optimization techniques and approaches.

UNIT I  UNCONSTRAINED OPTIMIZATION TECHNIQUES

UNIT II  CONSTRAINED OPTIMIZATION TECHNIQUES

UNIT III  ARTIFICIAL NEURAL NETWORKS AND SWARM INTELLIGENCE
Introduction – Activation functions, types of activation functions, neural network architectures, Single layer feed forward network, multilayer feed forward network, Neural network applications. Swarm intelligence- Various animal behaviors, Ant Colony optimization, Particle Swarm optimization.

UNIT IV  ADVANCED OPTIMIZATION TECHNIQUES
Multistage optimization – Dynamic programming; Stochastic programming; Multi objective optimization – Genetic algorithms and Simulated annealing technique.

UNIT V  STATIC AND DYNAMIC APPLICATIONS

TOTAL: 45 PERIODS

COURSE OUTCOMES: Upon completion of this course, the students will be able to:
CO1 Formulate unconstrained optimization techniques in engineering design application.
CO2 Formulate constrained optimization techniques for various application.
CO3 Implement neural network technique to real world design problems.
CO4 Apply genetic algorithms to combinatorial optimization problems.
CO5 Evaluate solutions by various optimization approaches for a design problem.

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ED3055 DESIGN OF HYDRAULIC AND PNEUMATIC SYSTEMS

COURSE OBJECTIVES:
The main learning objective of this course is to prepare the students for imparting knowledge on fluid power principles and inculcating the skills to design and develop hydraulic and Pneumatic circuits.

UNIT I FLUID POWER PRINCIPLES AND HYDRAULIC PUMPS

UNIT II HYDRAULIC ACTUATORS AND CONTROL COMPONENTS

UNIT III HYDRAULIC CIRCUITS AND SYSTEMS

UNIT IV PNEUMATIC AND ELECTRO PNEUMATIC SYSTEMS

UNIT V TROUBLE SHOOTING AND APPLICATIONS

TOTAL: 45 PERIODS

COURSE OUTCOMES: Upon completion of this course, the students will be able to:

CO1 Apply the principles of fluid power systems, and select relevant hydraulic pumps for the fluid power applications.

CO2 Select necessary control components and hydraulic actuators for the fluid power applications.

CO3 Design and develop hydraulic circuits and systems.

CO4 Design and develop pneumatic circuits and systems.

CO5 Solve problems and troubles in fluid power systems.
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ED3004  MECHANICAL MEASUREMENT AND ANALYSIS

COURSE OBJECTIVES:
The main learning objective of this course is to prepare the students for understanding the working principle of force/strain, vibration, acoustic, wind flow, structural health monitoring devices.

UNIT I  FORCES AND STRAIN MEASUREMENT

UNIT II  VIBRATION MEASUREMENTS

UNIT III  ACOUSTICS AND WIND FLOW MEASUREMENTS

UNIT IV  DISTRESS MEASUREMENTS

UNIT V  STRUCTURAL HEALTH MONITORING
Load testing on structures, buildings, bridges and towers – Rebound Hammer – acoustic emission – ultrasonic testing principles and application – Holography – use of laser for structural testing –Brittle coating - Wireless fatigue nodes – No Power and Low power devices

COURSE OUTCOMES: Upon completion of this course, the students will be able to:
CO1  measure physical quantities such as forces and strains.
CO2  apply different vibration measurements techniques.
CO3  measure physical quantities such as pressure and flow.
CO4  apply techniques involved in crack measurement.
CO5  select the appropriate non-destructive testing methods for various engineering applications

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COURSE OBJECTIVES:
The main learning objective of this course is to prepare the students for imparting knowledge on surface engineering and surface modification methods to solve the industrial problems.

UNIT I  FRICTION, WEAR AND LUBRICATION  9

UNIT II  CORROSION  9

UNIT III  SURFACE TREATMENTS  9

UNIT IV  ENGINEERING MATERIALS  9

UNIT V  SURFACE MEASURING INSTRUMENTS  9

TOTAL: 45 PERIODS

COURSE OUTCOMES: Upon completion of this course, the students will be able to:

CO1 Understand the basics of surface features, laws of friction, and different types of friction
CO2 Understand the types of corrosion and its preventive measures
CO3 Understand the types of surface properties and various surface modification techniques
CO4 Understand the different types of materials used in friction and wear applications
CO5 Develop knowledge of the need for surface-measuring instruments
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COURSE OBJECTIVES:
To impart knowledge on computer graphics which are used routinely in diverse areas as science, engineering, medicine, etc.

UNIT I INTRODUCTION TO COMPUTER GRAPHICS FUNDAMENTALS 9

UNIT II CURVES AND SURFACES MODELLING 9

UNIT III NURBS AND SOLID MODELING 9

UNIT IV VISIBLE SURFACE AND OBJECT RENDERING 9

UNIT V ASSEMBLY OF PARTS AND PRODUCT LIFE CYCLE 9

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:

CO1 Solve 2D and 3D transformations for the basic entities like line and circle.
CO2 Formulate the basic mathematics fundamental to CAD system.
CO3 Use the different geometric modeling techniques like feature-based modeling, surface modeling and solid modeling.
CO4 Create geometric models through animation and transform them into real world systems
CO5 Simulate assembly of parts using Computer-Aided Design software

TOTAL: 45 PERIODS
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COURSE OBJECTIVES:
The main learning objective of this course is to prepare the students for applying the principles of tire mechanics, steering, vertical, longitudinal and lateral dynamics in vehicle design.

UNIT I  TYRE MECHANICS
Tyre Classification, Tyre specification, Tyre forces and moments, Tyre structure, Rolling resistance and effect of various parameters on rolling resistance, Longitudinal forces, Lateral forces, Mechanism of force generation, Tractive and cornering property of tyre, Camber Thrust, Aligning Moment, Conicity and Plysteer, Performance of tyre on wet surface, Magic formulae tyre model, Tyre vibration.

UNIT II  STEERING DYNAMICS
Steering Linkages, Steering Geometry Error, Front Wheel Geometry, Steering system forces and moments, Steering system models, Effect of steering ratio, understeer and braking stability on steering system, Influence of front wheel drive, Four wheel steer, Steering of Vehicle with trailer.

UNIT III  VERTICAL DYNAMICS

UNIT IV  LONGITUDINAL DYNAMICS AND CONTROL

UNIT V  LATERAL DYNAMICS

TOTAL: 45 PERIODS

COURSE OUTCOMES: Upon completion of this course, the students will be able to:
CO1 Create a tire model based on required performance
CO2 Apply various vehicle performance and control methodologies to ensure stability and enhance ride properties
CO3 Formulate and develop mathematical model of a system
CO4 Predict vehicle performance, control methodologies to ensure stability and ride comfort.
CO5 Apply vertical, longitudinal and lateral dynamics vehicle design.
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COURSE OBJECTIVES:
The main learning objective of this course is to prepare the students for solving non-linear problems.

UNIT I  BENDING OF PLATES AND SHELLS  9
Review of Elasticity Equations – Bending of Plates and Shells – Finite Element Formulation of Plate and Shell Elements - Conforming and Non-Conforming Elements – C0 and C1 Continuity Elements – Degenerated shell elements - Application and Examples

UNIT II  NON-LINEAR PROBLEMS  9

UNIT III  DYNAMIC PROBLEM  9

UNIT IV  FLUID MECHANICS AND HEAT TRANSFER  9

UNIT V  ERROR ESTIMATES AND ADAPTIVE REFINEMENT  9
Error norms and Convergence rates – h-refinement with adaptivity – Adaptive refinement.

TOTAL: 45 PERIODS

COURSE OUTCOMES: Upon completion of this course, the students will be able to:

CO1  Apply concept of Finite Element Analysis to solve problems involving plate and shell elements.
CO2  Apply concept of Finite Element Analysis to solve problems involving geometric and material non linearity.
CO3  Formulate solution techniques to solve dynamic problems.
CO4  Apply concepts of Finite Element Analysis to solve fluid mechanics and heat transfer problems.
CO5  Investigate error norms, convergence rates and refinement.

REFERENCES:
COURSE OBJECTIVES:
The main learning objective of this course is to prepare the students for designing hybrid and electric vehicles.

UNIT I INTRODUCTION TO ELECTRIC VEHICLES

UNIT II ENERGY SOURCE
Introduction to engine power train - Battery basics- lead acid battery –lithium ion battery – alternative batteries – battery parameters- technical characteristics – battery power – Battery Thermal Management System - alternative energy sources: Fuel cells - Fuel Cell characteristics - Fuel cell types.

UNIT III SERIES HYBRID ELECTRIC DRIVE TRAIN DESIGN

UNIT IV PARALLEL HYBRID ELECTRIC DRIVE TRAIN DESIGN

UNIT V ELECTRIC VEHICLE DRIVE TRAIN

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:

CO1 Explain the working of hybrid vehicle and describe its main components and their function
CO2 Choose proper energy storage systems for vehicle applications
CO3 Design series hybrid electric vehicles.
CO4 Design parallel hybrid electric vehicles.
CO5 Describe the transmission components and their configurations for electric vehicles

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COURSE OBJECTIVES:
The main objective of this course is to prepare the students for acquiring the knowledge on selection and design of machine tools.

UNIT I  INTRODUCTION TO MACHINE TOOL DESIGN  9

UNIT II  REGULATION OF SPEEDS AND FEEDS  9
Aim of Speed and Feed Regulation, Layout of Speed Change Gears, Stepped Regulation of Speeds, Multiple Speed Motors, Ray Diagrams and Design Considerations, Design of Speed Gear Boxes, Feed Drives, Feed Box Design.

UNIT III  DESIGN OF MACHINE TOOL STRUCTURES  9

UNIT IV  DESIGN OF GUIDEWAYS AND POWER SCREWS  9

UNIT V  DESIGN OF SPINDLES AND SPINDLE SUPPORT  9

TOTAL:  45 PERIODS

COURSE OUTCOMES: Upon completion of this course, the students will be able to:
CO1  select the different machine tool mechanisms.
CO2  design the Multi speed Gear Box and feed drives
CO3  design the machine tool structures.
CO4  design the guideways and power screws
CO5  design the spindles and bearings

REFERENCES:
COURSE OBJECTIVES:
To impart students on the need, use, application and design of different material handling techniques, equipment and machines used in common use and in industrial sector.

UNIT I  INTRODUCTIONS AND DESIGN OF HOISTS

UNIT II  DRIVES OF HOISTING GEAR
Hand and power drives - Traveling gear - Rail traveling mechanism - cantilever and mono rail cranes-slewing ,jib and luffing gear-cog wheel drive-selecting the motor ratings.

UNIT III  CONVEYORS
Types-description-design and applications of Belt conveyors, apron conveyors and escalators Pneumatic conveyors, Screw conveyors and vibratory conveyors.

UNIT IV  ELEVATORS
Bucket elevators: design - loading and bucket arrangements - Cage elevators - shaft way, guides, counter weights, hoisting machine, safety devices.

UNIT V  INTEGRATED DESIGN
Integrated Design of systems - Valve Gear Mechanisms, Portable Air Compressor, Hay-Balelifter, Cam Testing Machine and Gear Box Design more than six speed.

TOTAL: 45 PERIODS

COURSE OUTCOMES: Upon completion of this course, the students will be able to:

CO1 design hoists used in any material handling applications.
CO2 design drive mechanisms and hoisting gear for different material handling applications.
CO3 design different conveyor systems for material handling applications.
CO4 design bucket, cage and forklift elevators for to and fro transportation of materials in vertical direction.
CO5 design of integrated mechanical system for machine tools, power transmission and engine parts

REFERENCES:

APPROVED DATA BOOKS:
COURSE OBJECTIVES:
To understand and apply the principles and concepts in Creativity and Innovation Management for Product Design and Development.

UNIT I  CREATIVITY THEORY, HEURISTICS & MODEL
Directed creativity: Five Mental Actions in Directed Creativity – Five Factors Driving the Need for Creativity and Innovation in Organizations – Two Key Challenges on the Road to Innovation – Quality Management & Creativity and Innovation – Proper Definition of Creativity & Innovation with Practical Advice – A High-level Model of Mechanics of Mind – Role of Perception in Creative Thinking with Practical Advice – Role of Memory in Creative Thinking with Practical Advice – Amabile’s Seven Heuristics on Creativity – Perkin’s Ten Heuristics on Creativity – Plsek’s Eight Heuristics on Creativity – Model of Directed Creativity Process.

UNIT II  CREATIVITY PRINCIPLES & TOOLS

UNIT III  CREATIVITY DESIGN & APPLICATION

UNIT IV  INNOVATION PRINCIPLES & PRACTICES

UNIT V  INNOVATION MANAGEMENT

TOTAL: 45 PERIODS

COURSE OUTCOMES: Upon completion of this course, the students will be able to:
CO1 Apply the heuristics of theory of creativity in new product design and development.
CO2 Apply the tools for creativity in new product design and development.
CO3 Apply the design principles of creativity in new product design and development.
CO4 Apply the various innovation principles and practices in new product design and development.
CO5 Apply the principles of innovation management in new product design and development.
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COURSE OBJECTIVES

1. To make the students to understand the basic principles of fluid flow, heat transfer, computational fluid dynamics (CFD) and its applications
2. To enlighten the students on the fundamental governing equations and turbulence models used in CFD solvers
3. To enable the students to understand grid generation techniques and post processing techniques.

UNIT I INTRODUCTION

Introduction to fluid flow and heat transfer – Mathematical description of fluid flow and heat transfer, incompressible and compressible flows, turbulent flows, boundary layer theory. Introduction to Computational Fluid Dynamics (CFD) – Objectives, modelling process, 2D and 3D simulations, advantages, limitations, application domains, software tools.

UNIT II GOVERNING EQUATIONS


UNIT III GRID GENERATION AND POST PROCESSING TECHNIQUES

Surface preparation, Volume meshing – cell types, structured, unstructured and hybrid meshing. Considerations for accurate and fast solutions. Mesh generation techniques, dynamic meshing, overset meshing, mesh size control, y+ and wall layer, adaptive mesh refinement, grid independence study. Post processing techniques – Vector plot, scalar plot, streamline plot, flow animation, x-y plot, surface area and mass flow integrated reports

UNIT IV NUMERICAL METHODS

Finite volume method, Discretization schemes – First order, higher order and hybrid schemes, stability of schemes. Steady and unsteady flow solvers – CG and AMG solvers, SIMPLE, SIMPLER & PISO solution algorithms. Initial and boundary conditions, material properties, solver control, convergence criteria, parallel processing.

UNIT V ADVANCED CFD SIMULATIONS

Compressible flow, conjugate heat transfer, VOF, MRF, porous media, radiation, combustion and emission simulations. Fluid flow and heat transfer modelling of IC engine, thermal systems, power generation and storage systems, turbomachinery etc. Introduction to fluid-structure interaction modelling

30 PERIODS

LABORATORY EXPERIMENTS (30 PERIODS):

1. Prepare a closed surface geometry for a given application as per given dimensions
2. Clean-up a raw geometry for the given flow domain and mark different boundaries
3. Prepare surface mesh and volume mesh as per given size and quality criteria
4. Prepare volume meshing with different grid controls like wall layering, boundary refinement, etc.
5. Perform a simple fluid flow analysis as per given problem description
6. Perform a simple heat transfer analysis as per given problem description
7. Perform an advanced CFD analysis as per given problem description

TOTAL : 60 PERIODS

COURSE OUTCOMES:

On successful completion of this course the student will be able to

CO1 Understand the basic principles of fluid flow, heat transfer, computational fluid dynamics (CFD) and its applications
CO2 Analyse the governing equations and boundary conditions
CO3 Create grid for any simulation domain and post process various simulations
CO4  Setup solvers and perform all common simulations
CO5  Perform advance fluid flow and heat transfer simulations

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