1. PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

| I. | To prepare students to excel in new product design and development through application of knowledge and practical skills |
| II. | To provide students with a solid foundation in mathematical modeling of engineering problems required for bringing new products fast into the market |
| III. | To provide students with required scientific and engineering knowledge so as to comprehend, analyze, design and create innovative products and solutions for real life problems |

2. PROGRAMME OUTCOMES (POs):

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<td>An ability to independently carry out research/investigation and development work to solve practical problems</td>
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<td>An ability to write and present a substantial technical report/document</td>
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<td>Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program</td>
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<td>Students will understand the importance of creativity in design process and will demonstrate an ability to identify, formulate, design a system and solve engineering problems.</td>
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<td>An ability to use the techniques, and modern engineering tools necessary for engineering practice in product development</td>
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<td>Responsibility of understanding ethically and professionally and develop confidence for self-education and ability for life-long learning.</td>
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3. PEO/PO Mapping:

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ANNA UNIVERSITY, CHENNAI
NON-AUTONOMOUS COLLEGES AFFILIATED TO ANNA UNIVERSITY
M.E. PRODUCT DESIGN AND DEVELOPMENT
REGULATIONS – 2021
CHOICE BASED CREDIT SYSTEM
I TO IV SEMESTERS CURRICULA AND SYLLABUS

**SEMMITER I**

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* Audit Course is optional

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## SEMESTER III, ELECTIVE IV

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## EMPLOYABILITY ENHANCEMENT COURSES (EEC)

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AUDIT COURSES (AC)
Registration for any of these courses is optional to students

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COURSE OBJECTIVES:

- To understand fundamental concepts of computer graphics and its tools in a generic framework.
- To impart the parametric fundamentals to create and manipulate geometric models using curves, surfaces and solids.
- To impart the parametric fundamentals to create and manipulate geometric models using NURBS and solids.
- To provide clear understanding of CAD systems for 3D modeling and viewing.
- To create strong skills of assembly modeling and prepare the student to be an effective user of a standards in CAD system.

UNIT – I INTRODUCTION TO COMPUTER GRAPHICS FUNDAMENTALS
Geometric Transformations: Coordinate Transformations, Windowing and Clipping, 2D Geometric transformations-Translation, Scaling, Shearing, Rotation and Reflection, Composite transformation, 3D transformations.

UNIT – II CURVES AND SURFACES MODELLING
Introduction to curves - Analytical curves: line, circle and conics – synthetic curves: Hermite cubic spline- Bezier curve and B-Spline curve – curve manipulations.

UNIT – III NURBS AND SOLID MODELING

UNIT – IV VISUAL REALISM
Animation - Conventional, Computer animation, Engineering animation - types and techniques.

UNIT – V ASSEMBLY OF PARTS AND PRODUCT LIFE CYCLE MANAGEMENT

TOTAL: 45 PERIODS
COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
1. Solve 2D and 3D transformations for the basic entities like line and circle.
2. Formulate the basic mathematics fundamental to CAD system.
3. Use the different geometric modeling techniques like feature based modeling, surface modeling and solid modeling.
4. Create geometric models through animation and transform them into real world systems

REFERENCES:

Mapping of CO with PO

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PD4153 REVERSE ENGINEERING

COURSE OBJECTIVES:
1. Applying the fundamental concepts and principles of reverse engineering in product design and development.
2. Applying the concept and principles material characteristics, part durability and life limitation in reverse engineering of product design and development.
3. Applying the concept and principles of material identification and process verification in reverse engineering of product design and development.
4. Applying the concept and principles of data processing, part performance and system compatibility in reverse engineering of product design and development.
5. Analyzing the various legal aspect and applications of reverse engineering in product design and development.
UNIT I  INTRODUCTION TO REVERSE ENGINEERING & GEOMETRIC FORM  9

UNIT II  MATERIAL CHARACTERISTICS, PART DURABILITY AND LIFE LIMITATION  9
Alloy Structure Equivalency – Phase Formation and Identification – Mechanical Strength – Hardness – Part Failure Analysis – Fatigue – Creep and Stress Rupture – Environmentally Induced Failure

UNIT III  MATERIAL IDENTIFICATION AND PROCESS de VERIFICATION  9

UNIT IV  DATA PROCESSING, PART PERFORMANCE AND SYSTEM COMPATIBILITY  9

UNIT V  ACCEPTANCE, LEGALITY AND INDUSTRIAL APPLICATIONS OF RE  9

TOTAL : 45 PERIODS

COURSE OUTCOMES:
Upon completion of the course, the students will be able to
1. Apply the fundamental concepts and principles of reverse engineering in product design and development.
2. Apply the concept and principles material characteristics, part durability and life limitation in reverse engineering of product design and development.
3. Apply the concept and principles of material identification and process verification in reverse engineering of product design and development.
4. Apply the concept and principles of data processing, part performance and system compatibility in reverse engineering of product design and development.
5. Analyze the various legal aspect and applications of reverse engineering in product design and development.

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 COURSE OBJECTIVES:
1. Applying the principles of essential theory of creativity in new product design and development.
2. Applying the principles of various methods and tools for creativity in new product design and development.
3. Applying the design principles of creativity in new product design and development.
4. Applying the various innovation principles and practices in new product design and development.
5. Applying the principles of innovation management in new product design and development.

UNIT I INTRODUCTION TO ESSENTIAL THEORY OF CREATIVITY

UNIT II METHODS AND TOOLS FOR CREATIVITY
Three basic principles behind the tools of directed creativity – Tools that prepare the mind for creative thought – Tools that stimulate the imagination for new idea – Development and action: the bridge between mere creativity and the rewards of innovation - ICEDIP: Inspiration, Clarification, Distillation, Perspiration, Evaluation and Incubation – Creativity and Motivation

UNIT III DESIGN AND APPLICATION OF CREATIVITY
Three levels of emotional design: Visceral, Behavioral and Reflective – Process design, reengineering, and creativity – Creativity and customer needs analysis – Innovative product and service design – Creative problem solving and incremental improvement.

UNIT IV INNOVATION PRINCIPLES & PRACTICES
Methods of Creativity Activation: Morphological Box – Requirements for Inventive Problem Solving – Altschuller’s Engineering Parameters– Altschuller’s Inventive Principles– Altschuller’s Contradiction Matrix Algorithm.

UNIT V INNOVATION MANAGEMENT

COURSE OUTCOMES:
Upon completion of the course, the students will be able to
1. Apply the principles of essential theory of creativity in new product design and development.
2. Apply the principles of various methods and tools for creativity in new product design and development.
3. Apply the design principles of creativity in new product design and development.
4. Apply the various innovation principles and practices in new product design and development.
5. Apply the principles of innovation management in new product design and development
REFERENCES
3. Geoffrey Petty," how to be better at Creativity", The Industrial Society 1999

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PD4152 INTEGRATED PRODUCT DEVELOPMENT

COURSE OBJECTIVES:
1. To Understand the principles of generic development process; product planning; customer need analysis for new product design and development.
2. To enhance the understanding of setting product specifications and generate, select, screen, and test concepts for new product design and development.
3. To apply the principles of product architecture and the importance of industrial design principles and DFM principles for new product development.
4. To expose the different Prototyping techniques, Design of Experiment principles to develop a robust design and importance to patent a developed new product.
5. Applying the concepts of economics principles: project management practices in development of new product.

UNIT– I INTRODUCTION TO PRODUCT DESIGN

UNIT– II PRODUCT SPECIFICATIONS, CONCEPT GENERATION, SELECTION AND TESTING
Establish Target and Final product specifications – Activities of Concept Generation - Concept Screening and Scoring - Concept Testing Methodologies.
UNIT–III  PRODUCT ARCHITECTURE AND INDUSTRIAL DESIGN  9
Product Architecture – Implications and establishing the architecture – Delayed Differentiation – Platform Planning – Related system level design issues - Need and impact of industrial design - Industrial design process - management of the industrial design process - assessing the quality of industrial design

UNIT– IV  DESIGN FOR MANUFACTURE, PROTOTYPING AND ROBUST DESIGN  9
DFM Definition - Estimation of Manufacturing cost- Reducing the component costs, costs of supporting function and assembly costs – Impact of DFM decision on other factors - Prototype basics - Principles of prototyping – Prototyping technologies - Planning for prototypes - Robust design –Robust Design Process

UNIT– V  PRODUCT DEVELOPMENT ECONOMICS AND MANAGING PROJECTS  9
Economic Analysis – Elements of Economic Analysis - Understanding and representing tasks- Baseline Project Planning - Accelerating the project - Project execution – Postmortem project evaluation.

TOTAL:45 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
1. Apply the principles of generic development process; product planning; customer need analysis for new product design and development.
2. Set product specifications and generate, select, screen, test concepts for new product design and development.
3. Apply the principles of product architecture, industrial design and design for manufacturing principles in new product development.
4. Apply the adopt Prototyping techniques and Design of Experiment principles to develop a robust design and document a new product for patent.

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UNIT I
RESEARCH DESIGN 6
Overview of research process and design, Use of Secondary and exploratory data to answer the research question, Qualitative research, Observation studies, Experiments and Surveys.

UNIT II
DATA COLLECTION AND SOURCES 6
Measurements, Measurement Scales, Questionnaires and Instruments, Sampling and methods.
Data - Preparing, Exploring, examining and displaying.

UNIT III
DATA ANALYSIS AND REPORTING 6
Overview of Multivariate analysis, Hypotheses testing and Measures of Association.
Presenting Insights and findings using written reports and oral presentation.

UNIT IV
INTELLECTUAL PROPERTY RIGHTS 6

UNIT V
PATENTS 6

REFERENCES

TOTAL : 30 PERIODS

PD4111 CAD LABORATORY AND MULTIBODY DYNAMICS LABORATORY L T P C 0 0 4 2

COURSE OBJECTIVE:
- To impart knowledge on how to prepare drawings for various mechanical components using any commercially available 3D modelling software’s.
- To expose the students to understand the forces and torques that come into action in various kinds of mechanical systems.

1. CAD Introduction & Sketcher
2. Solid modeling–Extrude, Revolve, Sweep, etc and Variational sweep, Loft, etc
3. Surface modeling–Extrude, Sweep, Trim..etc and Mesh of curves, Free form etc
4. Feature manipulation – Copy, Edit, Pattern, Suppress, History operations etc.
5. Assembly-Constraints, Exploded Views, Interference check
7. CAD data Exchange formats-IGES,PDES, PARASOLID,DXF and STL.
8. Free fall of rigid body
9. Projectile motion
10. Simulation of simple & Compound Pendulum
11. Kinematic & Dynamic Analysis four bar and slider crack mechanism and its inversions
12. Design of cam Profile for various follower output motion
13. Kinematic & Dynamic Analysis of Gear Tracks
14. Vibration Analysis SDOF and MDOF
15. Project on virtual product design using ADAMS

- Exercises in Modeling and drafting of Mechanical Components - Assembly using Parametric and feature based Packages like PRO-E / SOLID WORKS /CATIA / NX etc.
- Exercises in kinematics and dynamics using equations of motion in package like ADAMS.

**COURSE OUTCOMES:**

- With laboratory classes, it helps the students to get familiarized with the computer applications in design and preparing drawings for various mechanical components.
- The students get familiarized with modeling different systems and importing them into the multi body dynamic software.
- The students will be trained to obtain required dynamic properties by conducting multi body dynamic tests.
- The students will learn how to use this data in additional stress analysis software.

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**PD4112** REVERSE ENGINEERING LABORATORY

**COURSE OBJECTIVES:**

1. Applying the fundamental concepts and principles of reverse engineering in product design and development.
2. Applying the concept and principles material characteristics, part durability and life limitation in reverse engineering of product design and development.
3. Applying the concept and principles of material identification and process verification in reverse engineering of product design and development.
4. Applying the concept and principles of data processing, part performance and system compatibility in reverse engineering of product design and development.
5. Analyzing the various legal aspect and applications of reverse engineering in product design and development.
Exercises
1. Surface measurement – CMM.
2. 3D Laser scanning of components.
4. Material identification and process verification of welded components.
5. Reverse engineering of dental components - Bio medical applications.

COURSE OUTCOMES:
Upon completion of the course, the students will be able to
- Apply the fundamental concepts and principles of reverse engineering in product design and development.
- Apply the concept and principles material characteristics, part durability and life limitation in reverse engineering of product design and development.
- Apply the concept and principles of material identification and process verification in reverse engineering of product design and development.
- Apply the concept and principles of data processing, part performance and system compatibility in reverse engineering of product design and development.
- Analyze the various legal aspect and applications of reverse engineering in product design and development.

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ED4251 FINITE ELEMENT METHODS IN MECHANICAL DESIGN

COURSE OBJECTIVES
1. To learn mathematical models for one dimensional problems and their numerical solutions
2. To learn two dimensional scalar and vector variable problems to determine field variables
3. To learn Iso parametric transformation and numerical integration for evaluation of elementmatrices
4. To study various solution techniques to solve Eigen value problems
5. To learn solution techniques to solve non-linear problems
UNIT- I  
**FINITE ELEMENT ANALYSIS OF ONEDIMENSIONAL PROBLEMS**  
9+3


UNIT- II  
**FINITE ELEMENT ANALYSIS OF TWO DIMENSIONAL PROBLEMS**  
9+3


UNIT- III  
**ISO-PARAMETRIC FORMULATION**  
9+3

Natural Co-ordinate Systems – Lagrangian Interpolation Polynomials – Iso parametric Elements –Formulation – Shape functions -one dimensional , two dimensional triangular and quadrilateral elements -Serendipity elements- Jacobian transformation - Numerical Integration – Gauss quadrature – one, two and three point integration

UNIT- IV  
**EIGEN VALUE PROBLEMS**  
9+3

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+3

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

**COURSE OUTCOMES:**

On Completion of the course the student will be able to

**CO1** Develop mathematical models for one dimensional problems and their numericalsolutions

**CO2** Determine field variables for two dimensional scalar and vector variable problems

**CO3** Apply Isoparametric transformation and numerical integration for evaluation of elementmatrices

**CO4** Apply various solution techniques to solve Eigen value problems

**CO5** Formulate solution techniques to solve non-linear problems

**TOTAL = 60 PERIODS**

**REFERENCES:**

OBJECTIVES:
The main learning objective of this course is to prepare the students for:
1. Analyzing the different strengthening and failure mechanism of the metals
2. Applying the effects of metallurgical parameters in the materials design
3. Analyzing the relationship between the selection of materials and processing
4. Developing the novel material through understanding the properties of the existing metallic materials
5. Analyzing the different materials used in the engineering applications.

UNIT I    INTRODUCTION TO REVERSE ENGINEERING & GEOMETRICFORM

UNIT II   MATERIAL CHARACTERISTICS, PART DURABILITY AND LIFE LIMITATION
Alloy Structure Equivalency – Phase Formation and Identification – Mechanical Strength – Hardness – Part Failure Analysis – Fatigue – Creep and Stress Rupture – Environmentally Induced Failure

UNIT III  MATERIAL IDENTIFICATION AND PROCESS VERIFICATION

UNIT IV   DATA PROCESSING, PART PERFORMANCE AND SYSTEM COMPATIBILITY

UNIT V    ACCEPTANCE, LEGALITY AND INDUSTRIAL APPLICATIONS OF RE

OUTCOMES:
On Completion of the course the student will be able to
- Analyze the different strengthening and failure mechanism of the metals
- Apply the effects of metallurgical parameters in the materials design
- Analyze the relationship between the selection of materials and processing
- Develop the novel material through understanding the properties of the existing metallic materials
- Analyze the different materials used in the engineering applications
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REFERENCES:
8. www.astm.org/labs/pages/131350.htm

CM4152          SOLID FREEFORM MANUFACTURING          L  T  P  C
                                      3  0  0  3

COURSE OBJECTIVES:
- To acquaint the students with evolution of Solid Freeform Manufacturing (SFM) / Additive Manufacturing (AM), proliferation into various fields and its effects on supply chain.
- To gain knowledge on Design for Additive Manufacturing (DFAM) and its importance in quality improvement of fabricated parts.
- To acquaint with polymerization and sheet lamination processes and their applications.
- To acquaint with material extrusion and powder bed fusion processes.
- To gain knowledge on jetting and direct energy deposition processes and their applications.

UNIT I          INTRODUCTION
9

UNIT II          DESIGN FOR ADDITIVE MANUFACTURING
9
UNIT III VAT POLYMERIZATION AND SHEET LAMINATION PROCESSES


UNIT IV MATERIAL EXTRUSION AND POWDER BED FUSION PROCESSES


UNIT V JETTING AND DIRECT ENERGY DEPOSITION PROCESSES


TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of this course, the students shall be able to:

1. CO1: Relate the importance in the evolution of SFM/AM, proliferation into the various fields and its effects on supply chain.
2. CO2: Analyze the design for AM and its importance in the quality of fabricated parts.
3. CO3: Build knowledge on principles and applications of polymerization and sheet lamination processes with case studies.
4. CO4: Explain the principles of material extrusion and powder bed fusion processes and design guidelines.
5. CO5: Elaborate jetting and direct energy deposition processes and their applications.

REFERENCES:
OBJECTIVES:
(1) To apply various design rules in manufacturing processes
(2) To evaluate the process by design guidelines for optimum design
(3) To analyze the rules of concepts of GD&T
(4) To make the students to learn about tolerance analysis and allocation, geometrical tolerances
(5) Guidelines for design for manufacturing and assembly with suitable examples.

UNIT I TOLERANCE ANALYSIS

UNIT II TOLERANCE ALLOCATION

UNIT III GD&T

UNIT IV TOLERANCE CHARTING

UNIT V MANUFACTURING GUIDELINES

TOTAL: 45 PERIODS

OUTCOMES:
At the end of this course the students are expected
(1) To impart the knowledge about the significance of design for manufacturing and assembly
(2) To apply the principle of tolerancing in design
(3) Evaluate the process of GD & T using design guidelines
(4) Apply tolerance allocation and tolerance charting in design
(5) Apply guidelines for manufacturing and assembly
REFERENCES:

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CD4151 CONCEPTS OF ENGINEERING DESIGN

COURSE OBJECTIVES
- To impart knowledge on basic concepts in engineering design.
- To develop a product catering to the need of the customer and considering quality and societal aspects in design.
- To incorporate various design methods to develop a creative product.
- To gain knowledge on the selection of materials and manufacturing techniques for product design.
- To develop a robust and reliable product.

UNIT-I DESIGN FUNDAMENTALS

UNIT-II CUSTOMER-ORIENTED DESIGN&SOCIETAL CONSIDERATIONS

UNIT-III DESIGN METHODS
UNIT-IV MATERIAL SELECTION PROCESSING AND DESIGN


UNIT-V PROBABILITY CONCEPTS IN DESIGN FOR RELIABILITY


TOTAL= 45 PERIODS

OUTCOMES:
On Completion of the course, the student will be able to

- Appreciate the aspects of the need for design, design process used for designing various components.
- Get familiarized with concepts related to legal, human, and marketing factors during the design of products.
- Get acquainted with the knowledge of designing creative components.
- Gain knowledge on the material selection process and various design procedures.
- Get equipped with tools for improving quality, reliability, and performance of a product.

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1-low, 2-medium, 3-high, ‘-‘- no correlation
OBJECTIVES:
1. To give exposure to software tools needed to analyze engineering problems.
2. To expose the students to different applications of simulation and analysis tools.

A. SIMULATION
1. MATLAB basics, Dealing with matrices, Graphing-Functions of one variable and two variables
2. Use of MATLAB to solve simple problems in vibration
3. Mechanism Simulation using Multibody Dynamic software

B. ANALYSIS
1. Force and Stress analysis using link elements in Trusses, cables etc.
2. Stress and deflection analysis in beams with different support conditions.
3. Stress analysis of flat plates and simple shells.
5. Thermal stress and heat transfer analysis of plates.
6. Thermal stress analysis of cylindrical shells
7. Vibration analysis of spring-mass systems.
8. Model 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

TOTAL : 60 PERIODS

List of Equipment / Software:
Finite Element Analysis packages

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

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1-low, 2-medium, 3-high, “-“- no correlation
OBJECTIVE:
- To give exposure to develop digital and physical prototype models using RP machine / clay models of a new product/ existing product.

The students in a group have to develop digital and physical prototype models using RP machine / clay models of a new product/ existing product with enhanced feature involving the following areas:
- Automotive components
- Tool and die components
- Press tool components
- Consumer product
- Injection moulded products.

The fabricated models may be in the form of RP models, clay models, sheet metal models or cardboard models etc.

The design and development of the product will be reviewed in two stages for awarding internal marks. The end semester examination mark will be based on the demonstration of the new product developed and oral examination on the same by internal examiners.

TOTAL : 60 PERIODS

COURSE OUTCOMES:
Upon conclusion of this course the student will be able to

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<th>CO2 Apply theoretical knowledge to design and development of physical products using clay, wood, sheet metal and RP techniques</th>
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TOTAL : 60 PERIODS
OBJECTIVES:
1. To understand history, concepts and terminology of PLM
2. To understand functions and features of PLM/PDM
3. To understand different modules offered in commercial PLM/PDM tools
4. To demonstrate PLM/PDM approaches for industrial applications
5. To Use PLM/PDM with legacy data bases, CAx & ERP systems

UNIT I  HISTORY, CONCEPTS AND TERMINOLOGY OF PLM  9
Introduction to PLM, Need for PLM, opportunities of PLM, Different views of PLM - Engineering Data Management (EDM), Product Data Management (PDM), Collaborative Product Definition Management (cPDM), Collaborative Product Commerce (CPC), Product Lifecycle Management (PLM). PLM/PDM Infrastructure - Network and Communications, Data Management, Heterogeneous data sources and applications.

UNIT II  PLM/PDM FUNCTIONS AND FEATURES  9

UNIT III  DETAILS OF MODULES IN APDM/PLM SOFTWARE  9
Case studies based on top few commercial PLM/PDM tools

UNIT IV  ROLE OF PLM IN INDUSTRIES  9
Case studies on PLM selection and implementation (like auto, aero, electronic) - other possible sectors, PLM visioning, PLM strategy, PLM feasibility study, change management for PLM, financial justification of PLM, barriers to PLM implementation, ten step approach to PLM, benefits of PLM for-business, organization, users, product or service, process performance.

UNIT V  BASICS ON CUSTOMISATION/INTEGRATION OF PDM/PLM SOFTWARE  9
PLM Customization, use of EAI technology (Middleware), Integration with legacy data base, CAD, SLM and ERP

TOTAL: 45 PERIODS

OUTCOMES:
The students will be able to
1. Summarize the history, concepts and terminology of PLM
2. Use the functions and features of PLM/PDM
3. Use different modules offered in commercial PLM/PDM tools.
4. Implement PLM/PDM approaches for industrial applications.
5. Integrate PLM/PDM with legacy data bases, CAx & ERP systems.

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PD4311 PROJECT WORK I

OBJECTIVES:
1. To identify a specific problem for the current need of the society and collecting information related to the same through detailed review of literature.
2. To develop the methodology to solve the identified problem.
3. To train the students in preparing project reports and to face reviews and viva-voce examination.

SYLLABUS:
The student individually works on a specific topic approved by the head of the division under the guidance of a faculty member who is familiar in this area of interest. The student can select any topic which is relevant to the area of engineering design. The topic may be theoretical or case studies. At the end of the semester, a detailed report on the work done should be submitted which contains clear definition of the identified problem, detailed literature review related to the area of work and methodology for carrying out the work. The students will be evaluated through a viva-voce examination by a panel of examiners including one external examiner.

OUTCOME:
At the end of the course the students will have a clear idea of their area of work and they will be in a position to carry out the remaining phase II work in a systematic way.

PD4411 PROJECT WORK II

OBJECTIVES:

SYLLABUS:

TOTAL : 360 PERIODS
OUTCOMES:
- On completion of the project work students will be in a position to take up any challenging practical problem in the field of engineering design and find better solutions to it.

ED4080 TRIBOLOGY IN DESIGN  L  T  P  C
3  0  0  3

COURSE OBJECTIVES:
1. To study and measure the different types of surface features associated with the friction of metals and non-metals.
2. To study the different types of wear mechanism and surface modification techniques.
3. To analyze the various types of lubricants and lubrication system in the tribology.
4. To develop the methodology for deciding lubricants and lubrication regimes for different operating conditions.
5. To study the different types of high-pressure contacts and rolling bearings

UNIT I SURFACE INTERACTION AND FRICTION

UNIT II WEAR AND SURFACE TREATMENT

UNIT III LUBRICANTS AND LUBRICATION REGIMES

UNIT IV THEORY OF HYDRODYNAMIC AND HYDROSTATIC LUBRICATION
- Reynolds Equation-Assumptions and limitations-One and two dimensional Reynolds Equation Reynolds and Sommerfeld boundary conditions- Pressure wave, flow, load capacity and friction calculations in Hydrodynamic bearings-Long and short bearings-Pad bearings and Journal bearings-Squeeze film effects-Thermal considerations-Hydrostatic lubrication of Pad bearing Pressure, flow, load and friction calculations-Stiffness considerations- Various types of flow restrictors in hydro static bearings.

UNIT V HIGH PRESSURE CONTACTS AND ELASTO HYDRODYNAMIC LUBRICATION
- Rolling contacts of Elastic solids- contact stresses – Hertzian stress equation- Spherical and cylindrical contacts-Contact Fatigue life- Oil film effects- Elasto Hydrodynamic lubrication Theory Soft and hard EHL Reynolds equation for elasto hydrodynamic lubrication- - Film shape within and outside contact zones-Film thickness and friction calculation- Rolling bearings- Stresses and deflections-Traction drives.

TOTAL: 45 PERIODS
COURSE OUTCOMES:
On Completion of the course the student will be able to
- Develop the knowledge on the surface features and its role on the friction behavior of metals and nonmetals
- Understand the various types of wear mechanism and surface modification techniques
- Familiarize the different types of lubricants and lubrication systems in the tribology
- Methodology for deciding lubricants and lubrication regimes for different operating conditions
- Ability to understand the different types of high pressure contacts and rolling bearings

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CC4071 ADVANCED MACHINE TOOL DESIGN

COURSE OBJECTIVES
The main learning objective of this course is to prepare the students for:
1. Selecting the different machine tool mechanisms.
2. Designing the Multi speed Gear Box and feed drives.
3. Designing the machine tool structures.
4. Designing the guideways and power screws.
5. Designing the spindles and bearings.

UNIT I INTRODUCTION TO MACHINE TOOL DESIGN 9

UNIT II REGULATION OF SPEEDS AND FEEDS 9
Aim of Speed and Feed Regulation, 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

OUTCOMES:
On Completion of the course the student will be able to
1. Select the different machine tool mechanisms.
2. Design the Multi speed Gear Box and feed drives.
3. Design the machine tool structures.
4. Design the guideways and power screws.
5. Design the spindles and bearings.

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PD4001 GENERATIVE DESIGN AND TOPOLOGY OPTIMIZATION L T P C
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COURSE OBJECTIVES:
1. To impart knowledge on basic concepts in generative design.
2. To develop design methods to meet the needs of a customer.
3. To incorporate various design methods to develop a creative product.
4. To gain knowledge on topology aspects of design.
5. To gain knowledge on optimization in design.
UNIT I  INTRODUCTION  9

UNIT II  GENERATIVE DESIGN  9
Editable geometry - Integrated workflows - Multiple manufacturing methods - Additive – 3 or 5 axis milling – Applications.

UNIT III  LOW-DENSITY AREAS IN TOPOLOGY OPTIMIZATION  9
Localized mode in low-density areas - Localized deformation, Polynomial interpolation model, Breakdown issue in ESO. Dynamics – analysis and topology optimization under harmonic and random force excitations, Thermo-elastic problems - topology optimization in single and multiple materials.

UNIT IV  INTEGRATED LAYOUT AND TOPOLOGY OPTIMIZATION  9
Introduction to integrated optimization, Finite-circle method, Density points and embedded, meshing, MPC-based component-structure connections, integrated optimization based on implicit model.

UNIT V  POTENTIAL APPLICATIONS OF TOPOLOGY OPTIMIZATION  9
Shape-preserving design, Smart structure design, Structural features design, Topology optimization and additive manufacturing.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
On Completion of the course the student will be able to
- Appreciate the aspects of need for design, design process used for designing various components
- Get familiarized with concepts related to design methods during the design of products
- Get acquainted with the knowledge of designing creative components
- Gain knowledge on topology aspects of design.
- Get equipped with optimization tools for improving quality, reliability and performance of a product.

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COURSE OBJECTIVES:
1. Recognize the importance of data analytics
2. Exhibit competence on data analytics packages
3. Apply solution methodologies for industrial problems.

UNIT I  INTRODUCTION  9

UNIT II  MULTIPLE REGRESSION  9
Multiple Regression- Linear and Nonlinear techniques- Backward-Forward-Stepwise Hierarchical regression-Testing interactions (2way interaction) - Analysis of Variance and Covariance (ANOVA & ANCOVA) - Multivariate Analysis of Variance and Covariance (MANOVA & MANCOVA).

UNIT III  LOGISTIC REGRESSION  9
Regression with binary dependent variable -Simple Discriminant Analysis Multiple Discriminant analysis-Assessing classification accuracy- Conjoint analysis (Full profile method).

UNIT IV  PRINCIPAL COMPONENT ANALYSIS  9
Principal Component Analysis -Factor Analysis- Orthogonal and Oblique Rotation-Factor Score Estimation-Multidimensional Scaling-Perceptual Map-Cluster Analysis (Hierarchical Vs Nonhierarchical Clustering).

UNIT V  LATENT VARIABLE MODELS  9
Latent Variable Models an Introduction to Factor, Path, and Structural Equation Analysis- Time series data analysis (ARIMA model) – Decision tree analysis (CHAID, CART) - Introduction to Big Data Management.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
On completion of the course, the student will be able to:
- To recognize the importance of data analytics
- To Exhibit competence on data analytics packages
- To apply solution methodologies for industrial problems.

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OBJECTIVES:
- To appreciate the need and scope for robotics and to understand the principles of robot kinematics
- To design the drive systems and its control
- To understand the principles of sensors and vision systems
- To envision the industrial applications of robots and its safety
- To gain knowledge on artificial intelligence and expert systems.

UNIT I
INTRODUCTION AND ROBOT KINEMATICS

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

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

TOTAL : 45 PERIODS

OUTCOMES:
On Completion of the course the student will be able to
- Understand robot kinematics
- Incorporate mechanical components and concepts in robotics
- Understand the basics of various sensors to effectively design a robot
- Design suitable robots for specific applications
- Optimize the robots using Artificial Intelligence

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ED4092 ENGINEERING FRACTURE MECHANICS L T P C 3 0 0 3

COURSE OBJECTIVES:
1. Formulation of governing equations for elastic problems
2. Stresses calculations/displacements around the crack tip for different modes of fracture
3. Estimation of K1c/SIF/critical flaws/failure stresses for different crack geometries
4. Life assessment of the cracked components under different types of repeated/variable fatigue loads and design for its life extension.
5. Analysis of failed engineering components under different modes of fracture.

UNIT-I ELEMENTS OF SOLID MECHANICS 9

UNIT-II STRESS AND DISPLACEMENT AROUND THE CRACK TIP FOR DIFFERENT M ODES OF FRACTURE 9

UNIT-III STATIONARY CRACK UNDER STATIC LOADING 9
Two dimensional elastic fields – Analytical solutions for small scale yielding near a crack front -- plastic zone size –Specimen size calculations: K1c Testing for Fracture toughness of the Material.
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:
On Completion of the course the student will be able to

CO1 Formulate governing equation for elastic problems
CO2 Calculate stresses/displacements around the crack tip for different modes of fracture
CO3 Estimate K1c/SIF/critical flaws/failure stresses for different crack geometries
CO4 Assess the life of the cracked components under different types of repeated/variable fatigue loads and design for its life extension.
CO5 Analyze failed engineering components under different modes of fracture.

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PD4002 ENTERPRISE RESOURCE PLANNING AND MANAGEMENT \hspace{1cm} L T P C \\
\hspace{1.5cm} 3003

OBJECTIVES:
1. Students will be able to identify the needs of Enterprise resource planning.
2. Students will be able to understand the various technologies of ERP.
3. Students will be able to distinguish the various ERP packages.
4. Students will be able to understand the various architecture of ERP.
5. Students will be able to identify the issues in ERP procurement.

UNIT I ENTERPRISE RESOURCE PLANNING AND VALUE CHAIN MANAGEMENT 9

UNIT II TECHNOLOGY AND ARCHITECTURE 9

UNIT III ERP SYSTEM PACKAGES 9
SAP, People soft, Baan and Oracle – Comparison – Integration of different ERP applications – ERP as sales force automation – Integration of ERP and Internet – ERP Implementation strategies – Organizational and social issues.

UNIT IV ERP ARCHITECTURE 9
Overview – Architecture – AIM applications – Oracle SCM. SAP: Overview – Architecture – applications -Before and after Y2k – critical issues – Training on various modules of IBCS ERP Package- Oracle ERP and MAXIMO, including ERP on the NET

UNIT V ERP PROCUREMENT ISSUES 9

TOTAL: 45 PERIODS

OUTCOMES:
Upon completion of the course, the students will be able to
1. Able to acquire integrated view of the various facets of business, including planning, manufacturing, sales, finance and marketing.
2. Able to understand the development of software to integrate business activities such as inventory management and control, order tracking, customer service, finance and human resources.
3. Awareness on the software applications and tools that are available to business to use to drive out costs and improve efficiency.
4. Understand the architecture of various ERP packages available in the market.
5. Ability to learn the outsourcing concepts of ERP and its economics.

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REFERENCES:

AO4091 ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING L T P C
3 0 0 3

OBJECTIVES:
1. To gain knowledge on artificial intelligence.
2. To understand the concepts of Machine Learning.
3. To appreciate supervised learning and their applications.
4. To appreciate the concepts and algorithms of unsupervised learning.
5. To understand the theoretical and practical aspects of Probabilistic Graphical Models.

UNIT I ARTIFICIAL INTELLIGENCE

UNIT II INTRODUCTION TO MACHINE LEARNING

UNIT III SUPERVISED LEARNING

UNIT IV UNSUPERVISED LEARNING

UNIT V PROBABILISTIC GRAPHICAL MODELS

TOTAL: 45 PERIODS

OUTCOMES:
On Completion of the course the student will be able to
• Optimize the robots using Artificial Intelligence.
• Design a learning model appropriate to the application.
• Implement Probabilistic Discriminative and Generative algorithms for an application of your choice and analyze the results.
• Use a tool to implement typical Clustering algorithms for different types of applications.
• Identify applications suitable for different types of Machine Learning with suitable justification.
1-low, 2-medium, 3-high, ‘-‘- no correlation

REFERENCES:

PD4003 DESIGN FOR ADDITIVE MANUFACTURING L T P C 3 0 0 3

OBJECTIVES:
- To acquaint the students with evolution of Additive Manufacturing (AM).
- To gain knowledge on Design aspects of Additive Manufacturing (DFAM).
- To acquaint with Photo polymerization and Sintering processes and their applications.
- To acquaint the students with applications aspects of Additive Manufacturing.
- To gain knowledge in Future trends of Additive Manufacturing

UNIT I BASICS PRINCIPLES OF ADDITIVE MANUFACTURING 9
Introduction to the Basic Principles of Additive Manufacturing, Additive Manufacturing Processes, Extrusion, Beam Deposition

UNIT II DESIGN CONCEPTS IN ADDITIVE MANUFACTURING 9
Design/Fabrication Processes: Data Sources, Software Tools, File Formats, Model Repair and Validation, Pre- & Post-processing, Designing for Additive Manufacturing, Multiple Materials, Hybrids, Composite Materials, current and future directions.

UNIT III DESIGN FOR ADDITIVE MANUFACTURING 9

UNIT IV DESIGNING FOR 3D PRINTING 9
General design considerations for 3D printing, 3D printed features, Designing for Material Jetting, Binder Jetting, FFF, SLA/DLP, SLS, DMLS/SLM, design rules.

UNIT V DESIGNSTANDARDS FOR ADDITIVE MANUFACTURING 9
Methods of testing and Testing organization - ASTM, ANSI, NBS, NEMA, NFPA, VL, SPI AND SPE.

TOTAL : 45 PERIODS
OUTCOMES:
On Completion of the course the student will be able to
CO1: Recognize the importance in the evolution of SFM/AM, proliferation into the various fields and its effects on supply chain.
CO2: Evaluate the design for AM and its importance in the quality of fabricated parts.
CO3: Acquire knowledge on principles and applications of polymerization and sheet lamination processes with case studies.
CO4: Acquire knowledge on principles of material extrusion and powder bed fusion processes and design guidelines.
CO5: Perceive jetting and direct energy deposition processes and their applications.

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REFERENCES:

PD4004 QUALITY AND FINANCIAL CONCEPTS IN PRODUCT DEVELOPMENT

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OBJECTIVES:
The main learning objective of this course is to prepare students for:
1. Applying the concept and principles of quality tools such as seven old and new tools of quality, SPC, multivariate charts, box plots, Pareto charts in product development.
2. Applying the concept and principles of quality tools such as benchmarking, QFD, HoQ, and reliability in product development.
3. Applying the concept and principles of Six Sigma and Lean manufacturing in product development.
4. Applying the concept and principles of robust design and embodiment design in product development.
5. Applying the concept and principles of finance and working capital management in product development.
UNIT I QUALITY TOOLS I 9
Seven Statistical Tools of Quality – New Seven Management Tools – Multivariable Charts and 3D Plot – Statistical Process Control: Problems in Mean and Range Chart; p, np, u and c chart; Problems in Box Plot and Pareto Chart.

UNIT II QUALITY TOOLS II 9
Benchmarking: Types; Process; Benefits – Quality Function Deployment (QFD): Concept; Benefits; Process; House of Quality: Structure and Methodology – Reliability: Hazard / Failure Rate; Mean Time Between Failure; Simple problems in Series; Parallel; Combination; Standby Systems.

UNIT III DESIGN FOR SIXSIGMA AND LEAN PRINCIPLES 9
Six Sigma: Definition; Concept; Process (DMAIC Methodology) – Project selection for Six Sigma (Types of Quality Problems) – Key Tools in Lean Production / Manufacturing – 4R Total Improvement – PDSA Cycle: Phases; Benefits – Kaizen and Kairyo – 5S House Keeping – TPM: Definition; Objective; Pillars; Steps.

UNIT IV ROBUST DESIGN AND EMBODIMENT DESIGN 9

UNIT V FINANCE AND WORKING CAPITAL MANAGEMENT 9
Financial Planning: Definition; Need; Sources; Capital Structure; Capitalization; Term Loans; Short term Finance; Venture Capital; Export Finance – Working Capital Management: Definition; Significance; Assessment; Factors; Sources; Management.

TOTAL:45 PERIODS

OUTCOMES:
The student will
1. Apply the concept and principles of quality tools such as seven old and new tools of quality, SPC, multivariate charts, box plots, Pareto charts in product development.
2. Apply the concept and principles of quality tools such as benchmarking, QFD, HoQ, and reliability in product development.
3. Apply the concept and principles of Six Sigma and Lean manufacturing in product development.
4. Apply the concept and principles of robust design and embodiment design in product development.
5. Apply the concept and principles of finance and working capital management in product development.

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REFERENCES:

ED4093 OPTIMIZATION TECHNIQUES IN DESIGN L T P C
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COURSEOBJECTIVES:
1. To understand the basic concepts of unconstrained optimization techniques.
2. To understand the basic concepts of constrained optimization techniques.
3. To provide the mathematical foundation of artificial neural networks and swarm intelligence for design problems.
4. To implement optimization approaches and to select appropriate solution for design application.
5. To demonstrate selected optimization algorithms commonly used in static and dynamic applications.

UNIT– I UNCONSTRAINED OPTIMIZATION TECHNIQUES 9
Introduction to optimum design - General principles of optimization - Problem formulation & their classifications- Single variable and multivariable optimization, Techniques of unconstrained minimization - Golden section, Random, pattern and gradient search methods - Interpolation methods.

UNIT– II CONSTRAINED OPTIMIZATION TECHNIQUES 9
Optimization with equality and inequality constraints-Direct methods-Indirect methods using penalty functions, Lagrange multipliers-Geometric programming.

UNIT–III ARTIFICIAL NEURAL NETWORKS AND SWARM INTELLIGENCE 9
Introduction-Activation functions, types of activation functions, neural network architectures, Single layer feed forward network, multi layer feed forward network, Neural network applications. Swarm intelligence-Various animal behaviors, Ant Colony optimization, Particle Swarm optimization.

UNIT– IV ADVANCED OPTIMIZATION TECHNIQUES 9
Multistage optimization-dynamic programming, stochastic programming Multi objective optimization Genetic algorithms and Simulated Annealing technique.

UNIT– V STATIC AND DYNAMIC APPLICATIONS 9

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 applications.
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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ED4154 VIBRATION ANALYSIS AND CONTROL
L T P C 3 0 0 3

COURSE OBJECTIVES
1. To appreciate the basic concepts of vibration in damped and undamped systems
2. To calculate the natural frequencies and mode shapes of the two degree freedom systems
3. To determine the natural frequencies and mode shapes of the multi degree freedom and continuous systems
4. To learn the fundamentals of control techniques of vibration and noise levels
5. To use the instruments for the measuring and analyzing the vibration levels in a body

UNIT-I FUNDAMENTALS OF VIBRATION
UNIT-II  
**TWO DEGREE FREEDOM SYSTEM**  
9+3  
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**  
9+3  
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 & Eigenvectors for large system of equations using sub space, Lanczos method - Continuous System: Vibration of String, Shafts and Beams

UNIT-IV  
**VIBRATION AND NOISE CONTROL**  
9+3  

UNIT-V  
**EXPERIMENTAL METHODS IN VIBRATION ANALYSIS**  
9+3  

TOTAL = 60 PERIODS

**COURSE OUTCOMES:**

On Completion of the course the student will be able to

**CO1**  Apply the basic concepts of vibration in damped and undamped systems

**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

**REFERENCES:**

4. WilliamT.Thomson,“TheoryofVibrationwithApplications”,Taylor&Francis,2018

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1-low, 2-medium, 3-high, '-'- no correlation
OBJECTIVES:
1. To understand the different architectures for IoT.
2. To learn various protocols at the different layers for IoT.
3. To develop prototype systems using Arduino / RasberryPi.
4. To apply the use of data analytics in IoT.
5. To develop applications of IoT in Industrial contexts.

UNIT I ARCHITECTURES AND MODELS

UNIT II CONNECTIVITY

UNIT III SYSTEM DEVELOPMENT
Design Methodology – Case study – Basic blocks of IoT device – Raspberry Pi – Board, Interfaces, Linux, Setting up, Programming – Arduino – Other IoT Devices.

UNIT IV DATA ANALYTICS AND IoT SECURITY

UNIT V IoT IN INDUSTRY

OUTCOMES:
On completion of the course the student will be able to
- Explain the underlying architectures and models in IoT.
- Analyze different connectivity technologies for IoT.
- Develop simple applications using Arduino/RaspberryPi.
- Apply data analytics techniques to IoT.
- Study the need and suggest appropriate solutions for Industrial applications.

REFERENCES:
IC4291                  COMPUTATIONAL FLUID DYNAMICS                  L  T  P  C
                                  3  0  0  3

COURSE OBJECTIVES:

- This course aims to introduce numerical modeling and its role in the field of heat, fluid flow and combustion. It will enable the students to understand the various discretisation methods and solving methodologies and to create confidence to solve complex problems in the field of heat transfer and fluid dynamics.
- To develop finite volume discretised forms of the governing equations for diffusion processes.
- To develop finite volume discretised forms of the convection-diffusion processes.
- To develop pressure-based algorithms for flow processes.
- To introduce various turbulence models, Large Eddy Simulation and Direct Numerical Simulation.

UNIT – I                  GOVERNING DIFFERENTIAL EQUATIONS AND DISCRETISATION TECHNIQUES


UNIT – II                  DIFFUSION PROCESSES: FINITE VOLUME METHOD


UNIT – III                  CONVECTION-DIFFUSION PROCESSES: FINITE VOLUME METHOD

One dimensional convection – diffusion problem, Central difference scheme, upwind scheme – Hybrid and power law discretization techniques – QUICK scheme.

UNIT – IV                  FLOW PROCESSES: FINITE VOLUME METHOD

Discretisation of incompressible flow equations – Pressure based algorithms, SIMPLE, SIMPLER & PISO algorithms.

UNIT – V                  TURBULENCE MODELS

Turbulence – RANS equation - Algebraic Models, One equation model, Two equation models – k & standard k – ε model, Low Reynold number models of k- ε, Large Eddy Simulation (LES), Direct Numerical Simulation (DNS) - Introduction. Solving simple cases using standard CFD codes.

TOTAL:45 PERIODS
COURSE OUTCOMES:
On successful completion of this course the students will be able to:
- Analyse the governing equations and boundary conditions.
- Analyse various discretization techniques for both steady and unsteady diffusion problems.
- Analyse the various convection-diffusion problems by Finite-Volume method.
- Analyse the flow processes by using different pressure bound algorithms.
- Select and use the different turbulence models according to the type of flows.

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REFERENCES:

PD4006 HUMAN FACTORS ENGINEERING IN PRODUCT DESIGN

OBJECTIVES:
The main learning objective of this course is to prepare students for
1. Applying the fundamental concepts and principles of ergonomics in product design and development.
2. Applying the concept and principles of work place design in product design and development.
3. Applying the concept and principles of equipment design in product design and development.
4. Applying the concept and principles of environmental design in product design and development.
5. Applying the concept and principles of cognitive ergonomics & human factor application in product design and development.

UNIT I FUNDAMENTALS OF ANTHROPOMETRY IN ERGONOMICS
UNIT II  ERGONOMICS IN WORKPLACE DESIGN  9

UNIT III  ERGONOMICS IN EQUIPMENT DESIGN  9

UNIT IV  ERGONOMICS IN ENVIRONMENTAL DESIGN  9
Heat, cold and the design of the physical environment – Vision, light and lighting – Hearing, sound, noise and vibration.

UNIT V  COGNITIVE ERGONOMICS & HUMAN FACTOR APPLICATION  9

TOTAL = 45 PERIODS

OUTCOMES:
Upon completion of this course, the students will be able to:
1. Apply the fundamental concepts and principles of ergonomics in product design and.
2. Apply the concept and principles of workplace design in product design and development.
3. Apply the concept and principles of equipment design in product design and development.
4. Apply the concept and principles of environmental design in product design and development.
5. Apply the concept and principles of cognitive ergonomics & human factor application in product design and development.

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COURSE OBJECTIVES:
1. Fundamental concepts of electric and hybrid vehicle operation and architectures.
2. Understand the properties of batteries and its types.
3. Provide knowledge about design of series hybrid electric vehicles.
4. Provide knowledge about design of parallel hybrid electric vehicles.
5. Understand of electric vehicle drive train.

UNIT – I INTRODUCTION TO ELECTRIC VEHICLES

UNIT – II ENERGY SOURCE

UNIT – III SERIES HYBRID ELECTRIC DRIVE TRAIN DESIGN

UNIT – IV PARALLEL HYBRID ELECTRIC DRIVE TRAIN DESIGN

UNIT – V ELECTRIC VEHICLE DRIVE TRAIN

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

CO1 Explain how a hybrid vehicle works 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.

REFERENCES:
   http://nptel.ac.in/courses/108103009/
OBJECTIVES:
The main learning objective of this course is to prepare students for
1. Apply and develop mathematical model of a system
2. Applying the design and suggest bearings for specific applications
3. Applying a fatigue life calculation for various types of bearings
4. Apply and analyze bearing behavior
5. Study the dynamics of rotors mounted on Hydrodynamic Bearings.

UNIT I
INTRODUCTION TO ROTOR DYNAMICS
Torsional vibrations analysis – critical speeds and response to imbalance - Transfer matrix analysis - Instability of rotors - Gyroscopic effects

UNIT II
HYDRODYNAMIC BEARINGS
Hydrodynamic Lubrication equation for dynamic loadings - Squeeze film effects in journal bearings and thrust bearings - Rotating loads, alternating and impulse loads in journal bearings - Journal center Trajectory - Analysis of short bearings under dynamic conditions - Finite difference solution for dynamic conditions.

UNIT III
BALANCING OF ROTORS
Classification of rotors and balancing criteria, balancing of rigid and flexible rotors - balance criteria for flexible rotors

UNIT IV
ROTOR DYNAMICS IN TURBOMACHINEY DESIGN
Motion of the shaft in the bearing - Rotor supported on rigid and flexible supports - Campbell diagram, Rotor Dynamic Analyses - Undamped critical speed - Unbalance response - Damped eigenvalue analysis - Bearing stiffness and damping coefficients - Mechanics of Hydro dynamic Instability - Half frequency whirl and Resonance whip - bearing instability and Oil Whirl Technologies to Improve the Stability of Rotor-bearing Systems - Design configurations of stable journal bearings.

UNIT V
DYNAMICS OF ROTORS MOUNTED ON HYDRODYNAMIC BEARINGS
Hydrodynamic Lubrication equation for dynamic loadings - Squeeze film effects in journal bearings and thrust bearings - Rotating loads, alternating and impulse loads in journal bearings - Journal center Trajectory - Analysis of short bearings under dynamic conditions - Finite difference solution for dynamic conditions.

TOTAL = 45 PERIODS
OUTCOMES:
Upon completion of this course, the students will be able to:
- understand application of various types of bearings and their operating principles
- design and suggest bearings for specific applications
- perform fatigue life calculations for various types of bearings,
- understand and analyze bearing behavior
- study the dynamics of rotors mounted on Hydrodynamic Bearings

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REFERENCES:

OBJECTIVES:
1. To study different concepts in selecting bio and smart materials
2. To import knowledge on different electro-rheological and piezoelectric materials
3. To import knowledge on different shape memory materials and their applications of materials in biomedical engineering and special materials for actuators, sensors, etc.
4. To import knowledge on Materials for oral and maxillofacial surgery
5. To import knowledge on materials for cardiovascular ophthalmology and skin regeneration.

UNIT I INTRODUCTION

UNIT II DENTAL MATERIALS

UNIT III ORTHOPAEDIC MATERIALS
UNIT IV  WOUND DRESSING MATERIALS AND SURGICAL AIDS
Skin structure – defects (burn, ulcer, trauma etc) and disease- skin regeneration – classification of regenerative material – Sutures- Adhesives – classification – Surgical tools- materials – sterilization - Laparoscopic tools

UNIT V  CARDIOVASCULAR, OPHTHALMOLOGY AND DRUG DELIVERY MATERIALS

OUTCOMES:
On Completion of the course the student will be able to
- Use of Bio materials for cardiovascular Opthalmology and Skin Regeneration
- Use of Bio materials for Dental & Bone application
- Use of shape memory alloys in engineering application
- Explain the characteristics of Bio and smart materials
- Use of smart materials as sensors, actuators.

TOTAL: 45 PERIODS

REFERENCES:
AUDIT COURSES

AX4091 ENGLISH FOR RESEARCH PAPER WRITING L T P C 2 0 0 0

OBJECTIVES
- Teach how to improve writing skills and level of readability
- Tell about what to write in each section
- Summarize the skills needed when writing a Title
- Infer the skills needed when writing the Conclusion
- Ensure the quality of paper at very first-time submission

UNIT I INTRODUCTION TO RESEARCH PAPER WRITING 6
Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNIT II PRESENTATION SKILLS 6

UNIT III TITLE WRITING SKILLS 6
Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check

UNIT IV RESULT WRITING SKILLS 6
Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

UNIT V VERIFICATION SKILLS 6
Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first-time submission

TOTAL: 30 PERIODS

COURSE OUTCOMES
CO1 – Understand that how to improve your writing skills and level of readability
CO2 – Learn about what to write in each section
CO3 – Understand the skills needed when writing a Title
CO4 – Understand the skills needed when writing the Conclusion
CO5 – Ensure the good quality of paper at very first-time submission

REFERENCES
COURSE OBJECTIVES

- Summarize basics of disaster
- Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Develop the strengths and weaknesses of disaster management approaches

UNIT I INTRODUCTION
Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT II REPERCUSSIONS OF DISASTERS AND HAZARDS

UNIT III DISASTER PRONE AREAS IN INDIA
Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics

UNIT IV DISASTER PREPAREDNESS AND MANAGEMENT
Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT V RISK ASSESSMENT
Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People’s Participation in Risk Assessment. Strategies for Survival

TOTAL : 30 PERIODS

COURSE OUTCOMES

CO1: Ability to summarize basics of disaster
CO2: Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
CO3: Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
CO4: Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
CO5: Ability to develop the strengths and weaknesses of disaster management approaches
REFERENCES

AX4093 CONSTITUTION OF INDIA

OBJECTIVES
Students will be able to:
- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals’ constitutional Role and entitlement to civil and economic rights as well as the emergence nationhood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolutionin1917 and its impact on the initial drafting of the Indian Constitution.

UNIT I HISTORY OF MAKING OF THE INDIAN CONSTITUTION
History, Drafting Committee, (Composition & Working)

UNIT II PHILOSOPHY OF THE INDIAN CONSTITUTION
Preamble, Salient Features

UNIT III CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES

UNIT IV ORGANS OF GOVERNANCE
Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

UNIT V LOCAL ADMINISTRATION

UNIT VI ELECTION COMMISSION
Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.

TOTAL: 30 PERIODS

OUTCOMES
Students will be able to:
- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
- Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
- Discuss the passage of the Hindu Code Bill of 1956.
SUGGESTED READING
- The Constitution of India, 1950 (Bare Act), Government Publication.

AX4094  தமிழின் துவக்க நூல்  L T P C  2 0 0 0

UNIT I
சங்க இலக்கியம்  6
1. தமிழின் துவக்க நூல் வதொல்கொப்பியம்
   - பார்க்கி, முனை, போபால்
2. அகநொனூறு (82)
   - வம்பநேக திரிகாலநாய் அரங்கம்
3. குறிஞ்சிப் பொட்டின் மலர்க்கொட்சி
4. புறநொனூறு (95,195)
   - பபகன் பியினம் வங்கொமார்

UNIT II
அறநநறித் தமிழ்  6
1. அறநநறித் தக்கொர- இலக்கியம்
   - அரபி முப்பதிகொர, வங்கொமார், முப்பதிகொர, வங்கொமார், பகு, பகு
2. பிற அறநொனூறு - இலக்கியம்
   - அரங்கம், சிற்பநிலக்கொமார், முதிர்கொமார், அசைருக்கனூறு (கபொப்பாலம் விகிதம் வங்கொமார்)

UNIT III
இரட்டக் கொப்பியங்கள்  6
1. கண்கப்பதிகொர புரட்சி
   - சிற்பநிலக்கொமார் வங்கொமார் காலத்
2. பகுதிகளின் தக்கொமார் மணிப்பகொமார்
   - சிற்பநிலக்கொமார் அபதேக்கர்மார் காலத்

UNIT IV
அன்னனறித் தமிழ்  6
1. சிற்பநிலக்கொமார் பாபொரி
   - பபகன் வருகொரகான் வகும் சத்துக்கால், பபகன் முப்பதிகொர, பபகன் வருகொரகான் வகும் சத்துக்கால், அபமண் வருகொரகான் வகும் சத்துக்கால்
2. நாடகியன்
   - அன்னநநறித் பாபொரிய நாடக் தினம்
3. சிற்பநிலக்கொமார் (617, 618)
   - தபொருள் தினம் விகிதம்
4. திருமந்திரம் பகுதிகளின் தினம் வங்கொமார்
5. பபகன்
   - சிற்பநிலக்கொமார் வங்கொமார்
6. அகநொனூறு (4) - வணிகம்
UNIT V

தமிழ் தமிழ் இலக்கியம்

1. நவீன தமிழ் தமிழ்,
   - தமிழியல் புத்தகங்கள்,
   - தமிழியல் திசைகள்,
   - பல்கலைக் கழகங்கள்,
   - பயண இலக்கியம்,
   - நொட்டு விளிம்பு

2. நொட்டுவிடுத்தகள்

3. விளிம்பு விடுத்தகள்

4. பயண விளிம்பு விளிம்பு தமிழியல் தமிழியல்

5. அறிவியல் தமிழ்

6. உயிரியல் தமிழ்

7. சுற்றுசூழல் தமிழியல்

TOTAL: 30 PERIODS

தமிழ் இலக்கியம் வர்ணங்கள் / புத்தகங்கள்

1. தமிழ் விருது தமிழியல் (Tamil Virtual University)
   - www.tamilvu.org

2. தமிழ் விக்கிப்பீடியொ (Tamil Wikipedia)
   - https://ta.wikipedia.org

3. வொழியல் அரசியல் தொடர்பு

4. வொழியல் கல்வியினர்
   - தமிழ் பல்கலைக் கழகங்கள்

5. வொழியல் கல்வியினர்
   - தமிழ் வளர்ச்சி கழக (thamilvalarchithurai.com)

6. வொழியல் கல்வியினர்
   - தமிழ் பல்கலைக் கழகங்கள்