1. PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

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<tr>
<td>I.</td>
<td>To become effective and excellent collaborators and innovators, participating in efforts to address and provide fast and efficient solutions</td>
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<tr>
<td>II.</td>
<td>To provide creative and innovative solutions to industrial design problems using computer aided tools.</td>
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<tr>
<td>III.</td>
<td>To pursue advanced education, research and development and other creative/innovative efforts in their professional career.</td>
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2. PROGRAMME OUTCOMES (POs):

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<tr>
<td>1</td>
<td>An ability to independently carry out research/investigation and development work to solve practical problems.</td>
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<td>2</td>
<td>An ability to write and present a substantial technical report/document.</td>
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<td>3</td>
<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>4</td>
<td>Graduate will develop confidence for self-education and creativity knowledge in their field of Engineering.</td>
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<tr>
<td>5</td>
<td>Graduate will show the understanding of impact of engineering solutions on the society and also will be aware of contemporary issues.</td>
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<td>6</td>
<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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Every programme objectives must be mapped with 1,2,3,-, scale against the correlation PO’s.
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# ANNA UNIVERSITY, CHENNAI
NON-AUTONOMOUS COLLEGES AFFILIATED TO ANNA UNIVERSITY
M.E. COMPUTER AIDED DESIGN
REGULATIONS 2021
CHOICE BASED CREDIT SYSTEM
I TO IV SEMESTERS CURRICULA & SYLLABUS

## SEMESTER I

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### SEMESTER IV

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TOTAL CREDITS TO BE EARNED FOR THE AWARD OF THE DEGREE: 71
## PROFESSIONAL CORE COURSES (PCC)

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## RESEARCH METHODOLOGY AND IPR COURSE (RMC)

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### AUDIT COURSES (AC)

Registration for any of these courses is optional to students

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COURSE OBJECTIVES

1. To learn the concepts of theory of elasticity in three-dimensional stress system.
2. To study the shear centre of various cross-sections and deflections in beams subjected to unsymmetrical bending.
3. To learn the stresses in flat plates and curved members.
4. To study torsional stress of non-circular sections.
5. To learn the stresses in rotating members, contact stresses in point and line contact applications.

UNIT-I ELASTICITY 9+3

UNIT-II SHEAR CENTRE AND UNSYMMETRICAL BENDING 9+3
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 9+3
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 9+3
Torsion of rectangular cross section - St.Venants theory - elastic membrane analogy - Prandtl'sstress function - torsional stress in hollow thin walled tubes.

UNIT-V STRESSES IN ROTATING MEMBERS AND CONTACT STRESSES 9+3
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:
On Completion of the course the student 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 tomsymmetrical 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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Mapping of CO with PO

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ED4153 COMPUTER APPLICATIONS IN DESIGN

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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  

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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CD4151 CONCEPTS OF ENGINEERING DESIGN  

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COURSE OBJECTIVES

- To impart knowledge on basic concepts in engineering design.
- To develop a product catering to the need of a 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.
REFERENCES:

Mapping of CO with PO

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CD4152 DESIGN FOR SUSTAINABILITY

COURSE OBJECTIVES
1. Selecting the relevant process; applying the general design principles for manufacturability; GD & T.
2. Applying the design considerations while designing the cast and welded components.
3. Applying the design considerations while designing the formed and machined components.
4. Apply design considerations for assembled systems.
5. Apply design considerations for environmental issues.

UNIT-I INTRODUCTION
Introduction - Economics of process selection - General design principles for manufacturability; Geometric Dimensioning & Tolerance (GD&T)– Form tolerancing: straightness, flatness, circularity, cylindricity – Profile tolerancing: profile of a line, and surface – Orientation tolerancing: angularity, perpendicularity, parallelism – Location tolerancing: position, concentricity, symmetry – runout tolerancing: circular and total–Supplementary symbols.

UNIT-II CAST & WELDED COMPONENTS DESIGN

UNIT-III FORMED &MACHINED COMPONENTS DESIGN
Design considerations for: Metal extruded parts – Impact/Cold extruded parts – Stamped parts – Forged parts. Design considerations for: Turned parts– Drilled parts – Milled, planned, shaped and slotted parts–Ground parts.
UNIT-IV  DESIGN FOR ASSEMBLY

UNIT-V  DESIGN FOR ENVIRONMENT

TOTAL= 45 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
1.   Select relevant process; apply the general design principles for manufacturability; GD&T.
2.   Apply design considerations while designing the cast and welded components.
3.   Apply design considerations while designing the formed and machined components.
4.   Apply design considerations for assembled systems.
5.   Apply design considerations for environmental issues.

REFERENCES:
2.   Bralla, Design for Manufacture handbook, McGrawhill,1999

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1-low, 2-medium, 3-high, 4-“- no correlation

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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

TOTAL : 30 PERIODS

REFERENCES
COURSE OBJECTIVES:
- To impart knowledge on how to prepare drawings for various mechanical components using any commercially available 3D modeling software’s
  - CAD Introduction.
  - Sketcher
  - Solid modeling—Extrude, Revolve, Sweep and variational sweep, Loft
  - Surface modeling—Extrude, Sweep, Trim and Mesh of curves, Freeform.
  - Feature manipulation—Copy, Edit, Pattern, Suppress, History operations etc.
  - Assembly—Constraints, Exploded Views, Interference check
  - Drafting—Layouts, Standard & Sectional Views, Detailing & Plotting.

Exercises in modeling and drafting of mechanical components-assembly using parametric and feature-based packages like PRO-E/SOLIDWORKS/CATIA/NX

TOTAL: 60 PERIODS

OUTCOMES:
On completion of the course the student will be able to:
- Use the modern engineering tools necessary for engineering practice
- Draw 2D part drawings, sectional views, and assembly drawings as per standards.
- Create 3D Model on any CAD software.
- Convert 3D solid models into 2D drawings and prepare different views, sections, and dimensioning of part models.
- Examine interference to ensure that parts will not interfere.

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TOTAL:30 PERIODS
OUTCOMES:
On completion of the course the student will be able to
• Students comprehend concepts and methods adequate to understand inductive and deductive reasoning, and increase their general problem-solving skills.
• Students develop communicative skills (e.g. speaking, listening, reading, and/ or writing).

PD4391 PRODUCT LIFE CYCLE MANAGEMENT

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 databases, CAx & ERP systems

UNIT I HISTORY, CONCEPTS AND TERMINOLOGY OF PLM
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

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

UNIT IV ROLE OF PLM IN INDUSTRIES
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
PLM Customization, use of EAI technology (Middleware), Integration with legacy database, CAD, SLM and ERP

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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**REFERENCES**


**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 element matrices
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

TOTAL = 60 PERIODS

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

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<td>Determine field variables for two dimensional scalar and vector variable problems</td>
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<td>Apply Isoparametric transformation and numerical integration for evaluation of element matrices</td>
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<td>Apply various solution techniques to solve Eigen value problems</td>
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REFERENCES:

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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  9+3
Introduction - Sources of Vibration - Mathematical Models - Displacement, velocity and Acceleration.
Review Of Single Degree Freedom Systems - Vibration isolation Vibrometers and accelerometers
- Response To Arbitrary and non-harmonic Excitations – Transient Vibration – Impulse loads
Critical Speed Of Shaft-Rotor systems

UNIT II  TWO DEGREE FREEDOM SYSTEM  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:
   Publishing Com. Ltd., 2007

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CM4152 SOLID FREEFORM MANUFACTURING L T P C
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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

UNIT II DESIGN FOR ADDITIVE MANUFACTURING

UNIT III VAT POLYMERIZATION AND SHEET LAMINATION PROCESSES
UNIT IV  MATERIAL EXTRUSION AND POWDER BED FUSION PROCESSES  9

UNIT V  JETTING AND DIRECT ENERGY DEPOSITION PROCESSES  9

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of this course, the students shall be able to:
CO1: Relate the importance in the evolution of SFM/AM, proliferation into the various fields and its effects on supply chain.
CO2: Analyze the design for AM and its importance in the quality of fabricated parts.
CO3: Build knowledge on principles and applications of polymerization and sheet lamination processes with case studies.
CO4: Explain the principles of material extrusion and powder bed fusion processes and design guidelines.
CO5: Elaborate jetting and direct energy deposition processes and their applications.

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COURSE OBJECTIVE:
1. To evaluate the stiffness and natural frequency of spring-mass systems.
2. To determine the natural frequencies of damped and undamped torsional vibrations of single rotor systems and obtain the radius of gyration of a body through torsional oscillations.
3. To acquire the critical speed of shaft supported at its ends.
4. To assess the natural frequency, damping coefficient, mode shapes of specimens under free vibrations.
5. To determine the natural frequency of specimens under forced vibrations.

LIST OF EXPERIMENTS:
1) Determination of stiffness and natural frequency of undamped spring-mass systems arranged in series, parallel and series-parallel fashions.
2) Determination of effective radius of gyration of an irregular body through torsional oscillation of tri filar suspension.
3) Determination of natural frequency a single rotor undamped shaft system.
4) Determination of natural frequency a single rotor damped shaft system.
5) Determination of critical speed of shaft.
6) Determination of natural frequency and mode shapes of specimens supported at its ends through modal analysis.
7) Determination of damping coefficient of specimens supported at its ends.
8) Forced vibration of specimens supported under simply supported and cantilever boundary conditions – Determination of natural frequency.

TOTAL: 60 PERIODS

COURSE OUTCOMES:
On Completion of the course the student will be able to
CO 1 Evaluate the stiffness and natural frequency of spring-mass systems.
CO 2 Determine the natural frequencies of damped and undamped torsional vibrations of single rotor systems.
CO 3 Acquire the critical speed of shaft supported at its ends.
CO 4 Assess the natural frequency, damping coefficient, mode shapes of specimens under free vibrations.
CO 5 Determine the natural frequency of specimens under forced vibrations.

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ED4261  SIMULATION AND ANALYSIS LABORATORY

OBJECTIVES:
• To give exposure to software tools needed to analyze engineering 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

LIST OF EQUIPMENTS/SOFTWARE:
Finite Element Analysis packages

TOTAL: 60 PERIODS

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

CO1 Solve engineering problems numerically using Computer Aided Finite Element Analysis packages

CO2 Analyze the force, stress, deflection in mechanical components.

CO3 Analyze thermal stress and heat transfer in mechanical components.

CO4 Analyze the vibration of mechanical components.

CO5 Analyze the modal, harmonic, transient and spectrum concepts in mechanical components.

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COUSE OBJECTIVES:
- To identify a specific problem for the current need of the society and collecting information related to the same through detailed review of literature.
- To develop the methodology to solve the identified problem.
- 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.

TOTAL: 180 PERIODS

COURSE OUTCOMES:
On Completion of the course the student will be able to
CO1 Demonstrate a sound technical knowledge of their selected project topic.
CO2 Undertake problem identification, formulation and solution.
CO3 Design engineering solutions to complex problems utilising a systems approach

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.

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CD4411 PROJECT WORK II

OBJECTIVES:
- To solve the identified problem based on the formulated methodology.
- To develop skills to analyze and discuss the test results, and make conclusions.

SYLLABUS: The student should continue the phase I work on the selected topic as per the formulated methodology under the same supervisor. At the end of the semester, after completing the work to the satisfaction of the supervisor and review committee, a detailed report should be prepared and submitted to the head of the department. The students will be evaluated based on the report submitted and the viva-voce examination by a panel of examiners including one external examiner

TOTAL: 360 PERIODS
COURSE OUTCOMES:
On Completion of the course the student will be able to
CO1 Demonstrate a sound technical knowledge of their selected project topic.
CO2 Undertake problem identification, formulation and solution.
CO3 Design engineering solutions to complex problems utilising a systems approach.
CO4 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 better solutions to it.

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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
Characteristics of Successful Product development – Duration and Cost of Product Development –
Challenges of Product Development - Product Development Processes and Organizations –
Product Planning Process - Process of Identifying Customer Needs

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
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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COURSE OBJECTIVES:
1. Study of different composite materials and finding its mechanical strength
2. Fabrication of FRP and other composites by different manufacturing methods
3. Stress analysis of fiber reinforced Laminates for different combinations of plies with different orientations of the fiber.
4. Calculation of stresses in the lamina of the laminate using different failure theories
5. Calculation of residual stresses in different types of laminates under thermo-mechanical load using the Classical Laminate Theory.

UNIT-I INTRODUCTION TO COMPOSITE MATERIALS

UNIT- II MANUFACTURING OF COMPOSITES
Manufacturing of Polymer Matrix Composites (PMCs)-handlay-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

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

UNIT- V THERMO-STRUCTURAL ANALYSIS
Case studies: Implementation of CLT for evaluating residual stresses in the components made with different isotropic layers such as electronic packages etc.

COURSE OUTCOMES:
On Completion of the course the student will be able to
1. Calculate for mechanical strength of the composite material
2. Fabricate the FRP and other composites by different manufacturing methods
3. Analyze fiber reinforced Laminates for different combinations of plies with different orientations of the fiber.

TOTAL= 45 PERIODS
4. Evaluate the stresses in the lamina of the laminate using different failure theories
5. Analyze thermo-mechanical behavior and evaluate residual stresses in different types of laminates using the Classical Laminate Theory.

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ED4074 DESIGN OF HYDRAULIC AND PNEUMATIC SYSTEMS L T P C

COURSE OBJECTIVES:
1. To introduce the different components of hydraulic systems and its design and selection procedures.
2. To formulate a thorough understanding on the need and use of various control and regulating elements in hydraulic systems.
3. To enable them to independently design hydraulic circuits for industrial applications
4. To expose them to the different components of pneumatic systems and enable them to design simple pneumatic systems.
5. To make them understand the need to integrate electronics and develop low cost systems and provide solution to simple industrial applications

UNIT– I OIL HYDRAULIC SYSTEMS AND HYDRAULIC ACTUATORS
Hydraulic Power Generators – Selection and specification of pumps, pump characteristics. Linear and Rotary Actuators – selection, specification and characteristics, Hydrostatic drives, types, selection.

UNIT– II CONTROL AND REGULATION ELEMENTS
Pressure-direction and flow control valves-relief valves, non-return and safety valves-actuation systems, Proportional Electro hydraulic servo valves.
UNIT – III  HYDRAULIC CIRCUITS  9

UNIT – IV  PNEUMATIC SYSTEMS AND CIRCUITS  9
Pneumatic fundamentals-control elements, position and pressure sensing, Pneumatic equipments- selection of components - design calculations - logic circuits - switching circuits – fringe conditions modules and these integration-sequential circuits-cascade methods-mapping methods - step counter method - compound circuit design - combination circuit design-Karnaugh- Veitch map

UNIT – V  ELECTROMAGNETIC & ELECTRONIC CONTROL OF HYDRAULICS &  9
PNEUMATIC CIRCUIT

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
1. Design and select appropriate pumps in industries based on need.
2. Select correct sizing and rating of control elements in hydraulics.
3. Design basic circuits (hydraulic) for industrial applications.
4. Design basic pneumatic circuits for industrial applications.
5. Identify and provide solution for troubleshooting and design low cost automation for industrial application.

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COURSE OBJECTIVES:
1. To impart knowledge on various concepts in engineering design, material selection and manufacturing methods.
2. To learn the principles of implementing quality in a product or services using different tools.
3. To enhance the quality of product by use of failure mode effect analysis and implement methods to uphold the status of six sigma.
4. To develop a robust product or service using various strategies of design of experiments.
5. To maintain the quality of the product by use of statistical tools and enforce methods to improve the reliability of a product.

UNIT – I DESIGN FUNDAMENTALS, METHODS AND MATERIAL SELECTION

UNIT – II DESIGN FOR QUALITY
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 AND DESIGN FOR SIX SIGMA

UNIT – IV DESIGN OF EXPERIMENTS
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

TOTAL: 45 PERIODS
COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
1. Apply fundamentals of design process and material selection for developing a quality product
2. Apply the quality concepts to develop a robust product
3. Perform Failure Mode Effect Analysis on a product and use six sigma principles to enhance its quality
4. Apply different experimental design methods in product development
5. Implement various statistical tools to improve its quality and reliability

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MA4071  APPLIED PROBABILITY AND STATISTICS FOR DESIGN ENGINEERS

COURSE OBJECTIVES:
- To compute moments of standard distributions.
- To gain the knowledge about correlation and regression.
- To provide the most appropriate estimator of the parameter in statistical inference.
- To decide whether to accept or reject specific value of a parameters.
- To understand many real-world problems fall naturally within the frame work of multivariate normal theory.

UNIT - I  ONE DIMENSIONAL RANDOM VARIABLES
Random variables - Probability functions – Moments – Moment generating functions and their properties – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions – Function of a random variable.

UNIT - II  TWO DIMENSIONAL RANDOM VARIABLES
Joint distributions – Marginal and conditional distributions – Functions of two dimensional random variables – Correlation – Linear Regression.
UNIT- III  ESTIMATION THEORY

UNIT - IV  TESTING OF HYPOTHESIS
Sampling distributions – Type I and Type II errors – Small and large samples – Tests based on Normal, t, Chi square and F distributions for testing of mean, variance and proportions – Tests for independence of attributes and goodness of fit.

UNIT - V  MULTIVARIATE ANALYSIS
Random vectors and matrices – Mean vectors and covariance matrices – Multivariate normal density and its properties – Principal components - Population principal components – Principal components from standardized variables

COURSE OUTCOMES:
After completing this course, students should demonstrate competency in the following topics:

- Moments of discrete and continuous random variables.
- To deal problems involving two dimensional random variables.
- Unbiasedness of estimators, method of maximum likelihood estimation and Central Limit Theorem.
- Use statistical tests in testing hypotheses on data.
- Perform exploratory analysis of multivariate data, such as multivariate normal density, calculating descriptive statistics, testing for multivariate normality.

REFERENCES:

ED4080  TRIBOLOGY IN DESIGN  L  T  P  C
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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

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

REFERENCES:
COURSE OBJECTIVES
1. To study concept of Finite Element Analysis to solve problems involving plate and shell elements
2. To learn concept of Finite Element Analysis to solve problems involving geometric and material non linearity
3. To study solution techniques to solve dynamic problems
4. To study the concepts of Finite Element Analysis to solve fluid mechanics and heat transfer problems
5. To study error norms, convergence rates and refinement.

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=45PERIODS

COURSE OUTCOMES:
On Completion of the course the student 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.
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ED4152 ADVANCED MECHANISMS IN DESIGN

COURSE OBJECTIVES
1. To learn the concepts of gross motion capability and develop multi loop kinematic chainsand equivalent mechanisms
2. To study complex mechanisms to determine velocity and acceleration of output links.
3. To learn to locate inflection points and to draw the inflection circle
4. To study the synthesis of planar mechanisms
5. To learn to design of six bar coupler driven mechanisms and cam mechanisms

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 -crunode -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 & CAM MECHANISMS

TOTAL = 45 PERIODS

COURSE OUTCOMES:
On Completion of the course the student will be able to
1. Apply concepts of gross motion capability and develop multi loop kinematic chains andequivalent mechanisms
2. Determine velocity and acceleration of complex mechanisms
3. Evaluate inflection points and draw the inflection circle
4. Synthesise planar mechanisms
5. Design of six bar coupler driven mechanisms and cam mechanisms

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OBJECTIVE:
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  9

UNIT II  INTRODUCTION TO MACHINE LEARNING  9

UNIT III  SUPERVISED LEARNING  9

UNIT IV  UNSUPERVISED LEARNING  9

UNIT V  PROBABILISTIC GRAPHICAL MODELS  9

TOTAL:45PERIODS

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.

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1-low, 2-medium, 3-high, "-"- no correlation
REFERENCES:

CD4001 ADVANCED COMPUTER MANUFACTURING

COURSE OBJECTIVES:
1. To understand the impact of computer-integrated manufacturing (CIM) on productivity, product cost, and quality.
2. To obtain an overview of computer technologies for factory management and factory floor operations.
3. To understand the industrial applications of computer integrated manufacturing.
4. To understand evolution of cloud based design and manufacturing.

UNIT I INTRODUCTION

UNIT II ELEMENTS OF A GENERAL CIM SYSTEM
Types of CIM systems, CAD-CAM link for CIMS, Benefits of CAM, FMS and CIMS, Automated material handling systems, equipment and their functions. Integration of Robots in CIMS, automated guided vehicle navigation system, Automatic Storage and Retrieval Systems (AS/RS), Carousel storage system, design of automatic material handling system, KWO analysis, work-part transfer mechanisms.

UNIT III APPLICATION OF COMPUTER INTEGRATED MANUFACTURING (CIM) SYSTEMS
Concept and terminology, Part family formation, Classification and coding systems for components, Group technology machine cells. Group technology applications for computer-integrated manufacturing, Computer-aided Tooling Design for Manufacturing Processes-Industrial Applications.

UNIT IV INTELLIGENT SYSTEMS IN MANUFACTURING
Current Developments and Future Prospects-Artificial intelligence techniques and the components of an intelligent manufacturing system. Concept of Artificial Intelligence, Conceptual Learning, Artificial Neural Networks - Biological Neuron, Artificial Neuron, Types of Neural Networks, Applications in Manufacturing, key artificial intelligence technologies (fuzzy logic, artificial neural networks, expert systems and genetic algorithms).

UNIT V CLOUD-BASED DESIGN AND MANUFACTURING
Evolution of design and manufacturing systems, Characteristics and requirements for cloud-based design and manufacturing systems, Cloud-based design and manufacturing example scenario, Cloud-Based Desktop Factory.

TOTAL: 45 PERIODS
COURSE OUTCOMES:
- To understand the basics of CAD/CAM integration, PLM management and need of process planning in manufacturing
- To apply the knowledge of Expert systems, Group technology and part representation for various applications
- To analyze the use of CIM for the various industrial applications
- To know the use of AI in manufacturing
- To know the latest trends in the cloud based design and manufacturing and its contemporary issues

REFERENCES:
2. Intelligent Manufacturing Systems/ Andrew Kusiak/Prentice Hall.

ED4093 OPTIMIZATION TECHNIQUES IN DESIGN

UNIT- I UNCONSTRAINED OPTIMIZATION TECHNIQUES
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

UNIT–III  ARTIFICIAL NEURAL NETWORKS AND SWARM INTELLIGENCE
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
Multistage optimization–dynamic programming, stochastic programming Multi objective optimization Genetic algorithms and Simulated Annealing technique.

UNIT– V  STATIC AND DYNAMIC APPLICATIONS
Dynamic Applications – Optimum design of single, two degree of freedom systems, vibration absorbers. Application in Mechanisms–Optimum design of simple linkage mechanisms.

COURSEOUTCOMES:
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.

TOTAL: 45 PERIODS

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OBJECTIVES:
- To study different concepts in selecting bio and smart materials
- To import knowledge on different electro-rheological and piezoelectric materials
- To import knowledge on different shape memory materials and their applications of materials in biomedical engineering and special materials for actuators, sensors, etc.
- To import knowledge on Materials for oral and maxillofacial surgery
- 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, OPHTALMOLOGY AND DRUG DELIVERY MATERIALS

OUTCOMES:
On Completion of the course the student will be able to
- Use of Bio materials for cardiovascular Ophthalmology 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...

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COURSE OBJECTIVES:
1. The student will understand the principle of force and strain measurement.
2. The student will understand the vibration measurement and their applications.
3. To impart knowledge on the principle behind acoustics and wind flow measurements.
4. To familiarize with the distress measurements
5. To realize the non destructive testing principle and application

UNIT– I  FORCES AND STRAIN MEASUREMENT 9
Strain gauge, principle, types, performance and uses. Photo elasticity–Principle and applications

UNIT– II  VIBRATION MEASUREMENTS 9
Characteristics of Structural Vibrations–Linear Variable Differential Transformer(LVDT)–
Transducers for velocity and acceleration measurements. Vibration meter– Seismographs –
Vibration Analyzer – Display and recording of signals – Cathode Ray Oscilloscope – XY Plotter –
Chart Plotters–Digital data Acquisition systems.

UNIT– III  ACOUSTICS AND WIND FLOW MEASUREMENTS 9
Principles of Pressure and flow measurements–pressure transducers–sound level meter–
venturimeter and flow meters–wind tunnel and its use in structural analysis–structural modeling
–direct and indirect model analysis

UNIT– IV  DISTRESS MEASUREMENTS 9
Diagnosis of distress in structures–crack observation and measurements–corrosion of
reinforcement in concrete – Half-cell, construction and use – damage assessment – controlled
blasting for demolition.

UNIT– V  NON DESTRUCTIVE TESTING METHODS 9
Load testing on structures, buildings ,bridges and towers–Rebound Hammer –acoustice mission
–ultrasonic testing principles and application–Holography–use of laser for structural testing–Brittle
coating

TOTAL: 45 PERIODS
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 nondestructive testing methods for various engineering applications.

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BM4074
WEARABLE TECHNOLOGIES
L T P C 3 0 0 3

COURSE OBJECTIVES:
- Identify the motivation, guiding principles, and challenges of Wearable Computing.
- Develop skills pertaining to the design of a holistic interactive wearable system comprising of the physical, digital, and the human aspects.
- To provide the basic understanding of measurement and instrumentation systems and the insight of the resistive sensors and its applications in real life.
- To introduce the concept of the reactive sensors and self-generating sensors and its applications in real life
- To impart the importance of smart sensors, sensor interface standards for wearable device applications and to provide a brief overview of the wearable technology and its impact on social life

43
UNIT I
INTRODUCTION

UNIT II
WEARABLE SENSORS
Chemical and Biochemical sensors, System design, Challenges in chemical Bio-chemical sensing, Application areas - Inertia sensors, Parameters from inertia sensors - Applications for wearable motion sensors - Measurement of energy expenditure by body worn heat flow sensors.

UNIT III
FLEXIBLE ELECTRONICS

UNIT VI
ENERGY HARVESTING SYSTEMS

UNIT V
MONITORING PHYSICAL AND PHYSIOLOGICAL PARAMETERS
Wearable sensors for physiological signal measurement - Physical measurement: Cardiovascular diseases, Neurological diseases, Gastrointestinal diseases - Wearable and non-invasive assistive technologies: Assistive devices for individuals with severe paralysis, Wearable tongue drive system, Sensor signal-processing algorithm, Dual-mode tongue drive system.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
CO1: Understand the fundamentals of wearables, wearable design issues and user interfaces
CO2: Identify the different types of sensors used in wearable devices
CO3: Recognize the materials used in the field of flexible electronics technology and its power constraints
CO4: Summarize the techniques and issues associated with energy harvesting from human body
CO5: Elucidate the applications of wearable technology in health care

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PO
OBJECTIVES:
- To understand the fundamentals of Internet of Things
- To learn about the basics of IOT protocols
- To build a small low cost embedded system using IoT
- To apply the concept of I0T in the real world scenario

UNIT I INTRODUCTION AND ARCHITECTURE OF IoT

UNIT II INDUSTRIAL IoT

UNIT III IIOT ANALYTICS
Big Data Analytics and Software Defined Networks, Machine Learning and Data Science, Julia Programming, Data Management with Hadoop

UNIT IV IOT SECURITY

UNIT V CASE STUDY
Industrial IOT- Application Domains: Oil, chemical and pharmaceutical industry, Applications of UAVs in Industries, Real case studies: Milk Processing and Packaging Industries, Manufacturing Industries

TOTAL : 45 PERIODS

COURSE OUTCOMES:
Upon completion of this course, student will be able to
CO1: Understand the basic concepts and Architectures of Internet of Things.
CO2: Understand various IoT Layers and their relative importance.
CO3: Realize the importance of Data Analytics in IoT.
CO4: Study various IoT platforms and Security
CO5: Understand the concepts of Design Thinking.

REFERENCES:
1. Industry 4.0: The Industrial Internet of Things”, by Alasdair Gilchrist (Apress), 2017
3. Hands-On Industrial Internet of Things: Create a powerful Industrial IoT by Giacomo Veneri, Antonio Capasso, Packt, 2018.
COURSE OBJECTIVES:
The main learning objective of this course is to prepare students for:
1. Apply and develop mathematical model of a system
2. Applying vehicular vibrations and response of vehicle
3. Applying attire model based on required performance.
4. Applying the various vehicle performance, control methodologies to ensure stability and ride comfort
5. Applying the principles vertical, longitudinal and lateral dynamics vehicle design

UNIT-I BASIS OF VIBRATION

UNIT-II TYRES

UNIT-III VERTICAL DYNAMICS

UNIT-IV LONGITUDINAL DYNAMICS AND CONTROL

UNIT-V LATERAL DYNAMICS
Steady state handling characteristics. Steady state response to steering input. Testing of handling characteristics. Transient response characteristics, Direction control of vehicles. Roll center, Roll axis, Vehicle under side forces. Stability of vehicle on banked road and during turn. Effect of suspension on cornering

COURSE OUTCOMES:
On Completion of the course the student will be able to
CO1 Understand the basics of finding vibration in vehicle components and measuring equipments
CO2 Develop the knowledge of various tyres model and their parameters.
CO3 Design analysis and computer simulation of vertical dynamics in vehicles.
CO4 Understanding the aerodynamic concepts in longitudinal dynamics and control in vehicle dynamics.
CO5 Understand the concepts in lateral dynamics of vehicles.
### PD4151 CREATIVITY AND INNOVATION

**L T P C**

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<td>3. Applying the design principles of creativity in new product design and development.</td>
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<td>4. Applying the various innovation principles and practices in new product design and development.</td>
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<td>5. Applying the principles of innovation management in new product design and development.</td>
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#### 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 – Altshuller’s Engineering Parameters– Altshuller’s Inventive Principles– Altshuller’s Contradiction Matrix Algorithm.

#### UNIT V
**INNOVATION MANAGEMENT**


TOTAL: 45 PERIODS
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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CD4092 INDUSTRIAL ROBOTICS AND EXPERT SYSTEMS L T P C 3 0 0 3

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  9

UNIT III  ROBOT SENSORS  9

UNIT IV  ROBOT CELL DESIGN AND APPLICATION  9

UNIT V  ROBOT PROGRAMMING, ARTIFICIAL INTELLIGENCE  9
AND EXPERT SYSTEMS

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

REFERENCES

Mapping of CO with PO

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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 & GEOMETRIC FORM

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

TOTAL : 45 PERIODS

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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1-low, 2-medium, 3-high, '-'-no correlation
REFERENCES:
8. www.astm.org/labs/pages/131350.htm

IC4291      COMPUTATIONAL FLUID DYNAMICS      L   T   P   C
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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:

ED4092 ENGINEERING FRACTURE MECHANICS

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

UNIT-III  STATIONARY CRACK UNDER STATIC LOADING
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
Introduction to fatigue failure-S-N Curve-Crack Initiation-Crack propagation- Effect of an Overload-Variable amplitude Fatigue load-Crack closure- Characteristics of fatigue crack-Paris Law- Fatigue Crack Growth Test to evaluate Paris constants- life calculations for a given load amplitude – effects of changing the load spectrum
Environmental-assisted Fracture-Micro mechanisms-factors influencing Environmental-assisted fracture-Environment-assisted Fatigue Failure affecting fatigue performance, fatigue loading, constant and variable amplitude loading.

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

TOTAL (L: 45 )= 45 PERIODS

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.

REFERENCES:
ED4071 DESIGN OF HYBRID AND ELECTRIC VEHICLES L T P C

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 9

UNIT– II ENERGY SOURCE 9

UNIT–III SERIES HYBRID ELECTRIC DRIVE TRAIN DESIGN 9

UNIT– IV PARALLEL HYBRID ELECTRIC DRIVE TRAIN DESIGN 9
Control Strategies of ParallelHybridDriveTrain-DriveTrainParameters-EnginePowerCapacity-Electric Motor Drive Power Capacity-Transmission Design- Energy Storage Design

UNIT–V ELECTRIC VEHICLE DRIVE TRAIN 9

TOTAL: 45 PERIODS
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

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IL4093 SUPPLY CHAIN MANAGEMENT

OBJECTIVES:
- Explain the role of supply chain management in an organization.
- Identify the various aspects of supply chain management and the factors affecting them.
- Explain the relationship among various factors involved in planning, organising and controlling supply chain operations.
- Summarize the sourcing and inventory decisions involved in supply chain operations.
- Explain the use of information technology in supply chain management.

UNIT I INTRODUCTION SUPPLY CHAIN MANAGEMENT
Introduction, Types of supply chains with and examples, Evolution of SCM concepts, Supply chain performance, Strategic Fit, Drivers of Supply Chain Performance – key decision areas – External Drivers of Change. Supply contracts – centralized vs. decentralized system
UNIT II  SUPPLY CHAIN NETWORK DESIGN  9
Need for distribution network design- Factors affecting, Design options for distribution network. Network design decisions - Framework, factors influencing, Models of facility location and capacity allocation. Role of Transportation in supply chain, modes of transportation Modal Selection, Classification of carriers, Carrier Selection, Transportation Execution and Control. Food Mile Concept., design options.

UNIT III  DEMAND AND SUPPLY IN SUPPLY CHAIN  9
Forecasting in supply chain- Methods, Approach, Errors. Aggregate planning in supply chain- Problem, Strategies and Implementation. Predictable variability in supply chain, Managing supply and demand. Distribution strategies-direct shipment, traditional warehousing, cross docking, inventory pooling, transhipment, Choosing appropriate strategy, Milk Run Model.

UNIT IV  SOURCING AND INVENTORY DECISIONS IN SUPPLY CHAIN  9
Purchasing Vs Procurement Vs Strategic Sourcing, Item procurement importance matrix, Strategic Sourcing Methodology, Managing sourcing and procurement process, Supplier selection and evaluation, Bullwhip effect and its management, Economies of scale in supply chain- Cycle inventory, Estimation, Quantity discounts, Multi echelon cycle inventory. Uncertainty in supply chain- Safety inventory, Determination of appropriate level, Impact on uncertainty.

UNIT V  SUPPLYCHAIN AND INFORMATION SYSTEMS  9

OUTCOMES:
Students will be able to:
CO1: To introduce the concepts and elements of supply chain management.
CO2: to understand supply chain network design aspects for various manufacturing and service sectors.
CO3: To understand the principle of demand and supply in supply chain
CO4: To gain knowledge on the sourcing and inventory decisions in supply chain.
CO5: To understand the concepts of supply chain information systems.

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OBJECTIVES:
The students will be able to
- Understand Industry 4.0
- Apply IoT and IIoT for Industry 4.0
- Understand CPS for Industry 4.0

UNIT I
Introduction to Industry 4.0 The Various Industrial Revolutions - Digitalisation and the Networked Economy - Drivers, Enablers, Compelling Forces and Challenges for Industry 4.0 - Comparison of Industry 4.0 Factory and Today's Factory - Trends of Industrial Big Data and Predictive Analytics for Smart Business Transformation

UNIT II
Road to Industry 4.0 - Internet of Things (IoT) & Industrial Internet of Things (IIoT) & Internet of Services - Smart Manufacturing - Smart Devices and Products - Smart Logistics - Smart Cities - Predictive Analytics

UNIT III

UNIT IV
Role of data, information, knowledge and collaboration in future organizations - Resource-based view of a firm - Data as a new resource for organizations - Harnessing and sharing knowledge in organizations - Cloud Computing Basics - Cloud Computing and Industry 4.0

UNIT V
Industry 4.0 IIoT case studies - Opportunities and Challenges - Future of Works and Skills for Workers in the Industry 4.0 Era - Strategies for competing in an Industry 4.0 world – Society 5.0

OUTCOMES:
The students will be able to
- Use Industry 4.0 for Industrial Applications
- Use IoT and IIoT for Industry 4.0
- Apply smart devices Industrial Applications

TEXT BOOKS
1. Alasdair Gilchrist, Industry 4.0: The Industrial Internet of Things
COURSE OBJECTIVES:
1. Fundamental concepts related to material handling.
2. Design of various hoisting gears for different material handling applications.
3. Development of conveyer systems for material flow in different industrial production systems.
4. Design of elevators for various manufacturing and service applications.
5. Integrated mechanical system design for machine tools, power transmission and engine parts.

UNIT–I INTRODUCTIONS AND DESIGN OF HOISTS

UNIT–II DRIVES OF HOISTING GEAR
Hand and power drives - Traveling gear - Rail traveling mechanism - cantilever and monorailcranes-slewing,jibandluffinggear-cogwheeldrive-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-Design of fork lift trucks.

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

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
CO1 Design hoists and brakes used in any handling applications.
CO2 Design drive mechanisms and hoisting gear for different handling applications.
CO3 Design different conveyer systems for material handling applications.
CO4 Design bucket, cage and fork lift 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

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APPROVED DATA BOOKS:

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AUDIT COURSES

AX4091  ENGLISH FOR RESEARCH PAPER WRITING  L T P C

COURSE 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
AX4092 DISASTER MANAGEMENT L T P C 2 0 0 0

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 6
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 6
Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

UNIT III DISASTER PRONE AREAS IN INDIA 6
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 6
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 6
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 L T P C
2 0 0 0

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 nation hood in the early years of Indian nationalism.
• To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 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  தமிழ் தொழிலியல்  L T P C  2 0 0 0

UNIT I  தமிழ் தொழிலியல்  6
1. கம்பியியை தொழில நோய் பிரபலப்பியும்
   – பாதுகாக்க, வேலை, பராமரிப்
2. இல்லாத்தும் (82)
   - விளையாட்டு விளக்கிகள் அருங்கம்
3. விளக்கியும் பதிவு மருத்துவக்கல்லுத்
4. பாதுகாப்பு (95,195)
   - விளையாட்டு ஊற்றுக்கோட்டை கலாசாரம்

UNIT II  மூலம்  6
1. அவளியுடைய விளக்கு விளக்கிகள்
   - அம்மன் பொறியியை, அசுர்காதை, புராணத்தில் தொடர், புரட்சி
2. பி அவளியுடைய - விளக்கியும் மருத்துவக்கல்லுத்
   - விளக்கி, விளக்குத்துறையும், விளக்கியும், அவளியுடைய
   (சமயவியல் விளக்கியும் தொடர்)
UNIT III

1. கணக்கசோதனை பார்வை
   - தமிழ்ப் பொறியியல் கல்லூரி
   - செயல்பாடுமுறைப் பாடல்

UNIT IV

1. கணக்கெழுத்து பாடல்
   - பார்வையின் இலக்கியச் சிகிச்சை, பாடல் மறுபக்கம்
   - பார்வையின் இலக்கியச் சிகிச்சை
2. நற்றிகணக் குறிப்பிட்டு
3. திருமந்திரம் (617, 618)
4. தர்மபுராணம்
5. புறநொனூறு
6. அகநொனூறு (4)

UNIT V

1. தமிழ்ச் சொல்வாய்
2. தெய்வத்திய விளக்கம்
3. தெய்வத்திய விளக்கத் தமிழ் பல்கலைக்கழகம்
4. தமிழ்மலைத்தொகுத்துக்குழு விளக்கம்
5. அறிவியல் தமிழ்
6. இகணயத்தில் தமிழ்
7. சுற்றுசூழல் தமிழ்

TOTAL: 30 PERIODS

தமிழ் இகணய சொல்வாய் வழிபாடுகள் / புநர்பாடுகள்
1. தமிழ் விளக்கம் வழிபாடு (Tamil Virtual University) - www.tamilvu.org
2. தமிழ் விக்கிப்பீட்டி (Tamil Wikipedia) - https://ta.wikipedia.org
3. தமிழ் பல்கலைக்கழகம்
4. தமிழ் பல்கலைக்கழகம் - தமிழ் விளக்கம்
5. தமிழ் விளக்கம் - தமிழ் வழிபாடு (thamilvalarchithurai.com)
6. அறிவியல் தமிழ் - தமிழ் வழிபாடு