PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):
1. To impart knowledge to students in recent advances in the Computer Aided Manufacturing to educate them to prosper in Manufacturing engineering and research related professions.
2. To enhance the mathematical, scientific and engineering fundamentals the provide students with a solid foundation in required to solve analytical problems.
3. To coach students with good design and engineering skills so as to comprehend, analyze, design, and produce novel materials, products and solutions for the contemporary manufacturing issues.
4. To inculcate students with professional and ethical attitude, effective communication skills, teamwork skills, multidisciplinary approach, and an ability to relate Computer Integrated Manufacturing engineering issues to broader engineering and social context.
5. To provide student with an academic environment conscious of research excellence, organizing capabilities, written ethical codes, discipline and guidelines, and the life-long learning needed for a successful professional career.

PROGRAMME OUTCOMES (POs):
On successful completion of the programme,
1. Graduates will demonstrate knowledge of mathematics, science and engineering.
2. Graduates will demonstrate an ability to identify, formulate and solve engineering problems.
3. Graduate will demonstrate an ability to design and conduct experiments, analyze and interpret data.
4. Graduates will demonstrate an ability to design a system, component or process as per needs and specifications.
5. Graduates will demonstrate an ability to visualize and work on laboratory and multidisciplinary tasks.
6. Graduate will demonstrate skills to use modern engineering tools, software and equipment to analyze problems.
7. Graduates will demonstrate knowledge of professional and ethical responsibilities.
8. Graduate will be able to communicate effectively in both verbal and written form.
9. Graduate will show the understanding of impact of engineering solutions on the society and also will be aware of contemporary issues.
10. Graduate will develop confidence for self education and ability for life-long learning.
Mapping of PEOs with POs

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2
## ANNA UNIVERSITY, CHENNAI

**AFFILIATED INSTITUTIONS REGULATIONS 2017**

**M.E. CAD / CAM**

**CHOICE BASED CREDIT SYSTEM**

I TO IV SEMESTERS (FULL TIME) CURRICULUM AND SYLLABUS

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**PRACTICAL**

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**TOTAL**

|        |             | Total                          |          |                 | 21 | 9 | 0 | 12 | 15 |

# SEMESTER IV

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**TOTAL**

|        |             | Total                          |          |                 | 24 | 0 | 0 | 24 | 12 |

**TOTAL CREDITS TO BE EARNED FOR THE AWARD OF THE DEGREE: 72**
## FOUNDATION COURSES (FC)

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<tr>
<th>SL. NO.</th>
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## PROFESSIONAL CORE (PC)

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<td>1.</td>
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# LIST OF ELECTIVES FOR M.E. CAD / CAM

## SEMESTER I (Elective I)

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<th>SL. NO.</th>
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## SEMESTER II (Elective II & III)

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## EMPLOYABILITY ENHANCEMENT COURSES (EEC)

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MA5156     APPLIED MATHEMATICS FOR ENGINEERS     L T P C
4    0    0    4

OBJECTIVES:
This course is designed to enrich the knowledge in various advanced mathematical techniques such as matrix theory, calculus of variations, probability and random variables, Laplace transforms and Fourier transforms. The fundamental concepts in these areas will be more useful for the students to model the engineering problems and solving them by applying these methods.

UNIT I      MATRIX THEORY    12
The Cholesky decomposition - Generalized Eigenvectors - Canonical basis - QR factorization - Least squares method - Singular value decomposition.

UNIT II     CALCULUS OF VARIATIONS    12
Concept of variation and its properties – Euler’s equation – Functional dependant on first and higher order derivatives – Functionals dependant on functions of several independent variables – Variational problems with moving boundaries – Isoperimetric problems - Direct methods : Ritz and Kantorovich methods.

UNIT III   PROBABILITY AND RANDOM VARIABLES    12

UNIT IV    LAPLACE TRANSFORM TECHNIQUES FOR PARTIAL DIFFERENTIAL EQUATIONS    12

UNIT V    FOURIER TRANSFORM TECHNIQUES FOR PARTIAL DIFFERENTIAL EQUATIONS    12

TOTAL : 60 PERIODS

OUTCOMES:
After completing this course, students should demonstrate competency in the following skills:
• Apply various methods in matrix theory to solve system of linear equations.
• Maximizing and minimizing the functional that occur in various branches of engineering disciplines.
• Computation of probability and moments, standard distributions of discrete and continuous random variables and functions of a random variable.
• Application of Laplace and Fourier transforms to initial value, initial–boundary value and boundary value problems in Partial Differential Equations.

REFERENCES:
OBJECTIVE:
- To impart knowledge on computer graphics which are used routinely in diverse areas as science, engineering, medicine, etc.

UNIT I INTRODUCTION TO COMPUTER GRAPHICS FUNDAMENTALS 9
Output primitives (points, lines, curves etc.), 2-D & 3-D transformation (Translation, scaling, rotation) windowing - view ports - clipping transformation.

UNIT II CURVES AND SURFACES MODELING 9

UNIT III NURBS AND SOLID MODELING 9

UNIT IV VISUAL REALISM 9
Hidden – Line – Surface – solid removal algorithms shading – coloring. Introduction to parametric and variational geometry based software’s and their principles creation of prismatic and lofted parts using these packages.

UNIT V ASSEMBLY OF PARTS AND PRODUCT DATA EXCHANGE 9

TOTAL : 45 PERIODS

OUTCOMES:
- It helps the students to get familiarized with the computer graphics application in design.
- This understanding reinforces the knowledge being learned and shortens the overall learning curve which is necessary to solve CAE problems that arise in engineering.

REFERENCES:
OBJECTIVE:
- The purpose of this course is to make the students get familiarized with various computer aided tools that can be implemented in various industrial applications.

UNIT I  COMPUTER AIDED MANUFACTURING

UNIT II  COMPUTER AIDED PROCESS PLANNING

UNIT III  COMPUTER AIDED INSPECTION

UNIT IV  REVERSE ENGINEERING

UNIT V  DATA MANAGEMENT

TOTAL: 45 PERIODS

OUTCOME:
- It helps the students to get familiarized with computer aided tools for various industrial applications which includes manufacturing, process planning, inspection, data management and reverse engineering.

REFERENCES
OBJECTIVE:
To emphasize the knowledge on the quality improvement, automation, and advanced manufacturing techniques to create the highest-caliber products quickly, efficiently, inexpensively, and in synchronization with the marketing, sales, and customer service of the company.

UNIT I MANUFACTURING IN A COMPETITIVE ENVIRONMENT 9

UNIT II GROUP TECHNOLOGY & FLEXIBLE MANUFACTURING SYSTEMS 9

UNIT III COMPUTER SOFTWARE, SIMULATION AND DATABASE OF FMS 9

UNIT IV LEAN MANUFACTURING: 9

UNIT V JUST IN TIME 9

OUTCOME:
- To impart knowledge on the pace of changes in the manufacturing technology

REFERENCES
5. Taiichi Ohno, Toyota Production System Beyond Large-Scale Production, Productivity Press, 1988
OBJECTIVE:
- To develop a thorough understanding of the advanced finite element analysis techniques with an ability to effectively use the tools of the analysis for solving practical problems arising in engineering design

UNIT I 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.

OUTCOMES:
1. The students will understand the Finite Element Formulation of Plate and Shell Elements and its application.
2. The students will be able to gain knowledge in material & geometric non-and plasticity.
3. The students will be able to solve problems under dynamic conditions by applying various techniques.
4. The students can arrive at the solutions for fluid mechanics and heat transfer problems.
5. The students will acquire knowledge in error norms, convergence rates and refinement.
6. The students will solve the real world engineering problems using FEA.

TOTAL: 45 PERIODS

REFERENCES:
ED5161       CAD LABORATORY

OBJECTIVE:
- 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, etc and Variational sweep, Loft, etc
  - Surface modeling – Extrude, Sweep, Trim, etc and Mesh of curves, Free form etc
  - Feature manipulation – Copy, Edit, Pattern, Suppress, History operations etc.
  - Assembly – Constraints, Exploded Views, Interference check
  - Drafting – Layouts, Standard & Sectional Views, Detailing & Plotting.
  - CAD data Exchange formats - IGES, PDES, PARASOLID, DXF and STL

Exercises in Modeling and drafting of Mechanical Components - Assembly using Parametric and feature based Packages like PRO-E / SOLID WORKS / CATIA / NX etc

OUTCOME:
- With laboratory classes, it helps the students to get familiarized with the computer applications in design and preparing drawings for various mechanical components.

TOTAL: 60 PERIODS

ED5162       ADVANCED ANALYSIS AND SIMULATION LABORATORY

OBJECTIVES:
- To give exposure to software tools needed to analyze engineering problems.
- 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.
7. Vibration analysis of spring-mass systems.
8. Model analysis of Beams.
9. Harmonic, transient and spectrum analysis of simple systems.

TOTAL: 60 PERIODS

OUTCOME:
- Upon completion of this course, the Students can model, analyse and simulate experiments to meet real world system and evaluate the performance.
OBJECTIVES:

- To know the concept of design for manufacturing, assembly and environment.
- To know the computer application in design for manufacturing and assembly.

UNIT I INTRODUCTION
General design principles for manufacturability - strength and mechanical factors, mechanisms selection, evaluation method, Process capability - Feature tolerances Geometric tolerances - Assembly limits - Datum features - Tolerance stacks.

UNIT II FACTORS INFLUENCING FORM DESIGN
Working principle, Material, Manufacture, Design- Possible solutions - Materials choice – Influence of materials on form design - form design of welded members, forgings and castings.

UNIT III COMPONENT DESIGN - MACHINING CONSIDERATION

UNIT IV COMPONENT DESIGN – CASTING CONSIDERATION
Redesign of castings based on Parting line considerations - Minimizing core requirements, machined holes, redesign of cast members to obviate cores. Identification of uneconomical design - Modifying the design - group technology - Computer Applications for DFMA

UNIT V DESIGN FOR THE ENVIRONMENT

TOTAL: 45 PERIODS

OUTCOME:

- To make the students get acquainted with the design for manufacturing, assembly and environment.

REFERENCES:

OBJECTIVE:
To educate students with fundamental and advanced knowledge in the field of Additive manufacturing technology and the associated Aerospace, Architecture, Art, Medical and industrial applications

UNIT I  INTRODUCTION:  9

UNIT II  REVERSE ENGINEERING AND CAD MODELING:  9

UNIT III  LIQUID BASED AND SOLID BASED ADDITIVE MANUFACTURING SYSTEMS  9

UNIT IV  POWDER BASED ADDITIVE MANUFACTURING SYSTEMS  9

UNIT V  TOOLING  9
Classification, Soft tooling, Production tooling, Bridge tooling, direct and indirect tooling, Fabrication processes, Applications Case studies automotive, aerospace and electronics industries

TOTAL: 45 PERIODS

OUTCOMES:
The students will be able to
1. Understand history, concepts and terminology of additive manufacturing
2. Apply the reverse engineering concepts for design development
3. Understand the variety of additive manufacturing techniques
4. Design and develop newer tooling models
5. Analyse the cases relevant to mass customization and some of the important research challenges associated with AM and its data processing tools

REFERENCES:
ED5252 MECHANICAL BEHAVIOR OF MATERIALS L T P C 3 0 0 3

OBJECTIVE:
- To know the mechanical behavior of both metallic and non-metallic materials under different loading and temperature conditions.

UNIT I BASIC CONCEPTS OF MATERIAL BEHAVIOR 10
Elasticity in metals and polymers—Strengthening mechanisms, work hardening, solid solutioning, grain boundary strengthening, poly phase mixture, precipitation, particle, fibre and dispersion strengthening. Effect of temperature, strain and strain rate on plastic behaviour—Super plasticity—Griffith’s theory—Ductile, brittle transition in steel—High temperature fracture, creep—Larson Miller parameter—Deformation and fracture mechanism maps.

UNIT II BEHAVIOUR UNDER DYNAMIC LOADS AND DESIGN APPROACHES 10
Stress intensity factor and fracture toughness—Fatigue, low and high cycle fatigue test, crack initiation and propagation mechanisms and Paris law—Safe life, Stress life, strain-life and fail-safe design approaches—Effect of surface and metallurgical parameters on fatigue—Fracture of non metallic materials—Failure analysis, sources of failure, procedure of failure analysis.

UNIT III SELECTION OF MATERIALS 10
Motivation for selection, cost basis and service requirements—Selection for mechanical properties, strength, toughness, fatigue and creep—Selection for surface durability corrosion and wear resistance—Relationship between materials selection and processing—Case studies in materials selection with relevance to aero, auto, marine, machinery and nuclear applications—Computer aided materials selection.

UNIT IV MODERN METALLIC MATERIALS 8
Dual phase steels, High strength low alloy (HSLA) steel, Transformation induced plasticity (TRIP) Steel, Maraging steel, Nitrogen steel—Intermetallics, Ni and Ti aluminides—smart materials, shape memory alloys—Metallic glass and nano crystalline materials.

UNIT V NON METALLIC MATERIALS 7
Polymeric materials—Formation of polymer structure—Production techniques of fibers, foams, adhesives and coating—structure, properties and applications of engineering polymers—Advanced structural ceramics, WC, TIC, TaC, Al2O3, SiC, Si3N4 CBN and diamond—properties, processing and applications.

TOTAL : 45 PERIODS

OUTCOME:
- To familiarize the researchers in the area of material behavior under different loading and selection of materials for the design of engineering structures.

REFERENCES:
OBJECTIVE
The course aims at providing the basic concepts of product design, product features and its architecture so that student can have a basic knowledge in the common features a product has and how to incorporate them suitably in product.

UNIT I INTRODUCTION 8
Need for IPPD-Strategic importance of Product development - integration of customer, designer, material supplier and process planner, Competitor and customer - behavior analysis. Understanding customer-promoting customer understanding-involve customer in development and managing requirements - Organization process management and improvement

UNIT II CONCEPT GENERATION, SELECTION AND TESTING 10

UNIT III PRODUCT ARCHITECTURE 8
Product development management - establishing the architecture - creation - clustering - geometric layout development - Fundamental and incidental interactions - related system level design issues - secondary systems -architecture of the chunks - creating detailed interface specifications-Portfolio Architecture.

UNIT IV INDUSTRIAL DESIGN 8

UNIT V DESIGN FOR MANUFACTURING AND PRODUCT DEVELOPMENT 11
Definition - Estimation of Manufacturing cost-reducing the component costs and assembly costs – Minimize system complexity - Prototype basics - Principles of prototyping - Planning for prototypes - Economic Analysis - Understanding and representing tasks-baseline project planning - accelerating the project-project execution.

**a Term Project/Presentation must be given for Assessment – 3 (Compulsory)**

OUTCOMES:
On completion of the course the student will be able to
- Understand the integration of customer requirements in product design
- Apply structural approach to concept generation, selection and testing
- Understand various aspects of design such as industrial design, design for manufacture, economic analysis and product architecture

REFERENCES:
5. www.me.mit/2.7444

EQUIPMENTS FOR CAM LAB
1. CAM Software for tool path generation for planer machining, contour machining, drilling, turning etc. & post processing modulus for different CNC controllers : 10 Nos
2. Medium production type CNC turning center with popular industrial type controller : 1
3. Medium production type CNC machining center with popular industrial type controller : 1
4. Bench Model CMM : 1
5. Vision & image processing software : 2
6. Data Processing Software : 2

TOTAL: 30 PERIODS

CC5212
OBJECTIVE:
- It is proposed to carryout detailed design calculations and analysis of any mechanical component or mechanical system. This helps the students to get familiar with respect to the design methodologies applied to any component or mechanical system subjected to static, dynamic and thermo-mechanical loads.

Each student is required to select any new component or an integrated mechanical system that involves various sub components which are to be designed as per design standards and further required to be analyzed for optimum dimensions with respect to the strength and stiffness.

OUTCOME:
- It helps the students to get familiarized with respect to design standards, design calculations and analysis in designing any mechanical component or system.

TOTAL: 60 PERIODS

PD5091
OBJECTIVE:
To understand history, concepts and terminology of PLM
To understand functions and features of PLM/PDM
To understand different modules offered in commercial PLM/PDM tools
To understand PLM/PDM implementation approaches
To understand integration of PLM/PDM with other applications
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 A PDM/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, organisation, 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 data base, CAD, SLM and ERP

OUTCOMES:
The students will be able to
1. Understand history, concepts and terminology of PLM.
2. Apply the functions and features of PLM/PDM.
3. Understand different modules offered in commercial PLM/PDM tools.
4. Understand PLM/PDM implementation approaches.
5. Integrate PLM/PDM with other applications.
6. Analyse the case studies.

REFERENCES
CC5311 PROJECT WORK PHASE I

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

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.

CC5411 PROJECT WORK PHASE 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

OUTCOME:
- 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.

CC5001 COMPUTER CONTROL IN PROCESS PLANNING

OBJECTIVE
- To provide the student with an understanding of the importance of process planning role in manufacturing and the application of Computer Aided Process Planning tool in the present manufacturing scenario

UNIT I INTRODUCTION
UNIT II  PART DESIGN REPRESENTATION  9
Design Drafting - Dimensioning - Conventional tolerance - Geometric tolerance - CAD - input / output devices - topology - Geometric transformation - Perspective transformation - Data structure - Geometric modelling for process planning - GT coding - The optiz system - The MICLASS system.

UNIT III  PROCESS ENGINEERING AND PROCESS PLANNING  9

UNIT IV  COMPUTER AIDED PROCESS PLANNING SYSTEMS  9
Logical Design of a Process Planning - Implementation considerations - manufacturing system components, production Volume, No. of production families - CAM-I, CAPP, MIPLAN, APPAS, AUTOPLAN and PRO, CPPP.

UNIT V  AN INTERGRADED PROCESS PLANNING SYSTEMS  9

OUTCOMES:
- Have a sound knowledge in process planning
- Handle computer aided process planning tool

REFERENCES

WEB REFERENCES:

ED5071  OPTIMIZATION TECHNIQUES IN DESIGN  L T P C
3 0 0 3

OBJECTIVE:
- To impart knowledge on various categories of existing engineering problems and solutions to such problems through different optimization techniques and approaches.

UNIT I  UNCONSTRAINED OPTIMIZATION TECHNIQUES  10
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  10
Optimization with equality and inequality constraints - Direct methods – Indirect methods using penalty functions, Lagrange multipliers - Geometric programming
UNIT III   ADVANCED OPTIMIZATION TECHNIQUES  10
Multi stage optimization – dynamic programming; stochastic programming; Multi objective optimization, Genetic algorithms and Simulated Annealing techniques; Neural network & Fuzzy logic principles in optimization.

UNIT IV   STATIC APPLICATIONS  8

UNIT V   DYNAMIC APPLICATIONS  7
Dynamic Applications – Optimum design of single, two degree of freedom systems, vibration absorbers. Application in Mechanisms – Optimum design of simple linkage mechanisms.

OUTCOME:
- It helps the students to get familiarized with the different approaches of optimizing (maximizing or minimizing) an engineering problem or a function.

REFERENCES

ED5092   ADVANCED MECHANICS OF MATERIALS  L T P C
3 0 0 3

OBJECTIVE:
- To know the fundamentals of mechanics of materials under various loading conditions.

UNIT I   ELASTICITY  9

UNIT II   SHEAR CENTER AND UNSYMMETRICAL BENDING  10
Location of shear center 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  10
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  7
Torsion of rectangular cross section - St.Venants theory - elastic membrane analogy - Prandtl's stress function - torsional stress in hollow thin walled tubes.
UNIT V  STRESSES IN ROTATING MEMBERS AND CONTACT STRESSES  9
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.

OUTCOME:
- It helps the students to be familiarized with the stresses under different loading conditions.

REFERENCES:

ED5073  INFORMATION ANALYTICS  L T P C
3 0 0 3

OBJECTIVE:
- To expose the students with fundamental concepts and the tools needed to understand emerging role of information analytics in the organisation.

UNIT – I  DATA ANALYTICS LIFE CYCLE  9
Introduction to Big data Business Analytics - State of the practice in analytics role of data scientists - Key roles for successful analytic project - Main phases of life cycle - Developing core deliverables for stakeholders.

UNIT – II  STATISTICS  9
Sampling Techniques - Data classification, Tabulation, Frequency and Graphic representation - Measures of central value - Arithmetic mean, Geometric mean, Harmonic mean, Mode, Median, Quartiles, Deciles, Percentile - Measures of variation – Range, IQR, Quartile deviation, Mean deviation, standard deviation, coefficient variance, skewness, Moments & Kurtosis.

UNIT – III  PROBABILITY AND HYPOTHESIS TESTING  9

UNIT – IV  PREDICTIVE ANALYTICS  9
Predictive modeling and Analysis - Regression Analysis, Multicollinearity, Correlation analysis, Rank correlation coefficient, Multiple correlation, Least square, Curve fitting and good ness of fit.

UNIT – V  TIME SERIES FORECASTING AND DESIGN OF EXPERIMENTS  9
Forecasting Models for Time series: MA, SES, TS with trend, season - Design of Experiments, one way classification, two way classification, ANOVA, Latin square, Factorial Design.

TOTAL: 45 PERIODS
OUTCOMES:
Upon completion of the course, the students will be able to
1. Understand the importance of data analysis in the design of new products.
2. Carry out statistical analysis.
3. Do probability analysis and hypothesis testing.
4. Perform predictive analysis.
5. Learn the effect of forecasting methods and to apply for business process.
6. Build a reliable, scalable, distributed information system.

REFERENCES:

CC5002 MECHATRONICS APPLICATIONS IN MANUFACTURING

OBJECTIVES:
- To impart knowledge about the elements and techniques involved in Mechatronics systems which are very much essential to understand the emerging field of automation.

UNIT I INTRODUCTION

UNIT II SENSORS AND TRANSDUCERS
Introduction - Performance Terminology - Displacement, Position and Proximity - Velocity and Motion - Fluid pressure - Temperature sensors - Light sensors - Selection of sensors - Signal processing - Servo systems.

UNIT III MICROPROCESSORS IN MECHATRONICS

UNIT IV PROGRAMMABLE LOGIC CONTROLLERS
Introduction - Basic structure - Input / Output processing - Programming - Mnemonics Timers, Internal relays and counters - Data handling - Analog input / output - Selection of PLC.

UNIT V DESIGN AND MECHATRONICS
Designing - Possible design solutions - Case studies of Mechatronics systems.

TOTAL: 45 PERIODS

OUTCOMES:
- Upon completion of this course, the Students can able to design mechatronics system with the help of Microprocessor, PLC and other electrical and Electronics Circuits.

REFERENCES:
OBJECTIVES:
- To achieve an understanding of principles of safety management.
- To enable the students to learn about various functions and activities of safety department.
- To enable students to conduct safety audit and write audit reports effectively in auditing situations.
- To have knowledge about sources of information for safety promotion and training.
- To familiarize students with evaluation of safety performance.

UNIT I  SAFETY MANAGEMENT  9

UNIT II  OPERATIONAL SAFETY  9

UNIT III  SAFETY MEASURES  9
Layout design and material handling - Use of electricity - Management of toxic gases and chemicals - Industrial fires and prevention - Road safety - highway and urban safety - Safety of sewage disposal and cleaning - Control of environmental pollution - Managing emergencies in Industries - planning, security and risk assessments, on- site and off site. Control of major industrial hazards.

UNIT IV  ACCIDENT PREVENTION  9
Human side of safety - personal protective equipment - Causes and cost of accidents. Accident prevention programmes - Specific hazard control strategies - HAZOP - Training and development of employees - First Aid- Fire fighting devices - Accident reporting, investigation.

UNIT V  SAFETY, HEALTH, WELFARE & LAWS  9

TOTAL: 45 PERIODS

OUTCOMES:
- To understand the functions and activities of safety engineering department.
- To carry out a safety audit and prepare a report for the audit.
- To prepare an accident investigation report.
- To estimate the accident cost using supervisors report and data.
- To evaluate the safety performance of an organization from accident records.
- To identify various agencies, support institutions and government organizations involved in safety training and promotion.
REFERENCES:
1. Industrial safety and the law by P.M.C. Nair Publisher's, Trivandrum.
5. Occupational Safety Manual BHEL.

CD5071 ADVANCED TOOL DESIGN L T P C
3 0 0 3

OBJECTIVES:
- The purpose of this course is to make the students to get familiarized with the design of various tools that can be implemented for different mechanical operations

UNIT I INTRODUCTION TO TOOL DESIGN 8

UNIT II DESIGN OF CUTTING TOOLS 9
Mechanics of Metal cutting – Oblique and orthogonal cutting - Chip formation and shear angle - Single-point cutting tools – Milling cutters – Hole making cutting tools - Broaching Tools - Design of Form relieved and profile relieved cutters - Design of gear and thread milling cutters

UNIT III DESIGN OF JIGS AND FIXTURES 10

UNIT IV DESIGN OF PRESS TOOL DIES 10

UNIT V TOOL DESIGN FOR CNC MACHINE TOOLS 8

TOTAL: 45 PERIODS

OUTCOME:
- It helps the students to get familiarized with advanced tool design for various mechanical operations which includes cutting, jigs and fixtures, press tool dies and modern CNC machine tools.
REFERENCES:

ED5251 MECHANISMS DESIGN AND SIMULATION

OBJECTIVE:
- To develop a thorough understanding of the various mechanisms and its design and simulation with an ability to effectively use the various mechanisms in real life problems.

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

TOTAL : 45 PERIODS

** a Term Project must be given for Assessment – 3 (Compulsory)

OUTCOME:
- It helps the students to get familiarized with the advanced mechanisms which are necessary to design and simulate mechanisms.
REFERENCES:

ED5093 COMPUTATIONAL FLUID DYNAMICS

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 discretized forms of the CFD equations.
- To formulate explicit & implicit algorithms for solving the Euler Equations & Navier Strokes Equations.

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 MODELING OF COMBUSTION AND TURBULENCE
Mechanisms of combustion and Chemical Kinetics, Overall reactions and intermediate reactions, Reaction rate, Governing equations for combusting flows. Simple Chemical Reacting System (SCRS), Turbulence - Algebraic Models, One equation model & k – ε, k – ω models - Standard and High and Low Reynolds number models.

OUTCOME:
- On successful completion of this course the student will be able to apply the concepts of CFD to analyse the fluid flow and heat transfer in thermal systems.
REFERENCES:

CC5004 RELIABILITY IN ENGINEERING SYSTEMS

OBJECTIVES
• The ability to use statistical tools to characterise the reliability of an item;
• The working knowledge to determine the reliability of a system and suggest approaches to enhancing system reliability;
• The ability to select appropriate reliability validation methods

UNIT I RELIABILITY CONCEPT

UNIT II FAILURE DATA ANALYSIS

UNIT III RELIABILITY ASSESSMENT
Different configurations – Redundancy – m/n system – Complex systems: RBD – Baye’s method – Cut and tie sets – Fault Tree Analysis – Standby system.

UNIT IV RELIABILITY MONITORING

UNIT V RELIABILITY IMPROVEMENT

TOTAL: 45 PERIODS

OUTCOMES:
• Analyse the interference between strength and stress, or life data for estimating reliability;
• Apply the appropriate methodologies and tools for enhancing the inherent and actual reliability of components and systems, taking into consideration cost aspects; specify life test plans for reliability validation

REFERENCES
OBJECTIVE:
- To know the integrated design procedure of different machine elements for mechanical applications.

UNIT I  FUNDAMENTALS AND DESIGN OF SHAFTS  9

UNIT II  DESIGN OF GEARS AND GEAR BOXES  9

UNIT III  BRAKES & CLUTCHES  9
Dynamics and thermal aspects of brakes and clutches – Integrated design of brakes and clutches for machine tools, automobiles and mechanical handling equipments.

UNIT IV  INTEGRATED DESIGN  18
Integrated Design of systems consisting of shaft, bearings, springs, motor, gears, belt, rope, chain, pulleys, Cam & Follower, flywheel etc. Example - Design of Elevators, Escalators, Gear Box, Valve gear Mechanisms, Machine Tools

TOTAL: 45 PERIODS
The Pattern of Question Paper will consist of one Question from Unit – 4 for 50% of total marks.
** a Term Project must be given for Assessment – 3 (Compulsory)

OUTCOME:
- This will familiarize the students with the concepts of integration of design of machines and structures.

REFERENCES:

APPROVED DATA BOOKS
OBJECTIVE:
- To develop an understanding of the use and benefits of modeling and simulation in manufacturing systems design and operation.
- To develop an understanding of techniques to assess factory performance and identify areas for improvement.
- To develop an understanding of techniques to assess and manufacturing performance.
- To develop an understanding of techniques to enable responsive manufacturing systems.
- To provide the students with knowledge of a set of tools to enable them to assess the performance of a manufacturing facility.

UNIT I  MANUFACTURING SYSTEMS & CONTROL

UNIT II  MANUFACTURING PROCESSES

UNIT III  QUEUING MODELS
Notation for queues - Examples of queues in manufacturing systems - Performance measures - Little's result - Steady state analysis of M/M/m queue, queues with general distributions and queues with breakdowns - Analysis of a flexible machine center.

UNIT IV  QUEUING NETWORKS

UNIT V  PETRI NETS

TOTAL: 45 PERIODS

OUTCOMES:
- Model and simulate the operation of a small manufacturing system.
- Use simulation as a manufacturing system design technique.
- Justify the use of manufacturing modelling and simulation.
- Use techniques such as value stream mapping and IDEF to identify improvements required in a manufacturing system.
- Apply techniques such as design for changeover to improve manufacturing system performance.
- Explain how to use techniques such as experimental design to assess process capability within a manufacturing system.
- Describe current trends in global manufacturing.
OBJECTIVES:
- Impart the knowledge of quality assurance and inspection techniques.
- Familiarize with the various inspection and measurement techniques like contact and non-contact measurement by adapting Computer Aided Inspection.
- Impart the knowledge of working principles and calibration of various Systems.

UNIT I  MEASURING MACHINES  9

UNIT II  STATISTICAL QUALITY CONTROL  9
Data presentation - Statistical measures and tools - Process capability - Confidence and tolerance limits - Control charts for variables and for fraction defectives - Theory of probability - Sampling - ABC standard - Reliability and life testing.

UNIT III  LIQUID PENETRANT AND MAGNETIC PARTICLE TESTS  9

UNIT IV  RADIOGRAPHY  9
Sources of ray-x-ray production - properties of d and x rays - film characteristics - exposure charts - contrasts - operational characteristics of x ray equipment - applications.

UNIT V  ULTRASONIC AND ACOUSTIC EMISSION TECHNIQUES  9
Production of ultrasonic waves - different types of waves - general characteristics of waves - pulse echo method - A, B, C scans - Principles of acoustic emission techniques - Advantages and limitations - Instrumentation - applications.

TOTAL: 45 PERIODS

OUTCOMES:
- Acquire the knowledge in CMM and Image Processing
- Understand the concept of Laser Metrology and Computer Integrated Quality Assurance
- Acquire knowledge of magnetic particle testing
- Acquire knowledge of ultrasonic and Acoustic emission techniques

REFERENCES:
WEB REFERENCES:
1. www.metrologytooling.com
2. www.sisndt.com
3. www.iuk'tu-harburg.de

CC5006 QUALITY MANAGEMENT TECHNIQUES

OBJECTIVE:
- To provide student with the basic understanding of the approaches and techniques to assess and improve process and or product quality and reliability

UNIT I INTRODUCTION

UNIT II PLANNING
Vision, Mission, Quality policy and objective Planning and Organization for quality, Quality policy Deployment, Quality function deployment, introduction to BPR and analysis of Quality Costs.

UNIT III TQM PRINCIPLES

UNIT IV TQM TOOLS AND TECHNIQUES
PDSA, The Seven Tools of Quality, New Seven management tools, Concept of six sigma, FMEA, Bench Marking, JIT, POKA YOKE, 5S, KAIZEN, Quality circles.

UNIT V QUALITY SYSTEMS

TOTAL: 45 PERIODS

OUTCOMES:
- Have good knowledge of quality management principles
- Be well versed with Total Quality Management
- Have good knowledge of quality implementation techniques

REFERENCES
OBJECTIVES:
At the end of this course the student should be able to understand
- Concepts and applications of Cellular manufacturing systems
- Traditional and non-traditional approaches of Problem solving Performance measurement
- Human and economical aspects of CMS.

UNIT I  INTRODUCTION  2
Introduction to Group Technology, Limitations of traditional manufacturing systems, characteristics and design of groups, benefits of GT and issues in GT.

UNIT II  CMS PLANNING AND DESIGN  10

UNIT III  IMPLEMENTATION OF GT/CMS  10
Inter and Intra cell layout, cost and non-cost based models, establishing a team approach, Managerial structure and groups, batch sequencing and sizing, life cycle issues in GT/CMS.

UNIT IV  PERFORMANCE MEASUREMENT AND CONTROL  8
Measuring CMS performance - Parametric analysis - PBC in GT/CMS, cell loading, GT and MRP - framework.

UNIT V  ECONOMICS OF GT/CMS:  5
Conventional Vs group use of computer models in GT/CMS, Human aspects of GT/CMS - cases.

TOTAL: 45 PERIODS

OUTCOME:
- To impart knowledge on group technology, optimization algorithms, implementation of GT/CMS, Performance measurements and economical aspects of CMS.

REFERENCES
1. Askin, R.G. and Vakharia, A.J., G.T " Planning and Operation, in The automated factory-Hand

OBJECTIVE
- To understand the fundamentals of composite material strength and its mechanical behavior
- Understanding the analysis of fiber reinforced Laminate design for different combinations of plies with different orientations of the fiber.
- Thermo-mechanical behavior and study of residual stresses in Laminates during processing.
- Implementation of Classical Laminate Theory (CLT) to study and analysis for residual stresses in an isotropic layered structure such as electronic chips.
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 INTRODUCTION, LAMINA CONSTITUTIVE EQUATIONS

UNIT IV LAMINA STRENGTH ANALYSIS AND ANALYSIS OF LAMINATED FLAT PLATES

UNIT V THERMAL ANALYSIS

TOTAL: 45 PERIODS

OUTCOME
• At the end of the course the students will be in position to understand the mechanics and design related to layered components such as fiber reinforced polymer composites, isotropic layered structures (example electronic chips) etc and its manufacturing methodologies.

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

UNIT I MATEERIALS HANDLING EQUIPMENT 5
Types, selection and applications

UNIT II DESIGN OF HOISTS 10

UNIT III DRIVES OF HOISTING GEAR 10
Hand and power drives - Traveling gear - Rail traveling mechanism - cantilever and monorail cranes - slewing, jib and luffing gear - cogwheel drive - selecting the motor ratings.

UNIT IV CONVEYORS 10
Types - description - design and applications of Belt conveyors, apron conveyors and escalators - Pneumatic conveyors, Screw conveyors and vibratory conveyors.

UNIT V ELEVATORS 10
Bucket elevators: design - loading and bucket arrangements - Cage elevators - shaft way, guides, counter weights, hoisting machine, safety devices - Design of fork lift trucks.

TOTAL: 45 PERIODS

OUTCOME:
- The course would familiarize the student on the technique to select suitable material handling equipment and design them based on the need.

REFERENCES
OBJECTIVES:
- To teach students the basics of robotics, construction features, sensor applications, robot cell design, robot programming and application of artificial intelligence and expert systems in robotics.

UNIT I INTRODUCTION AND ROBOT KINEMATICS 10

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 AND EXPERT SYSTEMS 8

TOTAL: 45 PERIODS

OUTCOMES:
- The student will be able to design robots and robotic work cells and write program for controlling the robots.
- The student will be able to apply artificial intelligence and expert systems in robotics.

REFERENCES
OBJECTIVE:
- To impart knowledge on state of art IoT architecture, data and knowledge management and use of devices in IoT technology

UNIT-I INTRODUCTION
Machine to Machine (M2M) to IoT-The Vision-Introduction, From M2M to IoT, M2M towards IoT- the global context, A use case example, Differing Characteristics.

UNIT-II IoT STRUCTURE

UNIT-III IoT NETWORKING
M2M and IoT Technology Fundamentals- Devices and gateways, Local and wide area networking, Data management, Business processes in IoT, Everything as a Service (XaaS), M2M and IoT Analytics, Knowledge Management.

UNIT-IV IoT ARCHITECTURE

UNIT-V ARCHITECTURE MODELING

TOTAL: 45 PERIODS

OUTCOMES:
At the end of the course the student will be able to:
1. Understand the vision of IoT from a global context.
2. Determine the Market perspective of IoT.
3. Use of Devices, Gateways and Data Management in IoT.
4. Build state of the art architecture in IoT.
5. Understand the design constraints in the real world.
6. Apply of IoT in Industrial and Commercial Building Automation and Real World Design Constraints.

REFERENCES: