DEPARTMENT OF ENGINEERING DESIGN

Curriculum and Syllabus for

M.Tech. Engineering Design

(Applicable from the Academic year 2014 – 2015)
<table>
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* Student is permitted to choose an elective from other programmes. The electives may include the core subjects offered by other programmes.

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SEMESTER – I
PMA101 - ADVANCED ENGINEERING MATHEMATICS
[Common to M.Tech (Aero/Mech/Auto/CAD/Thermal/R&AC and IC Engine)]

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<td>Goal</td>
<td>Develop the Mathematical skills to formulate certain practical problems, solve them and analytically and numerically and to interpret the results.</td>
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**Objectives**

The course should enable the student to

- Understand the functional and the concepts of calculus of variation and its properties. Learns techniques to find the extremals of the variational problems involving one many unknown functions, functional dependent on higher order derivatives and isoperimetric problems.

- Learn to classify the initial and boundary value problems. Understands the D'Alemberts solution of the one dimensional wave equation. Understand the Fourier transform techniques for solving heat flow problems in infinite and semi infinite rod.

- Learn Harmonic functions and their properties. Understands solving the Laplace equation using Fourier transforms in a half plane with infinite strip and in a semi infinite strip.

- Understand to classify the partial differential equations. Learn the methods of solving second order partial differential equations numerically.

- Understands mapping and learns the concept of conformal mapping by doing the transformation from z plane to w plane.

**Outcomes**

The students should be able to:

- Able to find the extremals of the functional of different types and uses their technique to find the geodesic and solves isoperimetric problems. Using direct method finds the approximate solution and compares with the exact solutions using Ritz and Kantorovich methods.

- Able to form the wave equations with initial conditions and solve them using D'Alemberts solutions. Solves the wave equations using Laplace transform for displacements in long string – long string under its weight and free and forced vibrations. Applies Fourier transform techniques for solving the heat flow problems with infinite and semi infinite rods.

- Able to find the steady state temperature by solving the Laplace equation using Fourier transform techniques. Solves the heat flow problems in a half plane with infinite strip and in a semi infinite strip.

- Able to solve the initial and boundary value problems related heat flow, both one and two dimensional and vibration problems and obtains their numerical solutions. Understands the numerical techniques of solving the partial differential equation in engineering applications.

- Applies conformal mapping to fluid and heat flow problems.

**UNIT I      CALCULUS OF VARIATIONS**

Concept of variation and its properties- Euler’s Equation-Functional dependant on first and higher order derivatives - Functional dependant on functions of several independent variables- Isoperimetric problems –
Direct methods—Ritz and Kantrovich methods

UNIT II TRANSFORM METHODS

Laplace transform methods for one dimensional wave equation – Displacements in a long string – Longitudinal vibration of an elastic bar - Fourier Transform methods for one dimensional heat conduction problems in infinite and semi-infinite rod

UNIT III ELLIPTIC EQUATIONS

Laplace equation – Properties of Harmonic functions – Solutions of Laplace equation by means of Fourier transform in a half plane in an infinite strip and in a semi-infinite strip

UNIT IV NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS

Solution of Laplace and Poisson equation on a rectangular region by Lieebmann’s method – Diffusion equation by the explicit and Crank Nicolson – Implicit methods – Solution of wave equations by explicit scheme Cubic spline interpolation

UNIT V CONFORMAL MAPPING AND APPLICATIONS

The Schwarz – Christoffel transformation – Transformation of boundaries in parametric form – Physical applications - Application to fluid and heat flow

Total - 60

REFERENCES

PCD101 - COMPUTER AIDED GRAPHICS

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<td>Goal</td>
<td>To introduce the concepts of geometric modeling and three dimensional computer graphics</td>
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<td>To introduce the application concepts of three dimensional modeling</td>
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Objectives
The course should enable the students to:

1. To impart the knowledge on viewing transformations and algorithms
2. Understand the concepts of graphics and computing standards
3. Understand the concepts related to the applications of modeling

Outcome
The students should be able to:

1. Gain the knowledge on various transformations
2. Develop the on surface and solid modeling
3. Write algorithms related to 2D and 3D graphics

UNIT I  INTRODUCTION  8
Output primitives - Line drawing algorithm - Circles and other curves – Attributes of output - primitives - 2D, 3D transformations - Translation, Rotation, Scaling – Concatenation.

UNIT II  TECHNIQUES FOR GEOMETRIC MODELING  12

UNIT III  THREE DIMENSIONAL COMPUTER GRAPHICS  10

UNIT IV  GRAPHICS STANDARDS FOR CAD  8

UNIT V  3D MODELING APPLICATIONS AND SPECIAL TO TOPICS  7

Total : 45
TEXT BOOK

REFERENCES

WEB REFERENCES:
1. www.cadcamnet.com
2. www.cc.utah.edu/~asn8200/rapid.html
# PCD102 - FINITE ELEMENT METHODS

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## Goal

To teach the fundamentals of finite element method with emphasize on the underlying theory, assumption, and modelling issues as well as providing hands on experience using finite element software to model, analyze and design systems of mechanical and aerospace engineers.

## Objectives

### Outcome

The course should enable the students to:

1. Equip the students with the Finite Element Analysis fundamentals.
2. Formulate the design problems into FEA.
3. Introduce basic aspects of finite element technology, including domain discretization, polynomial interpolation, application of boundary conditions, assembly of global arrays, and solution of the resulting algebraic systems.
4. Understand the importance of verification and validation of finite element computations.

The students should be able to:

1. Solve ordinary and partial differential equations using the Galerkin method.
2. Develop the finite element equations to model engineering problems governed by 2nd, 3rd and 4th order ordinary differential equations.
3. Apply finite element techniques to formulate and solve structural, fluid, and thermal problems using finite element methodology.
4. Derive element matrix equation by different methods by applying basic laws in mechanics and integration by parts.

## Units

### UNIT I  INTRODUCTION

10

Relevance of finite element analysis in design – Modeling and discretization Interpolation, elements, nodes and degrees-of-freedom-applications of FEA


### UNIT II  BASIC ELEMENTS

10


### UNIT III  ISOPARAMETRIC ELEMENTS

8


### UNIT IV  FINITE ELEMENTS IN STRUCTURAL DYNAMICS APPLICATIONS

9

UNIT V  HEAT TRANSFER AND FLUID MECHANICS APPLICATIONS  8


Text Book:


References:


Web References:

2. http://www.mech.port.ac.uk/sdalby/mbm/CTFRProg.htm
PCD103 – INTEGRATED MECHANICAL DESIGN

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**Goal**

To teach the fundamentals of machine elements which emphasize on the underlying theory, assumption, and modeling issues as well as providing hands-on experience using finite element software to model, analyze and design systems of mechanical engineers.

**Objectives**

The course should enable the students to:

1. To equip the students with the machine design fundamentals and the phases of design.
2. To enable the students to understand the machine elements such as shaft, gear, clutch etc.
3. To introduce basic concepts of machine design.

**Outcome**

The students should be able to:

1. Design the machine element.
2. Develop the concepts.
3. Apply their new concept to optimize the Design.
4. Understand the importance of machine design this will lead the students to innovation.

**UNIT I** INTRODUCTION

- Phases of design – Standardization and interchangeability of machine elements - Tolerances from process and function – Individual and group tolerances – Selection of fits for different design situations – Design for assembly and modular constructions – Concepts of integration.

**UNIT II** SHAFTING

- Analysis and Design of shafts for different applications – detailed design – preparation of production drawings – integrated design of shaft, bearing and casing – design for rigidity.

**UNIT III** GEARS AND GEAR BOXES


**UNIT IV** CLUTCHES

- Integrated design of automobile clutches and over running clutches.

**UNIT V** BRAKES

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

**Total : 45**
REFERENCES:

WEB REFERENCES:
1. http://AGMA.org/
PCD104 - CONCEPT OF ENGINEERING DESIGN

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**Goal**
To introduce the concepts of design process, tools used in design methods, and knowledge on material selection, reliability and understanding of DFM/DFA, Legal and ethical issues in design and quality engineering.

**Objectives**
The course should enable the students to:

1. Widen students knowledge on design process
2. Enable Students to attain knowledge on tools used in Design Methods
3. Create an understanding on the process of material selection and design
4. Develop in depth knowledge on Engineering statistics and reliability
5. Create awareness on legal and ethical issues in Design and Quality Engineering.

**Outcome**
The students should be able to:

1. Get clear understanding on CAE / concurrent engineering and systems engineering
2. Attain problem solving skills through modeling/simulation and optimize design
3. Ability to do material selection based on economy and value analysis. Develop understanding on DFM/DFA
4. Have good understanding on DOE, Reliability theory and reliability centered maintenance
5. Exposed to laws, codes of ethics, Quality concepts and FMEA

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**UNIT I DESIGN PROCESS**


**UNIT II DESIGN METHODS**


**UNIT III MATERIAL SELECTION PROCESSING AND DESIGN**


**UNIT IV ENGINEERING STATISTICS AND RELIABILITY**


**UNIT V LEGAL AND ETHICAL ISSUES IN DESIGN AND QUALITY ENGINEERING**

9

TEXT BOOKS:

REFERENCES:
PCD 105 – ADVANCED STRENGTH OF MATERIALS

Goal
To make the students to understand the advanced concepts and techniques of strength of materials, both theoretical and experimental, with emphasis on the application of these to the solution of suitable problems in engineering. Provide advanced concepts for better understanding of complicated design problems.

Objectives
The course should enable the students to

1. Gain knowledge of stresses, strains and deformations in three dimensions.
2. Understand the concepts of unsymmetrical bending and the shear flow.
3. Provide knowledge on stresses and deformations in the curved beams and plates through mathematical models.
4. Understand the concept of torsion of non-circular sections.
5. Provide the knowledge on the stresses induced in the solid discs and ring due to rotation.

Outcome
The students should be able to

1. Use the concepts of conditions of equilibrium and compatibility equations and the plane stress.
2. Assess the stresses and the deflection of curved flexural members like chain links and crane hooks.
3. Apply the effect of stress, strains and deformations of flat circular and rectangular plates.
4. Assess the effect of twisting of non-circular sections and torsional shear stresses in the thin walled sections.
5. Assess the radial and tangential stresses in the solid discs and rings subjected to rotation.

UNIT I ELASTICITY

Shear Center: Location of Shear center for various sections - shear flows.

Unsymmetrical Bending: Stresses and deflections in beams subjected to unsymmetrical loading - Kern of a section.

UNIT II CURVED FLEXURAL MEMBERS
Circumferential and radial stresses- deflections- curved beam with restrained ends-closed ring subjected to concentrated load and uniform load chain links and crane hooks.

UNIT III STRESSES IN FLAT PLATES
Stresses in circular and rectangular plates due to various types of loading and end conditions -- buckling of plates and stress concentrations

UNIT IV TORISION OF NON-CIRCULAR SECTIONS
Torsion of rectangular cross sections-St. Venant’s theory - Elastic membrane Analog: y-Prandtl’s stress function-Torsional stresses in hollow thin-walled tubes.
UNIT V  STRESSES DUE TO ROTATION

Radial and tangential stresses in solid disc and ring of uniform, thickness and varying thickness-allowable speeds. Theor$\%$ of Contact Stresses:

Methods of computing contact stresses – Deflection of bodies in point and line contact
--Applications.

Total 45

REFERENCES:
8. Durelli, Phillips & Tsc, “Analysis of Stress and Strain”.

PCD 151 - CAD LAB

<table>
<thead>
<tr>
<th>PCD 151</th>
<th>CAD LAB</th>
<th>1 credits</th>
</tr>
</thead>
</table>
| **Goal** | To make students to understand and learn about design and development of various mechanical components using modelling software.  
To impart knowledge on all aspects of CAD industry.  
To provide quality education in the field of CAD recent developments |

**Objectives**

The course should enable the students to:

1. Learn and for giving hand on experience of using modelling softwares like Pro-E, CATIA V6
2. Train them for solving problems in short duration.

**Outcome**

The students should be able to:

1. Present an overview of CADD and describe its applications in different fields.
2. Describe common terms associated with CADD hardware and software.
3. Outline the basic principles associated with CADD and to demonstrate common drafting techniques used by professionals.
4. Introduce the advanced capabilities of CADD and how they can be used to increase productivity.
5. Provide information about the CADD industry resources.

---


Exercises in Modeling and Analysis of Mechanical Components and assembly using Parametric and Feature based packages like PRO-E/ SOLID WORKS / CATIA / NX/ ANSYS/NASTRAN etc.

**Total 45**

**Equipments for CAD Lab**

1. CAD Workstations : 10 Nos
2. CAD, 3D Modeling Software with assembly, mechanism simulation and drafting modules : 10 Nos
3. CAM Software for tool path generation for planer machining, contour machining, drilling, turning etc. & post processing modulus for different CNC controllers : 10 Nos
4. Medium production type CNC turning center with popular industrial type controller : 1
5. Medium production type CNC machining center with popular industrial type controller : 1
6. Bench Model CMM : 1
7. Vision & image processing software : 2
8. Data Processing Software : 2
### PCD 201 - OPTIMIZATION IN ENGINEERING DESIGN

**L T P C**

4 0 0 4

<table>
<thead>
<tr>
<th>PCD 201</th>
<th>OPTIMIZATION IN ENGINEERING DESIGN</th>
<th>4 Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Goal</strong></td>
<td>To make the students to understand the various concepts and techniques of optimization of linear and non-linear models, with emphasis on the application of these to the solution of various problems on design of machine elements. Provide a better understanding of design problems with optimization.</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Objectives</strong></th>
<th><strong>Outcome</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>The course should enable the students to</td>
<td>The students should be able to</td>
</tr>
<tr>
<td>1. Gain knowledge of fundamentals and classification of various optimization techniques.</td>
<td>1. Use the various techniques of optimization and provide an optimum solution to the problems involving the design of machine elements.</td>
</tr>
<tr>
<td>2. Understand the concepts of non-linear programming and various search methods.</td>
<td>2. Discrete the type of problems and optimize as per the requirements.</td>
</tr>
<tr>
<td>3. Provide knowledge on geometric programming.</td>
<td>3. Assess the search methods and provide local and/or global maxima or minima.</td>
</tr>
<tr>
<td>4. Understand the knowledge of optimization in designing of various machine elements.</td>
<td>4. stresses and the deflection of curved flexural members like chain links and crane hooks.</td>
</tr>
<tr>
<td></td>
<td>5. Apply the knowledge of optimization in designing of various machine elements and systems.</td>
</tr>
</tbody>
</table>

Pre-requisite knowledge in computer programming matrix theory and vector algebra.

**UNIT I**  
**INTRODUCTION TO OPTIMIZATION**


**UNIT II**  
**NON-LINEAR PROGRAMMING**

Nonlinear programming - I One Dimensional Minimization Methods:


Non-linear programming II - Unconstrained optimization techniques


**UNIT III**  
**NON-LINEAR PROGRAMMING**

Non-linear programming III : Constrained optimization techniques

Introduction: Characteristics of a constrained problem - direct methods: Complex method, cutting plane method, methods of feasible directions - Indirect methods: transformation techniques, penalty function method,
interior penalty function method, convex programming problems - exterior penalty function method.

UNIT IV   GEOMETRIC PROGRAMMING


UNIT V   OPTIMUM DESIGN OF MACHINE ELEMENTS

Functional requirements desirable and undesirable effects - functional requirements and material and geometrical parameters - adequate designs, optimum design - primary design equation, subsidiary design equations, limit equations basic procedural steps for methods of optimum design -- constrained parameters and free variables - normal, redundant and incompatible specifications - general planning.

Total 45

REFERENCE:
PCD 202 - MECHANICAL VIBRATIONS

<table>
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<td>2</td>
<td>4</td>
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</table>

**Goal**
To expose the students to understand the sources of the vibration in automobile and other machinery and study the various methods to reduce the noise and vibration

**Objectives**
The course should enable the students to:
1. Understand the sources of vibration and noise in automobiles and make design modifications
2. Learn to reduce the vibration and noise and improve the life of the components

**Outcome**
The students should be able to:
1. Translate a physical problem in mechanical vibration to an appropriate mathematical model.
2. Make engineering judgement on the problem of reducing vibration when required and the role of vibration in the design of mechanical equipment.

**UNIT I FUNDAMENTALS OF VIBRATION** 8

**UNIT II TWO DEGREE FREEDOM SYSTEM** 8

**UNIT III MULTI-DEGREE FREEDOM SYSTEM** 12

**UNIT IV VIBRATION OF CONTINUOUS SYSTEMS** 8

**UNIT V EXPERIMENTAL METHODS IN VIBRATION ANALYSIS** 9

**Total : 45**

**REFERENCES:**

WEB REFERENCES:
3. www.vibetech.com/techpaper.htm
PCD 203 - METALLIC MATERIALS & MANUFACTURING PROCESSES

L T P C
4 0 0 4

<table>
<thead>
<tr>
<th>PCD 203</th>
<th>METALLIC MATERIALS &amp; MANUFACTURING PROCESSES</th>
<th>4 Credits</th>
</tr>
</thead>
</table>

**Goal**
To impart in depth knowledge of the various composite materials and their components like fibres, matrix materials and their behaviour in the manufacturing and testing processes.
To predict the failures of composites when subjected to various forms of stresses using NDT methods and quality evaluation.

**Objectives**
The course should enable the students to:

1. Study the types of fibres and their structure and behaviours
2. Study the mathematical analysis of stresses acting on the composites
4. Understand the design principle

**Outcome**
The students should be able to understand,

1. Fibre characteristics and methods of production of fibres
2. The suitable composite manufacturing process when designing intricate and critical parts made of composites
3. The testing methods of composites thoroughly and practical input obtained
4. The failure of composites well and the production of quality composites with design life ensured.

**AIM**

- To study about various types of materials, manufacturing methods, tolerances in the design, manufacture and case studies for optimization in manufacturing.

**UNIT I ** INTRODUCTION
7
Factors for design based on mechanical, electrical and thermal properties – Dimensional tolerances, Factors considered for selection of materials.

**UNIT II ** TYPES OF MATERIALS
8
Ferrous metals and alloys - Steel, Stainless steel, Non-ferrous metals and alloys - Aluminium, Brass, Gun Metal.

**UNIT III ** MANUFACTURING METHODS
12
Design consideration in methods of manufacturing such as Casting - Sand casting, die casting, investment casting; Machining – Turning, drilling, milling and grinding; Unconventional – EDM, ECM; Forming techniques – Forging, extrusion, sheet metal forming; Powder metallurgy.

**UNIT IV ** ASSEMBLY OF COMPONENTS
10

**UNIT V ** CASE STUDIES
8
Case studies on optimization of design for cost, material and methods – Economics of machining.
REFERENCES

### PCD 251 - ANALYSIS AND SIMULATION LAB

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCD 251</td>
<td>ANALYSIS &amp; SIMULATION LAB</td>
<td>4</td>
</tr>
</tbody>
</table>

**Goal**
To learn various finite element analysis softwares such as ANSYS, ADAMS, NASTRAN, etc.,

**Objectives**

<table>
<thead>
<tr>
<th>The course should enable the students to:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Enhance interest in learning the design and analysis of components using software’s such as Pro-E, Ansys V12,.</td>
</tr>
<tr>
<td>2. Understand the various concepts of analysis of mechanical systems.</td>
</tr>
<tr>
<td>3. Understand the concepts of finite element analysis involving mechanical, structural and thermal related problems.</td>
</tr>
</tbody>
</table>

**Outcome**

<table>
<thead>
<tr>
<th>The students should be able to:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Develop the concepts and design the machine elements.</td>
</tr>
<tr>
<td>2. Analyze any mechanical components and visualize the results.</td>
</tr>
<tr>
<td>3. Take up any FEA related work and can solve it efficiently.</td>
</tr>
</tbody>
</table>

Analysis of Mechanical Components – Use of FEA packages, like ANSYS, NASTRAN etc. Exercises shall include FEA analysis of

- Machine elements under static loads
- Heat transfer in mechanical systems
- Determination of natural frequency
- Axi-Symmetric
- Non-linear systems

Use of kinematics and dynamics simulation software like ADAMS software. Analysis of velocity acceleration for mechanical linkages of different mechanisms.

**Equipments Required:**

- CAD work station / Pentium 4 : 10 Nos
- ADAMS Software : 2 Licenses
- ANSYS / NASTRAN / ABACUS : 10 Licenses
The students should do the project individually and in exceptional cases 2 members may be permitted to take one small item for design and simulation. Every project work shall have a guide who is the member of the faculty of the institution.

The students are required to design and simulate the chosen item in the college and demonstrate its working apart from submitting the project report. The report should contain the required drawings, information flow diagrams, process charts related to simulation.
# PCD 352 - PROJECT WORK PHASE – I

<table>
<thead>
<tr>
<th>PCD 352</th>
<th>PROJECT WORK Phase I</th>
<th>2 Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Goal</strong></td>
<td>To identify a project in the thrust areas and to create a work plan to design, fabricate and to analyze the refrigeration and air conditioning systems.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Objectives</strong></th>
<th><strong>Outcomes</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>The course should enable the students to:</td>
<td>The students should be able to:</td>
</tr>
<tr>
<td>1. Provide opportunity for the students to implement their skills acquired in the previous semesters to practical problems.</td>
<td>1. Students can identify the thrust areas in their field of interest.</td>
</tr>
<tr>
<td>2. To expose the students to do Literature survey and scheduling work plan.</td>
<td>2. Compare and analyze the performance of the various systems through literature survey.</td>
</tr>
<tr>
<td>3. Expose the students to technical report writing</td>
<td>3. Understand the concept of making a product is achieved</td>
</tr>
<tr>
<td></td>
<td>3. Gain knowledge on preparing a technical report.</td>
</tr>
</tbody>
</table>

Aim is to train the students in research work, writing report and presentation

Phase – I: Shall consist of identification of the project after literature survey. Students should present a review paper & submit it to the internal examiners.

Report should summarise the methodology to be adopted and work plan for the project work Phase – II.
### PCD 451 – PROJECT WORK PHASE – II

**L T P C**

<table>
<thead>
<tr>
<th>PCD 451</th>
<th>PROJECT WORK Phase - II</th>
<th>6 Credits</th>
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</thead>
<tbody>
<tr>
<td><strong>Goal</strong></td>
<td>Identify a project in the thrust areas and to create a work plan to design, To design, fabricate and analyze any system related to mechanical engineering.</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th><strong>Objectives</strong></th>
<th><strong>Outcomes</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>The course should enable the students to:</td>
<td>The students should be able to:</td>
</tr>
<tr>
<td>1. Provide opportunity for the students to implement their skills acquired in the previous semesters to practical problems.</td>
<td></td>
</tr>
<tr>
<td>2. To expose the students to work as scheduled in work plan.</td>
<td></td>
</tr>
<tr>
<td>3. Expose the students to technical report writing</td>
<td>1. Students can identify the thrust areas in their field of interest.</td>
</tr>
<tr>
<td></td>
<td>2. Compare and analyze the performance of the various systems both theoretically and practically through actual design and fabrication.</td>
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<tr>
<td></td>
<td>3. Complete understanding of making a product is achieved.</td>
</tr>
<tr>
<td></td>
<td>4. Students can prepare technical reports.</td>
</tr>
</tbody>
</table>

**Requirement:** Actual project work with presentation & submission of project report of thesis form to the examiners. The students should publish at least one paper in National / International conference or Journal before submission of the thesis. Proof of acceptance must be enclosed in the thesis.
### PCD 701 - MODEL ANALYSIS OF MECHANICAL SYSTEMS

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</table>

**Goal**

To make students to gain the concepts on model testing, measurement system, model analysis, review test procedure and to derive mathematical models.

<table>
<thead>
<tr>
<th>Objectives</th>
<th>Outcome</th>
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</thead>
<tbody>
<tr>
<td>The course should enable the students to:</td>
<td>The students should be able to:</td>
</tr>
<tr>
<td>1. Introduce model testing and review of test procedure</td>
<td>1. Develop skills on model testing, measurement methods, summary of analysis and to review test procedure</td>
</tr>
<tr>
<td>2. Understand the concepts of analysis of non-linear structures</td>
<td>2. Widen knowledge on SDOF/MDOF / FRF data and properties and to analyse non linear structures.</td>
</tr>
<tr>
<td>3. Gain the knowledge on mobility measurement techniques</td>
<td>3. Good understand the concepts of measurement system,DSP,calibration, measurement on non linear structures.</td>
</tr>
<tr>
<td>4. Understand various methods of modal parameter extraction</td>
<td>4. Gain the knowledge on model analysis,circle fit method, inverse method and curve fitting</td>
</tr>
<tr>
<td>5. Get exposed to the techniques on derivation of mathematical models.</td>
<td>5. Get exposure to different types of modal models, response model, spatial models and system models.</td>
</tr>
</tbody>
</table>

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**UNIT I**

**OVERVIEW**


**UNIT II**

**THEORETICAL BASIS**


**UNIT III**

**MOBILITY MEASUREMENT TECHNIQUES**


**UNIT IV**

**MODAL PARAMETER EXTRACTION METHODS**

fitting – Non linear systems.

UNIT V DERIVATION OF MATHEMATICAL MODELS

Skeletons and System Models.

REFERENCES:
2. Nuno Manuel Mendes Maia et al,” Theoretical and Experimental Modal Analysis“, John Wiley & Sons,
1997.

WEB REFERENCES:
1. www.vibetech.com/tech.paper.htm
UNIT - I

UNIT – II

UNIT -III

UNIT - IV

UNIT – V

TEXT BOOK:
REFERENCE:

PCD 703 - TRIBOLOGY IN DESIGN

<table>
<thead>
<tr>
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<td>4</td>
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</tbody>
</table>

Goal

To expose the students on the study and application of the principles of friction, lubrication and wear.

Objectives

The course should enable the students to:

1. Learn the principles of friction and wear.
2. Understand the standard procedure available for tribology using standard data and catalogues.
3. Design the fluid film bearings, rolling element bearings etc.,

Outcome

The students should be able to:

1. Design bearings of various types.
2. Perform the various measurements on surfaces and bearings.

UNIT I SURFACES, FRICTION AND WEAR


UNIT II LUBRICATION THEORY


UNIT III DESIGN OF FLUID FILM BEARINGS


UNIT IV ROLLING ELEMENT BEARINGS


UNIT V TRIBO MEASUREMENT IN INSTRUMENTATION

REFERENCES:

Objective

Goal
To impart the knowledge on hydraulic and pneumatic systems to make the students to be able to design various components of fluid power systems.

Objectives

<table>
<thead>
<tr>
<th>No.</th>
<th>Objective</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Hydraulic actuators and Pneumatic actuators and systems</td>
<td>The students should be able to:</td>
</tr>
<tr>
<td>2.</td>
<td>Control and regulation elements</td>
<td>1. Demonstrate good grounding in the subject area of fluid power</td>
</tr>
<tr>
<td>3.</td>
<td>Hydraulic circuits</td>
<td>2. Appreciate the circuits and feel the advantages over the similar mechanical systems</td>
</tr>
<tr>
<td>4.</td>
<td>Pneumatic systems and circuits</td>
<td>3. Gain knowledge no the use of special control and regulation elements</td>
</tr>
<tr>
<td>5.</td>
<td>Installation, Maintenance of systems</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Special circuits</td>
<td></td>
</tr>
</tbody>
</table>

UNIT I  OIL HYDRAULIC SYSTEMS AND HYDRAULIC ACTUATORS  5

Hydraulic Power Generators – Selection and specification of pumps, Pump characteristics. Linear and Rotary Actuators – Selection, specification and characteristics.

UNIT II  CONTROL AND REGULATION ELEMENTS  12

Pressure - direction and flow control valves - relief valves, non-return and safety valves - actuation systems.

UNIT III  HYDRAULIC CIRCUITS  5


UNIT IV  PNEUMATIC SYSTEMS AND CIRCUITS  16

Pneumatic fundamentals - control elements, position and pressure sensing - Logic circuits - switching circuits - fringe conditions modules and these integration - Sequential circuits - cascade methods - step counter method - Compound circuit design - Combination circuit design.
UNIT V  INSTALLATION, MAINTENANCE AND SPECIAL CIRCUITS

Pneumatic equipments - selection of components - design calculations – application -fault finding- hydro pneumatic circuits - use of microprocessors for sequencing - PLC, Low cost automation - Robotic circuits.

Total : 45

REFERENCES:


WEB REFERENCES:

1. www.pneumatics .com
2. www.fluidpower.com.tw
**PCD 705 - INTEGRATED PRODUCT & PROCESSES DEVELOPMENT**

<table>
<thead>
<tr>
<th>Credits</th>
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<tr>
<td>4</td>
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</table>

**Objective outcome**

**Goal**

To provide the advances in formal and informal communication in product development, modeling innovation processes and design of products.

**Objectives Outcome**

The course should enable the students to:

1. Understand the concept of integrated product and process development that combined the product design process to create a new standard for providing competitive and high quality products.

2. Gain the knowledge on the product design and development process.

The students should be able to:

1. Gain knowledge on the various process of design and processes involved in product development.

**UNIT I INTRODUCTION**


**UNIT II PRODUCT PLANNING**

Product Planning Process- Identify Opportunities- Evaluating and Prioritizing Projects-Allocating Resources and Timing- Pre-Project Planning-Reflect on the Results and the Process-Identifying Customer Needs- Raw Data from Customers- Interpreting Raw Data in Terms of Customer Needs-Organizing the Needs into a Hierarchy-Establishing the Relative Importance of the Needs-Reflecting on the Results and the Process

**UNIT III PRODUCT SPECIFICATIONS**

What are specifications-When are specifications established-Establishing target Specifications-Setting the Final Specifications-Concept Generation-The Activity of Concept Generation-Clarify the Problem- Search Externally-Search Internally-Explore Systematically- Reflect the Results and the Process

**UNIT IV CONCEPT SELECTION**

Concept Selection- Overview of Methodology-Concept Screening-Concept Testing Define the Purpose of the Concept Test- Choose a Survey Population- Choose a Survey Format- Communicate the Concept-Measure Customer Response-Interpret the Results- Reflect the Results and the Process

**UNIT V PRODUCT ARCHITECTURE**

Product Architecture-Implications of the Architecture-Establishing the Architecture-Delayed Differentiation-Platform Planning-Related System-Level Design Issues
TEXT BOOK


REFERENCES:

PCD 706 - COMPOSITE MATERIALS & MECHANICS

<table>
<thead>
<tr>
<th>Credits</th>
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</table>

Goal:
To impart in depth knowledge of the various composite materials and their components like fibres, matrix materials and their behaviour in the manufacturing and testing processes.

To predict the failures of composites when subjected to various forms of stresses using NDT methods and quality evaluation.

Objectives
The course should enable the students to:

1. Study the types of fibres and their structure and behaviors
2. Study the mathematical analysis of stresses acting on the composites
4. Understand the design principle

Outcome
The students should be able to understand,

1. Fibre characteristics and methods of production of fibres
2. The suitable composite manufacturing process when designing intricate and critical parts made of composites
3. The testing methods of composites thoroughly and practical input obtained
4. The failure of composites well and the production of quality composites with design life ensured.

UNIT I  INTRODUCTION 10
Smart materials Types- and Characteristics.

UNIT II  MECHANICS AND PERFORMANCE 10

UNIT III  MANUFACTURING 5

UNIT IV  ANALYSIS 10

UNIT V  DESIGN 10
Failure Predictions – Laminate Design Consideration – Bolted and Bonded Joints Design Examples.

Total : 45

TEXT BOOK:
REFERENCES:


To impart the knowledge on various dynamic systems and control of such system.

The course should enable the students to:
1. Understand the various dynamics systems
2. Study the performance and stability of various feedback systems
3. Analyse the signal flows and the control system

The students should be able to understand,
1. Gain the knowledge on the dynamic systems and the block diagram representations
2. Exposure to the performance and stability of feedback systems.
3. Gain the understanding of various methods of control system analysis.

UNIT I
INTRODUCTION
9

UNIT II
INTRODUCTION TO CONTROL SYSTEMS
9
Introduction – Control systems – Control system configurations – Control system Terminology – Control system classes – Feedback systems – Analysis of Feedback – Historical Developments of control systems – Control system analysis and Design Objectives.

UNIT III
SYSTEM REPRESENTATION
9

UNIT IV
PERFORMANCE AND STABILITY OF FEEDBACK SYSTEMS
9

UNIT V
ANALYSIS OF CONTROL SYSTEMS
9

Total : 45

TEXT BOOK

REFERENCES

**PCD 708 - ADVANCED TOOL DESIGN**

| Credits | 4 |

**Goal**

To Build up specialized expert knowledge in the domain of material, for different kinds of tools used in manufacturing industries and also to familiarize in the knowledge of designing and manufacturing the cutting tools, dies, jigs and future for conventional and CNC machine tools.

<table>
<thead>
<tr>
<th>Objectives</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>The course should enable the students to:</td>
<td>The students come out with the following:</td>
</tr>
<tr>
<td>1. Understand the importance of tool design for productive manufacturing and the basic procedure of tool design, drafting of tool drawing etc.,</td>
<td>1. The conventional practice and procedures adopted for tools &amp; Design such as problem statement, Drafting Hole location, Bush installation etc is understood</td>
</tr>
<tr>
<td>2. Bring in the required properties in the tool material by proper selection and heat treatment appropriate to the cutting process adopted.</td>
<td>2. The knowledge on materials for cutting tools, heat treatment required for different materials and different types of tools is obtained</td>
</tr>
<tr>
<td>3. Understand the concepts of tolerance and make use of gauges to measure the same</td>
<td>3. The design of dies, gauges and the importance of tolerance in the manufacturing and inspection of dies &amp; gauges is understood</td>
</tr>
<tr>
<td>4. Understand the design concepts of Jigs &amp; Fixtures</td>
<td>4. Jig &amp; Fixtures design for all type of machine tool is done appropriately</td>
</tr>
<tr>
<td>5. Get proper knowledge in the latest area of tooling for CNC machines tools</td>
<td>5. Tooling for CNC machine tools and automatic machine are also made effectively</td>
</tr>
</tbody>
</table>

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**UNIT I**

**TOOL-DESIGN METHODS**


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**UNIT II**

**TOOLING MATERIALS AND HEAT TREATMENT**


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**UNIT III**

**DESIGN OF DRILL JIGS**


---

**UNIT IV**

**DESIGN OF FIXTURES AND DIES**


UNIT V TOOL DESIGN FOR NUMERICALLY CONTROLLED MACHINE TOOLS


REFERENCES:

Web references:
1. www.irdi.on.ca/irdi/front.htm
2. www.techsolve.org/flashhome.htm
UNIT I INTRODUCTION
General design principles for manufacturability - strength and mechanical factors, mechanisms selection, evaluation method, General 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  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

REFERENCES:

WEBSITE
2. www.dfma.com
### PCD 710 - PLASTICITY & METAL FORMING

<table>
<thead>
<tr>
<th>PCD 710</th>
<th>PLASTICITY &amp; METAL FORMING</th>
<th>4Credits</th>
</tr>
</thead>
</table>

#### Goal
To impart in-depth knowledge on the metal forming process through fundamental concepts of plastic deformation, analysis of forgoing, rolling, drawing and other forming process, and the development of advanced processes for latest and new materials.

#### Objectives
The course should enable the students to:

1. Study the basic concepts of yield, stress, strain relationship in depths for plastic deformation of metal
2. Mathematically analysis various forming process and to understand the experiment technique for evaluating the same
3. Understand the unique Mechanical properties that are more relevant for plastic instability
4. Study the theory of sheet metal forming through anisotropic behaviors
5. Know the concepts of Advanced metal forming techniques and power metal techniques including analysis through FEM

#### Outcome
The students should be able to:

1. Gain knowledge on engineering stress, strain relationship yield criteria, equilibrium conditions
2. Gain knowledge on analytical and experimental techniques of various forming methods
3. Gain the sheet metal forming in understood by forming limit Diagram finite element methods etc.,

---

### UNIT I

**THEORY OF PLASTICITY**

- Theory of plastic deformation
- Engineering stress and strain relationship
- Stress tensor
- Strain tensor
- Yield criteria’s
- Plastic stress strain relationship
- Plastic work
- Equilibrium conditions
- Incremental plastic strain

### UNIT II

**CONSTITUTIVE RELATIONSHIPS AND INSTABILITY**

- Uniaxial tension test
- Mechanical properties
- Work hardening
- Compression test, bulge test, plane strain compression stress
- Plastic instability in uniaxial tension stress
- Plastic instability in biaxial tension stress

### UNIT III

**ANALYSIS OF METAL FORMING PROBLEMS**

- Slab analysis
- Slip line method
- Upper bound solutions
- Statistically admissible stress field
- Numerical methods
- Contact problems
- Effect of friction
- Thermo elastic
- Elasto plasticity
- Elasto visco plasticity
- Thermo mechanical coupling
- Analysis of forging, rolling, extrusion and wire drawing processes
- Experimental techniques of the evaluation of metal forming

### UNIT IV

**SHEET METAL FORMING**

- Bending theory
- Cold rolling theory
- Hill’s anisotropic theory
- Hill’s general yield theory
- Sheet metal forming
- Elements used
- Mesh generation and formulation
- Equilibrium equations
- Consistent full set algorithm
- Numerical solutions
- Procedures
- Examples of simulation of simple parts
- Bench mark tests
- Forming limit diagrams
Orbital forging, Isothermal forging, Warm forging, Hot and Cold isotropic pressing, high speed extrusion, rubber pad forming, micro blanking - Overview of Powder Metal techniques - Powder rolling - Tooling and process parameters

REFERENCES:

PCD 711 - VIBRATION CONTROL & CONDITION MONITORING

L T P C
4 0 0 4

PCD 711 | VIBRATION CONTROL & CONDITION MONITORING | 4 Credits
---|---|---
Goal | To provide the knowledge on various vibration control techniques and condition monitoring systems. |

<table>
<thead>
<tr>
<th>Objectives</th>
<th>Outcomes</th>
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<tbody>
<tr>
<td>The course should enable the students to</td>
<td>The students gain the knowledge on</td>
</tr>
<tr>
<td>1. Gain knowledge on fundamentals of various degrees of freedom.</td>
<td>1. Fundamentals of various degrees of freedom.</td>
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<td>2. Understand the concept of active vibration control.</td>
<td>2. Active vibration control.</td>
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<tr>
<td>3. Learn condition based maintenance principles and applications.</td>
<td>3. Condition based maintenance principles and applications.</td>
</tr>
<tr>
<td>4. Gain knowledge on dynamic balancing and alignment of machinery.</td>
<td>4. Dynamic balancing and alignment of machinery.</td>
</tr>
<tr>
<td>5. Gain knowledge on vibration control.</td>
<td>5. Vibration control.</td>
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</table>

UNIT I | INTRODUCTION 12
---|---

UNIT II | VIBRATION CONTROL 12
---|---

UNIT III | ACTIVE VIBRATION CONTROL 6
---|---

UNIT IV | CONDITION BASED MAINTENANCE PRINCIPLES AND APPLICATIONS 10
---|---

UNIT V | DYNAMIC BALANCING AND ALIGNMENT OF MACHINERY 6
---|---
Introduction, Dynamic Balancing of Rotors, Field Balancing in one Plane, two Planes, and in several

**TEXT BOOK:**

**REFERENCES:**

**WEB REFERENCES:**
3. www.vibetech.com/techpaper.htm
PCD 712 - INDUSTRIAL ROBOTICS & EXPERT SYSTEMS

<table>
<thead>
<tr>
<th>PCD 712</th>
<th>INDUSTRIAL ROBOTICS &amp; EXPERT SYSTEMS</th>
<th>3 Credits</th>
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<tbody>
<tr>
<td><strong>Goal</strong></td>
<td>To introduce the hardware and programming concepts of industrial robots and their applications.</td>
<td></td>
</tr>
<tr>
<td><strong>Objectives</strong></td>
<td>The course should enable the students to</td>
<td></td>
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<tr>
<td></td>
<td>1. Learn the concepts of robot kinematics.</td>
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<tr>
<td></td>
<td>2. Learn the principles of robot drives and controls.</td>
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<td></td>
<td>3. Learn the sensors used in robots.</td>
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<td></td>
<td>4. Learn the robot cell design.</td>
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<tr>
<td></td>
<td>5. Learn the concepts of expert systems.</td>
<td></td>
</tr>
<tr>
<td><strong>Outcome</strong></td>
<td>The students should be able to</td>
<td></td>
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<tr>
<td></td>
<td>1. Gain the knowledge on kinematics of robots and adaptive control.</td>
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<tr>
<td></td>
<td>2. Gain the knowledge on the robot actuators and controls.</td>
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<td></td>
<td>3. Gain the knowledge on sensors and selection of sensors for specific need.</td>
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<tr>
<td></td>
<td>4. Gain the knowledge on robot cell layouts and their applications.</td>
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<tr>
<td></td>
<td>5. Gain the knowledge on robot programming and artificial intelligence in robots.</td>
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</table>

UNIT I  INTRODUCTION AND ROBOT KINEMATICS  

Robot Kinematics – Forward & reverse transformation of type form depres of robotneedem manipulators - Adaptive control, Model, Reference adaptive control.

UNIT II  ROBOT DRIVES AND CONTROL  

UNIT III  ROBOT SENSORS  

UNIT IV  ROBOT CELL DESIGN AND APPLICATION  

UNIT V  ROBOT PROGRAMMING, ARTIFICIAL INTELLIGENCE AND EXPORT SYSTEMS  
TEXT BOOK:

REFERENCES:
PCD 713 - ENTERPRISE RESOURCE PLANNING

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
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<tr>
<td>PCD 713</td>
<td>ENTERPRISE RESOURCE PLANNING</td>
<td>4 Credits</td>
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</tbody>
</table>

**Goal:**
To provide the students with knowledge on various enterprise resource planning techniques.

**Objectives**
The course should enable the students to:
1. Gain knowledge on enterprise resource planning.
2. Understand technology and architecture.
3. Learn system packages.
4. Gain the knowledge on oracle and its applications.
5. Gain the knowledge on unit ERP procurement issues.

**Outcomes**
The students gain the knowledge on:
1. Enterprise resource planning.
2. Technology and architecture.
4. Oracle and its applications.
5. Unit ERP procurement issues.

**UNIT I**
ENTERPRISE RESOURCE PLANNING


**UNIT II**
TECHNOLOGY AND ARCHITECTURE


**UNIT III**
SYSTEM PACKAGES

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

**UNIT IV**
ORACLE

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

**UNIT V**
UNIT ERP PROCUREMENT ISSUES


Total: 45

**REFERENCES:**
PTE 701 - COMPUTATIONAL FLUID DYNAMICS

<table>
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<th>Course</th>
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<tr>
<td>PTE701</td>
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**Goal**
To impart the knowledge on numerical methods and algorithm to solve various complex problems in fluid mechanics.

**Objectives**
The course should enable the students to:

1. Learn about different governing equation and boundary condition
2. Enable the students to understand the various discretisation techniques and solving solution methodologies.
3. Understanding the Navier-stroke equation for different flow field.
4. Understand the requirement of the different turbulence model for solving the Reynolds Average Navier-stroke equation.
5. Learn the different grid generation methods.

**Outcome**
The students should be able to gain the knowledge on:

1. Formation different governing equation like continuity, momentum and energy equation.
2. Discretisation equation using finite difference method and finite volume methods, numerical error associated with first order and second order.
3. Derivation of Reynolds average Nevier-stroke equation.
5. Generation of the grid required in the computational domain for solving the Navier-stroke equation.

**UNIT I** GOVERNING EQUATIONS AND BOUNDARY CONDITIONS 8
Basics of CFD, Governing equations of Fluid Dynamics – Continuity momentum and Energy equations, Physical Boundary conditions, Mathematical behaviour of PDEs on CFD – Elliptic, Parabolic and Hyperbolic equations

**UNIT II** DISCRETISATION TECHNIQUES AND SOLUTION METHODOLOGIES 18

**UNIT III** CALCULATION OF FLOW – FIELD FOR N – S EQUATIONS 16

**UNIT IV** TURBULENCE MODELLING 10
UNIT V

GRID GENERATION

Algebraic Methods – Differential Equation methods – Adaptive grids

Total : 60

TEXT BOOKS


REFERENCES

PCD 714 – COMPUTER APPLICATION DESIGN

L T P C
4 0 0 4

PCD 714

COMPUTER APPLICATION DESIGN

4credits

Goal
To impart the knowledge on computer application in design and the solving techniques of various engineering problems

Objectives

The course should enable the students to:

1. Learn the fundamental of computer graphic fundamentals, visual realism and solid modeling
2. Solve techniques of various engineering problems

Outcome

The students should be able to:

1. Use the cad software and graphic fundamentals
2. Have a good grip on analysis of the models modelled in any of the modelling software.

UNIT I

INTRODUCTION TO COMPUTER GRAPHIC FUNDAMENTALS

Output primitives (points, lines, curves etc.), 2-D & 3-D transformation (Translation, scaling, rotators) windowing - view ports - clipping transformation.

UNIT II

INTRODUCTION TO CAD SOFTWARE

Writing interactive programs to solve design problems and production of drawings - using any languages like Auto LISP/C/FORTRAN etc.- creation of surfaces - solids etc. using solid modeling packages (prismatic and revolved parts).

UNIT III

VISUAL REALISM

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 IV

ASSEMBLY OF PARTS

Assembly of parts, tolerances analysis mass property calculations, mechanism simulation.

UNIT V

SOLID MODELING

Rapid prototyping - Data exchange - documentation - customizing solid modeling system.

Total : 45

REFERENCES:

UNIT I MANUFACTURING TECHNOLOGY 8
Overview-current themes in manufacturing -design- manufacture interface-overview of process planning technique.

UNIT II PRODUCTION PLANNING AND CONTROL 10
Discrete parts manufacturing-topology in manufacturing classificationof FMS decision Lean production-BPRMaster production scheduling-Requirements Planning-JIT.

UNIT III GROUP TECHNOLOGY AND PROCESS PLANNING 10
Part families, classification and coding-type of codification-case study-computer aided process planning-retrieval and generative.

UNIT IV FLEXIBLE MANUFACTURING SYSTEMS 10
Need classification-Integration-Interface-Software for FMS-Production flow analysis - flexible material handling -Petri network-applications.

UNIT V MANUFACTURING SIMULATION 7
Simulation language - type of software package-Simulation process-FIST codes-Case study.

UNIT VI PRACTICALS 30
Total No of periods: 75
REFERENCES:

AIM:
To impart knowledge on Non Destructive Testing procedures.

OBJECTIVES:
1. To understand principle behind various NDT techniques.
2. To study about NDT equipments and accessories.
3. To learn working procedures of various NDT techniques.

UNIT I Non-Destructive Testing: An Introduction

Introduction to various non destructive methods- Comparison of Destructive and Non destructive Tests, Visual Inspection, Optical aids used for visual inspection, Applications.

UNIT II Liquid Penetrant Testing, Magnetic Particle Testing

Physical principles, procedure for penetrant testing, Penetrant Testing materials, Penetrant testing methods – water washable, post – Emulsifiable methods, Applications, Principle of MPT, procedure used for testing a component, Equipment used for MPT, Applications

UNIT III Eddy Current Testing, Acoustic Emission

UNIT IV Ultrasonic Testing

9

Fundamentals of wave theory - Principle, Ultrasonic transducers, Inspection Methods, Normal Incident Pulse - Echo Inspection, Through - transmission Testing, angle Beam Pulse - Echo testing, Techniques for Normal Beam Ispection, Ultrasonic Flaw detection Equipment, Modes of display A-scan, B-Scan, C-Scan, Applications.

UNIT V Radiography, Comparison and selection of NDT methods

10

Basic principle, Effect of radiation on Film, Radiographic imaging, Inspection Techniques - Single wall single image, Double wall Penetration, Multiwall Penetration technique. Comparison and selection of various NDT techniques.

TOTAL:

45

TEXT BOOK:


REFERENCES:


WEB REFERENCE

www.ndt.net
PCD 717 MACHINE TOOL CONTROL AND CONDITION MONITORING

<table>
<thead>
<tr>
<th>PCD 717</th>
<th>MACHINE TOOL CONTROL AND CONDITION MONITORING</th>
<th>4 Credits</th>
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</table>

**Goal**
To introduce various types of machine tool control and various condition monitoring techniques.

**Objectives**
The course should enable the students to
1. Learn the overview of automatic controls in machine tools.
2. Learn the principles drive system and feedback devices of machine tools.
3. Learn the concepts of adaptive control and PLC.
4. Learn the monitoring methods of machine tools.

**Outcome**
The students should be able to
1. Gain the knowledge on various automatic control modules used in machine tools.
2. Gain the knowledge on actuators and feedback drives.
3. Gain the knowledge on various adaptive systems and their constraints.
4. Gain the knowledge on vibration, acoustic emission based monitoring systems and other monitoring methods.

**AIM:**
To impart knowledge on machine tool control and conditioning monitoring.

**OBJECTIVE:**
To introduce various types of machine tool control and various condition monitoring techniques.

**UNIT – I  OVERVIEW OF AUTOMATIC CONTROL IN MACHINE TOOLS**
Open loop and closed loop system in machine tools- process model formulation-transfer function-control actions-block diagram representation of mechanical pneumatic and electrical systems. Process computer - peripherals-Data logger-Direct digital control-Supervisory computer control.

**UNIT – II DRIVE SYSTEMS AND FEED BACK DEVICES IN MACHINE TOOLS**

**UNIT – III  ADAPTIVE CONTROL AND PLC**
Adaptive control-types – ACC, ACO, Real time parameter estimation, Applications - adaptive control for turning, milling, grinding and EDM. Programmable logic controller-Functions-Applications in machine tools.

**UNIT – IV  VIBRATION, ACOUSTIC EMISSION / SOUND.**

**UNIT – V  CONDITION MONITORING, THROUGH OTHER TECHNIQUES**
Visual & temperature monitoring, Leakage monitoring, Lubricant monitoring, condition monitoring of Lube and Hydraulic systems, Thickness monitoring, Image processing techniques in condition monitoring.

TOTAL: 45

REFERENCES:


PCD 718 FAILURE ANALYSIS

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<table>
<thead>
<tr>
<th>PCD 718</th>
<th>FAILURE ANALYSIS</th>
<th>4 Credits</th>
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</table>

**Goal**
To impart in depth knowledge of the various Quality Engineering tools used in the analysis of product/ process Failures to enable him to design Robust product/ process Which will not fail in its intended functions during its design Life period.
To develop a Pro active designer rather than a reactive one.

**Objectives**
The course should enable the students to:

1. Understand the various reasons causing Failure of products/ processes and of the Tools which will enable him to solve these These problems.
2. Predict before hand the causes for failures and incorporate the remedial measures in the design stage itself rather than doing a post mortem exercise.
3. Understand the importance of fixing geometrical and parametrical tolerances and other quality related specifications on the product drawing without any ambiguity.
4. Acquire knowledge in managing quality issues during product design through analytical route.

**Outcome**
The students should be able to understand

1. The concepts of various Quality Engineering tools and how to use them Effectively in the design of products.
2. without any ambiguity the theory and concepts of various tools used in Failure analysis.
3. The evaluation a product in case of a failure.
4. The testing and management of reliability risk analysis and Reliability Monitoring.

**UNIT I  INTRODUCTION**

8
Basic Probability-concept and various distributions, Concept of Reliability and analysis of various configurations of assemblies and sub-assemblies. Series, Parallel and other grouping. System reliability, Set theory, optimal Cut Set and Tie Set, ‘stardelta’ method, matrix method etc.

**UNIT II  PRODUCT FAILURE THEORY**

9
System reliability determination through ‘Event Tree’ analysis and Fault Tree Analysis (FTA), Failure Modes and Effects Analysis (FMEA), Failure Modes, Effects and Criticality Analysis (FMECA). R.P.N, Graph theory, etc.

**UNIT III  RELIABILITY PREDICTION MODELS**

9
Series and parallel systems - RBD approach - Standby systems - m/n configuration - Application of Baye's theorem - cut and tie set method - Markov analysis. Optimal allocation of component reliability
to achieve maximum system reliability - various techniques and methods such as Proportional, Conditional, Agree, Arinc, etc.

UNIT IV RELIABILITY EVALUATION
Concept of loading roughness, probability in design including evaluation of safety margin. Reliability of Engineering Design; Mean, Median & K statistics for Reliability evaluation (non parametric, Short Sample).

UNIT V RELIABILITY MANAGEMENT
Reliability testing - Reliability growth monitoring - Non parametric methods - Reliability and life cycle costs - Reliability allocation - Replacement model. Case Studies Diagnostic maintenance through ferrography, Vibration Signature, SOAP and other programme. Case studies done in Indian perspectives using Short Sample, nonparametric reliability

References:
1. Gupta AK, Reliability engineering and tero-technology, Macmillan India Ltd, Delhi
2. Srinath LS, Reliability Engineering, Affiliated East-West Press Pvt Ltd, Delhi
3. Connor PDT, Practical Reliability Engineering, John Wiley & Sons Ltd, Singapore
Goal

The goal of the programme is to provide advance concepts for ideal and non ideal flows, to impart the knowledge of various types of flow like two dimensional flow, turbulent flow and compressible flow through ducts and to provide the details shock waves.

Objectives

The course should enable the students to:

1. To understand advance concepts for ideal and non ideal flows.
2. To understand various types of flow like two dimensional flow, turbulent flow and compressible flow through ducts.
3. To understand the details of shock waves.

Outcome

The students should be able to:

1. To know advance concepts for ideal and non ideal flows.
2. To get the knowledge of various types of flow like two dimensional flow, turbulent flow and compressible flow through ducts.
3. To know the details of shock waves.

UNIT – I INTRODUCTION

Ideal and non-ideal flows, general equations of fluid motion, Navier - stokes equations and their exact solutions. Boundary layer theory, wedge flows, laminar flow over plates and through cylinders.

UNIT – II TWO DIMENSIONAL FLOW


UNIT – III TURBULENT FLOW

Turbulence, models and flow equations: steady and unsteady turbulent boundary layers

UNIT – IV COMPRESSIBLE FLOW THROUGH DUCTS

Introduction to compressible viscous flow, governing equations, flow with friction flow with heat transfer flow though nozzle and diffusers

UNIT – V SHOCK WAVE


TUTORIAL: 15,

TOTAL: 60
REFERENCES
5. Schlichting H - Boundary layer theory, McGraw Hill Inc
UNIT I  
RESEARCH METHODOLOGY

Types of research- Literature survey- Patent survey- literature review reporting- ethics and interventions of research- planning for research- research tools- seven management tools-graphical representations – Codes – Standards.

UNIT II  
QUANTITATIVE METHODS

Descriptions-statistics-distribution-sampling- hypothesis testing- regression-ANOVA- reliability- validity- uncertainty - sensitivity analysis- use of SPSS.

UNIT III  
QUALITATIVE METHODS

Historical analogy-market research- survey-analysis- delphi methodology-determination of index-life cycle analysis - modeling and simulation.

UNIT IV  
MEASUREMENT IN RESEARCH

12

Need for measurement- types of measuring instruments- configurations and functional descriptions of instruments- performance- characteristics- static and dynamic characteristics- manipulation, transmission and recording of data- data acquisition and processing systems- Computer aided experimentation.

UNIT V  
RESEARCH REPORT PREPARATION

5

Principles of Written communication- content preparation- synopsis writing- result analysis-discussion section-case studies.

REFERENCES


AIM
To study about robust design, embodiment principles, various methods in design of experiments, reliability charts and histograms and six sigma techniques.

UNIT I 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 II FAILURE MODE EFFECT ANALYSIS

Basic methods: Refining geometry and layout, general process of product embodiment - Embodiment checklist - Advanced methods: systems modeling, mechanical embodiment principles - FMEA method - linking fault states to systems modeling - Case study - computer monitor stand for a docking station.

UNIT III DESIGN OF EXPERIMENTS

Design of experiments - Basic methods - Two factorial experiments - Extended method reduced tests and fractional experiments, orthogonality, base design method, higher dimensional fractional factorial design - Statistical analysis of experiments: Degree of freedom, correlation coefficient, standard error of the residual t-test, ANOVA-ratio test, other indicators-residual plots, Advanced DOE method for product testing - Product applications of physical modeling and DOE, Blender panel display evaluation, coffee grinder experimental optimization - Taguchi method.

UNIT IV STATISTICAL CONSIDERATION AND RELIABILITY

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

UNIT V DESIGN FOR SIX SIGMA

Basis of SIX SIGMA - Project selection for SIX SIGMA - SIX SIGMA problem solving - SIX SIGMA in service and small organizations - SIX SIGMA and lean production - Lean SIX SIGMA and services

REFERENCES:

TOTAL :45
OBJEKTIVE:

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

OUTCOME:

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

UNIT I BASIC CONCEPTS OF MATERIAL BEHAVIOR


UNIT II BEHAVIOUR UNDER DYNAMIC LOADS AND DESIGN APPROACHES

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

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


UNIT V NON METALLIC MATERIALS

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.
REFERENCES:
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.

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

UNIT I INTRODUCTION

UNIT II KINEMATIC ANALYSIS

UNIT III PATH CURVATURE THEORY, COUPLER CURVE
Fixed and moving centres, 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

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.

Note: Tutorial/Practice: 30 Hrs Total 45 + 30 = 75 Hrs a Term Project must be given for Assessment – 3 (Compulsory)

REFERENCES:
Kenneth J, Waldron, Gary L. Kinzel, “Kinematics, Dynamics and Design of
OBJECTIVES:

- To study the concepts of latest metal forming techniques and their applications in metal forming industry.
- To study the thermo mechanical regimes and its requirements of metal forming

OUTCOME:

- The course would familiarize the students on the latest metal forming techniques and help them decide on the suitable method to form the metals for various industrial applications.

UNIT I INTRODUCTION TO THEORY OF PLASTICITY AND FORMING 9

UNIT II THEORY AND PRACTICE OF BULK FORMING PROCESSES 9
Analysis of plastic deformation in Forging, Rolling, Extrusion, rod/wire drawing and tube drawing – Effect of friction – calculation of forces, work done – Process parameters, equipment used – Defects – applications – Recent advances in Forging, Rolling, Extrusion and Drawing processes – Design consideration in forming - Formability of laminated sheet - Overview of FEM applications in Metal Forming analysis.

UNIT III SHEET METAL FORMING 9
Formability studies – Conventional processes – H E R F techniques – Superplastic forming techniques – Hydro forming – Stretch forming – Water hammer forming – Principles and process parameters – Advantage, Limitations and application

UNIT IV POWDER METALLURGY AND SPECIAL FORMING PROCESSES 9
Overview of P/M technique – Advantages – applications – Powder preform forging – powder rolling
- Tooling, process parameters and applications. - Orbital forging – Isothermal forging – Hot and cold isostatic pressing – High speed extrusion – Rubber pad forming – Fine blanking – LASER beam forming

UNIT V ELECTROMAGNETIC FORMING AND ITS APPLICATIONS 9
sheet forming, stamping, shearing and welding – Applications – Finite Element Analysis of EM forming.

TOTAL: 45 PERIODS

REFERENCES:

2. Proceedings of International Workshop on EMFT 2010, Anna University
PED 2705 PLATES AND SHELLS

OBJECTIVE:
To impart knowledge on the behavior of plates and shell elements, their places of utility and of course the design procedure of such elements in practical applications.

OUTCOME:
After undergoing this course, the students would be in a position to understand the behaviour of these commonly occurring structural elements in engineering design and would have developed the capability to design and analyse them in their normal design practice.

UNIT I  GENERAL INTRODUCTION
Review of equations of elasticity- kinematics, compatibility equations, stress measures- equations of motions- constitutive relations- transformation of stresses, strains and stiffness-energy principles and variational methods in elasticity- virtual work-external and internal virtual work-variational operator- functionals- Euler Lagrange equations- energy principles- Hamilton’s principle- principle of minimum total potential- applications

UNIT II  CLASSICAL THEORY OF PLATES
Plates as structural elements- stress and moment resultants- assumptions made in the classical theory- displacement fields and strains- equations of equilibrium in Cartesian coordinates and in polar coordinates- boundary conditions – bending of rectangular plates with various boundary conditions and loading- symmetrical and asymmetrical bending of circular plates-limitations of classical theory- finite element analysis(elementary treatment only; discussion of various elements used and their capabilities- not for examination)

UNIT III  BUCKLING ANALYSIS OF RECTANGULAR PLATES
Buckling of simply supported plates under compressive forces- governing equations- the Navier solution- biaxial compression of a plate- uniaxial compression of a plate- buckling of plates simply supported on two opposite edges- Levy’s solution- buckling of plates with various boundary conditions- general formulation- finite element analysis(elementary treatment only; discussion of various elements used and their capabilities- not for examination)

UNIT IV  VIBRATION OF PLATES
Governing equations for natural flexural vibrations of rectangular plates- natural vibrations of plates simply supported on all edges- vibration of plates with two parallel sides simply supported- Levy’s solution- vibration of plates with different boundary conditions- Rayleigh-Ritz method- Natural vibration of plates with general boundary conditions- transient analysis of rectangular plates- finite element analysis(elementary treatment only; discussion of various elements used and their capabilities- not for examination)

UNIT V  ANALYSIS OF THIN ELASTIC SHELLS OF REVOLUTION
Classification of shell surfaces- geometric properties of shells of revolution- general strain displacement relations for shells of revolution- stress resultants- equations of motion of thin shells-analytical solution for thin cylindrical shells- membrane theory- flexure under axisymmetric loads-shells with double curvature- geometric considerations- equations of equilibrium- bending of spherical shells- vibration of cylindrical shells- finite element analysis(elementary treatment only; discussion of various elements used and their capabilities- not for examination)
REFERENCES:

4. Wilhelm Flügge, stresses in shells, Springer - Verlag
7. Dr. N. Subramanian, Principles of Space Structures, Wheeler Publishing Co. 1999
PED 2706 SURFACE ENGINEERING

OBJECTIVES:
- To impart knowledge on surface engineering and surface modification methods that will come in handy to solve the industrial problems. This will also serve as a precursor for future research in the same field.

OUTCOME:
- It helps the students to get familiarized with the various theories and practice on surface engineering and surface modification methods which are necessary to solve the industrial practical problems that arise and also for the research.

UNIT I FRICTION
Topography of Surfaces – Surface features – Properties and measurement – Surface interaction – Adhesive Theory of Sliding Friction – Rolling Friction – Friction properties of metallic and non metallic materials – Friction in extreme conditions – Thermal considerations in sliding contact

UNIT II WEAR

UNIT III CORROSION

UNIT IV SURFACE TREATMENTS

UNIT V ENGINEERING MATERIALS

TOTAL: 45 PERIODS

REFERENCES
OBJECTIVE:

- To know about different types of bearings available for machine design and their operating principles
- To design hydrodynamic/ hydrostatic / rolling bearing for given specifications and analyze the bearings for their performance
- To understand the bearing behavior under dynamic conditions

OUTCOME:

- Acquisition of knowledge in the analysis of all types of bearings.
- Ability to make specifications of all types of bearings
- Skill for conducting dynamic / vibration analysis and trouble shooting of bearings

UNIT I  CLASSIFICATION AND SELECTION OF BEARINGS  6
Selection criteria-Dry and Boundary Lubrication Bearings-Hydrodynamic and Hydrostatic bearings- Electro Magnetic bearings-Dry bearings-Rolling Element bearings- Bearings for Precision Applications-Foil Bearings-Special bearings- Selection of plain Bearing materials –Metallic and Non metallic bearings

UNIT II  DESIGN OF FLUID FILM BEARINGS  10

UNIT III  SELECTION AND DESIGN OF ROLLING BEARINGS  10
Contact Stresses in Rolling bearings- Centrifugal stresses-Elasto hydrodynamic lubrication- Fatigue life calculations- Bearing operating temperature- Lubrication- Selection of lubricants- Internal clearance – Shaft and housing fit- Mounting arrangements-Materials for rolling bearings- Manufacturing methods- Ceramic bearings-Rolling bearing cages-bearing seals selection

UNIT IV  DYNAMICS OF HYDRO_DYNAMIC BEARINGS  10
Hydrodynamic Lubrication equation for dynamic loadings-Squeeze film effects in journal bearings and thrust bearings -Rotating loads , alternating and impulse loads in journal bearings – Journal centre Trajectory- Analysis of short bearings under dynamic conditions- Finite difference solution for dynamic conditions

UNIT V  ROTOR DYNAMICS  9
Rotor vibration and Rotor critical speeds- support stiffness on critical speeds- Stiffness and damping coefficients of journal bearings-computation and measurements of journal bearing coefficients -Mechanics of Hydro dynamic Instability- Half frequency whirl and Resonance whip- Design configurations of stable journal bearings

TOTAL: 45 PERIODS
REFERENCES:


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

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

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

REFERENCES:


TOTAL: 45 PERIODS
OBJECTIVE

- The main objective is to present the industrial related problems, procedures and design principles for pressure vessels and enhance the understanding of design procedure of pressure vessel and Design of piping layout.

OUTCOME

- It helps the student to get familiarized with the various theories and practice on pressure vessel and piping design and procedures which are necessary to solve the industrial practical problems that arise and also for the research in the field of pressure vessel design.

UNIT I INTRODUCTION 3

UNIT II STRESSES IN PRESSURE VESSELS 15

UNIT III DESIGN OF VESSELS 15
Design of Tall cylindrical self supporting process columns – Supports for short, vertical and horizontal vessels – stress concentration – at a variable Thickness transition section in a cylindrical vessel, about a circular hole, elliptical openings. Theory of Reinforcement – pressure vessel Design. Introduction to ASME pressure vessel codes

UNIT IV BUCKLING OF VESSELS 8
Buckling phenomenon – Elastic Buckling of circular ring and cylinders under external pressure – collapse of thick walled cylinders or tubes under external pressure – Effect of supports on Elastic Buckling of Cylinders – Buckling under combined External pressure and axial loading.

UNIT V PIPING 4

TOTAL: 45 PERIODS

REFERENCES
PED 2710 ENGINEERING FRACTURE MECHANICS

OBJECTIVE:

- To impart knowledge on mechanics of cracked components of different modes by which these components fail under static load conditions.
- To impart knowledge on mechanics of cracked components of different modes by which these components fail under fatigue load conditions.

OUTCOME:

- It helps the engineers to get familiarized with the design of components that contain crack under static load condition.
- It helps the engineers to get familiarized with the design of components that contain crack and its growth under fatigue load condition.

UNIT I ELEMENTS OF SOLID MECHANICS 9
The geometry of stress and strain, elastic deformation, plastic and elasto-plastic deformation - limit analysis – Airy’s function – field equation for stress intensity factor.

UNIT II STATIONARY CRACK UNDER STATIC LOADING 9

UNIT III ENERGY BALANCE AND CRACK GROWTH 9

UNIT IV FATIGUE CRACK GROWTH CURVE 9
Empirical relation describing crack growth law – life calculations for a given load amplitude – effects of changing the load spectrum -- rain flow method– external factors affecting the K1c values.- leak before break analysis.

UNIT V APPLICATIONS OF FRACTURE MECHANICS 9
Crack Initiation under large scale yielding – thickness as a design parameter – mixed mode fractures - crack instability in thermal and residual stress fields - numerical methods

TOTAL: 45 PERIODS

REFERENCES: