# NRI INSTITUTE OF TECHNOLOGY

(An Autonomous Institution Permanently Affiliated to JNTUK, Kakinada)
(Accredited by NAAC with "A" Grade and ISO 9001:2015 Certified Institution)
POTHAVARAPPADU (V), (VIA) NUNNA, AGIRIPALLI (M), PIN – 521 212

## DEPARTMENT OF MECHANICAL ENGINEERING

## COURSE STRUCTURE FOR FOURTH YEAR B. TECH PROGRAMME

### IV YEAR I SEMESTER

| Sl. No | Course Code | Title of the Course | Scheme of Instruction (Periods Per Week) | | | | Scheme of Examination (Maximum Marks) | | | No. of Credits |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | Total | CIA | SEA | Total | |
| 1 | HSS | Industrial Engineering and Management | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 3 |
| 2 | PC | Introduction to CAD/CAM | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 3 |
| 3 | PC | Metrology | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 3 |
| 4 | OE | **Open Elective – IV**<br>1.Nano Technology<br>2.Additive Manufacturing | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 3 |
| 5 | PE | **Professional Elective – III**<br>1. Unconventional Machining Process<br>2. Power Plant Engineering<br>3. Mechatronics<br>4. Advanced Mechanics of Materials | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 3 |
| 6 | PE | **Professional Elective – IV**<br>1. Mechanical Vibrations<br>2. Introduction to Composite materials<br>3. Refrigeration & Air-conditioning<br>4. Jet & Rocket Propulsion Engineering | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 3 |
| 7 | LC | Instrumentation and Metrology Lab | 0 | 0 | 2 | 2 | 40 | 60 | 100 | 1.5 |
| 8 | LC | Computational Fluid Dynamics Lab | 0 | 0 | 2 | 2 | 40 | 60 | 100 | 1.5 |
| 9 | PR | Term Paper/Internship | 0 | 0 | 1 | 1 | 40 | 60 | 100 | 1.5 |
| **Total** | | | 18 | 0 | 6 | 24 | 320 | 480 | 800 | 22.5 |

## IV YEAR II SEMESTER

| Sl. No | Course Code | Title of the Course | Scheme of Instruction (Periods Per Week) | | | | Scheme of Examination (Maximum Marks ) | | | No. of Credits |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | Total | CIA | SEA | Total | |
| 1 | PE | **Professional Elective – V /MOOCS**<br>1. Nano Technology<br>2. Introduction to Robotics<br>3. Energy Conservation and Management<br>4. Computer Graphics andGeometrical Modeling | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 3 |
| 2 | PE | **Professional Elective – VI /MOOCS**<br>1. Design for Manufacturing<br>2. Automobile Engineering<br>3. Metal Forming Process<br>4. Project Management | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 3 |
| 3 | PR | Major Project | | | | 18 | 80 | 120 | 200 | 8 |
| **Total** | | | 6 | 0 | 0 | 24 | 160 | 240 | 400 | 14 |

L - LECTURE T – TUTORIAL P - PRACTICAL

CIA – Continuous Internal Assessment SEA – Semester End Assessment

**IV B. Tech I Semester**

**18A4103401**

**INDUSTRIAL ENGINEERING & MANAGEMENT**

| | | | |
|---|---|---|---|
| **Lecture – Tutorial:** | 3-0 Hours | **Internal Marks:** | 40 |
| **Credits:** | 3 | **External Marks:** | 60 |

**Prerequisites:**

Fundamentals of Engineering mathematics, probability, and statistics

**Course Objectives:**

1. To impart fundamental knowledge and skill sets required in the Industrial Management and Engineering profession, which include the ability to apply basic knowledge of mathematics, probability and statistics and the domain knowledge of Industrial Management and Engineering.
2. To produce graduates with the ability to adopt a system approach to design, develop, implement, and innovate integrated systems that include people, materials, information, equipment, and energy.
3. To enable students to understand the interactions between engineering, business, technological and environmental spheres in the modern society.
4. To enable students to understand their role as engineers and their impact to society at the national and global context.

**Course Outcomes:**

**Upon successful completion of the course, the student will be able to:**

| | |
|---|---|
| CO1 | acquire fundamental knowledge of Industrial management and its importance overview of scientific principles of management, various tools of Industrial Engineering & Productivity measurement |
| CO2 | understand the concept of system approach and different types of production layouts, process layouts and acquire the domain knowledge of maintenance |
| CO3 | understand different types of production, work study, method study, work measurement techniques and design a system, component, or process, and synthesize solutions to achieve desired needs |
| CO4 | identify the role of statistics in engineering problem solving process, use of graphical techniques in data analysis |
| CO5 | use the techniques, skills, and modern engineering tools necessary for engineering practice with appropriate considerations for public health and safety, cultural, societal, and environmental constraints |
| CO6 | Use the techniques and tools necessary to reduce cost of a product without compromising quality, reliability & performance, and function effectively within multi-disciplinary teams and understand the fundamental precepts of effective project management |

**Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2- Medium, 3 – High)**

| | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO 10** | **PO 11** | **PO 12** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | | | | | | | 2 | 1 | | | |
| CO2 | | | 3 | 1 | 2 | | | | | | 1 | |
| CO3 | | | 1 | | 3 | 2 | | | | | | |
| CO4 | | 3 | 2 | | 1 | | | | | | | |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO5 | 2 | | | | 3 | | | | | | 1 | |
| CO6 | 2 | | | | 1 | | | | | | 3 | |

**UNIT I**

**INTRODUCTION:** Definition of industrial engineering (I.E), development, applications, role of an industrial engineer, differences between production management and industrial engineering, quantitative tools of IE and productivity measurement. concepts of management, importance, functions of management, scientific management, Taylor's principles, theory X and theory Y, Fayol's principles of management.

**PLANT LAYOUT:** Factors governing plant location, types of production layouts, advantages and disadvantages of process layout and product layout, applications, quantitative techniques for optimal design of layouts, plant maintenance, preventive, and breakdown maintenance.

**UNIT II**

**OPERATIONS MANAGEMENT:** Importance, types of production, applications, workstudy, method study and time study, work sampling, PMTS, micro-motion study, rating techniques, MTM, work factor system, principles of Ergonomics, flow process charts, string diagrams and Therbligs

**VALUE ANALYSIS:** Value engineering, implementation procedure, enterprise resource planning and supply chain management.

**UNIT III**

**STATISTICAL QUALITY CONTROL:** Quality control, its importance, SQC, attribute sampling inspection with single and double sampling, Control charts – X and R – charts X AND S charts and their applications, numerical examples.

**TOTAL QUALITY MANAGEMENT:** zero defect concept, quality circles, implementation, applications, ISO quality systems. six sigma – definition, basic concepts.

**UNIT IV**

**RESOURCE MANAGEMENT:** Concept of human resource management, personnel management and industrial relations, functions of personnel management, Job-evaluation, its importance and types, merit rating, quantitative methods, wage incentive plans, types.

**PROJECT MANAGEMENT:** PERT, CPM – differences & applications, critical path, determination of floats, importance, project crashing, smoothing and numerical examples.

**TEXTBOOKS:**

1. Industrial Engineering and management / O.P Khanna/Khanna Publishers.
2. Industrial Engineering and Production Management/MartandTelsang/S.Chand& Company Ltd. New Delhi
3. Maynard's Industrial Engineering Handbook by Harold Maynard and KjellZandin
4. Plant layout & Material Handling-Apple J.M (John Wiley Publishers)

**REFERENCE BOOKS:**

1. Industrial Management / Bhattacharya DK/Vikas publishers
2. Handbook of Industrial Engineering by GavrielSalvendy
3. Operations Management / J.G Monks/McGrawHill Publishers.
4.Industrial Engineering and Management Science/ T. R. Banga, S. C. Sharma, N.K.Agarwal/KhannaPublishers
5. Principles of Management /Koontz O' Donnel/McGraw Hill Publishers.

6. Statistical Quality Control /Gupta/Khanna Publishers
7. Industrial Engineering and Management /NVS Raju/Cengage Publishers

**E-RESOURCES:**

http://compass.astm.org/CUSTOMERS/license.html

https://ezproxy.wpi.edu/login?url=https://www.engineeringvillage.com/search/quick.url?database=3

**IV B. Tech I Semester**

**18A4103402**
**INTRODUCTION TO CAD/CAM**

| | | | |
|---|---|---|---|
| **Lecture – Tutorial:** | 3-0 Hours | **Internal Marks:** | 40 |
| **Credits:** | 3 | **External Marks:** | 60 |

**Prerequisites:**

Students are expected to have knowledge on:

1. Computer peripherals like Input and output devices
2. Various display devices, representation methods & Transformations in the Computer Graphics
3. commands used for 2D & 3D drawings in the AutoCAD software
4. Interactive Computer Graphics

Metal Cutting and Machine Tools

**Course Objectives:**

1. To impart fundamentals of computer aided design and manufacturing.
2. To learn 2D & 3D transformations of the basic entities like line, circle, ellipse etc.,
3. To understand the fundamentals used to create and manipulate geometric models
4. To get acquainted with the basic CAD software designed for geometric modeling
5. To learn working principles of NC machines, CNC control and part programming & DNC
6. To understand concept of Group Technology, FMS and CIM and interpret the importance of CAQC.

**Course Outcomes:**

**Upon successful completion of the course, the student will be able to:**

| | |
|---|---|
| CO1 | describe basic structure of CAD workstation, Memory types, input/output devicesand display devices and computer graphics |
| CO2 | acquire the knowledge of geometric modeling and execute the steps required inCAD software for developing 2D &3D models and perform transformations |
| CO3 | understand the construction of database models and geometric modeling features |
| CO4 | understand how to write the part programs for different models by using part programming |
| CO5 | explain features of Group Technology (GT), CAPP & FMS |
| CO6 | illustrateCAQC and CIM concepts |

**Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2- Medium, 3 – High)**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | 2 | 3 | 1 | - | - | - | - | - | 1 |
| CO2 | 3 | 2 | 1 | 2 | 3 | 1 | - | - | - | - | - | 1 |
| CO3 | 2 | 2 | 1 | 2 | 3 | 1 | - | - | - | - | - | 1 |
| CO4 | 2 | 2 | 1 | 2 | 3 | 2 | - | - | - | - | - | 1 |
| CO5 | 2 | 2 | 1 | 2 | 3 | 2 | - | - | - | - | - | 1 |
| CO6 | 2 | 1 | 3 | - | 2 | 1 | - | - | - | - | - | 1 |

**UNIT I**

Computers in industrial manufacturing, product cycle, CAD / CAM Hardware, basic structure, CPU, memory types, input devices, display devices, hard copy devices,

storage devices.

**COMPUTER GRAPHICS:** Raster scan graphics coordinate system, database structure for graphics modeling, transformation of geometry, 3D transformations, mathematics of projections, clipping, hidden surface removal

**GEOMETRIC MODELING:** Requirements, geometric models, geometric construction models, curve representation methods, surface representation methods, modeling facilities desired.

**UNIT II**

**DRAFTING AND MODELING SYSTEMS:** Basic geometric commands, layers, display control commands, editing, dimensioning and solid modeling.

**PART PROGRAMMING FOR NC MACHINES:** NC, NC modes, NC elements, CNC machine tools, structure of CNC machine tools, features of Machining center, turning center, CNC Part Programming: fundamentals, manual part programming methods, Computer Aided Part Programming. Direct Numerical Control

**UNIT III**

**GROUP TECHNOLOGY:** Part family, coding and classification, production flow analysis, types and advantages. Computer aided processes planning – importance, types.

**FMS**: Introduction, Equipment, Tool management systems, Layouts, FMS Control

**UNIT IV**

**COMPUTER AIDED QUALITY CONTROL:** Terminology used in quality control, use of computers in Quality control. Inspection methods- contact and noncontact types, computer aided testing, integration of CAQC with CAD/CAM

**COMPUTER INTEGRATED MANUFACTURING SYSTEMS:** Types of manufacturing systems, machine tools and related equipment, material handling systems, material requirement planning, computer control systems, human labour in manufacturing systems, CIMS benefits.

**TEXTBOOKS:**


1. CAD/CAM: Principles and Applications: Rao P N, Tata McGraw Hill Higher Education P Ltd 2002
2. CAD/CAM: Groover, Mikell P and Zimmer's Emory W, Prentice Hall India (P) Ltd, 2001
3. CAD/CAM/CIM: Radhakrishnan P, New Age International Publishers 1994


**REFERENCE BOOKS:**


1. Mastering CAD / CAM / Ibrahim Zeid / McGraw-Hill
2. Principles of Computer Aided Design and Manufacturing / FaridAmirouche / Pearson
3. Computer Numerical Control Concepts and programming / Warren S Seames / Thomson learning, Inc
4. Product manufacturing and cost estimation using CAD/CAE/ KuangHua Chang/Elsevier Publishers
5. CAD/CAM Concepts & applications/Alavala/PHI


**E-RESOURCES:**

**https://www.coursera.org/**

https://www.udemy.com/

**IV B. Tech I Semester**

**18A4103403**
**METROLOGY**

| | | | |
|---|---|---|---|
| **Lecture – Tutorial:** | 3-0 Hours | **Internal Marks:** | 40 |
| **Credits:** | 3 | **External Marks:** | 60 |

**Prerequisites:**

Metallurgy,Machine Design, Physics

**Course Objectives:**

1. Learn the system of limits, fits, tolerances, and gauge design
2. Know about the linear and angular measuring instruments.
3. know about optical and comparator measuring instruments
4. Understand the principles of surface roughness measurement
5. Understand the flatness measurement and principles of interferometry
6. Learn the gear and screw thread measurement.

**Course Outcomes:**

**Upon successful completion of the course, the student will be able to:**

| | |
|---|---|
| CO1 | Design limit gauges, tolerances, and fits for selected product quality. |
| CO2 | Evaluate various devices for linear and angular measurements. |
| CO3 | Outline the operation of optical and comparator measuring instruments |
| CO4 | Evaluate the surface roughness parameters. |
| CO5 | Demonstrate the flatness and interferometer measuring instruments |
| CO6 | Outline the working of gear and screw thread measuring instruments. |

**Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2- Medium, 3 – High)**

| | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO 10** | **PO 11** | **PO 12** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | | | | | | 1 | | | |
| CO2 | 1 | 3 | 2 | | | | | | | 1 | | |
| CO3 | 2 | 1 | 3 | | | | | | | | | 1 |
| CO4 | 3 | 2 | 1 | | | | | | | | 1 | |
| CO5 | 1 | 3 | 2 | | | | | | | 1 | | |
| CO6 | 2 | 3 | 3 | | | | | | | | | 1 |

**UNIT I**

**SYSTEMS OF LIMITS AND FITS:**

Introduction, nominal size, tolerance, limits, deviations, fits –Unilateral and bilateral tolerance system, hole and shaft basis systems- interchangeability, deterministic & statistical tolerances, selective assembly. International standard system of tolerances, selection of limits, and tolerances for correct functioning.

**LIMIT GAUGES:** Taylor's principle – design of go and no-go gauges; plug, ring, snap, gap, taper, profile, and position gauges

**LINEAR MEASUREMENT:** Length standards, end standards, slip gauges- calibration of the slip gauges, dial indicators, micrometers.

**UNIT II**

**MEASUREMENT OF ANGLES AND TAPERS:** Different methods – bevel protractor, angle slip gauges- Angle Dekker- spirit levels- sine bar- sine table, rollers, and spheres used to measure angles and tapers.

**COMPARATORS:** Types - mechanical, optical, electrical, and electronic, pneumatic comparators and their uses.

**OPTICAL MEASURING INSTRUMENTS:** Tools maker's microscope and uses - autocollimators, optical projector, optical flats, and their uses.

## UNIT III

**SURFACE ROUGHNESS MEASUREMENT:** Differences between surface roughness and surface waviness Numerical assessment of surface finish-CLA, Rt., R.M.S. Rz, R10 values, Method of measurement of surface finish – Profilograph, Talysurf,

**INTERFEROMETRY:** Interference of light, Michelson's interferometer, NPL flatness interferometer, and NPL gauge interferometer, laser interferometers, types, DC and AC laser interferometers, applications.

**FLATNESS MEASUREMENT**: Measurement of flatness of surfaces- instruments used- straight edges- surface plates autocollimator

## UNIT IV

**GEAR MEASUREMENT:** Nomenclature of gear tooth, tooth thickness measurement with gear tooth vernier &flange micrometer, pitch measurement, total composite error and tooth to tooth composite errors, rolling gear tester, involute profile checking

**SCREW THREAD MEASUREMENT**: Elements of measurement – errors in screw threads- the concept of virtual effective diameter, measurement of effective diameter, angle of thread and thread pitch, and profile thread gauges.

## TEXTBOOKS:

1.Engineering Metrology by Mahajan / Dhanpat Rai Publishers.
2.Dimensional Metrology/Connie Dotson/Cengage Learning.
3.Engineering Metrology by R.K.Jain / Khanna Publishers.
4.Engineering Metrology by I.C.Gupta / Dhanpat Rai Publishers.

## REFERENCE BOOKS:

1. Engineering Metrology by KL Narayana, Scitech publishers.
2. Engineering Metrology and Measurements by NV Raghavendra, LKrishna Murthy, Oxford publishers.
3. Precision Engineering in Manufacturing by R.L.Murthy / New Age.
4. BIS standards on Limits & Fits, Surface Finish, Machine Tool Alignment, etc.

## E-RESOURCES:

**https://www.npl.co.uk/resources**
**https://iopscience.iop.org/journal/0957-0233**

**IV B. Tech I Semester**

**Course Code:**
**ADDITIVE MANUFACTURING**
**(Open Elective – III)**

| | | | |
|---|---|---|---|
| **Lecture – Tutorial:** | 3-0 Hours | **Internal Marks:** | 40 |
| **Credits:** | 3 | **External Marks:** | 60 |

**Prerequisites:**

Introduction to CAD/CAM, Material science,

**Course Objectives:**

1. Student will develop a comprehensive understanding of the fundamentals of additive manufacturing.
2. Student will acquire knowledge on the aspects of materials and their properties used in AM.
3. Student will develop a deep understanding of AM process, monitoring & controlling these processes.
4. Student will recognize the tools used in RP.
5. Student will learn and identify various fields applying AM.
   Student will comprehend and present case studies on AM.

**Course Outcomes:**

**Upon successful completion of the course, the student will be able to:**

| | |
|---|---|
| CO1 | Paraphrase the fundamentals of AM. |
| CO2 | Interpret the materials used in AM. |
| CO3 | Illustrate the AM processes and analyze parameters controlling the AM process. |
| CO4 | Relate the tools used for RP. |
| CO5 | Analyze the application areas of AM |
| CO6 | Discuss and analyze case studies on AM. |

**Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2- Medium, 3 – High)**

| | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO 10** | **PO 11** | **PO 12** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | | 1 | | | | | | | | | |
| CO2 | 3 | 1 | 1 | | | | | | | | | 1 |
| CO3 | | | 1 | | | | | | | | | 1 |
| CO4 | | | 1 | 1 | 3 | 1 | | | | | | 1 |
| CO5 | | | 1 | 1 | 3 | 1 | | | | | | 1 |
| CO6 | | 1 | | 1 | 3 | | | | | | | 1 |

**UNIT I**

**Introduction:** Review of general manufacturing approaches (Casting, Welding, machining), Need - Development of Additive Manufacturing Technology -Principle – AM Process Chain- Classification –Rapid Prototyping- Rapid Tooling – Rapid Manufacturing – Applications- Benefits –Case studies.

**Materials used for AM:** Types of materials used for AM, Use of multiple materials, multifunctional and graded materials in AM, Role of solidification rate, Evolution of non-equilibrium structure, Structure property relationship, Grain structure and microstructure

**UNIT II**

**Process monitoring and Control for AM:**
Defects, Geometry, Temperature, Composition, Phase Transformation
**Additive Manufacturing Systems: Liquid based:** SLA, SGC; **Solid based:** LOM, FDM; **Powder based:** SLS, 3DP

**UNIT III**

**RAPID TOOLING:** Introduction to rapid tooling (RT), conventional tooling Vs RT, Need for RT. rapid tooling classification: indirect rapid tooling methods: spray metal deposition, RTV epoxy tools, Ceramic tools, investment casting, spin casting, die casting, sand casting, 3D Keltool process. Direct rapid tooling: direct AIM, LOM Tools, DTM Rapid Tool Process, EOS Direct Tool Process and Direct Metal Tooling using 3DP.

**UNIT IV**

**Application of AM for various Industries:**
Aerospace, Automobile, Oil and Gas, Agriculture.
**Case Studies: (To be presented by students)**

**TEXTBOOKS:**


1. Rapid prototyping: Principles and Applications /Chua C.K., Leong K.F. and LIM C.S/World Scientific
2. Ian Gibson, David W. Rosen, Brent Stucker, Additive manufacturing technologies: rapid prototyping to direct digital manufacturing Springer, 2010.


**REFERENCE BOOKS:**


1. Chua C.K., Leong K.F., and Lim C.S., "Rapid prototyping: Principles and applications", Third edition, World Scientific Publishers, 2010.
2. Rapid Manufacturing/ D. T. Pham and S. S. Dimov/ Springer/
3. Wholers Report 2000/Terry Y Wholers/ WholersAassociates.
4. Andreas Gebhardt, "Understanding Additive Manufacturing," Hanser, 2011, ISBN 9783446425521.


**E-RESOURCES:**

**https://libraryblogs.is.ed.ac.uk/eresources/tag/3d-printing-and-additive-manufacturing/**
**https://www.journals.elsevier.com/additive-manufacturing**

**IV B. Tech I Semester**

**18A4103511**

**UNCONVENTIONAL MACHINING PROCESSES**

**(Professional Elective – III)**

| | | | |
|---|---|---|---|
| **Lecture – Tutorial:** | 2-1 Hours | **Internal Marks:** | 40 |
| **Credits:** | 3 | **External Marks:** | 60 |

**Prerequisites:**

Manufacturing Technology I, Manufacturing Technology II, Engineering Mechanics

**Course Objectives:**

1. Student will be able to identify the classification of unconventional machining processes.
2. Student will be to understand the principle, mechanism of metal removal of various unconventional machining processes.
3. Student will study the various process parameters and their effect on the component machined on various unconventional machining processes.
4. Student will design various Hydraulic and Pneumatic circuits.
5. Student will apply basics of digital electronics for various applications of logic gates.
6. Student will relate different logic gates and their role in Programmable logic controllers.

**Course Outcomes:**

**Upon successful completion of the course, the student will be able to:**

| | |
|---|---|
| CO1 | Describe unconventional machining methods and working principles of mechanical energy-based processes |
| CO2 | Demonstrate electro-chemical machining principles in grinding, honing and deburring process. |
| CO3 | Explain principle, working, applications and various characteristics of electric discharge machining process. |
| CO4 | Identify the difference between EBM and LBM based on its characteristics, parameters, and accuracy. |
| CO5 | Explain the applications, characteristics and process of plasma arc machining based on MRR and accuracy. |
| CO6 | Compare different types of mechanical finishing process. |

**Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2- Medium, 3 – High)**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | | | 1 | 2 | | | | | | | |
| CO2 | 3 | | | 1 | 2 | | | | | | | |
| CO3 | 3 | | | 1 | 2 | | | | | | | |
| CO4 | 3 | | | 1 | 2 | | | | | | | |
| CO5 | 3 | | | 1 | 2 | | | | | | | |
| CO6 | 3 | | | 1 | 2 | | | | | | | |

**UNIT I**

**Introduction:** Need for non-traditional machining methods-classification of modern machining processes – considerations in process selection, applications.

**Abrasive jet machining, Water jet machining**– Elements of the process, mechanics of material removal, MRR process parameters, economic considerations, applications, and limitations.

## UNIT II

**Abrasive water jet machining and Ultrasonic machining:** Basic principles, equipment, process variables, mechanics of material removal, MRR, application and limitations.

**Chemical machining and Electro-Chemical machining (CHM and ECM):** Etchants – Maskant - techniques of applying maskants - Process Parameters – Surface finish and MRR-Applications. Principles of ECM- equipment's-Surface Roughness and MRR - Process Parameters- ECG and ECH - Applications.

## UNIT III

**Thermal Metal Removal Processes:** General principle and applications of Electric Discharge Machining, Electric Discharge Grinding and wire EDM – Mechanics of metal removal in EDM, Process parameters, selection of tool electrode and dielectric fluids, surface finish and machining accuracy, applications.

**Electron Beam Machining, Laser Beam Machining:** Basic principle and theory, mechanics of material removal, process parameters, efficiency & accuracy, applications

## UNIT IV

**Plasma Machining:** Application of plasma for machining, metal removal mechanism, process parameters, accuracy and surface finish and other applications of plasma in manufacturing industries.

**Advanced Nano Finishing Processes:** Magnetic abrasive finishing, abrasive flow finishing, working principles, equipments, effect of process parameters, applications, advantages and limitations Electro stream drilling and shaped tube electrolytic machining

## TEXTBOOKS:

1. Fundamentals of Machining Processes-Conventional and non – conventional processes/ Hassan Abdel – Gawad El-Hafy/CRC Press-2016.
2. Advanced Machining Processes /Vijay.K. Jain/Allied Publishers Pvt. Ltd., New Delhi, 2007

## REFERENCE BOOKS:

1. Modern Machining Process / Pandey P.C. and Shah H.S./ TMH.
2. New Technology / Bhattacharya A/ the Institution of Engineers, India 1984.
3. Non-Traditional Manufacturing Processes / Benedict /
4. Advanced Methods of Machining/Mc Geough/Chapman and Hall, London, 1998
5. Material and Processes in Manufacturing/ Paul De Garmo, J.T.Black, and Ronald. A.Kohser/Prentice Hall of India Pvt. Ltd., 8thEdition, New Delhi , 2001

## E-RESOURCES:

**http://www.sasurieengg.com/e-course-material/MECH/III-ear%20Sem%206/ME2026%20UMP.pdf**
**http://home.iitk.ac.in/~nsinha/Non-traditional-machining.pdf**

**IV B. Tech I Semester**

**Course Code:**

**POWER PLANT ENGINEERING**

**(Professional Elective – III)**

| | | | |
|---|---|---|---|
| **Lecture – Tutorial:** | 3-0 Hours | **Internal Marks:** | 40 |
| **Credits:** | 3 | **External Marks:** | 60 |

**Prerequisites:**

Basic Thermodynamics, Applied Thermodynamics & IC Engines and Gas Turbine.

**Course Objectives:**

1. To impart the Knowledge of sources of energy
2. To enable the Students the Concepts of Different Power Plants
3. To impart the Concepts of Hydroelectric Power Plant
4. To imbibe the Knowledge of Nuclear Power Station
5. To enable the Students the Concepts of Power Plant Instrumentation and Control
6. To impart the Knowledge of Power Plant Economics

**Course Outcomes:**

**Upon successful completion of the course, the student will be able to:**

| | |
|---|---|
| CO1 | Explain various types of Coals and Illustrate Dust Collector, Cooling Tower and Heat Rejection Systems |
| CO2 | Outline the Diesel and Gas Turbine Power Plant |
| CO3 | Explain Hydrological Cycle, interflow measurements from Hydrographs |
| CO4 | Explain Working Principle of Nuclear Power Plants, Nuclear Fuels and Reactor Operations |
| CO5 | Explain Cost Factors, Load and Power Distribution Factors |
| CO6 | Summarize the impact of Power Plants on the Environment |

**Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2- Medium, 3 – High)**

| | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO 10** | **PO 11** | **PO 12** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | 1 | 1 | 2 | 3 | 3 | 2 | | | | 3 |
| CO2 | 3 | 1 | 2 | 1 | 2 | 2 | 2 | 3 | | | | 2 |
| CO3 | 2 | 3 | 1 | 2 | 1 | 3 | 2 | 2 | | | | 2 |
| CO4 | 2 | 2 | 1 | 2 | 2 | 2 | 1 | 2 | | | | 3 |
| CO5 | 2 | 3 | 2 | 1 | 2 | 3 | 2 | 2 | | | | 2 |
| CO6 | 3 | 1 | 1 | 2 | 1 | 2 | 1 | 1 | | | 2 | 3 |

**UNIT I**

Introduction to the sources of energy – resources and development of power in India.

**STEAM POWER PLANT:** Plant layout, working of different circuits, fuel and handling equipment, types of coals, coal handling, choice of handling equipment, coal storage, Combustion: properties of coal – overfeed and underfeed fuel beds, traveling grate stokers, spreader stokers, retort stokers, pulverized fuel burning system and its components, ash handling systems, Dust collectors - cooling towers and heat rejection.

**UNIT II**

**DIESEL POWER PLANT:** Plant layout with auxiliaries – fuel supply system, air starting equipment, supercharging.

**GAS TURBINE PLANT:** Introduction – classification - construction – layout with auxiliaries, combined cycle power plants and comparison.

**HYDRO ELECTRIC POWER PLANT:** Waterpower – hydrological cycle / flow measurement – drainage area characteristics – hydrographs – storage and pondage – classification of dams and spill ways.

**UNIT III**

**NUCLEAR POWER STATION:** Nuclear fuel – breeding and fertile materials – nuclear reactor – reactor operation - Pressurized water reactor, boiling water reactor, sodium-graphite reactor, fast breeder reactor, homogeneous reactor, gas cooled reactor, radiation hazards and shielding – radioactive waste disposal.

**COMBINED OPERATIONS OF DIFFERENT POWER PLANTS:** Introduction, advantages of combined working, load division between power stations, storage type hydro-electric plant in combination with steam plant, run-of-river plant in combination with steam plant, pump storage plant in combination with steam or nuclear power plant, co-ordination of hydro-electric and gas turbine stations, co-ordination of hydro-electric and nuclear power stations, co-ordination of different types of power plants.

**UNIT IV**

**POWER PLANT INSTRUMENTATION AND CONTROL:** Importance of measurement and instrumentation in power plant, measurement of water purity, gas analysis, $O_2$ and $CO_2$ measurements, measurement of smoke and dust, measurement of moisture in carbon dioxide circuit,

**POWER PLANT ECONOMICS AND ENVIRONMENTAL CONSIDERATIONS**: Capital cost, investment of fixed charges, operating costs, general arrangement of power distribution, load curves, load duration curve, definitions of connected load, maximum demand, demand factor, average load, load factor, diversity factor –related exercises. effluents from power plants and Impact on environment – pollutants and pollution standards –methods of pollution control.

**TEXTBOOKS:**

1. A course in Power Plant Engineering /Arora and Domkundwar/Dhanpatrai & Co.
2. Power Plant Engineering /P.C.Sharma / S.K.Kataria Pub

**REFERENCE BOOKS:**

1. Power Plant Engineering: P.K.Nag/ II Edition /TMH.
2. Power station Engineering – ElWakil / McGrawHill.
3. An Introduction to Power Plant Technology / G.D. Rai/Khanna Publishers
4. Power Plant Engineering, P.K. Nag, Tata McGraw Hill.
5. Power Plant Engineering, F.T. Morse, Affiliated East-West Press Pvt. Ltd, New Delhi/Madras
6.Power Plant Technology El-Vakil, McGraw Hill.

**E-RESOURCES:**

https://www.freebookcentre.net/Mechanical/Power-Plant-Engineering.html
http://library.ddn.upes.ac.in:8081/upeslib/upeslib/links/ebooks_power.html

**IV B. Tech I Semester**

**Course code-**

**MECHATRONICS**

**(Professional Elective – III)**

| | | | |
|---|---|---|---|
| **Lecture – Tutorial:** | 2-1 Hours | **Internal Marks:** | 40 |
| **Credits:** | 3 | **External Marks:** | 60 |

**Prerequisites:**

Fundamentals of Engineering Mathematics, Electronic Devices and Circuits, Digital Electronics

**Course Objectives:**

1. Student will be able to introduce to integrative nature of Mechatronics.
2. Student will be exposed to the various types of sensors and transducers.
3. Student will understand the fundamentals of solid-state electronic devices.
4. Student will design various Hydraulic and Pneumatic circuits.
5. Student will apply basics of digital electronics for various applications of logic gates.
6. Student will relate different logic gates and their role in Programmable logic controllers.

**Course Outcomes:**

**Upon successful completion of the course, the student will be able to:**

| | |
|---|---|
| CO1 | Describe mechatronics system and their elements and levels |
| CO2 | Differentiate various sensors and transducers |
| CO3 | Understand solid state electronic devices, analog signal conditioning |
| CO4 | Demonstrate hydraulic and pneumatic actuating systems |
| CO5 | Understand Digital electronics and Logic gates |
| CO6 | Explain micro controllers and applications of PLC |

**Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2- Medium, 3 – High)**

| | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO 10** | **PO 11** | **PO 12** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | | | | | | | | | | | |
| CO2 | 3 | | | | | | | | | | | |
| CO3 | 3 | | | | | | | | | | | |
| CO4 | 2 | | 2 | | 2 | | | | | | | |
| CO5 | 3 | | | | | | | | | | | |
| CO6 | 2 | | | | 2 | | | | | | | |

**UNIT I**

**Introduction:** Definition of Mechatronics, Elements & Levels of Mechatronics system, mechatronics design process, System, Measurement System, Control system, Types of control system, Advantages, and disadvantages of mechatronics systems

**Sensors and Transducers:** Static and Dynamic characteristics of Transducers, displacement, position, proximity, velocity, motion, force, acceleration, torque, fluid pressure, liquid flow, liquid level, temperature and light sensors.

**UNIT II**

**Solid state Electronic Devices**: PN junction diode, BJT, FET, DIAC, TRIAC and LEDs. Analog signal conditioning - operational amplifiers, noise reduction, types of filters.

**Process Controllers:** Controller principle, Two-position, Proportional, Integral, Derivative, PI, PD & PID controllers

**UNIT III**

**Hydraulic and Pneumatic Actuating Systems**: Fluid systems, Hydraulic systems, and pneumatic systems,Comparison of hydraulic and pneumatic systems, components, control valves, Characteristics and their limitations, Design of Hydraulic and Pneumatic circuits

**Digital Electronics and Systems:** Digital logic control, Numbering system, Boolean algebra, Logic gates, Karnaugh maps, Applications of logic gates.

**UNIT IV**

**Microcontrollers and Programmable Logic Controllers:** Architecture of Microprocessor, Microcontroller, Basic structure of a PLC, PLCs versus Computers, PLC Programming using ladder diagrams, logics, latching, sequencing, timers, relays and counters,

**Dynamic models and analogies:** Mechanical, Electrical, fluid, and thermal systems, Pneumatic and Hydraulic systems.

**TEXTBOOKS:**


1. MECHATRONICS Integrated Mechanical Electronics Systems/KP Ramachandran, GK Vijaya Raghavan & MS Balasundaram/WILEY India Edition
2. Mechatronics Electronics Control Systems in Mechanical and Electrical Engineering, WBolton, 3/e Pearson Education Press, 2005.


**REFERENCE BOOKS:**


1. Devadas Shetty and Richard A Kolk, Mechatronic System Design, 2/e, Cengage learning, 2010.
2. Clarence W. de Silva, Mechatronics an Integrated Approach, CRC Press, 2004.
3. Mechatronics, Robert H Bishop, CRC Press, 2005.
4. James J Allen, Micro Electromechanical Systems Design, CRC Press Taylor & Francis group, 2005.
5. Ganesh S Hedge, Mechatronics, Jones & Bartlett Learning, 2010.
6. Mechatronics – Principles and Application / Godfrey C. Onwubolu/Elsevier, Indian print
7. Mechatronics – N. Shanmugam / Anuradha Agencies Publishers.
8. Mechatronics /Smaili A, Mrad F/ Oxford Higher Education, Oxford University Press


**E-RESOURCES:**

**https://mechatronics.colostate.edu/resources/**
**https://esearch.sc4.edu/mechatronics/web**

**IV B. Tech I Semester**

**Course Code:**

# ADVANCED MECHANICS OF MATERIALS

**(Professional Elective – III)**

| | | | |
|---|---|---|---|
| **Lecture – Tutorial:** | 3-0 Hours | **Internal Marks:** | 40 |
| **Credits:** | 3 | **External Marks:** | 60 |

**Prerequisites:**

Fundamentals of Engineering Mathematics, Engineering Mechanics, Strength of Materials

**Course Objectives:**

1. Find Deflections in fixed and continues beams
2. Understanding stresses in thick cylinders
3. Curved beam stresses with different cross sections
4. Strain energy under different loading conditions

**Course Outcomes:**

**Upon successful completion of the course, the student will be able to:**

| | |
|---|---|
| CO1 | Calculate deflections in fixed and continuous beams |
| CO2 | Determine the stresses in thick cylinders |
| CO3 | Analyse the curved beams for stresses with different cross sections |
| CO4 | Calculate the stresses in rotating disks |
| CO5 | Determine the Strain Energy under static and gradually applied load |
| CO6 | Determine the Strain Energy under impact and shear stresses |

**Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2- Medium, 3 – High)**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 3 | 1 | | | | | | | | 2 |
| CO2 | 3 | 3 | 3 | 1 | | | | | | | | 2 |
| CO3 | 3 | 3 | 3 | 1 | | | | | | | | 2 |
| CO4 | 3 | 3 | 3 | 1 | | | | | | | | 2 |
| CO5 | 3 | 3 | 3 | 1 | | | | | | | | 2 |
| CO6 | 3 | 3 | 3 | 1 | | | | | | | | 2 |

## UNIT I

**Thick cylinders:** Introduction, Stresses in thick Cylindrical shell(Lame's theory), Radial Deflection, Stresses in Compound Cylinders

**Fixed beams and continuous beams:** Introduction, analysis of fixed beams by Macaulay's method Clapeyron's theorem of three moments, Beams with constant moments of inertia

## UNIT II

**Curved beams:** Stresses in Beams of small and large initial curvature, The Winkler-Bach theory, Assumptions for stresses in the bending of curved bars, Stresses in Crane Hook and C-Clamp with Rectangular, circular and trapezoidal cross section

## UNIT III

**Centrifugal Stresses**: Introduction, Rotating Ring, Rotating Disc, Rotating Disc of uniform strength

## UNIT IV

**Strain Energy :**Resilience, Proof Resilience, Strain energy stored in a body when the

load is applied gradually, Load is applied suddenly, Load is applied with impact, Strain energy stored in a body due to shear stress

**TEXTBOOKS:**

1. S.S. Rattan, “Strength of Materials”, 2nd edition, Tata Mc-Graw Hill Private Limited, New Delhi, 2012
2. “Strength of Materials”,Sadhu sing.

**REFERENCE BOOKS:**

1. James M. Gere, “Mechanics of Materials”, 7th edition, Cengage learning India, 2010.
2. S. B. Junarkar, Mechanics of Structures, Charotar Publishers, 2010
3. AdarshSwaroop, “Mechanics of Materials” 1st edition, New Age International Pvt. Ltd, 2012.
4. Popov, Mechanics of Solids, 2/e, New Pearson Education, 2015.

**E-RESOURCES:**

**http://www.oup.com/academic/product/advanced-mechanics-of-materials-780195143720?lang=en&cc=cn**

**https://www.coursera.org/courses?query=mechanics%20of%20materials**

**IV B. Tech I Semester**

**Course Code:**
**NANOTECHNOLOGY**
**(Open Elective – IV)**

| | | | |
|---|---|---|---|
| **Lecture – Tutorial:** | 3-0 Hours | **Internal Marks:** | 40 |
| **Credits:** | 3 | **External Marks:** | 60 |

**Prerequisites:**

Physics, Chemistry, Biology, and Mathematics

**Course Objectives:**

1. Students will know about band structure, history, and applications of nanotechnology.
2. Students will know about the properties of different materials and their behaviour at nanoscale.
3. Students will know about characterization techniques and tools used at the nanoscale.
4. Students will know about the synthesis and fabrication of materials at nanoscale.
5. Students will know about applications of silicon carbide, alumina, and zirconia.
6. Students will know about the applications of nanomaterials in various fields.

**Course Outcomes:**

**Upon successful completion of the course, the student will be able to:**

| | |
|---|---|
| CO1 | Explain solids and their band structure and applications of nanotechnology. |
| CO2 | Demonstrate about properties of materials and their behaviour at nanoscale. |
| CO3 | Outline different characterization techniques and tools used at the nanoscale. |
| CO4 | Summarize about synthesis and fabrication of materials at nanoscale. |
| CO5 | Explain about applications of silicon carbide, alumina, and zirconia. |
| CO6 | Outline the applications of nanomaterials in various fields. |

**Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2- Medium, 3 – High)**

| | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO 10** | **PO 11** | **PO 12** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | 2 | | | | | | 1 | | | |
| CO2 | 3 | 2 | 1 | | | | | | | 1 | | |
| CO3 | 3 | 2 | 1 | | | | | | | | | 1 |
| CO4 | 3 | 1 | 2 | | | | | | | | 1 | |
| CO5 | 3 | 1 | 2 | | | | | | | 1 | | |
| CO6 | 3 | 2 | 1 | | | | | | | | | 1 |

**UNIT I**

**INTRODUCTION**: Basics of Quantum Mechanics, Band Structure in Solids, History, and Scope, Classification of Nanostructured Materials, Fascinating Nanostructures, Applications of Nanomaterials, Nature the best of nanotechnologist, Challenges, and Future Prospects, Carbon Nano Technology.

**PROPERTIES OF MATERIALS:**

Mechanical properties, electrical properties, dielectric properties, thermal properties, magnetic properties, optoelectronic properties. Effect of size reduction on properties, electronic structure of nanomaterials.

**UNIT II**

**CHARACTERIZATION TECHNIQUES**: X-Ray diffraction and Scherrer method, Small Angle X-ray scattering (SAXS), scanning electron microscopy, Scanning Tunneling Microscope (STM), scanning probe microscopy, transmission electron microscopy, atomic force microscopy, piezo response microscopy, X-ray photoelectron spectroscopy, XANES and XAFS, angle-resolved photoemission spectroscopy, diffuse reflectance spectra, photoluminescence spectra, Raman spectroscopy., Field Ion Microscope (FEM), Three-dimensional Atom Probe (3DAP), Nanoindentation.

**UNIT III**

**SYNTHESIS AND FABRICATION:** Synthesis of bulk polycrystalline samples, growth of single crystals. Synthesis techniques for nanoparticle preparation Bottom-Up Approach Physical Vapor Deposition, Inert Gas Condensation, Laser Ablation, Chemical Vapor Deposition, Molecular Beam Epitaxy, Sol-gel method, Self-assembly, hydrothermal growth, thin-film growth, Top-Down Approach Ball milling, microfabrication, lithography. Consolidation of Nano powders: Shock wave consolidation, Hot isostatic pressing, and Coldisostatic pressing Spark plasma sintering.

**UNIT IV**

**SILICON CARBIDE**: Application of Silicon carbide, Sintering of SiC, sintering of nanoparticles, nanoparticles of alumina and zirconia, wear materials and nanocomposites,

**APPLICATIONS OF NANOMATERIALS**: Nano-electronics, Micro and Nano-electromechanical systems (MEMS/NEMS), Nano sensors, Nano catalysts, Food, and Agricultural Industries, Cosmetic and Consumer Goods, Structure and Engineering, Automotive Industry, Water Treatment, and the environment, Nano-medical applications, Nanobiology and a New Methodology in medical diagnostics, Nanomedicine Protocols for nano-drug Administration, Textiles, Paints, Energy, Defense and Space Applications, Nanotribology, Concerns, and challenges of Nanotechnology.

**TEXTBOOKS:**

1. Nanoscience and nanotechnology by M.S Ramachandra Rao, Shubra Singh, Wiley publishers.
2. Nano Materials- A.K.Bandyopadhyay/ New Age Publishers.
3. Nano Essentials- T.Pradeep/TMH
4.Textbook of Nano Science and Nano Technology – B.S. Murthy, P. Shankar, BaldevRaj, B.B. Rath, and James Munday, University Press-IIM.

**REFERENCE BOOKS:**

1. Introduction to Nanotechnology – Charles P. Poole, Jr., and Frank J. Owens, Wiley India Edition, 2012.
2. Nanomaterials, Nanotechnologies and Design by Michael F. Ashby, Paulo J. Ferreira and Daniel L. Schodek.
3. Carbon Nanotubes: Properties and Applications- Michael J. O'Connell
4. Electron Transport in Mesoscopic systems - S. Dutta, Cambridge University Press.

**E-RESOURCES:**

**https://www.hsls.pitt.edu/e-journals/Nanotechnology**
**https://www.nature.com/nnano/**

**IV B. Tech I Semester**

**Course Code:**

**MECHANICAL VIBRATIONS**

**(Professional Elective – IV)**

| | | | |
|---|---|---|---|
| **Lecture – Tutorial:** | 3-0 Hours | **Internal Marks:** | 40 |
| **Credits:** | 3 | **External Marks:** | 60 |

**Prerequisites:**

Fundamentals of Engineering Mathematics, Engineering Mechanics, Strength of Materials

**Course Objectives:**

1. To analyse single DOF Systems
2. To analyse Damped Vibrations
3. To understand forced vibrations
4. ToAnalyse 2 DOF Systems

**Course Outcomes:**

**Upon successful completion of the course, the student will be able to:**

| | |
|---|---|
| CO1 | Analyze single degree freedom system for its natural frequency and vibration response |
| CO2 | Analyze single degree freedom system for its natural frequency and damped vibration response |
| CO3 | Determine response of Single degree freedom systems under harmonic excitations |
| CO4 | Understanding Vibration measuring instruments |
| CO5 | Determine the response of Two-degree freedom systems under free and forced vibrations |
| CO6 | Understanding Dynamic vibration absorber |

**Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2- Medium, 3 – High)**

| | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO 10** | **PO 11** | **PO 12** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 3 | 1 | | | | | | | | 2 |
| CO2 | 3 | 3 | 3 | 1 | | | | | | | | 2 |
| CO3 | 3 | 3 | 3 | 1 | | | | | | | | 2 |
| CO4 | 3 | 3 | 3 | 1 | | | | | | | | 2 |
| CO5 | 3 | 3 | 3 | 1 | | | | | | | | 2 |
| CO6 | 3 | 3 | 3 | 1 | | | | | | | | 2 |

**UNIT I**

**Undamped free vibrations of SDOF Systems:** Introduction, basic concepts of vibration, importance of vibration study, elements of a vibrating system, types of vibration, methods of vibration analysis, harmonic motion, Equation of motion, free vibration of undamped translational system, free vibration of undamped torsional system, Raleigh's energy method.

**Damped free vibrations of SDOF systems:** Introduction, types of damping, free vibration with viscous and coulomb damping, logarithmic decrement.

**UNIT II**

**Damped free vibrations of SDOF Systems:** introduction, types of damping, free vibration with viscous and coulomb damping, logarithmic decrement.

**Harmonically Exited Vibrations:** Introduction, equations of motion, response of undamped and damped systems under harmonic excitation, response of a damped system under harmonic motion of the base, response of a damped system under rotating unbalance, vibration, measuring instruments-vibrometer and accelerometer, critical speed

**UNIT III**

**Two Degree of Freedom Systems:** Introduction, equations of motion for forced vibration, free vibration analysis of an undamped system, torsional system, coordinate coupling and principal coordinates, forced vibration analysis. Dynamic vibration absorber

**UNIT IV**

**Numerical methods for multi DOF systems:**
Maxwell's reciprocal theorem, influence coefficients, Rayleigh's method, Dunkerley's method, stodola method, orthogonality principle, method of matrix iteration and numerical.

**TEXTBOOKS:**

1. G. K. Grover, Mechanical Vibrations, 8/e, Nem Chand & Bros

**REFERENCE BOOKS:**

1. L. Meirovich,ElementsofVibrationAnalysis,2/e.TataMcGrawHill,2007.
2. J.S.Raoand
K.Gupta,IntroductoryCourseonTheoryandPracticeofMechanicalVibrations,2/e,New Age International,1999.
3. S.S.Rao,MechanicalVibrations,5/e,PearsonEducationInc.,2011.

**E-RESOURCES:**

https://nptel.ac.in/courses/112/103/112103112/
https://nptel.ac.in/courses/112/103/112103111/

**IV B. Tech I Semester**

**18A4103522**

**INTRODUCTION TO COMPOSITE MATERIALS**

**(Professional Elective – IV)**

| | | | |
|---|---|---|---|
| **Lecture – Tutorial:** | 3-0 Hours | **Internal Marks:** | 40 |
| **Credits:** | 3 | **External Marks:** | 60 |

**Prerequisites:**

Engineering Mechanics, Mechanics of Materials.

**Course Objectives:**

1. Student will know the fundamental concepts of composites.
2. Student will be able to understand the various types of composites .
3. Student will be able to understand the fabrication and manufacturing techniques of composites .
4. Student will understand the joining methods and theories of failures of composites.
5. Student will be in a position to apply the joining techniques and failure theories of composites
6. Student will be able to test the characteristics of composites

**Course Outcomes:**

**Upon successful completion of the course, the student will be able to:**

| | |
|---|---|
| CO1 | Identify various types of composites. |
| CO2 | Understand the basic concepts of reinforcements. |
| CO3 | Apply the fabrication and manufacturing techniques of composites. |
| CO4 | Understand the joining and theories of failures of composites. |
| CO5 | Select appropriate joining techniques of composites. |
| CO6 | Identify the characteristics of various composites. |

**Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2- Medium, 3 – High)**

| | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO 10** | **PO 11** | **PO 12** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | | | | | 1 | | | | | 2 | |
| CO2 | 2 | | 3 | | | | | | | | 1 | |
| CO3 | | 3 | 2 | | 1 | | | | | | | |
| CO4 | | 2 | 3 | | | | | | | | | 1 |
| CO5 | 2 | - | - | - | 3 | | | | | | 1 | |
| CO6 | 2 | | | | 3 | | | | | | 1 | |

**UNIT I**

**Introduction:** Classifications of Engineering Materials, Concept of composite materials, Matrix materials, Functions of a Matrix, Desired Properties of a Matrix, Polymer Matrix (Thermosets and Thermoplastics), Metal matrix, Ceramic matrix.

**Types of Reinforcements/Fibers**: Role and Selection or reinforcement materials, Types of fibres, Glass fibers, Carbon fibers, Aramid fibers, Metal fibers, Alumina fibers, Boron Fibers, Silicon carbide fibers, Quartz and Silica fibers, Multiphase fibers, Whiskers, Flakes etc.,

Mechanical properties of fibres. Material properties that can be improved by forming a composite material and its engineering potential

**UNIT II**

**Various types of composites:** Classification based on Matrix Material: Organic Matrix composites, Polymer matrix composites (PMC), Carbon matrix Composites or Carbon-Carbon Composites, Metal matrix composites (MMC), Ceramic matrix composites (CMC);

**Classification based on reinforcements**: Fibre Reinforced Composites, Fiber Reinforced Polymer (FRP) Composites, Laminar Composites, Particulate Composites, Comparison with Metals, Advantages & limitations of Composites

**UNIT III**

**Fabrication methods:** Processing of Composite Materials: Overall considerations, Autoclave curing, Other Manufacturing Processes like filament welding, compression molding, resin-transfer method, pultrusion, pre-peg layer, Fiber-only performs, Combined Fiber-Matrix performs

**Manufacturing Techniques:** Tooling and Specialty materials, Release agents, Peel plies, release films and fabrics, Bleeder and breather plies, bagging films

**UNIT IV**

**Joining Methods and Failure Theories**: Joining –Advantages and disadvantages of adhesive and mechanically fastened joints. Typical bond strengths

**Testing of Composites:** Mechanical testing of composites, tensile testing, Compressive testing, Intra-laminar shear testing, Inter-laminar shear testing, Fracture testing etc.

**TEXTBOOKS:**

1. Materials characterization, Vol. 10, ASM hand book
2. Mechanical Metallurgy by G. Dieter Mc-Graw Hill
3. Thermal Analysis of Materials by R.F. Speyer, Marcel Decker
4. Engineering Materials: Polymers, Ceramics and Composites A.K Bhargava Prentice Hall India.

**REFERENCE BOOKS:**

[1] Jones, R M, Mechanics of Composite Materials, Scripta Book Co.
[2] Agarwal, B D and Broutman, J. D, Analysis and Performance of Fiber Composites, New York, John Willey and Sons, 1990
[3] Mallik, P. K, Fiber reinforced composites : materials, manufacturing and design, New York- Marcel and Dekker, 1993 (2ndedition)
[4] Arthur, K Kaw, Mechanics of Composite Materials, CRC Press, 1997.
[5] Reddy J N, Mechanics of Laminated Composite Plates, CRC Press
[6] Mallik, P. K, Composite Engineering Hand Book, New York, Marcel and Dekker, Principles of Composite Material Mechanics,
[7] Author: Ronald Gibson An Introduction to Composite Materials, Authors: D. Hull and T.W. Clyne

**E-RESOURCES:**

https://www.intechopen.com/chapters/71222
https://nptel.ac.in/content/storage2/courses/105108124/pdf/Lecture_Notes/LNm1.pdf

**IV B. Tech I Semester**

**Course Code:**

**REFRIGERATION & AIR CONDITIONING**

**(Refrigeration and Psychometric tables and charts allowed)**

**(Professional Elective – IV)**

| | | | |
|---|---|---|---|
| **Lecture – Tutorial:** | 3-1 Hours | **Internal Marks:** | 40 |
| **Credits:** | 3 | **External Marks:** | 60 |

**Prerequisites:**

Thermodynamics

**Course Objectives:**

1. To provide an insight of fundamentals of Refrigeration.
2. To impart the basic of Refrigerants and different types of refrigeration systems.
3. To enable the students of methods to improve performance of vapor compression systems.
4. To imbibe the knowledge of steam jet, vapor absorption, thermoelectric and vortex tube systems.
5. To enable the students learn basics and psychometric properties and processes used in Air Conditioning systems.
6. To impart the knowledge of Air Conditioning systems for human comfort conditions.

**Course Outcomes:**

**Upon successful completion of the course, the student will be able to:**

| | |
|---|---|
| CO1 | Understand the basic concepts of refrigeration and their applications. |
| CO2 | Identify eco-friendly refrigerants and use P-H charts to evaluate the performance of refrigerationsystems. |
| CO3 | Explain the methods to improve performance of vapor compression systems. |
| CO4 | Analyze steam jet, vapor absorption, thermoelectric and vortex tube systems |
| CO5 | Analyze air conditioning processes using principles of psychometry. |
| CO6 | Design of Air Conditioning systems for human comfort conditions. |

**Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2- Medium, 3 – High)**

| | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO 10** | **PO 11** | **PO 12** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 1 | | | | 1 | | | | | |
| CO2 | 3 | 2 | 1 | | | | 1 | | | | | |
| CO3 | 3 | 3 | 2 | | | | 1 | | | | | |
| CO4 | 3 | 3 | 2 | | | | 1 | | | | | |
| CO5 | 3 | 3 | 1 | | | | 1 | | | | | |
| CO6 | 3 | 2 | 2 | | | | 3 | | | | | |

**UNIT I**

**FUNDAMENTALS OF REFRIGERATION**: Introduction- Necessity and applications, unit of Refrigeration and C.O.P - Heat Engine, Refrigerator and Heat Pump-Types of Refrigeration systems and its Applications.

**REFRIGERANTS**: Classification of refrigerants- Desirable Properties-Nomenclature-Commonly used refrigerants- Alternate refrigerants –Greenhouse effect, global warming

**AIR REFRIGERATION SYSTEM:** Introduction-Air refrigeration system working on Reversed Carnot cycle – Air refrigeration system working on Bell Coleman cycle- COP-Open and Dense air systems, Applications.

## UNIT II

**VAPOUR COMPRESSION REFRIGERATION SYSTEM:** Working principle-Simple vapour compression refrigeration cycle – COP- Representation of cycle on T-s and P-h charts- Effect of Sub cooling and Superheating --Actual Vapour compression cycle and its applications.

**VCR SYSTEM COMPONENTS:** Compressors-Classification-Working -Condensers – Classification-Working-Evaporators –Classification-Working, Expansion devices – Types-Working.

## UNIT III

**VAPOUR ABSORPTION REFRIGERATION SYSTEM:** Description and working of Aqua-Ammonia system- Calculation of maximum COP- Lithium Bromide- Water system-Principle of Operation of three fluid absorption systems, Applications.

**STEAM JET REFRIGERATION SYSTEM:** Principle of working –Analysis- Applications. and operation of Thermo electric Refrigeration, Vortex tube refrigeration, Adiabatic demagnetization Refrigeration.

**PSYCHOMETRY:** Introduction- Psychometric properties and relations- Psychometric chart Psychometric Processes-Sensible, Latent and Total heat–Sensible Heat Factor and Bypass Factor.

## UNIT IV

**HUMAN COMFORT**: Thermodynamics of Human Body-Effective temperature–Comfort chart.

**AIR CONDITIONING SYSTEMS:** Introduction-Components of Air conditioning system-Classification of Air conditioning systems-Central and Unitary systems- Comfort and Industrial air conditioning systems -Summer, Winter and Year-round systems- filters, grills and registers, fans and blowers.

**DESIGN OF AIR CONDITION SYSTEMS**: Summer air conditioning –ADP-System with Ventilated and re-circulated air with and without bypass factor- RSHF, GSHF and ESHF. Air conditioning Load Calculations.

## TEXTBOOKS:


1. C. P. Arora. , Refrigeration and air conditioning - TMH, 2nd Edition, 2000.
2. R. Dossat, Principles of Refrigeration - - Pearson 4th Edition 2001
3. Refrigeration and Air conditioning / SC Arora &Domkundwar / Dhanpatrai


## REFERENCE BOOKS:


1. S. C. Arora, Domkundwar, A course in refrigeration and air conditioning-Dhanapat Rai& sons 5th Edition ,1997.
2. Manohar Prasad, Refrigeration and Air conditioning, New Age international, 2003
3.Basic Refrigeration and Air-Conditioning / Ananthanarayanan / TMH


## E-RESOURCES:

**https://researchguides.austincc.edu/c.php?g=434739&p=5832566**
**http://ecoursesonline.iasri.res.in/course/view.php?id=445**

**IV B. Tech I Semester**

**Course Code:**

**JET AND ROCKET PROPULSION ENGINEERING**

**(Professional Elective – IV)**

| | | | |
|---|---|---|---|
| **Lecture – Tutorial:** | 3-1 Hours | **Internal Marks:** | 40 |
| **Credits:** | 3 | **External Marks:** | 60 |

**Prerequisites:**

Thermodynamics & IC Engine and Gas Turbine.

**Course Objectives:**

1. To provide an insight of fundamentals and salient features of Gas Turbine .
2. To impart the basic of jet Propulsion and jet engines.
3. To enable the students the concepts of Turbo Propulsion and Turbo jet.
4. To imbibe the knowledge of jet Propulsion and Rocket Propulsion system.
5. To enable the students learn basics of Rocket engine.
6. To impart the knowledge of Rocket Technology for Rocket engine.

**Course Outcomes:**

**Upon successful completion of the course, the student will be able to:**

| | |
|---|---|
| CO1 | Illustrate the thermodynamic aspects of gas turbines |
| CO2 | Analyze the performance of jet engines |
| CO3 | Compare different aspects of thermal jet engines |
| CO4 | Summarize the working of rocket engines |
| CO5 | Apply thrust mechanics to determine forces in rockets |
| CO6 | Contrast the aspects of electrical, nuclear and plasma arc propulsions |

**Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2- Medium, 3 – High)**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 2 | | | | | | | | | |
| CO2 | | 3 | 2 | | | | 2 | | | | | |
| CO3 | 2 | 2 | | | | | 3 | | | | | |
| CO4 | 3 | 2 | 1 | | | | 2 | | | | | |
| CO5 | | 3 | 2 | | | | | | | | | |
| CO6 | 3 | 1 | 1 | | | | 1 | | | | | |

**UNIT I**

**Introduction to Jet Propulsion**

Elements of Gas Turbine theory – Thermodynamic cycles, open closed and semi-closed – Parameters of performance – Refinements simple cycle.

**Jet Propulsion**

Historical sketch – Reaction Principle – Essential features of propulsion devices – Thermal Jet Engines, Classification of – Energy flow, thrust, thrust power and propulsion efficiency – Need for Thermal jet engines and applications.

**UNIT II**

**Turbo Propulsion and Turbojets**

Thermodynamic cycles, Plant layout, essential components, principles of operation – performance evaluation – thrust Augmentation and Thrust reversal – Contrasting with Piston Engine Propeller Plant. Ramjet – Thermodynamic Cycle, Plant layout, essential components – Principle of operation – Performance evaluation- Comparison among atmospheric thermal jet engines – Square jet and Pulse jet, Elementary treatment of jet, Applications of Turbojets

**UNIT III**

**Rocket Engines**

Need - applications – Basic principle of operation and parameters of performance – Classification, solid and liquid propellant rocket engines, advantages, domains of application – Propellants – Comparison of propulsion systems.

**UNIT IV**

**Rocket Technology**

Flight mechanics, application Thrust Profiles, Acceleration – stating of Rockets, need for Feed systems, injectors and expansion nozzles – Rocket heat transfer and ablative cooling- Testing & Instrumentation – Advances Propulsion Systems, Elementary treatment of Electrical, Nuclear and Plasma Arc Propulsion.

**TEXTBOOKS:**

1. Gill Smith and Zierys, Fundamentals of I.C Engines, Revised Edition, Oxford &Ibh Publishing Co.Calcutta, 3rd Edition, 2007

2. Sutton, Rocket Propulsion, John Wiley & Sons, 8th Edition, 2010

3. Cohen, Rogers and Saravana Muto Gas Turbines, Prentice Hall, 6th Edition, 2008

4. V Ganesan, Gas Turbines, Tata McGraw-Hill Education, 3rd Education, 2010

**REFERENCE BOOKS:**

1. Hill and Paterson, Thermodynamics of Propulsion, Prentice Hall, 2nd Edition, 1991

**E-RESOURCES:**

**https://www.sciencedirect.com/topics/engineering/jet-propulsion**

**https://nptel.ac.in/courses/101/104/101104019/**

**Lab code**

**ICS metrology ICS metrology lab**

| | | | |
|---|---|---|---|
| **Practice:** | 3 | **Internal Marks:** | 40 |
| **Credits:** | 1.5 | **External Marks:** | 60 |

**Prerequisites:** Machine Design, Engineering Physics

**Course Objectives:**

**Course Objectives: The student can learn**

1.Calibration of pressure gauge, temperature measuring instruments

2.Calibration of displacement, speed measuring instruments

3.Calibration of vibration measuring instruments

4.Measuring and gauging instruments for inspection of precision linear, geometric forms, angular and surface finish measurements.

5.The machine tool alignment test on lathe, milling and drilling machines

6.Operating tool maker's microscope and surface roughness measuring instrument.

**COURSE OUTCOMES:**

**Upon successful completion of the course, the student will be able to:**

| | |
|---|---|
| CO1 | Explain the calibration of pressure gauge, temperature measuring instruments |
| CO2 | Demonstrate the calibration of displacement, speed measuring instruments |
| CO3 | Explain the calibration of vibration measuring instruments |
| CO4 | Explain the working of various instruments like vernier calipers, bevel protractor ,micrometers and dial indicators |
| CO5 | Familiarize the working of tool maker's microscope and surface roughness measuring instruments. |
| CO6 | Demonstrate the Machine tool alignment test on the lathe, drilling and milling machines |

**Contribution of Course Outcomes towards achievement of Program Outcomes**

**(1 – Low, 2- Medium, 3 – High)**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | | | | | | | 1 | | |
| CO2 | 3 | 3 | 2 | | | | | | | | | |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO3 | 3 | 1 | 3 | | | | | | | | | |
| CO4 | 2 | 3 | 2 | | | | | | | 1 | | |
| CO5 | 1 | 3 | 2 | | | | | | | 1 | | |
| CO6 | 2 | 3 | 2 | | | | | | | 1 | | |

**List of Experiments:**

**INSTRUMENTATION LAB**

1. Calibration of pressure gauge.

2. Calibration of transducer for temperature, thermocouple and resistance temperature detector measurement.

3. Study and calibration of LVDT transducer for displacement measurement.

4. Calibration of strain gauge.

5. Calibration of capacitive transducer.

6. Study and calibration of photo and magnetic speed pickups.

7. Study and calibration of a rotameter.

8. Study and use of a seismic pickup for the measurement of vibration amplitude of an engine bed at various loads.

9. Study and calibration of Mcleod gauge for low pressure.

**METROLOGY LAB**

1. Measurement of bore by internal micrometres and dial bore indicator / rollers and slip gauges.

2. Use of gear teeth vernier calipers for checking the chordal addendum and chordal thickness of spur gear.

3. Alignment test on the lathe/milling machine using dial indicators.

4. Measurement of linear and angular dimensions using Tool makers microscope.

5. Angle and taper measurements by Bevel protractor, Sine bars, spirit level etc.

6. Measurement of effective diameter of a thread using Two wire/ Three wire method.

7. Surface roughness measurement by Talysurf instrument.

**EQUIPMENT REQUIRED:**

pressure gauge, Thermocouple, LVDT transducer ,Rotameter, Mcleod gauge, Strain gauge, Micrometres, Slip gauges, Gear teeth vernier calipers,

| |
|---|
| Lathe/Milling machine, Bevel protractor, Sine bars, Spirit level , Talysurf instrument. |
| **REFERENCE BOOKS:** |
| 1. Engineering Metrology by KL Narayana, Scitech publishers.<br>2. Engineering Metrology and Measurements by NV Raghavendra, LKrishna Murthy, Oxford publishers<br>3.Precision Engineering in Manufacturing by R.L.Murthy / New Age. |
| **E-RESOURCES:** |
| **https://www.npl.co.uk/resources**<br>**https://iopscience.iop.org/journal/0957-0233** |

**Lab code-**

# COMPUTATIONAL FLUID DYNAMICS LABORATORY

| | | | |
|---|---|---|---|
| **Practice:** | 3 | **Internal Marks:** | 40 |
| **Credits:** | 1.5 | **External Marks:** | 60 |

**Prerequisites:**

Basic courses of Fluid Mechanics, Heat transfer and Numerical methods are required as prerequisites

Knowledge of matrices, differentiation, integration and differential equations is expected

**Course Objectives:**

1. Solving Problems of fluid mechanics and heat transfer by writing programs in MATLAB.
2. Using ANSYS-FLUENT build a geometry, mesh that geometry, Perform CFD method on the mesh, perform the calculation and post-process the results.
3. Understanding the validation of the numerical result by comparison with known analytical results.
4. Understanding the numerical result by invoking the physical principles of fluid mechanics and heat transfer
5. Illustrate the working concepts of thermal engineering
6. Solve mechanical engineering problems

**COURSE OUTCOMES:**

**Upon successful completion of the course, the student will be able to:**

| | |
|---|---|
| CO1 | Identify, model, analyze and solve mechanical engineering problems |
| CO2 | Understand basic knowledge of computational methods in Fluid flow applications. |
| CO3 | Alalyze Initial Boundary value problems and determine various quantities of interest. |
| CO4 | Use modern modeling and simulation tools and techniques |
| CO5 | Develop practical solutions for mechanical engineering problems under professional and ethical constraints |
| CO6 | Design and conduct laboratory experiments for thermal, fluids and mechanical systems |

**Contribution of Course Outcomes towards achievement of Program Outcomes**

| (1 – Low, 2- Medium, 3 – High) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO 10** | **PO 11** | **PO 12** |
| CO1 | | 3 | 1 | 2 | 3 | 1 | 2 | | | | | 1 |
| CO2 | 2 | | 2 | | 2 | | 2 | | | | | 2 |
| CO3 | 2 | 1 | | 1 | | 2 | | | | | | 2 |
| CO4 | 2 | 1 | 2 | 2 | 1 | 2 | 2 | | | | | 2 |
| CO5 | 2 | 3 | 3 | 2 | 3 | 3 | 2 | | | | | 3 |
| CO6 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | | | | | 3 |

**List of Experiments:**

**PART-A**

**Writing Programs in MATLAB for the following**

1. Solution of Transcendental equations
2. Solution of Simultaneous algebraic equations
3. Numerical differentiation and Integration
4. Solution of Ordinary Differential Equation
5. Solution of a Tri-diagonal matrix using Thomas Algorithm.
6. Solution of Partial differential equations related to
   - i) Elliptical Partial differential equations
   - ii) Parabolic Partial differential equations
   - iii) Hyperbolic Partial differential equations
7. Solution of 1-D and 2-D heat conduction with (Finite Difference method)
   - i) Constant temperature boundary conditions
   - ii) Constant heat flux boundary conditions
   - iii) Convective boundary conditions
8. Solution of Incompressible Navier-Stokes equations (Finite difference and Finite Volume methods)
9. Solution of Inviscid incompressible fluid flows. (Finite difference and Finite Volume methods)

**PART-B**

**Using ANSYS-FLUENT solve the following heat transfer analysis problems**

1. steady state conduction

2. Lumped heat transfer

3. Convective heat transfer – Internal flow (study both velocity and thermal boundary layers)

4. Convective heat transfer – External flow (study both velocity and thermal boundary layers)

5. Radiation heat transfer– Emissivity

**EQUIPMENT REQUIRED:**

**SOFTWARE REQUIRED**

1. MATLAB R2009b and above.
2. Windows 7 and above.
3. Ansys 14 and above

**REFERENCE BOOKS:**


1. Computational Fluid Dynamics by Anderson JD
2. Introduction to Computational Fluid Dynamics by Atul Sharma


**E-RESOURCES:**

https://onlinecourses.nptel.ac.in/noc22_me02/preview
https://books.google.co.in/books/about/An_Introduction_to_Computational_Fluid_D.html?id=RvBZ-UMpGzIC

**IV B. Tech II Semester**

**Course Code:**
**NANOTECHNOLOGY**
**(Professional Elective – V)**

| | | | |
|---|---|---|---|
| **Lecture – Tutorial:** | 3-0 Hours | **Internal Marks:** | 40 |
| **Credits:** | 3 | **External Marks:** | 60 |

**Prerequisites:**

Physics, Chemistry, Biology, and Mathematics

**Course Objectives:**

1. Students will know about band structure, history, and applications of nanotechnology.
2. Students will know about the properties of different materials and their behaviour at nanoscale.
3. Students will know about characterization techniques and tools used at the nanoscale.
4. Students will know about the synthesis and fabrication of materials at nanoscale.
5. Students will know about applications of silicon carbide, alumina, and zirconia.
6. Students will know about the applications of nanomaterials in various fields.

**Course Outcomes:**

**Upon successful completion of the course, the student will be able to:**

| | |
|---|---|
| CO1 | Explain solids and their band structure and applications of nanotechnology. |
| CO2 | Demonstrate about properties of materials and their behaviour at nanoscale. |
| CO3 | Outline different characterization techniques and tools used at the nanoscale. |
| CO4 | Summarize about synthesis and fabrication of materials at nanoscale. |
| CO5 | Explain about applications of silicon carbide, alumina, and zirconia. |
| CO6 | Outline the applications of nanomaterials in various fields. |

**Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2- Medium, 3 – High)**

| | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO 10** | **PO 11** | **PO 12** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | 2 | | | | | | 1 | | | |
| CO2 | 3 | 2 | 1 | | | | | | | 1 | | |
| CO3 | 3 | 2 | 1 | | | | | | | | | 1 |
| CO4 | 3 | 1 | 2 | | | | | | | | 1 | |
| CO5 | 3 | 1 | 2 | | | | | | | 1 | | |
| CO6 | 3 | 2 | 1 | | | | | | | | | 1 |

**UNIT I**

**INTRODUCTION**: Basics of Quantum Mechanics, Band Structure in Solids, History, and Scope, Classification of Nanostructured Materials, Fascinating Nanostructures, Applications of Nanomaterials, Nature the best of nanotechnologist, Challenges, and Future Prospects, Carbon Nano Technology.

**PROPERTIES OF MATERIALS:**

Mechanical properties, electrical properties, dielectric properties, thermal properties, magnetic properties, optoelectronic properties. Effect of size reduction on properties, electronic structure of nanomaterials.

**UNIT II**

**CHARACTERIZATION TECHNIQUES**: X-Ray diffraction and Scherrer method, Small Angle X-ray scattering (SAXS), scanning electron microscopy, Scanning Tunneling Microscope (STM), scanning probe microscopy, transmission electron microscopy, atomic force microscopy, piezo response microscopy, X-ray photoelectron spectroscopy, XANES and XAFS, angle-resolved photoemission spectroscopy, diffuse reflectance spectra, photoluminescence spectra, Raman spectroscopy., Field Ion Microscope (FEM), Three-dimensional Atom Probe (3DAP), Nanoindentation.

## UNIT III

**SYNTHESIS AND FABRICATION:** Synthesis of bulk polycrystalline samples, growth of single crystals. Synthesis techniques for nanoparticle preparation Bottom-Up Approach Physical Vapor Deposition, Inert Gas Condensation, Laser Ablation, Chemical Vapor Deposition, Molecular Beam Epitaxy, Sol-gel method, Self-assembly, hydrothermal growth, thin-film growth, Top-Down Approach Ball milling, microfabrication, lithography. Consolidation of Nano powders: Shock wave consolidation, Hot isostatic pressing, and Coldisostatic pressing Spark plasma sintering.

## UNIT IV

**SILICON CARBIDE**: Application of Silicon carbide, Sintering of SiC, sintering of nanoparticles, nanoparticles of alumina and zirconia, wear materials and nanocomposites,

**APPLICATIONS OF NANOMATERIALS**: Nano-electronics, Micro and Nano-electromechanical systems (MEMS/NEMS), Nano sensors, Nano catalysts, Food, and Agricultural Industries, Cosmetic and Consumer Goods, Structure and Engineering, Automotive Industry, Water Treatment, and the environment, Nano-medical applications, Nanobiology and a New Methodology in medical diagnostics, Nanomedicine Protocols for nano-drug Administration, Textiles, Paints, Energy, Defense and Space Applications, Nanotribology, Concerns, and challenges of Nanotechnology.

## TEXTBOOKS:

1. Nanoscience and nanotechnology by M.S Ramachandra Rao, Shubra Singh, Wiley publishers.
2. Nano Materials- A.K.Bandyopadhyay/ New Age Publishers.
3. Nano Essentials- T.Pradeep/TMH
4.Textbook of Nano Science and Nano Technology – B.S. Murthy, P. Shankar, BaldevRaj, B.B. Rath, and James Munday, University Press-IIM.

## REFERENCE BOOKS:

1. Introduction to Nanotechnology – Charles P. Poole, Jr., and Frank J. Owens, Wiley India Edition, 2012.
2. Nanomaterials, Nanotechnologies and Design by Michael F. Ashby, Paulo J. Ferreira and Daniel L. Schodek.
3. Carbon Nanotubes: Properties and Applications- Michael J. O'Connell
4. Electron Transport in Mesoscopic systems - S. Dutta, Cambridge University Press.

## E-RESOURCES:

**https://www.hsls.pitt.edu/e-journals/Nanotechnology**
**https://www.nature.com/nnano/**

**IV B. Tech II Semester**

**Course code-**

# INTRODUCTION TO ROBOTICS

**(Professional Elective – V)**

| | | | |
|---|---|---|---|
| **Lecture – Tutorial:** | 2-1 Hours | **Internal Marks:** | 40 |
| **Credits:** | 3 | **External Marks:** | 60 |

**Prerequisites:**

Fundamentals of Engineering Mathematics, Engineering Mechanics

**Course Objectives:**

1. Student will know the fundamental concepts of industrial robotic technology.
2. Student will be exposed to the various types of end effectors.
3. Student will apply the basic mathematics to calculate kinematic forces in robot manipulator.
4. Student will understand the robot controlling and programming methods.
5. Student will be in a position to describe various actuators, sensors.
6. Student will be aware of the various industrial applications of robots.

**Course Outcomes:**

**Upon successful completion of the course, the student will be able to:**

| | |
|---|---|
| CO1 | Identify various robot configurations. |
| CO2 | Understand the basic components of robots. |
| CO3 | Evaluate D-H notations for simple robot manipulator. |
| CO4 | Perform trajectory planning for a manipulator by avoiding obstacles. |
| CO5 | Select appropriate actuators and sensors for a robot. |
| CO6 | Illustrate the industrial applications of robots. |

**Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2- Medium, 3 – High)**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | | | | | 1 | | | | | 2 | |
| CO2 | 2 | | 3 | | | | | | | | 1 | |
| CO3 | | 3 | 2 | | 1 | | | | | | | |
| CO4 | | 2 | 3 | | | | | | | | | 1 |
| CO5 | 2 | - | - | - | 3 | | | | | | 1 | |
| CO6 | 2 | | | | 3 | | | | | | 1 | |

## UNIT I

**Introduction:** Automation and robotics, Robot anatomy, robot motions, Joint notation schemes, work volume, speed of motions, load carrying capacity, Speed of response & stability, Precision of movement- Spatial resolution, accuracy, repeatability, compliance. Classification of robots by coordinate system and control system.

**Components of the Industrial Robotics:** Function line diagram representation of robot components, number of degrees of freedom, Types of end effectors, Mechanical grippers, gripper mechanisms, other types of grippers, Considerations in gripper selection and design.

## UNIT II

**Motion Analysis:** Transformation matrices- Translation, Rotation, Combined translation and rotation, Homogeneous transformation matrix - Problems.

**Manipulator Kinematics:** Description of Link and Joint parameters, Kinematic modelling of the manipulator, D-H Notation, Kinematic relationship between adjacent links, Forward and Inverse kinematics. Differential kinematics

## UNIT III

**Trajectory Planning:** Terminology, Steps in trajectory planning, Slew motion, joint integrated motion, straight line motion, circular motion, Joint space technique, Cartesian space technique, cubic polynomial with and without via points.

**Robot Programming and Languages:** Lead through programming, robot program as a path in space, WAIT, SIGNAL, DELAY commands, Branching, capabilities and limitations. Textual robot languages, generations, Language structure, Elements and functions.

**Dynamics:** Differential transformation and manipulators, Jacobians – problems Dynamics: Lagrange – Euler and Newton – Euler formulations – Problems.

## UNIT IV

**Robotic Actuators and Sensors:** Pneumatic, Hydraulic actuators, electric & stepper motors, Internal &external sensors, Position, Velocity sensors, Tactile, Proximity and Range sensors.

**Robot Applications in Manufacturing:** Material Transfer - Material handling, loading and unloading- Processing - spot and continuous arc welding & spray painting - Assembly and Inspection

## TEXTBOOKS:


1. Mikell P. Groover and Mitchell Weiss, Roger N. Nagel,NicholasG.Odrey , Industrial Robotics — Mc Graw Hill, 1986.
2. R K Mittal and I J Nagrath, Robotics and control, Illustrated Edition, Tata McGraw Hill India 2003.


## REFERENCE BOOKS:


1. Saeed B. Niku, Introduction to Robotics – Analysis, System, Applications, 2nd Edition, John Wiley & Sons, 2010.
2. H. Asada and J.J.E. Slotine, Robot Analysis and Control, 1st Edition Wiley-Interscience, 1986.
3. Robert J. Schillin, Fundamentals of Robotics: Analysis and control, Prentice-Hall Of India Pvt. Limited, 1996.
4. Mohsen shahinpoor, A robot Engineering textbook, Harper & Row Publishers,1987.
5. John.J.Craig Addison, Introduction to Robotics: Mechanics and Control, Wesley, 1999.
6. K.S. FU, R.C. Gonzalez and C.S.G Lee, Robotics: Control, sensing, vision, and intelligence. Mc Graw Hill, 1987.
7. Richard D. Klafter, Thomas Robotic Engineering an integrated approach, PHI publications 1988.


## E-RESOURCES:

**https://ocw.mit.edu/courses/mechanical-engineering/2-12-introduction-to-robotics-fall-2005/**

**https://onlinecourses.nptel.ac.in/noc21_de13/preview**

**IV B. Tech II Semester**

**Course Code:**

**ENERGY CONSERVATION AND MANAGEMENT**

**(Professional Elective – V)**

| | | | |
|---|---|---|---|
| **Lecture – Tutorial:** | 3-0 Hours | **Internal Marks:** | 40 |
| **Credits:** | 3 | **External Marks:** | 60 |

**Prerequisites:**

Environment Studies, Elements of Mechanical Engineering, Thermodynamics

**Course Objectives:**

1. Student will understand about Energy conservation and role of Energy Management.
2. Student will understand about Energy conservation in Electrical systems.
3. Student will understand about Energy conservation in Thermal systems.
4. Student will understand bout Principles of Energy Management, Energy demand estimation and applications of life cycle costing analysis.

**Course Outcomes:**

**Upon successful completion of the course, the student will be able to:**

| | |
|---|---|
| CO1 | Student should be able to know basics of Energy conservation and Environmental Aspects Associated With Energy Utilization |
| CO2 | Student should be able to know basics of Energy Management. |
| CO3 | Students should be able to Evaluate the energy saving & conservation in different Energy conservation in Electrical systems. |
| CO4 | Students should be able to Evaluate the energy saving & conservation in different Energy conservation in Thermal systems. |
| CO5 | Students should be able to prepare Energy demand estimation, Organizing and Managing Energy Management Programs. |
| CO6 | Students should be able to Economic Aspects Calculation of simple payback method and Applications of life cycle costing analysis |

**Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2- Medium, 3 – High)**

| | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO 10** | **PO 11** | **PO 12** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | | | 1 | | 1 | | | | | 2 | |
| CO2 | 2 | | 3 | | | | | 1 | | | 1 | |
| CO3 | | 3 | 2 | | 1 | | | | | 1 | | |
| CO4 | | 2 | 3 | 3 | | | 1 | | | | | 1 |
| CO5 | 3 | | | 2 | | | | 1 | | | 1 | |
| CO6 | 2 | | | 3 | | | | | | 1 | | |

**UNIT I**

**Introduction:** Energy – Power – Past & Present Scenario Of World; National Energy Consumption Data – Environmental Aspects Associated With Energy Utilization – Energy Auditing: Need, Types, Methodology And Barriers. Role Of Energy Managers. Instruments For Energy Auditing.Basic Principles of Energy Audit and management Energy audit – Definitions – Concept – Types of audit – Energy index – Cost index – Pie charts – Sankey diagrams – Load profiles – Energy conservation schemes and energy saving potential.

**UNIT II**

**Electrical Systems:** Lighting Modification of existing systems – Replacement of existing systems – Luminous efficiency-Luminance or brightness – Types of lamps – Types of lighting – Electric lighting fittings-Electric Motors – Motor Efficiency Computation, Energy Efficient Motors,Energy conservation measures.

**UNIT III**

**Thermal Systems:** Stoichiometry, Boilers, Furnaces and Thermic Fluid Heaters, Space Heating and Ventilation – Air–Conditioning (HVAC) and Water Heating – Efficiency Computation and Encon Measures. Steam: Distribution & Usage: Steam Traps, Condensate Recovery, Flash Steam Utilization, Insulators & Refractories.

**UNIT IV**

**Energy Management:** Principles of Energy Management, Energy demand estimation, Organizing and Managing Energy Management Programs, Energy pricing.Computation of Economic Aspects Calculation of simple payback method – Net present worth method – Power factor correction –Applications of life cycle costing analysis – Return on investment.

**TEXTBOOKS:**


1. Energy management by W.R. Murphy & G. Mckay Butter worth, Elsevier publications. 2012
2. Energy efficient electric motors by John .C. Andreas, Marcel Dekker Inc Ltd–2nd edition, 1995.


**REFERENCE BOOKS:**


1. Electric Energy Utilization and Conservation by S C Tripathy, Tata McGraw hill publishing company Ltd. New Delhi.
2. Energy management by Paul o' Callaghan, Mc–Graw Hill Book company–1st edition, 1998.
3. Energy management hand book by W.C.Turner, John wiley and sons.
4. Energy management and conservation by v Sharma and p venkataseshaiah International Publishing House pvt.ltd,2011.


**E-RESOURCES:**

**https://www.electricalindia.in/energy-management-and-conservation/**

**https://www.springer.com/journal/12053**

**IV B. Tech II Semester**

**Course Code:**

**COMPUTER GRAPHICS AND GEOMETRICAL MODELING**

**(Professional Elective – V)**

| | | | |
|---|---|---|---|
| **Lecture – Tutorial:** | 3-0 Hours | **Internal Marks:** | 40 |
| **Credits:** | 3 | **External Marks:** | 60 |

**Prerequisites:**

Engineering Drawing, Engineering mathematics, CAD

**Course Objectives:**

1. Student will understand about Energy conservation and role of Energy Management.
2. Student will understand about Energy conservation in Electrical systems.
3. Student will understand about Energy conservation in Thermal systems.
4. Student will understand bout Principles of Energy Management, Energy demand estimation and applications of life cycle costing analysis.

**Course Outcomes:**

**Upon successful completion of the course, the student will be able to:**

| | |
|---|---|
| CO1 | Student should be able to know basics of Energy conservation and Environmental Aspects Associated with Energy Utilization |
| CO2 | Student should be able to know basics of Energy Management. |
| CO3 | Students should be able to Evaluate the energy saving & conservation in different Energy conservation in Electrical systems. |
| CO4 | Students should be able to Evaluate the energy saving & conservation in different Energy conservation in Thermal systems. |
| CO5 | Students should be able to prepare Energy demand estimation, Organizing and Managing Energy Management Programs. |
| CO6 | Students should be able to Economic Aspects Calculation of simple payback method and Applications of life cycle costing analysis |

**Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2- Medium, 3 – High)**

| | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO 10** | **PO 11** | **PO 12** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | | | 1 | | 1 | | | | | 2 | |
| CO2 | 2 | | 3 | | | | | 1 | | | 1 | |
| CO3 | | 3 | 2 | | 1 | | | | | 1 | | |
| CO4 | | 2 | 3 | 3 | | | 1 | | | | | 1 |
| CO5 | 3 | | | 2 | | | | 1 | | | 1 | |
| CO6 | 2 | | | 3 | | | | | | 1 | | |

**UNIT I**

**CAD Tools:** Definition of CAD Tools, Graphics standards, Graphics software: requirements of graphics software, Functional areas of CAD, Efficient use of CAD software. Basics of Geometric Modelling: Requirement of geometric modelling, Geometric models, Geometric construction methods, Modelling facilities desired.

**UNIT II**

**Geometric modelling:** Classification of wireframe entities, Curve representation methods, Parametric representation of analytic curves: line, circle, arc, conics, Parametric representation of synthetic curves: Hermite cubic curve, Bezier curve, B-Spline curve, NURBS, Curve manipulations.

**UNIT III**

**Solid Modelling:** Geometry and topology, Boundary representation, The Euler-Poincare formula, Euler operators, Constructive solid geometry: CSG primitives, Boolean operators, CSG expressions, Interior, Exterior, closure, Sweeping: linear and non-linear, Solid manipulations

**UNIT IV**

**Transformations**: 2-D and 3-D transformations: translation, scaling, rotation, reflection, concatenation, homogeneous coordinates, Perspective projection, orthotropic projection, isometric projection, Hidden surface removal, shading, rendering. CAD/ CAM Data Exchange: Evaluation of data exchange format, Data exchange formats: IGES, PDES, CGM, STEP Dimensioning and tolerances: Linear, angular, angular dimensions, maximum material condition (MMC), Least material condition (LMC), Regardless of feature size (RFS).

**TEXTBOOKS:**


1. CAD/CAM Concepts and Applications/ Alavala/ PHI.
2. Mastering CAD/CAM / Ibrhim Zeid / Mc Graw Hill International.
3. CAD/CAM Principles and Applications/ P.N.Rao/TMH/3rd Edition
4. CAD/CAM /Groover M.P./ Pearson education


**REFERENCE BOOKS:**


1. CAD / CAM / CIM, Radhakrishnan and Subramanian/ New Age
2. Principles of Computer Aided Design and Manufacturing/ Farid Amirouche/ Pearson
3. Computer Numerical Control Concepts and programming/ Warren S Seames/ Thomson.


**E-RESOURCES:**

**https://www.cs.princeton.edu/courses/archive/spr00/cs598b/**

**IV B. Tech II Semester**

**Course Code:**

**DESIGN FOR MANUFACTURING**

**(Professional Elective-VI)**

| | | | |
|---|---|---|---|
| **Lecture – Tutorial:** | 3-0 Hours | **Internal Marks:** | 40 |
| **Credits:** | 3 | **External Marks:** | 60 |

**Prerequisites:**

Manufacturing Process, Engineering Materials, Design of Machine Elements- I, II

**Course Objectives:**

1. Student will know the the basic concept of DFMA for economical production
2. Student will be exposed to the proper materials for design considerations.
3. Student will apply understand the field of metal casting.
4. Student will understand the machining and forming considerations in Design for Manufacturing..
5. Student will be in a position of joining and integrate the knowledge of compliance analysis
6. Student will be aware of design considerations in interference analysis for assembly..

**Course Outcomes:**

**Upon successful completion of the course, the student will be able to:**

| | |
|---|---|
| CO1 | Understand the basic concept of DFMA for economical production |
| CO2 | Identify and select the proper materials. |
| CO3 | Apply the knowledge in the field of metal casting. |
| CO4 | Select the machining and forming considerations in Design for Manufacturing. |
| CO5 | Apply the design considerations in joining and integrate the knowledge of compliance analysis |
| CO6 | Apply the design considerations in interference analysis for assembly. |

**Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2- Medium, 3 – High)**

| | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO 10** | **PO 11** | **PO 12** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | | | | | 1 | | | | | 2 | |
| CO2 | 2 | | 3 | | | | | | | | 1 | |
| CO3 | | 3 | 2 | | 1 | | | | | | | |
| CO4 | | 2 | 3 | | | | | | | | | 1 |
| CO5 | 2 | - | - | - | 3 | | | | | | 1 | |
| CO6 | 2 | | | | 3 | | | | | | 1 | |

**UNIT I**

**Introduction to DFMA**: History of DFMA, Steps for applying DFMA during product design, Advantages of applying DFMA during product design, Reasons for not implementing DFMA,

**Introduction to Manufacturing Process:** Classification of manufacturing process, Basic manufacturing processes, Mechanical properties of material: Tensile properties, engineering stress-strain, True stress strain, Compression properties, Shear properties Introduction to materials and material selection: Classification of engineering

materials, Material selection for product design.

**UNIT II**

**DFM methodology for Sand casting:** Typical characteristics of sand cast part, Design Recommendation for sand casting, Die casting: Suitable material consideration, General design consideration, Specific design Recommendation. Powder metal processing: Typical characteristics, Design recommendations

**UNIT III**

**DFM methodology for Machining:** Recommended materials for machinability, Design Recommendations, Turning operation: Suitable materials, Design Recommendations,

**DFM methodology for Forging**: Forging processes, Forging nomenclature, Suitable materials for forging, Design Recommendations, Extrusion: Process, Suitable material for extrusion, Design Recommendation for metal extrusion. Rolled Section: Process, Design Recommendations of rolled section,

**UNIT IV**

**DFM methodology for Welding**: Review of welding Processes, design recommendation for welding process, Solder and brazed assembly: Process, Typical characteristics, Suitable materials, Design detail recommendations, adhesively bonded assemblies: Typical characteristics, Suitable materials, Design Recommendations for adhesive joint Assembly: Compliance analysis and interference analysis for the design of assembly – design and development of features for automatic assembly –liaison diagrams. Environment: Motivations for environment, principles of environment-eco-efficiency, product life cycle perspective, environment tools and processes, environment design guidelines.

**TEXTBOOKS:**


1. L. C. Schmidt, G. Dieter, Engineering Design, 4thedition, McGraw Hill Education India Private Limited.
2. James G. Bralla, Hand Book of Product Design for Manufacturing, McGraw Hill Co., 2nd edition1986.
3. Robert Matousek., Engineering Design - A Systematic Approach, Blackie & Sons Ltd, 1963.
4. P.Dewhurst, W.Knight, G.Boothroyd, Product Design for Manufacture and Assembly, CRC Press.


**REFERENCE BOOKS:**


1. A K Chitale and R C Gupta, “Product Design and Manufacturing”, PHI, New Delhi,
2. J. Lesko, Industrial Design, Materials and Manufacture Guide, John Willy and Sons, Inc
3. O. Molloy, S. Tilley and E.A. Warman Design for Manufacturing and assembly, Chapman &Hall, London, UK.
4. D. E. Whitney, Mechanical Assemblies: Their Design, Manufacture, and Role in Product Development, Oxford University Press, New York


**E-RESOURCES:**

**https://news.ewmfg.com/blog/manufacturing/dfm-design-for-manufacturing**
**https://www.plm.automation.siemens.com/global/en/our-story/glossary/design-for-manufacturing-and-assembly-dfma/53982**

**IV B. Tech II Semester**

**Course Code:**

**AUTOMOBILE ENGINEERING**

**(Professional Elective-VI)**

| | | | |
|---|---|---|---|
| **Lecture – Tutorial:** | 3-0 Hours | **Internal Marks:** | 40 |
| **Credits:** | 3 | **External Marks:** | 60 |

**Prerequisites:**

Thermodynamics, Machine Design, Metallurgy

**Course Objectives:**

1. Students will know about the basic layout of an automobile.
2. Students will know about the operation of engine cooling and lubrication systems.
3. Students will know about the operation of ignition, electrical, and air conditioning systems.
4. Students will know about the principles of transmission and steering systems.
5. Students will know about the principles of suspension and braking systems.
6. Students will know about emissions from automobiles and energy alternatives.

**Course Outcomes:**

**Upon successful completion of the course, the student will be able to:**

| | |
|---|---|
| CO1 | Explain the basic layout of an automobile and the fuel systems used. |
| CO2 | Demonstrate the operation of cooling and lubrication systems in automobiles. |
| CO3 | Outline the operation of ignition, electrical, and air conditioning systems in automobiles. |
| CO4 | Summarize the operation of transmission and steering systems. |
| CO5 | Explain the operation of suspension and braking systems. |
| CO6 | Outline the emissions from automobiles and energy alternatives. |

**Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2- Medium, 3 – High)**

| | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO 10** | **PO 11** | **PO 12** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 3 | 1 | | | | | 1 | | | | |
| CO2 | 3 | 1 | 2 | | | | | | 1 | | | |
| CO3 | 3 | 2 | 1 | | | | | | 1 | | | |
| CO4 | 2 | 3 | 1 | | | | | | | 1 | | |
| CO5 | 2 | 3 | 1 | | | | | | | | 1 | |
| CO6 | 3 | 2 | 1 | | | | | | | | | |

**UNIT I**

**INTRODUCTION:** Components of four-wheeler automobile chassis and body power unit, power transmission, rear-wheel drive, front-wheel drive, four-wheel drive types of automobile engines, engine construction engine lubrication, splash and pressure lubrication systems, oil filters, oil pumps, crankcase ventilation, engine service, reboring, decarburization, Nitriding of the crank shaft.

**FUEL SYSTEM:**

**S.I. ENGINE:** Fuel supply systems, Mechanical and electrical fuel pumps, carburetor

types, air filters, petrol injection.

**C.I. ENGINES:** Requirements of diesel injection systems, types of injection systems, fuel pump, nozzle, Alternative fuels for Automobile injection, Classification, Properties, Hybrid vehicles injection timing, testing of fuel pumps.

**UNIT II**

**COOLING SYSTEM:** Cooling Requirements, Air Cooling, Liquid Cooling, and Forced Circulation System, Radiators, Types Cooling Fans, water pumps, thermostat, evaporating cooling pressure sealed cooling antifreeze solutions.

**IGNITION SYSTEM:** Function of an ignition system, battery ignition system, constructional features of storage battery, autotransformer, contact breaker points, condenser and spark plug Magneto coil ignition system, electronic ignition system using contact breaker, electronic ignition using contact triggers spark advance and retard mechanism.

**ELECTRICAL SYSTEM:** Charging circuit, generator, current-voltage regulator starting system, Bendix drive mechanism solenoid switch, lighting systems, Horn, wiper, fuel gauge, oil pressure gauge, engine temperature indicator, etc.

**UNIT III**

**TRANSMISSION SYSTEM:** Clutches, principle, types, cone clutch, single-plate clutch, multi-plate clutch, magnetic and centrifugal clutches, fluid flywheel, Gearboxes, types, sliding mesh, construct mesh, synchromesh gearboxes, epicyclic gearbox, overdrive torque converter. Propeller shaft Hotch Kiss drive, Torque tube drive universal joint, differential rear axles, types of wheels, and tires.

**STEERING SYSTEM**: Steering geometry camber, castor, kingpin rake, combined angle toe in, center point steering. Types of steering mechanism Ackerman steering mechanism, Davis steering mechanism, steering gear types, steering linkages.

**SUSPENSION SYSTEM:** Objects of suspension systems, rigid axle suspension system, torsion bar, shock absorber, independent suspension system.

**UNIT IV**

**BRAKING SYSTEM:** Mechanical brake system, Hydraulic brake system, Master cylinder, wheel cylinder, tandem master cylinder, Requirement of brake fluid, Pneumatic and vacuum brakes.

**ENGINE SERVICE:** Introduction, service details of the engine cylinder head, valves, valve mechanism, piston connecting rod assembly, cylinder block, crankshaft, main bearings, engine reassembly precautions.

**EMISSIONS FROM AUTOMOBILES:** Pollution standards National and international Pollution Control Techniques, Energy alternatives: Solar, Photovoltaic, Hydrogen, Biomass, alcohols, LPG, CNG, liquid Fuels, and gaseous fuels, Hydrogen as a fuel for IC Engines. Their merits and demerits. Standard Vehicle maintenance practice.

**TEXTBOOKS:**

1.Automobile Engineering by Kripal Singh Vol. 1 & Vol. 2.
2.Automobile Engineering by K.M Gupta, Umesh publication, Vol. 1 & Vol. 2.
3.Automobile Engineering / William Crouse/TMH Distributors.
4.Automobile Engineering/P. S Gill/S.K. Kataria& Sons/New Delhi.

**REFERENCE BOOKS:**

1. A Textbook of Automobile Engineering by R K Rajput. Laxmi Publications.

2. A Textbook of Automobile Engineering By Khalil U Siddiqui New Age International.
3. Automobile Engineering / C Srinivasan/McGraw-Hill.
4. Alternative fuels of Automobiles by P.Rami Reddy, Frontline publications.

**E-RESOURCES:**

**https://journals.sagepub.com/home/pid**
**https://hud.libguides.com/mechanical_automotive**

**IV B. Tech II Semester**

**Course Code:**

**METAL FORMING PROCESS**

**(Professional Elective – VI)**

| | | | |
|---|---|---|---|
| **Lecture – Tutorial:** | 3-0 Hours | **Internal Marks:** | 40 |
| **Credits:** | 3 | **External Marks:** | 60 |

**Prerequisites:**

Fundamentals of formability of materials and different metal forming processes and its applications.

To impart knowledge on various aspects of metal forming and to develop the skill to analyses under different conditions.

**Course Objectives:**

1. Student will know the various fundamental concepts of metal forming process
2. Student will be understand the various process parameters and applied loads in forging.
3. Student will be exposed to the various process parameters in sheet metal working.
4. Student will be understand Rolling and Extrusion processes and associated parameters
5. Student will be understand the various methods to Drawing processes
6. Student will beaware of various High Energy Rate forming processes.

**Course Outcomes:**

**Upon successful completion of the course, the student will be able to:**

| | |
|---|---|
| CO1 | Understand the fundamental concepts of metal forming. |
| CO2 | Know the various process parameters and applied loads in forging. |
| CO3 | Know the various process parameters and applied loads in sheet metal working. |
| CO4 | Analyze Rolling and Extrusion processes and associated parameters |
| CO5 | Analyze Drawing. |
| CO6 | Analyze various High Energy Rate forming processes. |

**Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2- Medium, 3 – High)**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | | 2 | | 3 | | | | | | | |
| CO2 | 2 | | 2 | | 3 | | | | | | | |
| CO3 | 2 | | 2 | | 3 | | | | | | | |
| CO4 | 2 | | 3 | | 3 | | | | | | | |
| CO5 | 2 | | 2 | | 3 | | | | | | | |
| CO6 | 2 | | 2 | | 3 | | | | | | | |

**UNIT I**

**Fundamentals of Metal Forming**: Classification of forming processes- classification, mechanisms of metal forming: slab method, Upper and lower bound analysis, Deformation energy method, temperature of metal working, hot working, Warm working, cold working friction and lubricants. Formability limits, Strain rates in metal

forming Development of metallurgical structure during deformation Flow curves Plastic stressstrain relationship - plastic work - the principle of normality -incremental plastic strain. Strain rate - super plasticity

**UNIT II**

**Forging:** Classification of forging processes, forging of plate, forging of circular discs, open die and closeddie forging, forging defects, and powder metallurgy forging. Problems on flow stress, true strain and forging load.

**Press tool design:** Design of various press tools and dies like piercing dies, blanking dies, compound dies and progressive dies, blanking, punching, problems on Blanking and punching force, clearances, Elastic recovery and shear.

**Sheet metal forming:** Forming methods, bending, stretch forming, Spinning.

**UNIT III**

**Rolling:** Rolling processes, forces and geometrical relationship in rolling, simplified analysis, rolling load, rolling variables, theories of cold and hot rolling, problems and defects in rolling, torque and power calculations, Problems.

**Extrusion:** Classification, Hot Extrusion, Analysis of Extrusion process, defects in extrusion, extrusion of tubes and production of seamless pipes. Problems on extrusion load.

**UNIT IV**

**Drawing:** Drawing of tubes, rods, and wires: Wire drawing dies, tube drawing process, analysis of wire, deep drawing and tube drawing. Problems on draw force. Cup drawing

**Advanced Metal forming processes**: Electromagnetic forming. Explosive Forming, Electrohydraulic forming.

**Miscellaneous Forming Processes:** Coining, Thread Rolling, Tube piercing,

**TEXTBOOKS:**


1. Manufacturing Science- Amitabha Ghosh , Ashok Kumar Mallik, EWP
2. Fundamentals of Metal Forming Processes – B.L. Juneja
3. Mechanical Metallurgy by G. E. Dieter, McGraw-Hill.


**REFERENCE BOOKS:**


1. Metal Forming: Fundamentals and Applications by TaylanAltan (ASM Series in Metal Processing)
2. Introduction to Industrial Mechanical Working Process by G. W. Rowe
3. Manufacturing Technology (Foundry, Forming and Welding) by P. N. Rao, TMH
4. Materials & Processes In Manufacturing By E.Paul De Germo, J T Black & Ronald A Koshav
5.Modern Control Engineering by Ogata, PHI Publ. Prentice-Hall of India Pvt. Ltd.


**E-RESOURCES:**

**https://www.sciencedirect.com/topics/materials-science/metal-forming-process**
**https://www.springer.com/journal/12289**

**IV B. Tech II Semester**

**Course Code:**

**PROJECT MANAGEMENT**

**(Professional Elective – VI)**

| | | | |
|---|---|---|---|
| **Lecture – Tutorial:** | 3-0 Hours | **Internal Marks:** | 40 |
| **Credits:** | 3 | **External Marks:** | 60 |

**Prerequisites:**

**Course Objectives:**

1. Student will know the types of projects and benefits of project management.
2. Student will understand the job role of a Project manager.
3. Student will be able to conduct the feasibility studies of any project.
4. Student will understand how to manage the project management activities.
5. Student will be able to plan for the completion of the project if the project time needs to be reduced.
6. Student will get the knowledge of risk management.

**Course Outcomes:**

**Upon successful completion of the course, the student will be able to:**

| | |
|---|---|
| CO1 | Understand the significance of project management its objectives and various phases involved in project management life cycle. |
| CO2 | Role and responsibilities of a Project Manager |
| CO3 | Gain knowledge regarding project feasibility study and various Organizational issues. |
| CO4 | Able to apply various tools like CPM & PERT in project management. |
| CO5 | Understand how to speed up a project's timeline by adding additional resources. |
| CO6 | Gain knowledge in risk management and role of IT in project management. |

**Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2- Medium, 3 – High)**

| | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO 10** | **PO 11** | **PO 12** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | | | | | | | | | | | 3 |
| CO2 | 2 | | | | | | | | | | | 3 |
| CO3 | 2 | | | | | | | | | | | 3 |
| CO4 | 2 | | | | | | | | | | | 3 |
| CO5 | 2 | | | | | | | | | | | 3 |
| CO6 | 2 | | | | | | | | | | | 3 |

**UNIT I**

**Basics of Project Management:** Introduction, Evolution of project management, Objectives of project management, Types of projects, Types of project delays, Benefits of project Management, Stake holders of a project.

**Project Management Life cycle**: Phases of Project Management Life Cycle, Role of a Project Manager (PM).

**UNIT II**

**Project Feasibility study:** Introduction, Pre-Feasibility Study, Types of feasibility,

Steps of feasibility study.

**Project Organizational Structures**: Introduction, Concept of Organizational Structure, Essential qualities of a project manager, Organizational structure for projects, Project management offices.

**UNIT III**

**Techniques of Project Management:** Introduction, simple network techniques, construction rules of drawing, Fulkerson's rule, Critical path method (CPM)- floats, critical path, project duration, PERT: Introduction, different Time estimates, expected time, variance, expected project duration and probability of completion.

**Crashing of Project network:** Introduction, General guidelines for network crashing, Types of crashing, problems

**UNIT IV**

**Project Risk Management and failure:** Introduction, Types of Risk, Steps in Risk Management, Risk Assessment, Project failure-causes of project failure.

**Project Management Information System**: Introduction, Project Management Information System (PMIS), Planning of PMIS.

**TEXTBOOKS:**


1. P. Panneerselvam, R. Senthil kumar, "Project Management" PHI 2009
2. Ramakrishna &Kamaraju "Essentials of Project Management" Kindle Edition PHI, 2010


**REFERENCE BOOKS:**


1. Harold Kerzner "Project Management- A system approach to planning, scheduling & Controlling" Eleventh Edition, wiley.
2. Thomas Erickson & P. V. Khatri "Project Management" Global Vision Publishing House (2015).


**E-RESOURCES:**

https://www.projectmanager.com/resources