



SRI VASAVI INSTITUTE OF ENGINEERING & TECHNOLOGY

An Autonomous Institute

(Approved by AICTE, New Delhi & Affiliated to JNTU Kakinada)
Accredited by NBA (Mech, ECE & CSE) & NAAC with 'A' Grade
Nandamuru, Pedana Mandal, Krishna Dist – 521369.

DEPARTMENT OF MECHANICAL ENGINEERING COURSE STRUCTURE AND COURSE SYLLABUS

B.TECH. – I YEAR I SEMESTER (FOR GROUP-B BRANCHES)

S.No.	Category	Title	L/D	T	P	Credits
1	BS&H	Engineering Physics	3	0	0	3
2	BS&H	Linear Algebra & Calculus	3	0	0	3
3	Engineering Science	Basic Electrical & Electronics Engineering	3	0	0	3
4	Engineering Science	Engineering Graphics	1	0	4	3
5	Engineering Science	Introduction to Programming	3	0	0	3
6	Engineering Science	IT Workshop	0	0	2	1
7	BS&H	Engineering Physics Lab	0	0	2	1
8	Engineering Science	Electrical & Electronics Engineering Workshop	0	0	3	1.5
9	Engineering Science	Computer Programming Lab	0	0	3	1.5
10	BS&H	NSS/NCC/Scouts & Guides/Community Service	-	-	1	0.5
Total			13	00	15	20.5

B.Tech. – I Year II Semester (for Group-B Branches)

S.No.	Category	Title	L	T	P	Credits
1	BS&H	Communicative English	2	0	0	2
2	BS & H	Engineering Chemistry / Chemistry /Fundamental Chemistry	3	0	0	3
3	Engineering Science	Differential Equations & Vector Calculus	3	0	0	3
4	Engineering Science	Basic Civil & Mechanical Engineering	3	0	0	3
5	Professional Core	Engineering Mechanics/Network Analysis/Data structures (Branch specific)	3	0	0	3
6	BS&H	Communicative English Lab	0	0	2	1
7	BS&H	Engineering Chemistry / Chemistry /Fundamental Chemistry Lab	0	0	2	1
8	Engineering Science	Engineering Workshop	0	0	3	1.5
9	Professional Core	Engineering Mechanics & Building Practices Lab Engineering Mechanics Lab/Network Analysis Lab/ Data structures Lab	0	0	3	1.5
10		Health and wellness, Yoga and Sports	-	-	1	0.5
Total			14	00	11	19.5

L	T	P	C
3	0	0	3

ENGINEERING PHYSICS

(for Mechanical Engineering)

Course Objectives:

To bridge the gap between the Physics in school at 10+2 level and UG level engineering courses by identifying the importance of the optical phenomenon like interference, diffraction etc, enlightening the periodic arrangement of atoms in crystalline solids and concepts of quantum mechanics, introduce novel concepts of dielectric and magnetic materials, physics of semiconductors.

Course Outcomes:

CO1: Analyze the intensity variation of light due to polarization, interference and diffraction.CO2: Familiarize with the basics of crystals and their structures.

CO3: Explain fundamentals of quantum mechanics and apply it to one dimensional motion of particles.

CO4: Summarize various types of polarization of dielectrics and classify the magnetic materials.

CO5: Explain the basic concepts of Quantum Mechanics and the band theory of solids.CO6: Identify the type of semiconductor using Hall effect.

UNIT I Wave Optics**12Hours**

Interference: Introduction - Principle of superposition –Interference of light - Interference in thin films (Reflection Geometry) & applications - Colours in thin films- Newton's Rings, Determination of wavelength and refractive index.

Diffraction: Introduction - Fresnel and Fraunhofer diffractions - Fraunhofer diffraction due to single slit, double slit & N-slits (Qualitative) – Diffraction Grating - Dispersive power and resolving power of Grating (Qualitative). Polarization: Introduction -Types of polarization - Polarization by reflection, refraction and Double refraction - Nicol's Prism -Half wave and Quarter wave plates.

UNIT II Crystallography and X-ray diffraction**11Hours**

Crystallography: Space lattice, Basis, Unit Cell and lattice parameters – Bravais Lattices – crystal systems (3D) – coordination number - packing fraction of SC, BCC & FCC - Miller indices – separation between successive (hkl) planes.

X-ray diffraction: Bragg's law - X-ray Diffractometer – crystal structure determination by Laue's and powder methods

UNIT III Dielectric and Magnetic Materials**13Hours**

Dielectric Materials: Introduction - Dielectric polarization - Dielectric polarizability, Susceptibility, Dielectric constant and Displacement Vector – Relation between the electric vectors - Types of polarizations- Electronic (Quantitative), Ionic (Quantitative) and Orientation polarizations (Qualitative) - Lorentz internal field - Clausius- Mossotti equation - complex dielectric constant – Frequency dependence of polarization – dielectric loss

Magnetic Materials: Introduction - Magnetic dipole moment - Magnetization-Magnetic susceptibility and permeability – Atomic origin of magnetism - Classification of magnetic materials: Dia, para, Ferro, anti-ferro & Ferri magnetic materials - Domain concept for

Ferromagnetism & Domain walls (Qualitative) - Hysteresis - soft and hard magnetic materials and its Applications.

UNIT IV Quantum Mechanics and Free electron Theory**10Hours**

Quantum Mechanics: Dual nature of matter – Heisenberg's Uncertainty Principle – Significance and properties of wave function – Schrodinger's time independent and dependent wave equations – Particle in a one-dimensional infinite potential well.

Free Electron Theory: Classical free electron theory (Qualitative with discussion of merits and demerits) – Fermi-Dirac distribution - Density of states - Fermi energy-Quantum free electron theory – electrical conductivity based on quantum free electron theory.

UNIT V Semiconductors**9Hours**

Semiconductors: Formation of energy bands – classification of crystalline solids - Intrinsic semiconductors: Density of charge carriers – Electrical conductivity – Fermi level – Extrinsic semiconductors: density of charge carriers – dependence of Fermi energy on carrier concentration and temperature - Drift and diffusion currents – Einstein's equation – Hall effect and its applications.

Textbooks:

1. A Text book of Engineering Physics, M. N. Avadhanulu, P.G.Kshirsagar & TVS Arun Murthy, S. Chand Publications, 11th Edition 2019.
2. Engineering Physics - Shatendra Sharma, Jyotsna Sharma, Pearson Education, 2018
3. Engineering Physics – P.K.Palani Samy

Reference Books:

1. Engineering Physics - B.K. Pandey and S. Chaturvedi, Cengage Learning 2021.
2. Engineering Physics – Sanjay D. Jain, D. Sahasrabudhe and Girish, University Press.2010
3. Engineering Physics - M.R. Srinivasan, New Age international publishers (2009).

Web Resources: <https://www.loc.gov/rr/scitech/selected-internet/physics.html>

L	T	P	C
3	0	0	3

LINEAR ALGEBRA & CALCULUS

(for Mechanical Engineering)

Course Objectives:

- To equip the students with standard concepts and tools at an intermediate to advanced level mathematics to develop the confidence and ability among the students to handle various real-world problems and their applications.

Course Outcomes: At the end of the course, the student will be able to

CO1: Develop and use of matrix algebra techniques that are needed by engineers for practical applications.

CO2: Utilize mean value theorems to real life problems.

CO3: Familiarize with functions of several variables which is useful in optimization.

CO4: Learn important tools of calculus in higher dimensions.

CO5: Familiarize with double and triple integrals of functions of several variables in two dimensions using Cartesian and polar coordinates and in three dimensions using cylindrical and spherical coordinates.

UNIT I Matrices

Rank of a matrix by echelon form, normal form. Cauchy–Binet formulae (without proof). Inverse of Non- singular matrices by Gauss-Jordan method, System of linear equations: Solving system of Homogeneous and Non-Homogeneous equations by Gauss elimination method, Jacobi and Gauss Seidel Iteration Methods.

UNIT II Eigenvalues, Eigenvectors and Orthogonal Transformation

Eigenvalues, Eigenvectors and their properties, Diagonalization of a matrix, Cayley-Hamilton Theorem (without proof), finding inverse and power of a matrix by Cayley-Hamilton Theorem, Quadratic forms and Nature of the Quadratic Forms, Reduction of Quadratic form to canonical forms by Orthogonal Transformation.

UNIT III Calculus

Mean Value Theorems: Rolle's Theorem, Lagrange's mean value theorem with their geometrical interpretation, Cauchy's mean value theorem, Taylor's and Maclaurin theorems with remainders (without proof), Problems and applications on the above theorems.

UNIT IV Partial differentiation and Applications (Multi variable calculus) Functions of several variables: Continuity and Differentiability, Partial derivatives, total derivatives, chain rule, Directional derivative, Taylor's and Maclaurin's series expansion of functions of two variables. Jacobians, Functional dependence, maxima and minima of functions of two variables, method of Lagrange multipliers.

UNIT V Multiple Integrals (Multi variable Calculus)

Double integrals, triple integrals, change of order of integration, change of variables to polar, cylindrical and spherical coordinates. Finding areas (by double integrals) and volumes (by double integrals and triple integrals).

Textbooks:

- Higher Engineering Mathematics, B. S. Grewal, Khanna Publishers, 2017, 44th Edition
- Advanced Engineering Mathematics, Erwin Kreyszig, John Wiley & Sons, 2018, 10th

Edition.

Reference Books:

1. Thomas Calculus, George B. Thomas, Maurice D. Weir and Joel Hass, Pearson Publishers, 2018, 14th Edition.
2. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Alpha Science International Ltd., 2021 5th Edition (9th reprint).
3. Advanced Modern Engineering Mathematics, Glyn James, Pearson publishers, 2018, 5th Edition.
4. Advanced Engineering Mathematics, Micheael Greenberg, , Pearson publishers, 9th edition
5. Higher Engineering Mathematics, H. K Das, Er. Rajnish Verma, S. Chand Publications, 2014, Third Edition (Reprint 2021)

L	T	P	C
3	0	0	3

BASIC ELECTRICAL & ELECTRONICS ENGINEERING

Course Objectives

To expose to the field of electrical & electronics engineering, laws and principles of electrical/electronic engineering and to acquire fundamental knowledge in the relevant field.

Course Outcomes: After the completion of the course students will be able to

CO1. Describe fundamental laws, operating principles of motors/generators, MC/MI instruments (L2)

CO2. Demonstrate the working of electrical machines, measuring instruments and power generation stations. (L2)

CO3. Apply mathematical tools and fundamental concepts to derive various equations related to electrical circuits and machines. (L3)

CO4. Calculate electrical load and electricity bill of residential and commercial buildings. (L4)

PART A: BASIC ELECTRICAL ENGINEERING

UNIT I DC & AC Circuits

DC Circuits: Electrical circuit elements (R, L and C), Ohm's Law and its limitations, KCL & KVL, series, parallel, series-parallel circuits, Super Position theorem, Simple numerical problems.

AC Circuits: A.C. Fundamentals: Equation of AC Voltage and current, waveform, time period, frequency, amplitude, phase, phase difference, average value, RMS value, form factor, peak factor, Voltage and current relationship with phasor diagrams in R, L, and C circuits, Concept of Impedance, Active power, reactive power and apparent power, Concept of power factor (Simple Numerical problems).

UNIT II Machines and Measuring Instruments

Machines: Construction, principle and operation of (i) DC Motor, (ii) DC Generator, (iii) Single Phase Transformer, (iv) Three Phase Induction Motor and (v) Alternator, Applications of electrical machines.

Measuring Instruments: Construction and working principle of Permanent Magnet Moving Coil (PMMC), Moving Iron (MI) Instruments and Wheat Stone bridge.

UNIT III Energy Resources, Electricity Bill & Safety Measures

Energy Resources: Conventional and non-conventional energy resources; Layout and operation of various Power Generation systems: Hydel, Nuclear, Solar & Wind power generation.

Electricity bill: Power rating of household appliances including air conditioners, PCs, Laptops, Printers, etc. Definition of "unit" used for consumption of electrical energy, two-part electricity tariff, calculation of electricity bill for domestic consumers.

Equipment Safety Measures: Working principle of Fuse and Miniature circuit breaker (MCB), merits and demerits. Personal safety measures: Electric Shock, Earthing and its types, Safety Precautions to avoid shock.

Textbooks:

1. Basic Electrical Engineering, D. C. Kulshreshtha, Tata McGraw Hill, 2019, First Edition
2. Power System Engineering, P.V. Gupta, M.L. Soni, U.S. Bhatnagar and A.

Chakrabarti, Dhanpat Rai & Co, 2013

3. Fundamentals of Electrical Engineering, Rajendra Prasad, PHI publishers, 2014, Third Edition

Reference Books:

1. Basic Electrical Engineering, D. P. Kothari and I. J. Nagrath, Mc Graw Hill, 2019, Fourth Edition
2. Principles of Power Systems, V.K. Mehtha, S.Chand Technical Publishers, 2020
3. Basic Electrical Engineering, T. K. Nagsarkar and M. S. Sukhija, Oxford University Press, 2017
4. Basic Electrical and Electronics Engineering, S. K. Bhattacharya, Person Publications, 2018, Second Edition.

Web Resources:

1. <https://nptel.ac.in/courses/108105053>
2. <https://nptel.ac.in/courses/108108076>

PART B: BASIC ELECTRONICS ENGINEERING

Course Objectives:

- To teach the fundamentals of semiconductor devices and its applications, principles of digital electronics.

Course Outcomes: After the completion of the course students will be able to

- **CO1.** Student will be able to Understand Diode & Bipolar Junction Transistor (L1)
- **CO2.** Student will be able to Develop Power Supply. (L2)
- **CO3.** Student will be able to Understand electronic instructions (L1)
- **CO4.** Student will be able to Understand Combinational & Sequential Circuits. (L1)

UNIT I SEMICONDUCTOR DEVICES

Introduction - Evolution of electronics – Vacuum tubes to nano electronics - Characteristics of PN Junction Diode — Zener Effect — Zener Diode and its Characteristics. Bipolar Junction Transistor — CB, CE, CC Configurations and Characteristics — Elementary Treatment of Small Signal CE Amplifier.

UNIT II BASIC ELECTRONIC CIRCUITS AND INSTRUMENTATION

Rectifiers and power supplies: Block diagram description of a dc power supply, working of a full wave bridge rectifier, capacitor filter (no analysis), working of simple zener voltage regulator. Amplifiers: Block diagram of Public Address system, Circuit diagram and working of common emitter (RC coupled) amplifier with its frequency response. Electronic Instrumentation: Block diagram of an electronic instrumentation system.

UNIT III DIGITAL ELECTRONICS

Overview of Number Systems, Logic gates including Universal Gates, BCD codes, Excess-3 code, Gray code, Hamming code. Boolean Algebra, Basic Theorems and properties of Boolean Algebra, Truth Tables and Functionality of Logic Gates – NOT, OR, AND, NOR, NAND, XOR and XNOR. Simple combinational circuits–Half and Full Adders. Introduction to sequential circuits, Flip flops, Registers and counters (Elementary Treatment only)

Textbooks:

1. R. L. Boylestad & Louis Nashlesky, Electronic Devices & Circuit Theory, Pearson Education, 2021.

2. R. P. Jain, Modern Digital Electronics, 4th Edition, Tata Mc Graw Hill, 2009

Reference Books:

1. R. S. Sedha, A Textbook of Electronic Devices and Circuits, S. Chand & Co, 2010.
2. Santiram Kal, Basic Electronics- Devices, Circuits and IT Fundamentals, Prentice Hall, India, 2002.
3. R. T. Paynter, Introductory Electronic Devices & Circuits – Conventional Flow Version, Pearson Education, 2009.

End examination pattern:

- i) Question paper shall be in two parts viz., Part A and Part B with equal weightage of 35 marks each.
- ii) In each part, question 1 shall contain 5 compulsory short answer questions for a total of 5 marks such that each question carries 1 mark.
- iii) In each part, questions from 2 to 4, there shall be either/or type questions of 10 marks each. Student shall answer any one of them.

The questions from 2 to 4 shall be set by covering one unit of the syllabus for each question.

L	T	P	C
1	0	4	3

ENGINEERING GRAPHICS

(Common to All branches of Engineering)

Course Objectives:

- To enable the students with various concepts like dimensioning, conventions and standards related to Engineering Drawing
- To impart knowledge on the projection of points, lines and plane surfaces
- To improve the visualization skills for better understanding of projection of solids
- To develop the imaginative skills of the students required to understand Section of solids and Developments of surfaces.
- To make the students understand the viewing perception of a solid object in Isometric and Perspective projections.

Course Outcomes:

CO1: Understand the principles of engineering drawing, including engineering curves, scales, orthographic and isometric projections.

CO2: Draw and interpret orthographic projections of points, lines, planes and solids in front, top and side views.

CO3: Understand and draw projection of solids in various positions in first quadrant.

CO4: Explain principles behind development of surfaces.

CO5: Prepare isometric and perspective sections of simple solids.

UNIT I

Introduction: Lines, Lettering and Dimensioning, Geometrical Constructions and Constructing regular polygons by general methods.

Curves: construction of ellipse, parabola and hyperbola by general, Cycloids, Involute, Normal and tangent to Curves.

Scales: Plain scales, diagonal scales and vernier scales.

UNIT II

Orthographic Projections: Reference plane, importance of reference lines or Plane, Projections of a point situated in any one of the four quadrants.

Projections of Straight Lines: Projections of straight lines parallel to both reference planes, perpendicular to one reference plane and parallel to other reference plane, inclined to one reference plane and parallel to the other reference plane. Projections of Straight Line Inclined to both the reference planes

Projections of Planes: regular planes Perpendicular to both reference planes, parallel to one reference plane and inclined to the other reference plane; plane inclined to both the reference planes.

UNIT III

Projections of Solids: Types of solids: Polyhedra and Solids of revolution. Projections of solids in simple positions: Axis perpendicular to horizontal plane, Axis perpendicular to vertical plane and Axis parallel to both the reference planes, Projection of Solids with axis inclined to one reference plane and parallel to another plane.

UNIT IV

Sections of Solids: Perpendicular and inclined section planes, Sectional views and True shape of section, Sections of solids in simple position only.

Development of Surfaces: Methods of Development: Parallel line development and radial line development. Development of a cube, prism, cylinder, pyramid and cone.

UNIT V

Conversion of Views: Conversion of isometric views to orthographic views; Conversion of orthographic views to isometric views.

Computer graphics: Creating 2D&3D drawings of objects including PCB and Transformations using Auto CAD (*Not for end examination*).

Textbook:

1. N. D. Bhatt, Engineering Drawing, Charotar Publishing House, 2016.

Reference Books:

1. Engineering Drawing, K.L. Narayana and P. Kannaiah, Tata McGraw Hill, 2013.
2. Engineering Drawing, M.B.Shah and B.C. Rana, Pearson Education Inc, 2009.
3. Engineering Drawing with an Introduction to AutoCAD, Dhananjay Jolhe, Tata McGraw Hill, 2017.

L	T	P	C
3	0	0	3

INTRODUCTION TO PROGRAMMING

(Common to All branches of Engineering)

Course Objectives:

- To introduce students to the fundamentals of computer programming.
- To provide hands-on experience with coding and debugging.
- To foster logical thinking and problem-solving skills using programming.
- To familiarize students with programming concepts such as data types, control structures, functions, and arrays.
- To encourage collaborative learning and teamwork in coding projects.

Course Outcomes: A student after completion of the course will be able to

CO1: Understand basics of computers, the concept of algorithm and algorithmic thinking.

CO2: Analyse a problem and develop an algorithm to solve it.

CO3: Implement various algorithms using the C programming language.

CO4: Understand more advanced features of C language.

CO5: Develop problem-solving skills and the ability to debug and optimize the code.

UNIT I Introduction to Programming and Problem Solving

History of Computers, Basic organization of a computer: ALU, input-output units, memory, program counter, Introduction to Programming Languages, Basics of a Computer Program-Algorithms, flowcharts (Using Dia Tool), pseudo code. Introduction to Compilation and Execution, Primitive Data Types, Variables, and Constants, Basic Input and Output, Operations, Type Conversion, and Casting.

Problem solving techniques: Algorithmic approach, characteristics of algorithm, Problem solving strategies: Top-down approach, Bottom-up approach, Time and space complexities of algorithms.

UNIT II Control Structures

Simple sequential programs Conditional Statements (if, if-else, switch), Loops (for, while, do-while) Break and Continue.

UNIT III Arrays and Strings

Arrays indexing, memory model, programs with array of integers, two dimensional arrays, Introduction to Strings.

UNIT IV Pointers & User Defined Data types

Pointers, dereferencing and address operators, pointer and address arithmetic, array manipulation using pointers, User-defined data types-Structures and Unions.

UNIT V Functions & File Handling

Introduction to Functions, Function Declaration and Definition, Function call Return Types and Arguments, modifying parameters inside functions using pointers, arrays as parameters. Scope and Lifetime of Variables, Basics of File Handling

Note: The syllabus is designed with C Language as the fundamental language of implementation.

Textbooks:

1. "The C Programming Language", Brian W. Kernighan and Dennis M. Ritchie, Prentice-Hall, 1988
2. Schaum's Outline of Programming with C, Byron S Gottfried, McGraw-Hill Education, 1996

Reference Books:

1. Computing fundamentals and C Programming, Balagurusamy, E., McGraw-Hill Education, 2008.
2. Programming in C, Rema Theraja, Oxford, 2016, 2nd edition
3. C Programming, A Problem Solving Approach, Forouzan, Gilberg, Prasad, CENGAGE, 3rd edition

L	T	P	C
0	0	2	1

IT WORKSHOP

COURSE OBJECTIVES:

- To introduce the internal parts of a computer, peripherals, I/O ports, connecting cables
- To demonstrate configuring the system as Dual boot both Windows and other Operating Systems Viz. Linux, BOSS
- To teach basic command line interface commands on Linux.
- To teach the usage of Internet for productivity and self-paced life-long learning
- To introduce Compression, Multimedia and Antivirus tools and Office Tools such as Word processors, Spread sheets and Presentation tools.

COURSE OUTCOMES:

At the end of the course, the students will be able to:

CO1: Demonstrate Hardware troubleshooting

CO2: Identify Hardware components and inter dependencies.

CO3: Describe usage of web browsers, email, news groups and discussion forums.

CO4: Design word documents and create presentations using different styles.

CO5: Prepare spreadsheets with calculations

SYLLABUS:

PC Hardware & Software Installation

Task 1: Identify the peripherals of a computer, components in a CPU and its functions. Draw the block diagram of the CPU along with the configuration of each peripheral and submit to your instructor.

Task 2: Every student should disassemble and assemble the PC back to working condition. Lab instructors should verify the work and follow it up with a Viva. Also students need to go through the video which shows the process of assembling a PC. A video would be given as part of the course content.

Task 3: Every student should individually install MS windows on the personal computer. Lab instructor should verify the installation and follow it up with a Viva.

Task 4: Every student should install Linux on the computer. This computer should have windows installed. The system should be configured as dual boot (VMWare) with both Windows and Linux. Lab instructors should verify the installation and follow it up with a Viva

Task 5: Every student should install BOSS on the computer. The system should be configured as dual boot (VMWare) with both Windows and BOSS. Lab instructors should verify the installation and follow it up with a Viva

Internet & World Wide Web

Task1: Orientation & Connectivity Boot Camp: Students should get connected to their Local Area Network and access the Internet. In the process they configure the TCP/IP setting. Finally students should demonstrate, to the instructor, how to access the websites and email. If there is no internet connectivity preparations need to be made by the instructors to simulate the WWW on the LAN.

Task 2: Web Browsers, Surfing the Web: Students customize their web browsers with the LAN proxy settings, bookmarks, search toolbars and pop up blockers. Also, plug-ins like Macromedia Flash and JRE for applets should be configured.

Task 3: Search Engines & Netiquette: Students should know what search engines are and how to use the search engines. A few topics would be given to the students for which they need to search on Google. This should be demonstrated to the instructors by the student.

Task 4: Cyber Hygiene: Students would be exposed to the various threats on the internet and would be asked to configure their computer to be safe on the internet. They need to customize their browsers to block pop ups, block active x downloads to avoid viruses and/or worms.

LaTeX and WORD

Task 1 – Word Orientation: The mentor needs to give an overview of La TeX and Microsoft (MS) office or equivalent (FOSS) tool word: Importance of La TeX and MS office or equivalent (FOSS) tool Word as word Processors, Details of the four tasks and features that would be covered in each, Using La TeX and word – Accessing, overview of toolbars, saving files, Using help and resources, rulers, format painter in word.

Task 2: Using La TeX and Word to create a project certificate. Features to be covered:- Formatting Fonts in word, Drop Cap in word, Applying Text effects, Using Character Spacing, Borders and Colors, Inserting Header and Footer, Using Date and Time option in both La TeX and Word.

Task 3: Creating project abstract Features to be covered:- Formatting Styles, Inserting table, Bullets and Numbering, Changing Text Direction, Cell alignment, Footnote, Hyperlink, Symbols, Spell Check, Track Changes.

Task 4: Creating a Newsletter: Features to be covered:- Table of Content, Newspaper columns, Images from files and clipart, Drawing toolbar and Word Art, Formatting Images, Textboxes, Paragraphs and Mail Merge in word.

EXCEL

Excel Orientation: The mentor needs to tell the importance of MS office or equivalent (FOSS) tool Excel as a Spreadsheet tool, give the details of the four tasks and features that would be covered in each. Using Excel – Accessing, overview of toolbars, saving excel files, Using help and resources.

Task 1: Creating a Scheduler - Features to be covered: Gridlines, Format Cells, Summation, auto fill, Formatting Text

Task 2: Calculating GPA -. Features to be covered:- Cell Referencing, Formulae in excel – average, std. deviation, Charts, Renaming and Inserting worksheets, Hyper linking, Count function,

LOOKUP/VLOOKUP

Task 3: Split cells, freeze panes, group and outline, Sorting, Boolean and logical operators, Conditional formatting

POWER POINT

Task 1: Students will be working on basic power point utilities and tools which help them create basic power point presentations. PPT Orientation, Slide Layouts, Inserting Text, Word Art, Formatting Text, Bullets and Numbering, Auto Shapes, Lines and Arrows in PowerPoint.

Task 2: Interactive presentations - Hyperlinks, Inserting –Images, Clip Art, Audio, Video, Objects, Tables and Charts.

Task 3: Master Layouts (slide, template, and notes), Types of views (basic, presentation, slide slotter, notes etc), and Inserting – Background, textures, Design Templates, Hidden slides.

AI TOOLS – ChatGPT

Task 1: Prompt Engineering: Experiment with different types of prompts to see how the model responds. Try asking questions, starting conversations, or even providing incomplete sentences to see how the model completes them.

- Ex: Prompt: "You are a knowledgeable AI. Please answer the following question: What is the capital of France?"

Task 2: Creative Writing: Use the model as a writing assistant. Provide the beginning of a story or a description of a scene, and let the model generate the rest of the content. This can be a fun way to brainstorm creative ideas

- Ex: Prompt: "In a world where gravity suddenly stopped working, people started floating upwards. Write a story about how society adapted to this new reality."

Task 3: Language Translation: Experiment with translation tasks by providing a sentence in one language and asking the model to translate it into another language. Compare the output to see how accurate and fluent the translations are.

- Ex: Prompt: "Translate the following English sentence to French: 'Hello, how are you doing today?'"

REFERENCE BOOKS:

1. Comdex Information Technology course tool kit, Vikas Gupta, WILEY Dream tech, 2003
2. The Complete Computer upgrade and repair book, Cheryl A Schmidt, WILEY Dream tech, 2013, 3rd edition
3. Introduction to Information Technology, ITL Education Solutions limited, Pearson Education, 2012, 2nd edition
4. PC Hardware - A Handbook, Kate J. Chase, PHI (Microsoft)
5. LaTeX Companion, Leslie Lamport, PHI/Pearson.
6. IT Essentials PC Hardware and Software Companion Guide, David Anfinson and Ken Quamme. – CISCO Press, Pearson Education, 3rd edition
7. IT Essentials PC Hardware and Software Labs and Study Guide, Patrick Regan – CISCO Press, Pearson Education, 3rd edition

L	T	P	C
0	0	2	1

ENGINEERING PHYSICS LAB
(for Mechanical Engineering)

Course Objectives:

To study the concepts of optical phenomenon like interference, diffraction etc., recognize the importance of energy gap in the study of conductivity and Hall effect in semiconductors and study the parameters and applications of dielectric and magnetic materials by conducting experiments.

Course Outcomes: The students will be able to

CO1: Operate optical instruments like travelling microscope and spectrometer. CO2: Estimate the wavelengths of different colours using diffraction grating.
CO3: Plot the intensity of the magnetic field of circular coil carrying current with distance. CO4: Evaluate dielectric constant and magnetic susceptibility for dielectric and magnetic materials respectively.
CO5: Calculate the band gap of a given semiconductor. CO6: Identify the type of semiconductor using Hall effect.

List of Experiments:

1. Determination of radius of curvature of a given Plano-convex lens by Newton's rings.
2. Determination of wavelengths of different spectral lines in mercury spectrum using diffraction grating in normal incidence configuration.
3. Verification of Brewster's law
4. Determination of dielectric constant using charging and discharging method.
5. Study the variation of B versus H by magnetizing the magnetic material (B-H curve).
6. Determination of wavelength of Laser light using diffraction grating.
7. Estimation of Planck's constant using photoelectric effect.
8. Determination of the resistivity of semiconductors by four probe methods.
9. Determination of energy gap of a semiconductor using p-n junction diode.

10. Magnetic field along the axis of a current carrying circular coil by Stewart Gee's Method.
11. Determination of Hall voltage and Hall coefficient of a given semiconductor using Hall effect.
12. Determination of temperature coefficients of a thermistor.
13. Determination of acceleration due to gravity and radius of Gyration by using a compound pendulum.
14. Determination of magnetic susceptibility by Kundt's tube method.
15. Determination of rigidity modulus of the material of the given wire using Torsional pendulum.
16. Sonometer: Verification of laws of stretched string.
17. Determination of young's modulus for the given material of wooden scale by non-uniform bending (or double cantilever) method.
18. Determination of Frequency of electrically maintained tuning fork by Melde's experiment.

Note: Any TEN of the listed experiments are to be conducted. Out of which any TWO experiments may be conducted in virtual mode.

References:

- A Textbook of Practical Physics - S. Balasubramanian, M.N. Srinivasan, S. Chand Publishers, 2017.

Web Resources

- www.vlab.co.in
<https://phet.colorado.edu/en/simulations/filter?subjects=physics&type=html,prototype>

L	T	P	C
0	0	3	1.5

ELECTRICAL & ELECTRONICS ENGINEERING WORKSHOP**Course Objectives:**

To impart knowledge on the fundamental laws & theorems of electrical circuits, functions of electrical machines and energy calculations.

Course Outcomes:

After completion of this course, the student will be able to

CO1. Measure voltage, current and power in an electrical circuit. (L3)

CO2. Measure of Resistance using Wheat stone bridge (L4)

CO3. Discover critical field resistance and critical speed of DC shunt generators. (L4)

CO4. Investigate the effect of reactive power and power factor in electrical loads. (L5)

Activities:

1. Familiarization of commonly used Electrical & Electronic Workshop Tools: Bread board, Solder, cables, relays, switches, connectors, fuses, Cutter, plier, screwdriver set, wire stripper, flux, knife/blade, soldering iron, de-soldering pump etc.
 - Provide some exercises so that hardware tools and instruments are learned to be used by the students.
2. Familiarization of Measuring Instruments like Voltmeters, Ammeters, multimeter, LCR-Q meter, Power Supplies, CRO, DSO, Function Generator, Frequency counter.
 - Provide some exercises so that measuring instruments are learned to be used by the students.
3. Components:
 - Familiarization/Identification of components (Resistors, Capacitors, Inductors, Diodes, transistors, IC's etc.) – Functionality, type, size, colour coding package, symbol, cost etc.
 - Testing of components like Resistor, Capacitor, Diode, Transistor, ICs etc. - Compare values of components like resistors, inductors, capacitors etc with the measured values by using instruments

PART A: ELECTRICAL ENGINEERING LAB**List of experiments:**

1. Verification of KCL and KVL
2. Verification of Superposition theorem
3. Measurement of Resistance using Wheat stone bridge
4. Magnetization Characteristics of DC shunt Generator
5. Measurement of Power and Power factor using Single-phase wattmeter
6. Measurement of Earth Resistance using Megger
7. Calculation of Electrical Energy for Domestic Premises

Reference Books:

1. Basic Electrical Engineering, D. C. Kulshreshtha, Tata McGraw Hill, 2019, First Edition
2. Power System Engineering, P.V. Gupta, M.L. Soni, U.S. Bhatnagar and A. Chakrabarti, Dhanpat Rai & Co, 2013
3. Fundamentals of Electrical Engineering, Rajendra Prasad, PHI publishers, 2014, Third Edition

Note: Minimum Six Experiments to be performed.

PART B: ELECTRONICS ENGINEERING LAB**Course Objectives:**

- To impart knowledge on the principles of digital electronics and fundamentals of electron devices & its applications.

Course Outcomes: At the end of the course, the student will be able to

CO1: Identify & testing of various electronic components.

CO2: Understand the usage of electronic measuring instruments.

CO3: Plot and discuss the characteristics of various electron devices.

CO4: Explain the operation of a digital circuit.

List of Experiments:

1. Plot V-I characteristics of PN Junction diode A) Forward bias B) Reverse bias.
2. Plot V – I characteristics of Zener Diode and its application as voltage Regulator.
3. Implementation of half wave and full wave rectifiers
4. Plot Input & Output characteristics of BJT in CE and CB configurations
5. Frequency response of CE amplifier.
6. Simulation of RC coupled amplifier with the design supplied
7. Verification of Truth Table of AND, OR, NOT, NAND, NOR, Ex-OR, Ex-NOR gates using ICs.

8. Verification of Truth Tables of S-R, J-K& D flip flops using respective ICs.

Tools / Equipment Required: DC Power supplies, Multi meters, DC Ammeters, DC Voltmeters, AC Voltmeters, CROs, all the required active devices.

References:

1. R. L. Boylestad & Louis Nashlesky, Electronic Devices & Circuit Theory, Pearson Education, 2021.
2. R. P. Jain, Modern Digital Electronics, 4th Edition, Tata Mc Graw Hill, 2009
3. R. T. Paynter, Introductory Electronic Devices & Circuits – Conventional Flow Version, Pearson Education, 2009.

Note: Minimum Six Experiments to be performed. All the experiments shall be implemented using both Hardware and Software.

L	T	P	C
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COMPUTER PROGRAMMING LAB**COURSE OBJECTIVES:**

The course aims to give students hands – on experience and train them on the concepts of the C- programming language.

COURSE OUTCOMES:

At the end of the course, the students will be able to:

- CO1:** Read, understand, and trace the execution of programs written in C language.
- CO2:** Select the right control structure for solving the problem.
- CO3:** Develop C programs which utilize memory efficiently using programming constructs like pointers.
- CO4:** Develop, Debug and Execute programs to demonstrate the applications of arrays, functions, basic concepts of pointers in C.

SYLLABUS:**UNIT-I****WEEK 1**

Objective: Getting familiar with the programming environment on the computer and writing the first program.

Suggested Experiments/Activities:

Tutorial 1: Problem-solving using Computers.

Lab1: Familiarization with programming environment

- i) Basic Linux environment and its editors like Vi, Vim & Emacs etc.
- ii) Exposure to Turbo C, gcc
- iii) Writing simple programs using printf(), scanf()

WEEK 2

Objective: Getting familiar with how to formally describe a solution to a problem in a series of finite steps both using textual notation and graphic notation.

Suggested Experiments /Activities:

Tutorial 2: Problem-solving using Algorithms and Flow charts.

Lab 1: Converting algorithms/flow charts into C Source code.

Developing the algorithms/flowcharts for the following sample programs

- i) Sum and average of 3 numbers
- ii) Conversion of Fahrenheit to Celsius and vice versa

- iii) Simple interest calculation

WEEK 3

Objective: Learn how to define variables with the desired data-type, initialize them with appropriate values and how arithmetic operators can be used with variables and constants.

Suggested Experiments/Activities:

Tutorial 3: Variable types and type conversions:

Lab 3: Simple computational problems using arithmetic expressions.

- i) Finding the square root of a given number
- ii) Finding compound interest
- iii) Area of a triangle using heron's formulae
- iv) Distance travelled by an object

UNIT-II

WEEK 4

Objective: Explore the full scope of expressions, type-compatibility of variables & constants and operators used in the expression and how operator precedence works.

Suggested Experiments/Activities:

Tutorial 4: Operators and the precedence and associativity:

Lab 4: Simple computational problems using the operator's precedence and associativity

- i) Evaluate the following expressions.
 - a. $A+B*C+(D*E) + F*G$
 - b. $A/B*C-B+A*D/3$
 - c. $A+++B---A$
 - d. $J=(i++) + (++i)$
- ii) Find the maximum of three numbers using conditional operator
- iii) Take marks of 5 subjects in integers, and find the total, average in float

WEEK 5

Objective: Explore the full scope of different variants of "if construct" namely if- else, null-else, if-else if*-else, switch and nested-if including in what scenario each one of them can be used and how to use them. Explore all relational and logical operators while writing conditionals for "if construct".

Suggested Experiments/Activities:

Tutorial 5: Branching and logical expressions:

Lab 5: Problems involving if-then-else structures.

- i) Write a C program to find the max and min of four numbers using if-else.
- ii) Write a C program to generate electricity bill.
- iii) Find the roots of the quadratic equation.
- iv) Write a C program to simulate a calculator using switch case.
- v) Write a C program to find the given year is a leap year or not.

WEEK 6

Objective: Explore the full scope of iterative constructs namely while loop, do-while loop and for loop in addition to structured jump constructs like break and continue including when each of these statements is more appropriate to use.

Suggested Experiments/Activities:

Tutorial 6: Loops, while and for loops

Lab 6: Iterative problems e.g., the sum of series

- i) Find the factorial of given number using any loop.
- ii) Find the given number is a prime or not.
- iii) Compute sine and cos series
- iv) Checking a number palindrome
- v) Construct a pyramid of numbers.

UNIT-III

WEEK 7:

Objective: Explore the full scope of Arrays construct namely defining and initializing 1-D and 2-D and more generically n-D arrays and referencing individual array elements from the defined array. Using integer 1-D arrays, explore search solution linear search.

Suggested Experiments/Activities:

Tutorial 7: 1 D Arrays: searching.

Lab 7: 1D Array manipulation, linear search

- i) Find the min and max of a 1-D integer array.
- ii) Perform linear search on 1D array.
- iii) The reverse of a 1D integer array
- iv) Find 2's complement of the given binary number.
- v) Eliminate duplicate elements in an array.

WEEK 8:

Objective: Explore the difference between other arrays and character arrays that can be used as Strings by using null character and get comfortable with string by doing experiments that will reverse a string and concatenate two strings. Explore sorting solution bubble sort using integer arrays.

Suggested Experiments/Activities:

Tutorial 8: 2 D arrays, sorting and Strings.

Lab 8: Matrix problems String operations, Bubble sort,

- i) Addition of two matrices
- ii) Multiplication two matrices
- iii) Sort array elements using bubble sort
- iv) Concatenate two strings without built-in functions
- v) Reverse a string using built-in and without built-in string functions

UNIT-IV

WEEK 9:

Objective: Explore pointers to manage a dynamic array of integers, including memory allocation & value initialization, resizing changing and reordering

the contents of an array and memory de-allocation using malloc (), calloc (), realloc () and free () functions. Gain experience processing command-line arguments received by C

Suggested Experiments/Activities:

Tutorial 9: Pointers, structures and dynamic memory allocation

Lab 9: Pointers and structures, memory dereference.

- i) Write a C program to find the sum of a 1D array using malloc()
- ii) Write a C program to find the total, average of n students using structures
- iii) Enter n students data using calloc() and display failed students list
- iv) Read student name and marks from the command line and display the student details along with the total.
- v) Write a C program to implement realloc()

WEEK 10:

Objective: Experiment with C Structures, Unions, bit fields and self-referential structures (Singly linked lists) and nested structures

Suggested Experiments/Activities:

Tutorial 10: Bitfields, Self-Referential Structures, Linked lists

Lab10 : Bitfields, linked lists

Read and print a date using dd/mm/yyyy format using bit-fields and differentiate the same without using bit- fields

- i) Create and display a singly linked list using self-referential structure.
- ii) Demonstrate the differences between structures and unions using a C program.
- iii) Write a C program to shift/rotate using bitfields.
- iv) Write a C program to copy one structure variable to another structure of the same type.

UNIT-V

WEEK 11:

Objective: Explore the Functions, sub-routines, scope and extent of variables, doing some experiments by parameter passing using call by value. Basic methods of numerical integration

Suggested Experiments/Activities:

Tutorial 11: Functions, call by value, scope and extent,

Lab 11: Simple functions using call by value, solving differential equations using Eulers theorem.

- i) Write a C function to calculate NCR value.
- ii) Write a C function to find the length of a string.
- iii) Write a C function to transpose of a matrix.
- iv) Write a C function to demonstrate numerical integration of differential equations using Euler's method

WEEK 12:

Objective: Explore how recursive solutions can be programmed by writing recursive functions that can be invoked from the main by programming at-least five distinct problems that have naturally recursive solutions.

Suggested Experiments/Activities:**Tutorial 12:** Recursion, the structure of recursive calls**Lab 12:** Recursive functions

- i) Write a recursive function to generate Fibonacci series.
- ii) Write a recursive function to find the lcm of two numbers.
- iii) Write a recursive function to find the factorial of a number.
- iv) Write a C Program to implement Ackermann function using recursion.
- v) Write a recursive function to find the sum of series.

WEEK 13:

Objective: Explore the basic difference between normal and pointer variables, Arithmetic operations using pointers and passing variables to functions using pointers

Suggested Experiments/Activities:**Tutorial 13:** Call by reference, dangling pointers**Lab 13:** Simple functions using Call by reference, Dangling pointers.

- i) Write a C program to swap two numbers using call by reference.
- ii) Demonstrate Dangling pointer problem using a C program.
- iii) Write a C program to copy one string into another using pointer.
- iv) Write a C program to find no. of lowercase, uppercase, digits and other characters using pointers.

WEEK 14:

Objective: To understand data files and file handling with various file I/O functions. Explore the differences between text and binary files.

Suggested Experiments/Activities:**Tutorial 14:** File handling**Lab 14:** File operations

- i) Write a C program to write and read text into a file.
- ii) Write a C program to write and read text into a binary file using fread() and fwrite()
- iii) Copy the contents of one file to another file.
- iv) Write a C program to merge two files into the third file using command-line arguments.
- v) Find no. of lines, words and characters in a file
- vi) Write a C program to print last n characters of a given file.

TEXTBOOKS:

1. Ajay Mittal, Programming in C: A practical approach, Pearson.
2. Byron Gottfried, Schaum's Outline of Programming with C, McGraw Hill

REFERENCE BOOKS:

1. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice-Hall of India
2. C Programming, A Problem-Solving Approach, Forouzan, Gilberg, Prasad, CENGAGE

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NSS/NCC/SCOUTS & GUIDES/COMMUNITY SERVICE

Course Objectives:

The objective of introducing this course is to impart discipline, character, fraternity, teamwork, social consciousness among the students and engaging them in selfless service.

Course Outcomes: After completion of the course the students will be able to

- CO1:** Understand the importance of discipline, character and service motto.
- CO2:** Solve some societal issues by applying acquired knowledge, facts, and techniques.
- CO3:** Explore human relationships by analyzing social problems.
- CO4:** Determine to extend their help for the fellow beings and downtrodden people.
- CO5:** Develop leadership skills and civic responsibilities.

UNIT I Orientation

General Orientation on NSS/NCC/ Scouts & Guides/Community Service activities, career guidance.

Activities:

- i) Conducting –ice breaking sessions-expectations from the course-knowing personal talents and skills
- ii) Conducting orientations programs for the students –future plans-activities-releasing road map etc.
- iii) Displaying success stories-motivational biopics- award winning movies on societal issues etc.
- iv) Conducting talent show in singing patriotic songs-paintings- any other contribution.

UNIT II Nature

& Care Activities:

- i) Best out of waste competition.
- ii) Poster and signs making competition to spread environmental awareness.
- iii) Recycling and environmental pollution article writing competition.
- iv) Organising Zero-waste day.
- v) Digital Environmental awareness activity via various social media platforms.
- vi) Virtual demonstration of different eco-friendly approaches for sustainable living.
- vii) Write a summary on any book related to environmental issues.

UNIT III

Community Service

Activities:

- i) Conducting One Day Special Camp in a village contacting village-area leaders- Survey in the village, identification of problems- helping them to solve via media-authorities-experts-etc.
 - ii) Conducting awareness programs on Health-related issues such as General Health, Mental health, Spiritual Health, HIV/AIDS,
 - iii) Conducting consumer Awareness. Explaining various legal provisions etc.
 - iv) Women Empowerment Programmes- Sexual Abuse, Adolescent Health and Population Education.
- Any other programmes in collaboration with local charities, NGOs etc.

Reference Books:

1. Nirmalya Kumar Sinha & Surajit Majumder, *A Text Book of National Service Scheme*
Vol;I, Vidya Kutir Publication, 2021 (ISBN 978-81-952368-8-6)
2. *Red Book - National Cadet Corps* – Standing Instructions Vol I & II, Directorate General of NCC, Ministry of Defence, New Delhi
3. Davis M. L. and Cornwell D. A., “Introduction to Environmental Engineering”, McGraw Hill, New York 4/e 2008
4. Masters G. M., Joseph K. and Nagendran R. “Introduction to Environmental Engineering and Science”, Pearson Education, New Delhi. 2/e 2007
5. Ram Ahuja. *Social Problems in India*, Rawat Publications, New Delhi.

General Guidelines:

1. Institutes must assign slots in the Timetable for the activities.
2. Institutes are required to provide instructor to mentor the students.

Evaluation Guidelines:

- Evaluated for a total of 100 marks.
- A student can select 6 activities of his/her choice with a minimum of 01 activity per unit. Each activity shall be evaluated by the concerned teacher for 15 marks, totalling to 90 marks.
- A student shall be evaluated by the concerned teacher for 10 marks by conducting viva voce on the subject

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COMMUNICATIVE ENGLISH (for Mechanical Engineering)

Course Objectives:

The main objective of introducing this course, *Communicative English*, is to facilitate effective listening, Reading, Speaking and Writing skills among the students. It enhances the same in their comprehending abilities, oral presentations, reporting useful information and providing knowledge of grammatical structures and vocabulary. This course helps the students to make them effective in speaking and writing skills and to make them industry ready.

Course Outcomes:

CO1: Understand the context, topic, and pieces of specific information from social or Transactional dialogues.

CO2: Apply grammatical structures to formulate sentences and correct word forms.

CO3: Analyze discourse markers to speak clearly on a specific topic in informal discussions.

CO4: Evaluate reading / listening texts and to write summaries based on global comprehension of these texts.

CO5: Create a coherent paragraph, essay, and resume.

UNIT I

Lesson: HUMAN VALUES: Gift of Magi (Short Story)

Listening: Identifying the topic, the context and specific pieces of information by listening to short audio texts and answering a series of questions.

Speaking: Asking and answering general questions on familiar topics such as home, family, work, studies and interests; introducing oneself and others.

Reading: Skimming to get the main idea of a text; scanning to look for specific pieces of information.

Writing: Mechanics of Writing-Capitalization, Spellings, Punctuation-Parts of Sentences.

Grammar: Parts of Speech, Basic Sentence Structures-forming questions

Vocabulary: Synonyms, Antonyms, Affixes (Prefixes/Suffixes), Root words.

UNIT II

Lesson: NATURE: The Brook by Alfred Tennyson (Poem)

Listening: Answering a series of questions about main ideas and supporting ideas after listening to audio texts.

Speaking: Discussion in pairs/small groups on specific topics followed by short structure talks.

- Reading:** Identifying sequence of ideas; recognizing verbal techniques that help to link the ideas in a paragraph together.
- Writing:** Structure of a paragraph - Paragraph writing (specific topics)
- Grammar:** Cohesive devices - linkers, use of articles and zero article; prepositions.
- Vocabulary:** Homonyms, Homophones, Homographs.

UNIT III

Lesson: BIOGRAPHY: Elon Musk

- Listening:** Listening for global comprehension and summarizing what is listened to.
- Speaking:** Discussing specific topics in pairs or small groups and reporting what is discussed
- Reading:** Reading a text in detail by making basic inferences -recognizing and interpreting specific context clues; strategies to use text clues for comprehension.
- Writing:** Summarizing, Note-making, paraphrasing
- Grammar:** Verbs - tenses; subject-verb agreement; Compound words, Collocations
- Vocabulary:** Compound words, Collocations

UNIT IV

Lesson: INSPIRATION: The Toys of Peace by Saki

- Listening:** Making predictions while listening to conversations/ transactional dialogues without video; listening with video.
- Speaking:** Role plays for practice of conversational English in academic contexts (formal and informal) - asking for and giving information/directions.
- Reading:** Studying the use of graphic elements in texts to convey information, reveal trends/patterns/relationships, communicate processes or display complicated data.
- Writing:** Letter Writing: Official Letters, Resumes
- Grammar:** Reporting verbs, Direct & Indirect speech, Active & Passive Voice
- Vocabulary:** Words often confused, Jargons

UNIT V

Lesson: MOTIVATION: The Power of Intrapersonal Communication (An Essay)

- Listening:** Identifying key terms, understanding concepts and answering a series of relevant questions that test comprehension.
- Speaking:** Formal oral presentations on topics from academic contexts
- Reading:** Reading comprehension.
- Writing:** Writing structured essays on specific topics.
- Grammar:** Editing short texts –identifying and correcting common errors in grammar and usage (articles, prepositions, tenses, subject verb agreement)
- Vocabulary:** Technical Jargons

Textbooks:

1. Pathfinder: Communicative English for Undergraduate Students, 1st Edition, OrientBlack Swan, 2023 (Units 1,2 & 3)
- 2.
3. Empowering with Language by Cengage Publications, 2023 (Units 4 & 5)

Reference Books:

1. Dubey, Sham Ji & Co. English for Engineers, Vikas Publishers, 2020
2. Bailey, Stephen. Academic writing: A Handbook for International Students. Routledge, 2014.
3. Murphy, Raymond. English Grammar in Use, Fourth Edition, Cambridge University Press, 2019.
4. Lewis, Norman. Word Power Made Easy- The Complete Handbook for Building a Superior Vocabulary. Anchor, 2014.

Web Resources:**GRAMMAR:**

1. www.bbc.co.uk/learningenglish
2. <https://dictionary.cambridge.org/grammar/british-grammar/>
3. www.eslpod.com/index.html
4. <https://www.learngrammar.net/>
5. <https://english4today.com/english-grammar-online-with-quizzes/>
6. <https://www.talkenglish.com/grammar/grammar.aspx>

VOCABULARY

1. <https://www.youtube.com/c/DailyVideoVocabulary/videos>
2. https://www.youtube.com/channel/UC4cmBAit8i_NJZE8qK8sfpA

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ENGINEERING CHEMISTRY (for Mechanical Engineering)

Course Objectives:

- To familiarize engineering chemistry and its applications
- To impart the concept of soft and hard waters, softening methods of hard water
- To train the students on the principles and applications of electrochemistry, polymers, surface chemistry, and cement

Course Outcomes: At the end of the course, the students will be able to

CO1: Demonstrate the corrosion prevention methods and factors affecting corrosion.

CO2: Explain the preparation, properties, and applications of thermoplastics & thermosetting, elastomers & conducting polymers.

CO3: Explain calorific values, octane number, refining of petroleum and cracking of oils.

CO4: Explain the setting and hardening of cement.

CO5: Summarize the concepts of colloids, micelle and nanomaterials.

UNIT I Water Technology

Soft and hardwater, Estimation of hardness of water by EDTA Method, Estimation of dissolved Oxygen - Boiler troubles –Priming, foaming, scale and sludge, Caustic embrittlement, Industrial water treatment – Specifications for drinking water, Bureau of Indian Standards(BIS) and World health organization(WHO) standards, Ion-exchange processes - desalination of brackish water, reverse osmosis (RO) and electrodialysis.

UNIT II Electrochemistry and Applications

Electrodes –electrochemical cell, Nernst equation, cell potential calculations.

Primary cells – Zinc-air battery, Secondary cells – Nickel-Cadmium (NiCad), and lithium ion batteries- working principle of the batteries including cell reactions; Fuel cells-Basic Concepts, the principle and working of hydrogen-oxygen Fuel cell.

Corrosion: Introduction to corrosion, electrochemical theory of corrosion, differential aeration cell corrosion, galvanic corrosion, metal oxide formation by dry electrochemical corrosion, Pilling Bedworth ratios and uses, Factors affecting the corrosion, cathodic and anodic protection, electroplating and electroless plating (Nickel and Copper).

UNIT III Polymers and Fuel Chemistry

Introduction to polymers, functionality of monomers, Mechanism of chain growth, step growth polymerization.

Thermoplastics and Thermo-setting plastics:- Preparation, properties and applications of polystyrene. PVC Nylon 6,6 and Bakelite.

Elastomers – Preparation, properties and applications of Buna S, Buna N, Thiokol rubbers.

Fuels – Types of fuels, calorific value of fuels, numerical problems based on calorific value; Analysis of coal (Proximate and Ultimate analysis), Liquid Fuels, refining of petroleum, Octane and Cetane number- alternative fuels- propane, methanol, ethanol and bio fuel-bio diesel.

UNIT IV Modern Engineering Materials

Composites- Definition, Constituents, Classification- Particle, Fibre and Structural reinforced composites, properties and Engineering applications

Refractories- Classification, Properties, Factors affecting the refractory materials and Applications.

Lubricants- Classification, Functions of lubricants, Mechanism, Properties of lubricating oils – Viscosity, Viscosity Index, Flash point, Fire point, Cloud point, saponification and Applications.

Building materials- Portland Cement, constituents, Setting and Hardening of cement.

UNIT V Surface Chemistry and Nanomaterials

Introduction to surface chemistry, colloids, nanometals and nanometal oxides, micelle formation, synthesis of colloids (Braggs Method), chemical and biological methods of preparation of nanometals and metal oxides, stabilization of colloids and nanomaterials by stabilizing agents, adsorption isotherm (Freundlich and Langmuir), BET equation (no derivation) applications of colloids and nanomaterials – catalysis, medicine, sensors, etc.

Textbooks:

1. Jain and Jain, Engineering Chemistry, 16/e, DhanpatRai, 2013.
2. Peter Atkins, Julio de Paula and James Keeler, Atkins' Physical Chemistry, 10/e, Oxford University Press, 2010.

Reference Books:

1. H.F.W. Taylor, Cement Chemistry, 2/e, Thomas Telford Publications, 1997.
2. D.J. Shaw, Introduction to Colloids and Surface Chemistry, Butterworth-Heinemann, 1992.
Textbook of Polymer Science, Fred W. Billmeyer Jr, 3rd Edition

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DIFFERENTIAL EQUATIONS AND VECTOR CALCULUS (for Mechanical Engineering)

Course Objectives:

- To enlighten the learners in the concept of differential equations and multivariable calculus.
- To furnish the learners with basic concepts and techniques at plus two level to lead them into advanced level by handling various real-world applications.

Course Outcomes: At the end of the course, the student will be able to CO1:

Solve the differential equations related to various engineering fields.

CO2: Identify solution methods for partial differential equations that model physical processes.

CO3: Interpret the physical meaning of different operators such as gradient, curl and divergence.

CO4: Estimate the work done against a field, circulation and flux using vector calculus.

UNIT I Differential equations of first order and first degree

Linear differential equations – Bernoulli's equations- Exact equations and equations reducible to exact form. Applications: Newton's Law of cooling – Law of natural growth and decay- Electrical circuits.

UNIT II Linear differential equations of higher order (Constant Coefficients)

Definitions, homogenous and non-homogenous, complimentary function, general solution, particular integral, Wronskian, Method of variation of parameters. Simultaneous linear equations, Applications to L-C-R Circuit problems and Simple Harmonic motion.

UNIT III Partial Differential Equations

Introduction and formation of Partial Differential Equations by elimination of arbitrary constants and arbitrary functions, solutions of first order linear equations using Lagrange's method. Homogeneous Linear Partial differential equations with constant coefficients.

UNIT IV Vector differentiation

Scalar and vector point functions, vector operator Del, Del applies to scalar point functions- Gradient, Directional derivative, del applied to vector point functions-Divergence and Curl, vector identities.

UNIT V Vector integration

Line integral-circulation-work done, surface integral-flux, Green's theorem in the plane (without proof), Stoke's theorem (without proof), volume integral, Divergence theorem (without proof) and related problems.

Textbooks:

1. Higher Engineering Mathematics, B. S. Grewal, Khanna Publishers, 2017, 44th Edition
2. Advanced Engineering Mathematics, Erwin Kreyszig, John Wiley & Sons, 2018, 10th Edition.

Reference Books:

1. Thomas Calculus, George B. Thomas, Maurice D. Weir and Joel Hass, Pearson Publishers, 2018, 14th Edition.
2. Advanced Engineering Mathematics, Dennis G. Zill and Warren S. Wright, Jones and Bartlett, 2018.
3. Advanced Modern Engineering Mathematics, Glyn James, Pearson publishers, 2018, 5th Edition.
4. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Alpha Science International Ltd., 2021 5th Edition (9th reprint).
5. Higher Engineering Mathematics, B. V. Ramana, , McGraw Hill Education, 2017

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BASIC CIVIL AND MECHANICAL ENGINEERING

(Common to All branches of Engineering)

Course Objectives:

- Get familiarized with the scope and importance of Civil Engineering sub-divisions.
- Introduce the preliminary concepts of surveying.
- Acquire preliminary knowledge on Transportation and its importance in nation's economy.
- Get familiarized with the importance of quality, conveyance and storage of water.
- Introduction to basic civil engineering materials and construction techniques.

Course Outcomes: On completion of the course, the student should be able to:

- CO1: Understand various sub-divisions of Civil Engineering and to appreciate their role in ensuring better society.
- CO2: Know the concepts of surveying and to understand the measurement of distances, angles and levels through surveying.
- CO3: Realize the importance of Transportation in nation's economy and the engineering measures related to Transportation.
- CO4: Understand the importance of Water Storage and Conveyance Structures so that the social responsibilities of water conservation will be appreciated.
- CO5: Understand the basic characteristics of Civil Engineering Materials and attain knowledge on prefabricated technology.

UNIT I

Basics of Civil Engineering: Role of Civil Engineers in Society- Various Disciplines of Civil Engineering- Structural Engineering- Geo-technical Engineering- Transportation Engineering - Hydraulics and Water Resources Engineering - Environmental Engineering-Scope of each discipline - Building Construction and Planning- Construction Materials-Cement - Aggregate - Bricks- Cement concrete- Steel. Introduction to Prefabricated construction Techniques.

UNIT II

Surveying: Objectives of Surveying- Horizontal Measurements- Angular Measurements- Introduction to Bearings Levelling instruments used for levelling -Simple problems on levelling and bearings-Contour mapping.

UNIT III

Transportation Engineering Importance of Transportation in Nation's economic development- Types of Highway Pavements- Flexible Pavements and Rigid Pavements - Simple Differences. Basics of Harbour, Tunnel, Airport, and Railway Engineering.

Water Resources and Environmental Engineering: Introduction, Sources of water- Quality of water- Specifications- Introduction to Hydrology-Rainwater Harvesting-Water Storage and Conveyance Structures (Simple introduction to Dams and Reservoirs).

Textbooks:

1. Basic Civil Engineering, M.S.Palanisamy, , Tata McGraw Hill publications (India) Pvt. Ltd. Fourth Edition.
2. Introduction to Civil Engineering, S.S. Bhavikatti, New Age International Publishers. 2022. First Edition.
3. Basic Civil Engineering, Satheesh Gopi, Pearson Publications, 2009, First Edition.

Reference Books:

1. Surveying, Vol- I and Vol-II, S.K. Duggal, Tata McGraw Hill Publishers 2019. Fifth Edition.
2. Hydrology and Water Resources Engineering, Santosh Kumar Garg, Khanna Publishers, Delhi. 2016
3. Irrigation Engineering and Hydraulic Structures - Santosh Kumar Garg, Khanna Publishers, Delhi 2023. 38th Edition.
4. Highway Engineering, S.K.Khanna, C.E.G. Justo and Veeraraghavan, Nemchand and Brothers Publications 2019. 10th Edition.
5. Indian Standard DRINKING WATER — SPECIFICATION IS 10500-2012.

PART B: BASIC MECHANICAL ENGINEERING

Course Objectives: The students after completing the course are expected to

- Get familiarized with the scope and importance of Mechanical Engineering in different sectors and industries.
- Explain different engineering materials and different manufacturing processes.
- Provide an overview of different thermal and mechanical transmission systems and introduce basics of robotics and its applications.

Course Outcomes: On completion of the course, the student should be able to

CO1: Understand the different manufacturing processes.

CO2: Explain the basics of thermal engineering and its applications.

CO3: Describe the working of different mechanical power transmission systems and power plants.

CO4: Describe the basics of robotics and its applications.

UNIT I

Introduction to Mechanical Engineering: Role of Mechanical Engineering in Industries and Society- Technologies in different sectors such as Energy, Manufacturing, Automotive, Aerospace, and Marine sectors.

Engineering Materials - Metals-Ferrous and Non-ferrous, Ceramics, Composites, Smart materials.

UNIT II

Manufacturing Processes: Principles of Casting, Forming, joining processes, Machining, Introduction to CNC machines, 3D printing, and Smart manufacturing.

Thermal Engineering – Working principle of Boilers, Otto cycle, Diesel cycle, Refrigeration and air-conditioning cycles, IC engines, 2-Stroke and 4-Stroke engines, SI/CI Engines, Components of Electric and Hybrid Vehicles.

UNIT III

Power plants – Working principle of Steam, Diesel, Hydro, Nuclear power plants.

Mechanical Power Transmission - Belt Drives, Chain, Rope drives, Gear Drives and their applications.

Introduction to Robotics - Joints & links, configurations, and applications of robotics.

(Note: The subject covers only the basic principles of Civil and Mechanical Engineering systems. The evaluation shall be intended to test only the fundamentals of the subject.)

Textbooks:

1. Internal Combustion Engines by V.Ganesan, By Tata McGraw Hill publications (India) Pvt. Ltd.
2. A text book of Theory of Machines by S.S. Rattan, Tata McGraw Hill Publications, (India) Pvt. Ltd.
3. An introduction to Mechanical Engg by Jonathan Wicker and Kemper Lewis, Cengage learning India Pvt. Ltd.

Reference Books:

1. G. Shanmugam and M.S.Palanisamy, Basic Civil and the Mechanical Engineering, Tata McGraw Hill publications (India) Pvt. Ltd.
2. Thermal Engineering by Mahesh M Rathore Tata McGraw Hill publications (India) Pvt. Ltd.
3. 3D printing & Additive Manufacturing Technology- L. Jyothish Kumar, Pulak M Pandey, Springer publications
4. Appuu Kuttan KK, Robotics, I.K. International Publishing House Pvt. Ltd. Volume-I

L	T	P	C
3	0	0	3

ENGINEERING MECHANICS

(Common to Civil, Mechanical Engineering & Allied branches)

Course Objectives:

- To get familiarized with different types of force systems.
- To draw accurate free body diagrams representing forces and moments acting on a body to analyze the equilibrium of system of forces.
- To teach the basic principles of center of gravity, centroid and moment of inertia and determine them for different simple and composite bodies.
- To apply the Work-Energy method to particle motion.
- To understand the kinematics and kinetics of translational and rotational motion of rigid bodies.

Course Outcomes: On Completion of the course, the student should be able to

CO1: Understand the fundamental concepts in mechanics and determine the frictional forces for bodies in contact.

CO2: Analyze different force systems such as concurrent, coplanar and spatial systems and calculate their resultant forces and moments.

CO3: Calculate the centroids, center of gravity and moment of inertia of different geometrical shapes.

CO4: Apply the principles of work-energy and impulse-momentum to solve the problems of rectilinear and curvilinear motion of a particle.

CO5: Solve the problems involving the translational and rotational motion of rigid bodies.

UNIT I

Introduction to Engineering Mechanics– Basic Concepts. Scope and Applications

Systems of Forces: Coplanar Concurrent Forces– Components in Space–Resultant–Moment of Force and its Application –Couples and Resultant of Force Systems.

Friction: Introduction, limiting friction and impending motion, Coulomb's laws of dry friction, coefficient of friction, Cone of Static friction.

UNIT II

Equilibrium of Systems of Forces: Free Body Diagrams, Lami's Theorem, Equations of Equilibrium of Coplanar Systems, Graphical method for the equilibrium, Triangle law of forces, converse of the law of polygon of forces condition of equilibrium, Equations of Equilibrium for Spatial System of forces, Numerical examples on spatial system of forces using vector approach, Analysis of plane trusses.

Principle of virtual work with simple examples

UNIT III

Centroid: Centroids of simple figures (from basic principles)–Centroids of Composite Figures.

Centre of Gravity: Centre of gravity of simple body (from basic principles), Centre of gravity of composite bodies, Pappus theorems.

Area Moments of Inertia: Definition– Polar Moment of Inertia, Transfer Theorem, Moments of Inertia of Composite Figures, Products of Inertia, Transfer Formula for Product of Inertia.

Mass Moment of Inertia: Moment of Inertia of Masses, Transfer Formula for Mass Moment of Inertia, Mass Moment of Inertia of composite bodies.

UNIT IV

Rectilinear and Curvilinear motion of a particle: Kinematics and Kinetics –D'Alembert's Principle - Work Energy method and applications to particle motion-Impulse Momentum method.

UNIT V

Rigid body Motion: Kinematics and Kinetics of translation, Rotation about fixed axis and plane motion, Work Energy method and Impulse Momentum method.

Textbooks:

1. Engineering Mechanics, S. Timoshenko, D. H. Young, J.V. Rao, S. Pati., , McGraw Hill Education 2017. 5th Edition.
2. Engineering Mechanics, P.C.Dumir- S.Sengupta and Srinivas V veeravalli , Universitypress. 2020. First Edition.
3. A Textbook of Engineering Mechanics, S.S Bhavikatti. New age international publications 2018. 4th Edition.

Reference Books:

1. Engineering Mechanics, Statics and Dynamics, Rogers and M A. Nelson., McGraw Hill Education. 2017. First Edition.
2. Engineering Mechanics, Statics and Dynamics, I.H. Shames., PHI, 2002. 4th Edition.
3. Engineering Mechanics, Volume-I: Statics, Volume-II: Dynamics, J. L. Meriam and L. G. Kraige., John Wiley, 2008. 6th Edition.
4. Introduction to Statics and Dynamics, Basudev Battachatia, Oxford University Press, 2014. Second Edition
5. Engineering Mechanics: Statics and Dynamics, Hibbeler R.C., Pearson Education, Inc., New Delhi, 2022, 14th Edition

L	T	P	C
0	0	2	1

COMMUNICATIVE ENGLISH LAB
(for Mechanical Engineering)

Course Objectives:

The main objective of introducing this course, Communicative English Laboratory, is to expose the students to a variety of self-instructional, learner friendly modes of language learning. The students will get trained in basic communication skills and also make them ready to face job interviews.

Course Outcomes:

CO1: Understand the different aspects of the English language proficiency with emphasis on LSRW skills.

CO2: Apply communication skills through various language learning activities.

CO3: Analyze the English speech sounds, stress, rhythm, intonation and syllable division for better listening and speaking comprehension.

CO4: Evaluate and exhibit professionalism in participating in debates and group discussions.

CO5: Create effective Course Objectives:

List of Topics:

1. Vowels & Consonants
2. Neutralization/Accent Rules
3. Communication Skills & JAM
4. Role Play or Conversational Practice
5. E-mail Writing
6. Resume Writing, Cover letter, SOP
7. Group Discussions-methods & practice
8. Debates - Methods & Practice
9. PPT Presentations/ Poster Presentation
10. Interviews Skills

Suggested Software:

- Walden Infotech
- Softx Communicative English lab software
- Young India Films

Reference Books:

1. Raman Meenakshi, Sangeeta-Sharma. *Technical Communication*. Oxford Press.2018.
2. Taylor Grant: *English Conversation Practice*, Tata McGraw-Hill Education India, 2016
3. Hewing's, Martin. *Cambridge Academic English (B2)*. CUP, 2012.
4. J. Sethi & P.V. Dhamija. *A Course in Phonetics and Spoken English*, (2nd Ed), Kindle, 2013

Web Resources:**Spoken English:**

1. www.esl-lab.com
2. www.englishmedialab.com
3. www.englishinteractive.net
4. <https://www.britishcouncil.in/english/online>
5. <http://www.letstalkpodcast.com/>
6. https://www.youtube.com/c/mmmEnglish_Emma/featured
7. <https://www.youtube.com/c/ArnelsEverydayEnglish/featured>
8. <https://www.youtube.com/c/engvidAdam/featured>
9. <https://www.youtube.com/c/EnglishClass101/featured>
10. <https://www.youtube.com/c/SpeakEnglishWithTiffani/playlists>
11. https://www.youtube.com/channel/UCV1h_cBE0Drdx19qkTM0WNw

Voice & Accent:

2. <https://www.youtube.com/user/letstalkaccent/videos>
3. <https://www.youtube.com/c/EngLanguageClub/featured>
4. https://www.youtube.com/channel/UC_OskgZBoS4dAnVUgJVexc
<https://www.youtube.com/channel/UCNfm92h83W2i2ijc5Xwp>

L	T	P	C
0	0	2	1

ENGINEERING CHEMISTRY LAB
(for Mechanical Engineering)

Course Objectives:

- To verify the fundamental concepts with experiments

Course Outcomes: At the end of the course, the students will be able to

CO1: Determine the cell constant and conductance of solutions.

CO2: Prepare advanced polymer materials.

CO3: Determine the physical properties like surface tension, adsorption and viscosity.

CO4: Estimate the Iron and Calcium in cement.

CO5: Calculate the hardness of water.

List of Experiments:

1. Determination of Hardness of a groundwater sample.
2. Estimation of Dissolved Oxygen by Winkler's method
3. Determination of Strength of an acid in Pb-Acid battery
4. Preparation of a polymer (Bakelite)
5. Determination of percentage of Iron in Cement sample by colorimetry
6. Estimation of Calcium in port land Cement
7. Preparation of nanomaterials by precipitation method.
8. Adsorption of acetic acid by charcoal
9. Determination of percentage Moisture content in a coal sample
10. Determination of Viscosity of lubricating oil by Redwood Viscometer 1
11. Determination of Viscosity of lubricating oil by Redwood Viscometer 2
12. Determination of Calorific value of gases by Junker's gas Calorimeter

Reference:

"Vogel's Quantitative Chemical Analysis 6th Edition 6th Edition" Pearson Publications by J. Mendham, R.C. Denney, J.D. Barnes and B. Sivasankar

L	T	P	C
0	0	3	1.5

ENGINEERING WORKSHOP

(Common to All branches of Engineering)

Course Objectives:

To familiarize students with wood working, sheet metal operations, fitting, electrical house wiring skills, and basic repairs of two-wheeler vehicle.

Course Outcomes:

CO1: Identify workshop tools and their operational capabilities.

CO2: Practice on manufacturing of components using workshop trades including fitting, carpentry, foundry and welding.

CO3: Apply fitting operations in various applications.

CO4: Apply basic electrical engineering knowledge for House Wiring Practice

SYLLABUS

1. **Demonstration:** Safety practices and precautions to be observed in workshop.
2. **Wood Working:** Familiarity with different types of woods and tools used in wood working and make following joints.
 - a) Half – Lap joint b) Mortise and Tenon joint c) Corner Dovetail joint or Bridle joint
3. **Sheet Metal Working:** Familiarity with different types of tools used in sheet metal working, Developments of following sheet metal job from GI sheets.
 - a) Tapered tray b) Conical funnel c) Elbow pipe d) Brazing
4. **Fitting:** Familiarity with different types of tools used in fitting and do the following fitting exercises.
 - a) V-fit b) Dovetail fit c) Semi-circular fit d) Bicycle tire puncture and change of two-wheeler tyre
5. **Electrical Wiring:** Familiarity with different types of basic electrical circuits and make the following connections.
 - a) Parallel and series b) Two-way switch c) Godown lighting
 - d) Tube light e) Three phase motor f) Soldering of wires
6. **Foundry Trade:** Demonstration and practice on Moulding tools and processes, Preparation of Green Sand Moulds for given Patterns.
7. **Welding Shop:** Demonstration and practice on Arc Welding and Gas welding. Preparation of Lap joint and Butt joint.
8. **Plumbing:** Demonstration and practice of Plumbing tools, Preparation of Pipe joints with coupling for same diameter and with reducer for different diameters.
9. **Basic repairs of Two-wheeler vehicle** – Demonstration of working of two-wheeler vehicle and its repairs.

Textbooks:

1. Basic Workshop Technology: Manufacturing Process, Felix W.; Independently Published, 2019. Workshop Processes, Practices and Materials; Bruce J. Black, Routledge publishers, 5th Edn. 2015.
2. A Course in Workshop Technology Vol I. & II, B.S. Raghuwanshi, Dhanpath Rai & Co., 2015 & 2017.

Reference Books:

1. Elements of Workshop Technology, Vol. I by S. K. Hajra Choudhury & Others, Media Promoters and Publishers, Mumbai. 2007, 14th edition
2. Workshop Practice by H. S. Bawa, Tata-McGraw Hill, 2004.
3. Wiring Estimating, Costing and Contracting; Soni P.M. & Upadhyay P.A.; Atul Prakasan, 2021-22

L	T	P	C
0	0	3	1.5

ENGINEERING MECHANICS LAB
(Mechanical Engineering & allied branches)

Course Objectives: The students completing the course are expected to:

- Verify the Law of Parallelogram and Triangle of Forces.
- Determine the coefficients of friction of Static and Rolling friction and Centre of gravity of different plane Lamina.
- Analyse the system of Pulleys and Moment of Inertia of Compound Pendulum and Flywheel.

Course Outcomes:

CO1: Evaluate the coefficient of friction between two different surfaces and between the inclined plane and the roller.

CO2: Verify Law of Polygon of forces and Law of Moment using force polygon and bell crank lever.

CO3: Determine the Centre of gravity and Moment of Inertia of different configurations.

CO4: Verify the equilibrium conditions of a rigid body under the action of different force systems.

Students have to perform any 10 of the following Experiments:

List of Experiments:

1. Verification of Law of Parallelogram of Forces.
2. Verification of Law of Triangle of Forces.
3. Verification of the Law of polygon for coplanar-concurrent forces acting on a particle in equilibrium and to find the value of unknown forces considering particle to be in equilibrium using universal force table.
4. Determination of coefficient of Static and Rolling Frictions
5. Determination of Centre of Gravity of different shaped Plane Lamina.
6. Verification of the conditions of equilibrium of a rigid body under the action of coplanar non-concurrent, parallel force system with the help of a simply supported beam.
7. Study of the systems of pulleys and draw the free body diagram of the system.
8. Determine the acceleration due to gravity using a compound pendulum.
9. Determine the Moment of Inertia of the compound pendulum about an axis perpendicular to the plane of oscillation and passing through its centre of mass.
10. Determine the Moment of Inertia of a Flywheel.
11. Verification of Law of Moment using Rotation Disc Apparatus and Bell Crank Lever.

References:

1. S. Timoshenko, D. H. Young, J.V. Rao, S. Pati., Engineering Mechanics, 5th Edition, McGrawHill Education.
2. Hibbeler R.C., Engineering Mechanics: Statics and Dynamics, 14th Edition, Pearson Education, Inc., New Delhi, 2022

L	T	P	C
0	0	1	0.5

HEALTH AND WELLNESS, YOGA AND SPORTS FOR II SEMESTER

Course Objectives:

The main objective of introducing this course is to make the students maintain their mental and physical wellness by balancing emotions in their life. It mainly enhances the essential traits required for the development of the personality.

Course Outcomes: After completion of the course the student will be able to

CO1: Understand the importance of yoga and sports for Physical fitness and sound health.

CO2: Demonstrate an understanding of health-related fitness components. **CO3:** Compare and contrast various activities that help enhance their health. **CO4:** Assess current personal fitness levels.

CO5: Develop Positive Personality

UNIT I

Concept of health and fitness, Nutrition and Balanced diet, basic concept of immunity Relationship between diet and fitness, Globalization and its impact on health, Body Mass Index(BMI) of all age groups.

Activities:

- Organizing health awareness programmes in community
- Preparation of health profile
- Preparation of chart for balance diet for all age groups

UNIT II

Concept of yoga, need for and importance of yoga, origin and history of yoga in Indian context, classification of yoga, Physiological effects of Asanas- Pranayama and meditation, stress management and yoga, Mental health and yoga practice.

Activities:

Yoga practices – Asana, Kriya, Mudra, Bandha, Dhyana, Surya Namaskar

UNIT III

Concept of Sports and fitness, importance, fitness components, history of sports, Ancient and Modern Olympics, Asian games and Commonwealth games.

Activities:

- Participation in one major game and one individual sport viz., Athletics, Volleyball, Basketball, Handball, Football, Badminton, Kabaddi, Kho-kho, Table tennis, Cricket etc.
Practicing general and specific warm up, aerobics

- ii) Practicing cardiorespiratory fitness, treadmill, run test, 9 min walk, skipping and running.

Reference Books:

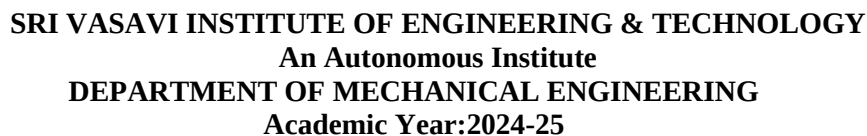
1. Gordon Edlin, Eric Golanty. Health and Wellness, 14th Edn. Jones & Bartlett Learning, 2022
2. T.K.V.Desikachar. The Heart of Yoga: Developing a Personal Practice
3. Archie J.Bahm. Yoga Sutras of Patanjali, Jain Publishing Company, 1993
4. Wiseman, John Lofty, SAS Survival Handbook: The Ultimate Guide to Surviving Anywhere Third Edition, William Morrow Paperbacks, 2014
5. The Sports Rules Book/ Human Kinetics with Thomas Hanlon. -- 3rd ed. Human Kinetics, Inc. 2014

General Guidelines:

1. Institutes must assign slots in the Timetable for the activities of Health/Sports/Yoga.
2. Institutes must provide field/facility and offer the minimum of five choices of as manyas Games/Sports.
3. Institutes are required to provide sports instructor / yoga teacher to mentor the students.

Evaluation Guidelines:

- Evaluated for a total of 100 marks.
- A student can select 6 activities of his/her choice with a minimum of 01 activity per unit. Each activity shall be evaluated by the concerned teacher for 15 marks, totalling to 90 marks.
- A student shall be evaluated by the concerned teacher for 10 marks by conducting vivavoce on the subject.



S.No.	Category	Title	L	T	P	Credits
1	BS	Numerical Methods and Transform Techniques	3	0	0	3
2	HSMC	Universal Human Values– Understanding Harmony& Ethical Human Conduct	2	1	0	3
3	Engineering Science	Thermo dynamics	2	0	0	2
4	Professional Core	Mechanics of Solids	3	0	0	3
5	Professional Core	Material Science and Metallurgy	3	0	0	3
6	Professional Core	Mechanics of Solids and Materials Science Lab	0	0	3	1.5
7	Professional Core	Computer-aided Machine Drawing	0	0	3	1.5
8	Engineering Science	Python programming Lab	0	0	2	1.0
9	Skill Enhancement Course	Embedded Systems and IoT	0	1	2	2
Total			13	2	10	20

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THERMO DYNAMICS

II Year-I Semester

L	T	P	C
2	0	0	2

Course Objectives

- Familiarize concepts of heat, work, energy and governing rules for conversion of one form to other.
- Explain relationships between properties of matter and basic laws of thermodynamics.
- Teach the concept of entropy for identifying the disorder and feasibility of a thermodynamic process.
- Introduce the concept of available energy for maximum work conversion.
- Provide fundamental concepts of Refrigeration and Psychrometry.

Unit - I

Introduction: Basic Concepts : System, boundary, Surrounding, control volume, Universe, Types of Systems, Macroscopic and Microscopic viewpoints, Concept of Continuum, Thermodynamic Equilibrium, State, Property, Process, Cycle – Reversibility – Quasi static Process, Irreversible Process, Causes of Irreversibility

Unit -II

Energy in State and in Transition, Types, Work and Heat, Point and Path function. Zeroeth Law of Thermodynamics – PMM-I, Joule's Experiment – First law of Thermodynamics and applications. Limitations of the First Law – Enthalpy, Thermal Reservoir, Heat Engine, Heat pump, Parameters of performance.

Unit - III

Second Law of Thermodynamics, Kelvin-Planck and Clausius Statements and their Equivalence / Corollaries, PMM-II, Carnot's principle, Carnot cycle and its specialties, Thermodynamic scale of Temperature, Clausius Inequality, Entropy, Principle of Entropy Increase – Energy Equation, Availability and Irreversibility – Thermodynamic Potentials, Gibbs and Helmholtz Functions, Maxwell Relations – Elementary Treatment of the Third Law of Thermodynamics.

Unit - IV

Pure Substances, P-V-T- surfaces, T-S and h-s diagrams, Mollier Charts, Phase Transformations – Triple point at critical state properties during change of phase, Dryness Fraction – Clausius – Clapeyron Equation Property tables. Mollier charts – Various Thermodynamic processes and energy Transfer – Steam Calorimetry.

Unit – V

Introduction to Refrigeration: working of Air,Vapour compression,VCR system Components, COP Refrigerants.

Introduction to Air Conditioning: Psychrometric properties & processes – characterization of sensible and latent heat loads – load concepts of SHF.



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Requirements of human comfort and concept of effective temperature- comfort chart – comfort air conditioning, and load calculations.

Text Books:

1. P.K.Nag, Engineering Thermodynamics, 5/e, Tata McGraw Hill, 2013.
2. Claus Borgnakke Richard E. Sonntag, Fundamentals of Thermodynamics, 7/e, Wiley, 2009.

Reference Books

1. J.B. Jones, and R.E. Dugan, Engineering Thermodynamics, 1/e, Prentice Hall, 1995.
2. Y.A.Cengel & M.A.Boles , Thermodynamics – An Engineering Approach, 7/e, McGraw Hill, 2010.
3. P.Chattopadhyay, Engineering Thermodynamics, 1/e, Oxford University Press, 2011.
4. CP Arora, Refrigeration and Air-conditioning, 4/e, McGraw Hill, 2021.

Online Learning Resources:

- <https://www.edx.org/learn/thermodynamics>.
- <https://archive.nptel.ac.in/courses/112/106/112106310>.
- <https://www.youtube.com/watch?v=7NI5P4KqrAs&t=1s>
- https://kp.kiit.ac.in/pdf_files/02/Study-Material_3rd-Semester_Winter_2021_Mechanical-Engg.-_Thermal-Engineering-1_Abhijit-Samant.pdf
- <https://www.coursera.org/learn/thermodynamics-intro>

Course Outcomes:

COs	Statements	Blooms Level
CO1	Explain the importance of thermodynamic properties related to conversion of heat energy into work.	L3
CO2	Apply the Zeroeth and First Law of Thermodynamics.	L3
CO3	Apply the Second Law of Thermodynamics.	L3
CO4	Analyze the Mollier charts, T-S and h-s diagrams, Steam calorimetry, Phase Transformations	L4
CO5	Evaluate the COP of refrigerating systems and properties, processes of psychrometry and sensible and latent heat loads.	L5



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II Year I Semester

L	T	P	C
3	0	0	3

MECHANICS OF SOLIDS

Course Objectives: The objectives of the course are to

- Understand the behaviour of basic structural members subjected to uni axial and bi axial loads.
- Apply the concept of stress and strain to analyse and design structural members and machine parts under axial, shear and bending loads, moment and torsional moment.
- Students will learn all the methods to analyse beams, columns, frames for normal, shear, and torsion stresses and to solve deflection problems in preparation for the design of such structural components. Students are able to analyse beams and draw correct and complete shear and bending moment diagrams for beams.
- Students attain a deeper understanding of the loads, stresses, and strains acting on a structure and their relations in the elastic behavior
- Design and analysis of Industrial components like pressure vessels.

UNIT- I

SIMPLE STRESSES & STRAINS : Elasticity and plasticity – Types of stresses & strains– Hooke's law – stress – strain diagram for mild steel – Working stress – Factor of safety – Lateral strain, Poisson's ratio & volumetric strain – Bars of varying section – composite bars – Temperature stresses- Complex Stresses - Stresses on an inclined plane under different uniaxial and biaxial stress conditions - Principal planes and principal stresses - Mohr's circle - Relation between elastic constants, Strain energy – Resilience – Gradual, sudden, impact and shock loadings.

UNIT-II

SHEAR FORCE AND BENDING MOMENT :Definition of beam – Types of beams – Concept of shear force and bending moment – S.F and B.M diagrams for cantilever, simply supported and overhanging beams subjected to point loads, u.d.l, uniformly varying loads and combination of these loads – Point of contra flexure – Relation between S.F., B.M and rate of loading at a section of a beam.

UNIT-III

FLEXURAL STRESSES :Theory of simple bending, Derivation of bending equation, Determination of bending stresses – section modulus of rectangular, circular, I and T sections– Design of simple beam sections.

SHEAR STRESSES: Derivation of formula – Shear stress distribution across various beams sections like rectangular, circular, triangular, I and T sections.

UNIT-IV

DEFLECTION OF BEAMS :Bending into a circular arc – slope, deflection and radius of curvature – Differential equation for the elastic line of a beam – Double integration and Macaulay's methods – Determination of slope and deflection for cantilever and simply



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supported beams subjected to point loads, UDL and UVL. Mohr's theorem and Moment area method – application to simple cases.

TORSION: Introduction-Derivation- Torsion of Circular shafts- Pure Shear-Transmission of power by circular shafts, Shafts in series, Shafts in parallel.

UNIT– V

THIN AND THICK CYLINDERS: Thin seamless cylindrical shells – Derivation of formula for longitudinal and circumferential stresses – hoop, longitudinal and volumetric strains – changes in dia, and volume of thin cylinders– Thin spherical shells. Wire wound thin cylinders. Lamé's equation – cylinders subjected to inside & outside pressures – compound cylinders.

COLUMNS:

Buckling and Stability, Columns with Pinned ends, Columns with other support Conditions, Limitations of Euler's Formula, Rankine's Formula

Text Books:

1. GH Ryder, Strength of materials, Palgrave Macmillan publishers India Ltd, 1961.
2. B.C. Punmia, Strength of materials,10/e, Lakshmi publications Pvt. Ltd, New Delhi, 2018.

Reference Books:

1. Gere & Timoshenko, Mechanics of materials, 2/e, CBS publications, 2004.
2. U.C. Jindal, Strength of Materials, 2/e, Pearson Education, 2017.
3. Timoshenko, Strength of Materials Part – I & II, 3/e, CBS Publishers, 2004.
4. Andrew Pytel and Ferdinand L. Singer, Strength of Materials, 4/e, Longman Publications, 1990.
5. Popov, Mechanics of Solids, 2/e, New Pearson Education, 2015.

Online Learning Resources:

- https://onlinecourses.nptel.ac.in/noc19_ce18/preview.
- https://youtube/iY_ypychVNY?si=310htc4ksTQJ8Fv6.
- https://www.youtube.com/watch?v=WEy939Rkd_M&t=2s
- <https://www.classcentral.com/course/swayam-strength-of-materials-iitm-184204>
- <https://www.coursera.org/learn/mechanics-1>
- <https://www.edx.org/learn/engineering/massachusetts-institute-of-technology-mechanical-behavior-of-materials-part-1-linear-elastic-behavior>
- <https://archive.nptel.ac.in/courses/112/107/112107146/>



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Course Outcomes:

COs	Statements	Blooms Level
CO1	Analyze beams, columns, frames for normal, shear, and torsion stresses and to solve deflection problems in preparation for the design of such structural components	L4
CO2	Analyze beams and draw correct and complete shear and bending Moment diagrams for beams.	L4
CO3	Apply the concept of stress and strain to analyze and design structural members and machine parts under axial, shear and bending loads, and Moments.	L3
CO4	Model &Analyze the behavior of basic structural members subjected to various loads	L4
CO5	Analyze the Industrial components like pressure vessels.	L4



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II Year-I Semester

L	T	P	C
3	0	0	3

MATERIAL SCIENCE & METALLURGY

Course Objective:

- Understand the crystalline structure of different metals and study the stability of phases in different alloy systems.
- Study the behavior of ferrous and non ferrous metals and alloys and their application in different domains
- Able to understand the effect of heat treatment, addition of alloying elements on properties of ferrous metals.
- Grasp the methods of making of metal powders and applications of powder metallurgy
- Comprehend the properties and applications of ceramic, composites and other advanced methods

UNIT- I

Structure of Metals and Constitution of alloys: Crystallization of metals, Packing Factor - SC, BCC, FCC& HCP-line density, plane density. Grain and grain boundaries, effect of grain boundaries– determination of grain size. Imperfections, Slip and Twinning.

Necessity of alloying, types of solid solutions, Hume Rothery's rules, intermediate alloy phases, and electron compounds

Equilibrium Diagrams: Experimental methods of construction of equilibrium diagrams, Isomorphous alloy systems, equilibrium cooling and heating of alloys, Lever rule, coring miscibility gaps, eutectic systems, congruent melting intermediate phases, peritectic reaction. Transformations in the solid state – allotropy, eutectoid, peritectoid reactions, phase rule, relationship between equilibrium diagrams and properties of alloys. Study of binary phase diagrams such as Cu-Ni and Fe-Fe₃C.

UNIT-II

Ferrous metals and alloys: Structure and properties of White Cast iron, Malleable Cast iron, grey cast iron, Spheroidal graphite cast iron, Alloy cast iron. Classification of steels, structure and properties of plain carbon steels, Low alloy steels, Hadfield manganese steels, tool and die steels.

Non-ferrous Metals and Alloys: Structure and properties of Copper and its alloys, Aluminium and its alloys, Titanium and its alloys, Magnesium and its alloys, Super alloys.

UNIT-III

Heat treatment of Steels: Effect of alloying elements on Fe-Fe₃C system, annealing, normalizing, hardening, TTT diagrams, tempering, hardenability, surface - hardening methods, age hardening treatment, Cryogenic treatment.

UNIT-IV

Powder Metallurgy: Basic processes- Methods of producing metal powders- milling atomization- Granulation-Reduction-Electrolytic Deposition. Compacting methods – Sintering - Methods of manufacturing sintered parts. Secondary operations, Applications of powder metallurgical products.



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UNIT– V

Ceramic and Advanced materials: Crystalline ceramics, glasses, cermets, abrasive materials, Classification of composites, manufacturing methods, particle reinforced composites, fiber reinforced composites, PMC, MMC, CMC and CCCs. Introduction to Nano materials and smart materials.

Text Books:

1. S.H.Avner, Introduction to Physical Metallurgy, 2/e, Tata McGraw- Hill, 1997.
2. Donald R.Askeland, Essentials of Materials science and Engineering, 4/e, CL Engineering publications, 2018.

Reference Books:

1. Dr. V.D.kodgire, Material Science and Metallurgy, 39/e, Everest Publishing House, 2017.
2. V.Raghavan, Material Science and Engineering, 5/e, Prentice Hall of India, 2004.
3. William D. Callister Jr, Materials Science and Engineering: An Introduction, 8/e, John Wiley and Sons, 2009.
4. George E.Dieter, Mechanical Metallurgy, 3/e, McGraw-Hill, 2013.
5. Yip-Wah Chung, Introduction to Material Science and Engineering, 2/e, CRC Press, 2022.
6. A V K Suryanarayana, Material Science and Metallurgy, B S Publications, 2014.
7. U. C. Jindal, Material Science and Metallurgy, 1/e, Pearson Publications, 2011.

Online Learning Resources:

- <https://archive.nptel.ac.in/courses/113/106/113106032/>
- <https://www.edx.org/learn/mechanics/massachusetts-institute-of-technology-mechanical-behavior-of-materials-part-3-time-dependent-behavior>.
- <https://www.youtube.com/watch?v=9Sf278j1GTU>
- <https://www.coursera.org/learn/fundamentals-of-materials-science>
- <https://www.coursera.org/learn/material-behavior>.

Course Outcomes:

COs	Statements	Blooms Level
CO1	Interpret the crystalline structure of different metals and study the stability of phases in different alloy systems.	L3
CO2	Interpret the behavior of ferrous and non-ferrous metals and alloys and their application in different domains.	L3
CO3	Analyze the effect of heat treatment processes, addition of alloying elements on properties of ferrous metals.	L3
CO4	Grasp the methods of making of metal powders and applications of powder metallurgy.	L3
CO5	Comprehend the properties and applications of ceramic, composites and other advanced methods.	L4



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II Year I Semester

L	T	P	C
0	0	3	1.5

MECHANICS OF SOLIDS & MATERIALS SCIENCE LAB

Course Objective:

- Evaluate the values of yield stress, ultimate stress and bending stress of the given specimen under tension test and bending test
- Conduct the torsion test to determine the modulus of rigidity of given specimen.
- Justify the Rockwell hardness test over with Brinell hardness and measure the hardness of the given specimen.
- Examine the stiffness of the open coil and closed coil spring and grade them.
- Analyze the microstructure and characteristics of ferrous and non ferrous alloy specimens.

NOTE: Any 6 experiments from each section A and B.

A) MECHANICS OF SOLIDS LAB:

1. Tensile test
2. Bending test on
 - a) Simply supported beam
 - b) Cantilever beam
3. Torsion test
4. Hardness test
 - a) Brinell's hardness test
 - b) Rockwell hardness test
 - c) Vickers hardness test
5. Test on springs
6. Impact test
 - a) Charpy test
 - b) Izod test
7. Punch shear test
8. Liquid penetration test

B) MATERIAL SCIENCE LAB:

1. Preparation and study of the Microstructure of pure metals.
2. Preparation and study of the Microstructure of Mild steel, medium carbon steels, and High carbon steels.
3. Study of the Microstructures of Cast Irons.
4. Study of the Microstructures of Non-Ferrous alloys.
5. Study of the Microstructures of Heat treated steels.
6. Hardenability of steels by Jominy End Quench Test.



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Virtual lab:

1. To investigate the principal stresses σ_a and σ_b at any given point of a structural element or machine component when it is in a state of plane stress. (<https://virtual-labs.github.io/exp-rockwell-hardness-experiment-iiith/objective.html>)
2. To find the impact resistance of mild steel and cast iron. (<https://sm-nitk.vlabs.ac.in/exp/izod-impact-test>).
3. To find the impact resistance of mild steel. (<https://sm-nitk.vlabs.ac.in/exp/charpy-impact-test/index.html>)
4. To find the Rockwell hardness number of mild steel, cast iron, brass, aluminum and spring steel etc. (<https://sm-nitk.vlabs.ac.in/exp/rockwell-hardness-test>)
5. To determine the indentation hardness of mild steel, brass, aluminum etc. using Vickers hardness testing machine. (<https://sm-nitk.vlabs.ac.in/exp/vickers-hardness-test>).

Course Outcomes:

COs	Statements	Blooms Level
CO1	Demonstrate the stress strain behavior of different materials.	L3
CO2	Evaluate the hardness of different materials.	L4
CO3	Demonstrate the relation between elastic constants and hardness of materials.	L3
CO4	Identify various microstructures of steels and cast irons.	L3
CO5	Evaluate hardness of treated and untreated steels.	L4



L	T	P	C
0	0	3	1.5

COMPUTER-AIDED MACHINE DRAWING

Course Objectives

- Introduce conventional representations of material and machine components.
- Train to use software for 2D and 3D modeling.
- Familiarize with thread profiles, riveted, welded and key joints.
- Teach solid modeling of machine parts and their sections.
- Explain creation of 2D and 3D assembly drawings and Familiarize with limits, fits, and tolerances in mating components

The following are to be done by any 2D software package

Conventional representation of materials and components:

Detachable joints: Drawing of thread profiles, hexagonal and square-headed bolts and nuts, bolted joint with washer and locknut, stud joint, screw joint and foundation bolts.

Riveted joints: Drawing of rivet, lap joint, butt joint with single strap, single riveted, double riveted double strap joints.

Welded joints: Lap joint and T joint with fillet, butt joint with conventions.

Keys: Taper key, sunk taper key, round key, saddle key, feather key, woodruff key.

Couplings: rigid – Muff, flange; flexible – bushed pin-type flange coupling, universal coupling, Oldham's' coupling.

The following exercises are to be done by any 3D software package:

Sectional views:

Creating solid models of complex machine parts and sectional views.

Assembly drawings:(Any four of the following using solid model software)

Lathe tool post, tool head of shaping machine, tail-stock, machine vice, gate valve, carburetor, piston, connecting rod, eccentric, screw jack, plumber block, axle bearing, pipe vice, clamping device, Geneva cam, universal coupling.

Production drawing:

Representation of limits, fits and tolerances for mating parts. Use any four parts of above assembly drawings and prepare manufacturing drawing with dimensional and geometric tolerances.

Textbooks:

- 1 Machine Drawing by K.L.Narayana, P.Kannaiah and K.Venkat Reddy, New Age International Publishers, 3/e, 2014
- 2 Machine drawing by N.Sideswar, P. Kannaiah, V.V.S.Sastry, TMH Publishers. 2014.



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Reference Books:

1. Cecil Jensen, Jay Helsel and Donald D.Voisinet, Computer Aided Engineering Drawing, Tata McGraw-Hill, NY, 2000.
2. James Barclay, Brain Griffiths, Engineering Drawing for Manufacture, Kogan Page Science, 2003.
3. N.D.Bhatt, Machine Drawing, Charotar Publishers, 50/e, 2014.

Online Learning Resources:

- <https://eeedocs.wordpress.com/wp-content/uploads/2014/02/machinedrawing.pdf>
- <https://archive.nptel.ac.in/courses/112/105/112105294/>
- https://www.edx.org/learn/engineering/dassault-systemes-solidworks-solidworks-cad-fundamentals?index=product&queryID=c90b35a82a6ef58b0d6f89679c63f6a1&position=2&linked_from=autocomplete&c=autocomplete
- https://www.youtube.com/watch?v=0bQkS3_3Fq4

Course Outcomes:

COs	Statements	Blooms Level
CO1	Demonstrate the conventional representations of materials and machine components.	L3
CO2	Model riveted, welded and key joints using CAD system.	L6
CO3	Create solid models and sectional views of machine components.	L6
CO4	Generate solid models of machine parts and assemble them.	L5
CO5	Distinguish the 3D assemblies and 2D drawings.	L4



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II Year II Semester

L	T	P	C
2	0	0	2

INDUSTRIAL MANAGEMENT

Course Objectives: The objectives of the course are to

- Introduce the scope and role of industrial engineering and the techniques for optimal design of layouts
- Illustrate how work study is used to improve productivity
- Explain TQM and quality control techniques
- Introduce financial management aspects and
- Discuss human resource management and value analysis.

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 break down maintenance.

UNIT-II

WORK STUDY: Importance, types of production, applications, work study, 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.

UNIT-III

STATISTICAL QUALITY CONTROL: Quality control, Queuing assurance and its importance, SQC, attribute sampling inspection with single and double sampling, $\bar{C}$ Control charts – $\bar{X}$ and R –charts $\bar{X}$ and S charts and their applications, numerical examples.

TOTALQUALITYMANAGEMENT: zero defect concept, quality circles, implementation, applications, ISO quality systems. Six Sigma–definition, basic concepts

UNIT- IV

FINANCIAL MANAGEMENT: Scope and nature of financial management, Sources of finance, Ratio analysis, Management of working capital, estimation of working capital requirements, stock management, Cost accounting and control, budget and budgetary control, Capital budgeting – Nature of Investment Decisions – Investment Evaluation criteria- NPV, IRR, PI, Payback Period, and ARR, numerical problems.



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UNIT-V

HUMAN 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, and types.

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

Text Books:

1. O.P Khanna, Industrial Engineering and Management, Dhanpat Rai Publications (P) Ltd, 2018.
2. Mart and Telsang, Industrial Engineering and Production Management, S.Chand&Company Ltd. NewDelhi, 2006.

Reference Books:

1. Bhattacharya DK, Industrial Management, S.Chand, publishers, 2010.
2. J.G Monks, Operations Management, 3/e, McGraw Hill Publishers 1987.
3. T.R. Banga, S.C.Sharma, N. K. Agarwal, Industrial Engineering and Management Science, Khanna Publishers, 2008.
4. Koontz O' Donnell, Principles of Management, 4/e, McGraw Hill Publishers, 1968.
5. R.C. Gupta, Statistical Quality Control, Khanna Publishers, 1998.
6. NVS Raju, Industrial Engineering and Management, 1/e, Cengage India Private Limited, 2013.

Online Learning Sources

- https://onlinecourses.nptel.ac.in/noc21_me15/preview
- https://onlinecourses.nptel.ac.in/noc20_mg43/preview
- <https://www.edx.org/learn/industrial-engineering>
- <https://youtube.com/playlist?list=PL299B5CC87110A6E7&si=TghLCbEobuxjEaXi>
- https://youtube.com/playlist?list=PLbjTnj-t5Gkl0z3OHOGK5RB9mvNYvnImW&si=oaX_5RG69hS3v2ll

Course Outcomes:

COs	Statements	Blooms Level
CO1	Illustrate how to design the optimal layout	L3
CO2	Demonstrate work study methods	L3
CO3	Distinguish Quality Control techniques	L4
CO4	Evaluate the financial management aspects	L5
CO5	Analyze the human resource management methods and value analysis	L4



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L	T	P	C
3	0	0	3

II Year II Semester

MANUFACTURING PROCESSES

Course Objective: The objectives of the course are to

- Know the working principle of different metal casting processes and gating system.
- Classify the welding processes, working of different types of welding processes and welding defects.
- Know the nature of plastic deformation, cold and hot working process, working of a rolling mill and types, extrusion processes.
- Understand the principles of forging, tools and dies, working of forging processes.
- Know about the Additive manufacturing.

UNIT- I

Casting: Steps involved in making a casting – Advantage of casting and its applications. Patterns and Pattern making – Types of patterns – Materials used for patterns, pattern allowances and their construction, Molding, different types of cores , Principles of Gating, Risers, casting design considerations. Methods of melting and types of furnaces, Solidification of castings and casting defects- causes and remedies. Basic principles and applications of special casting processes - Centrifugal casting, Die casting, Investment casting and shell molding.

UNIT-II

Welding: Classification of welding processes, types of welded joints and their characteristics, Gas welding, Different types of flames and uses, Oxy – Acetylene Gas cutting. Basic principles of Arc welding, power characteristics, Manual metal arc welding, submerged arc welding, TIG & MIG welding. Electro-slag welding.

Resistance welding, Friction welding, Friction stir welding, Forge welding, Explosive welding; Thermit welding, Plasma Arc welding, Laser welding, electron beam welding, Soldering & Brazing.

Heat affected zones in welding; pre & post heating, welding defects –causes and remedies.

UNIT-III

Bulk Forming: Plastic deformation in metals and alloys-recovery, recrystallization and grain growth. Hot working and Cold working-Strain hardening and Annealing. Bulk forming processes: Forging-Types of Forging, forging defects and remedies; Rolling – fundamentals, types of rolling mills and products, Forces in rolling and power requirements. Extrusion and its characteristics. Types of extrusion, Impact extrusion, Hydrostatic extrusion; Wire drawing and Tube drawing.



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UNIT– IV

Sheet metal forming-Blanking and piercing, Forces and power requirement in these operations, Deep drawing, Stretch forming, Bending, Spring back and its remedies, Coining, Spinning, Types of presses and press tools.

High energy rate forming processes: Principles of explosive forming, electromagnetic forming, Electro hydraulic forming, rubber pad forming, advantages and limitations.

UNIT -V

Additive manufacturing - Steps in Additive Manufacturing (AM), Classification of AM processes, Advantages of AM, and types of materials for AM, VAT photo polymerization AM Processes, Extrusion - Based AM Processes, Powder Bed Fusion AM Processes, Direct Energy Deposition AM Processes, Post Processing of AM Parts, Applications

Text books:

1. Kalpakjain S and Steven R Schmid, Manufacturing Processes for Engineering Materials, 5/e, Pearson Publications, 2007.
2. P.N. Rao, Manufacturing Technology -Vol I, 5/e, McGraw Hill Education, 2018.

Reference Books:

1. A.Ghosh & A.K.Malik, Manufacturing Science, East West Press Pvt. Ltd, 2010.
2. Lindberg and Roy, Processes and materials of manufacture, 4/e, Prentice Hall India Learning Private Limited, 1990.
3. R.K. Jain, Production Technology, Khanna Publishers, 2022.
4. Sharma P.C., A Text book of Production Technology, 8/e, S Chand Publishing, 2014.
5. H.S. Shaun, Manufacturing Processes, 1/e, Pearson Publishers, 2012.
6. WAJ Chapman , Workshop Technology, 5/e, CBS Publishers & Distributors Pvt. Ltd, 2001.
7. Hindustan Machine Tools, Production Technology, Tata McGraw Hill Publishers, 2017.
8. Ian Gibson, David W Rosen, Brent Stucker., Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing, 2/e, Springer, 2015.

Online Learning Resources:

- <https://www.edx.org/learn/manufacturing/massachusetts-institute-of-technology-fundamentals-of-manufacturing-processes>
- https://onlinecourses.nptel.ac.in/noc21_me81/preview
- www.coursera.org/learn/introduction-to-additive-manufacturing-processessera
- <https://archive.nptel.ac.in/courses/112/103/112103263/>
- <https://elearn.nptel.ac.in/shop/nptel/principles-of-metal-forming-technology/?v=c86ee0d9d7ed>



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Course Outcomes:

COs	Statements	Blooms Level
CO1	Prepare the patterns and core boxes for metal casting processes	L3
CO2	Distinguish the different welding processes	L4
CO3	Demonstrate the different types of bulk forming processes	L3
CO4	Illustrate the sheet metal forming processes	L4
CO5	Differentiate the different types of additive manufacturing processes	L4



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II Year II Semester

L	T	P	C
3	0	0	3

FLUID MECHANICS & HYDRAULIC MACHINES

Course Objectives: The students completing this course are expected to

- Understand the properties of fluids, manometry, hydrostatic forces acting on different surfaces
- Understand the kinematic and dynamic behavior through various laws of fluids like continuity, Euler's, Bernoulli's equations, energy and momentum equations.
- Understand the theory of boundary layer, working and performance characteristics of various hydraulic machines like pumps and turbines.

UNIT I

Fluid statics: Dimensions and units: physical properties of fluids - specific gravity, viscosity and its significance, surface tension, capillarity, vapor pressure. Atmospheric, gauge and vacuum pressure, Measurement of pressure – Manometers - Piezometer, U-tube, inverted and differential manometers. Pascal's & hydrostatic laws.

Buoyancy and floatation: Meta center, stability of floating body. Submerged bodies. Calculation of metacenter height. Stability analysis and applications.

UNIT II

Fluid Kinematics: Introduction, flow types. Equation of continuity for one dimensional flow, circulation and vorticity, Stream line, path line and streak lines and stream tube. Stream function and velocity potential function, differences and relation between them. Condition for irrotational flow, flownet, source and sink, double and vortex flow.

Fluid dynamics: surface and body forces –Euler's and Bernoulli's equations for flow along a streamline, momentum equation and its applications, force on pipe bend.

Closed conduit flow: Reynold's experiment- Darcy Weisbach equation- Minor losses in pipes- pipes in series and pipes in parallel total energy line hydraulic gradient line.

UNIT III

Boundary Layer Theory: Introduction, momentum integral equation, displacement, momentum and energy thickness, separation of boundary layer, control of flow separation, Stream lined body, Bluff body and its applications, basic concepts of velocity profiles.

Dimensional Analysis: Dimensions and Units, Dimensional Homogeneity, Non dimensionalization of equations, Method of repeating variables and Buckingham Pi Theorem.

UNIT IV

Basics of turbo machinery: hydrodynamic force of jets on stationary and moving flat, inclined, and curved vanes, jet striking centrally and at tip, velocity diagrams, work done and efficiency, flow over radial vanes.

Hydraulic Turbines: classification of turbines, impulse and reaction turbines, Pelton



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wheel, Francis turbine and Kaplan turbine-working proportions, work done, efficiencies, hydraulic design –draft tube-theory-functions and efficiency.

UNIT V

Performance of hydraulic turbines: Geometric similarity, Unit and specific quantities, characteristic curves, governing of turbines, selection of type of turbine, cavitation, surge tank, water hammer. Hydraulic systems- hydraulic ram, hydraulic lift, hydraulic coupling. Fluidics – amplifiers, sensors and oscillators. Advantages, limitations and applications.

Centrifugal pumps: classification, working, work done – manometric head- losses and efficiencies-specific speed- pumps in series and parallel-performance characteristic curves, cavitation & NPSH. **Reciprocating pumps:** Working, Discharge, slip, indicator diagrams.

Text Books:

1. Y.A. Cengel, J.M.Cimbala, Fluid Mechanics, Fundamentals and Applications, 6/e, McGraw Hill Publications, 2019.
2. Dixon, Fluid Mechanics and Thermodynamics of Turbo machinery, 7/e, Elsevier Publishers, 2014.

Reference Books:

1. P N Modi and S M Seth, Hydraulics & Fluid Mechanics including Hydraulics Machines, Standard Book House, 2017.
2. RK Bansal, Fluid Mechanics and Hydraulic Machines, 10/e, Laxmi Publications (P)Ltd, 2019.
3. Rajput, Fluid Mechanics and Hydraulic Machines, S Chand & Company, 2016.
4. D.S. Kumar, Fluid Mechanics and Fluid Power Engineering, S K Kataria & Sons, 2013.
5. D. Rama Durgaiah, Fluid Mechanics and Machinery, 1/e, New Age International, 2002.

Online Learning Resources:

- <https://archive.nptel.ac.in/courses/112/105/112105206/>
- <https://archive.nptel.ac.in/courses/112/104/112104118/>
- <https://www.edx.org/learn/fluid-mechanics>
- https://onlinecourses.nptel.ac.in/noc20_ce30/previewnptel.ac.in
- www.coursera.org/learn/fluid-powerera



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Course Outcomes:

COs	Statements	Blooms Level
CO1	Use the basic concepts of fluid properties.	L3
CO2	Apply the mechanics of fluids in static and dynamic conditions.	L3
CO3	Analyze the Boundary layer theory, flow separation and dimensional analysis.	L4
CO4	Estimate the hydro dynamic forces of jet on vanes indifferent positions.	L5
CO5	Evaluate performance of hydraulic pump and turbines.	L5



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L	T	P	C
3	0	0	3

II Year II Semester

THEORY OF MACHINES

Course Objectives: The objectives of the course are to make the students learn about

- Introduce various basic mechanisms and their applications.
- Explain importance of degree of freedom.
- Familiarize velocity and acceleration in mechanisms.
- Describe the cams and follower motions.
- Explain the importance of gyroscopic couples.
- Introduce the equation of motion for single degree of freedom system.

UNIT – I: Simple Mechanisms

10 Hrs

Simple Mechanisms: Classification of mechanisms – Basic kinematic concepts and definitions – Degree of freedom, mobility – Grashof's law, kinematic inversions of four bar chain and slider crank chains- Limit positions – Mechanical advantage- Transmission angle- Description of some common mechanisms- Quick return mechanism, straight line mechanisms – UniversalJoint – Rocker mechanisms.

UNIT – II: Plane and motion analysis

12 Hrs

Plane and motion analysis: Displacement, velocity and acceleration analysis of simple mechanisms, graphical velocity analysis using instantaneous centers, velocity and acceleration analysis using loop closure equations – kinematic analysis of simple mechanisms – slider crank mechanism dynamics – Coincident points – Coriolis component of acceleration.

UNIT – III: Gyroscope & Gear Profile

10Hrs

Gyroscope: Principle of gyroscope, gyroscopic effect in an aeroplane, ship, car and two wheeler, simple problems

Gear Profile: Involute and cycloidal gear profiles, gear parameters, fundamental law of gearing and conjugate action, spur gear contact ratio and interference/undercutting – helical, bevel, worm, rack & pinion gears, epicyclic and regular gear train kinematics.

UNIT – IV: Balancing of Rotating masses & Cams

12 Hrs

Balancing of Rotating masses: Need for balancing, balancing of single mass and several masses in different planes, using analytical and graphical methods.

Cams: Classification of cams and followers- Terminology and definitions – Displacement diagrams –Uniform velocity, parabolic, simple harmonic and cycloidal motions – derivatives of follower motions- specified contour cams- circular and tangent cams –pressure angle and undercutting.



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UNIT – V: Vibrations & Turning Moment Diagrams and Flywheels

10Hrs

Vibrations: Introduction, degree of freedom, types of vibrations, free natural vibrations, Newton method and energy method for single degree of freedom. Damped vibrations- under damped, critically damped; and over damped systems, forced vibrations with and without damping in single degree of freedom; Vibration isolation and transmissibility.

Turning Moment Diagrams and Flywheels: Turning moment diagrams for steam engine, I.C engine and Multi Cylinder Engine. Crank effort – coefficient of fluctuation of energy, coefficient of fluctuation of speed – Fly Wheel and their design, fly wheels for punching press.

Text Books:

1. S.S.Rattan, Theory of Machines, 4/e, Tata Mc-Graw Hill, 2014.
2. P.L.Ballaney, Theory of Machines & Mechanisms, 25/e, Khanna Publishers, Delhi, 2003.

Reference Books:

1. F. Haidery, Dynamics of Machines, 5/e, NiraliPrakashan, Pune, 2003.
2. J.E.Shigley, Theory of Machines and Mechanisms, 4/e, Oxford, 2014.
3. G.K.Groover, Mechanical Vibrations, 8/e, Nemchand Bros, 2009.
4. Norton, R.L., Design of Machinery – An Introduction to Synthesis and Analysis of Mechanisms and Machines, 2/e, McGraw Hill, New York, 2000.
5. William T. Thomson, Theory of vibration with applications, 4/e, Englewood Cliffs, N.J.: Prentice Hall, 1993.

Course Outcomes:

COs	Statements	Blooms Level
CO1	Analyze the different mechanisms and their inversions.	L4
CO2	Calculate velocity and acceleration of different links in a mechanism	L4
CO3	Apply the effects of gyroscopic couple in ships, aero planes and road vehicles.	L3
CO4	Evaluate unbalance mass in rotating machines.	L5
CO5	Analyze free and forced vibrations of single degree freedom systems.	L4



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L	T	P	C
0	0	3	1.5

FLUID MECHANICS & HYDRAULIC MACHINES LAB

Course Objective: To impart practical exposure on the performance evaluation methods of various flow measuring equipment and hydraulic turbines and pumps.

List of Experiments

1. Impact of jets on Vanes.
2. Performance Test on Pelton Wheel.
3. Performance Test on Francis Turbine.
4. Performance Test on Kaplan Turbine.
5. Performance Test on Single Stage Centrifugal Pump.
6. Performance Test on Multi Stage Centrifugal Pump.
7. Performance Test on Reciprocating Pump.
8. Calibration of Venturimeter.
9. Calibration of Orificemeter.
10. Determination of friction factor for a given pipeline.
11. Determination of loss of head due to sudden contraction in a pipeline.
12. Turbine flow meter.

Virtual Lab:

1. To study different patterns of a flow through a pipe and correlate them with the Reynolds number of the flow. (<https://me.iitp.ac.in/Virtual-Fluid-Laboratory/reynolds/introduction.html>)
2. To calculate Total Energy at different points of venturimeter. (<https://me.iitp.ac.in/Virtual-Fluid-Laboratory/bernoulli/introduction.html>).
3. To calculate the flow (or point) velocity at center of the given tube using different flow rates. (<https://me.iitp.ac.in/Virtual-Fluid-Laboratory/pitot/introduction.html>)
4. To determine the hydrostatic force on a plane surface under partial submerge and full submerge condition. (<https://me.iitp.ac.in/Virtual-Fluid-Laboratory/cop/introduction.html>).
5. To determine the discharge coefficient of a triangular notch. (<https://me.iitp.ac.in/Virtual-Fluid-Laboratory/notch/introduction.html>)
6. To determine the coefficient of impact of jet on vanes. (<https://fm-nitk.vlabs.ac.in/exp/impact-of-jet>).
7. To determine friction in pipes. (<https://fm-nitk.vlabs.ac.in/exp/friction-in-pipes/index.html>).



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Course Outcomes:

COs	Statements	Blooms Level
CO1	Demonstrate the devices used for measuring flow.	L3
CO2	Compute major losses in pipes.	L5
CO3	Calculate the operating parameters of turbines.	L4
CO4	Distinguish the working of different types of pumps.	L4
CO5	Demonstrate the devices used for measuring flow.	L3



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II Year II Semester

L	T	P	C
0	0	3	1.5

MANUFACTURING PROCESSES LAB

Course Objective: Acquire practical knowledge on Metal Casting, Welding, Press Working and Processing of Plastics.

List of Experiments

1. Design and making of pattern
 - i. Single piece pattern
 - ii. Split pattern
2. Sand properties testing
 - i. Sieve analysis(dry sand)
 - ii. Clay content test
 - iii. Moisture content test
 - iv. Strength test(Compression test & Shear test)
 - v. Permeability test
3. Mould preparation
 - i. Straight pipe
 - ii. Bent pipe
 - iii. Dumble
 - iv. Gear blank
4. Gas cutting and welding
5. Manual metal arc welding
 - i. Lap joint
 - ii. Butt joint
6. Injection Molding
7. Blow Molding
8. Simple models using sheet metal operations
9. Study of deep drawing and extrusion operations
10. To make weldments using TIG/MIG welding
11. To weld using Spot welding machine
12. To join using Brazing and Soldering
13. To make simple parts on a 3D printing machine
14. Demonstration of metal casting.

Virtual Lab:

1. To study and observe various stages of casting through demonstration of casting process. (<https://virtual-labs.github.io/exp-sand-casting-process-dei/theory.html>)
2. To weld and cut metals using an oxyacetylene welding setup. (<https://virtual-labs.github.io/exp-gas-cutting-processes-iitkgp/index.html>).
3. To simulate Fused deposition modelling process (FDM) (<https://3dpdei.vlabs.ac.in/exp/simulation-modelling-process>)



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4. <https://altair.com/inspire-mold/>
5. <https://virtual-labs.github.io/exp-simulation-cartesian-system-dei/theory.html>

Course Outcomes:

COs	Statements	Blooms Level
CO1	Prepare moulds for sand casting.	L3
CO2	Fabricate different types of components using various manufacturing techniques.	L5
CO3	Adapt unconventional manufacturing methods.	L3
CO4	prepare Different Weld joints.	L3
CO5	Demonstrate the different types of 3d Printing techniques.	L3



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B.Tech. – III Year I Semester

S.No.	Subject Code	Category	Title	L	T	P	C	
1	B23ME51	Professional Core	Machine Tools and Metrology	3	0	0	3	
2	B23ME52	Professional Core	Thermal Engineering	3	0	0	3	
3	B23ME53	Professional Core	Design of Machine Elements	3	0	0	3	
4	B23ME54	Professional Elective	Professional Elective - I	3	0	0	3	
5	B23CC51	Open Elective-I	OR Entrepreneurship Development & Venture Creation	3	0	0	3	
	B23CC55A		1. Sustainable Energy Technologies					
	B23CC55B		2. Applied Operations Research					
	B23CC55C		3. Nano Technology					
	B23CC55D		4. Thermal Management of Electronic systems					
	B23CC55E		5. Entrepreneurship					
6	B23ME56	Professional Core	Thermal Engineering Lab	0	0	3	1.5	
7	B23ME57	Professional Core	Theory of Machines Lab	0	0	3	1.5	
8	B23ME58	Skill Enhancement course	Machine tools and Metrology Lab	0	0	4	2	
9	B23ME59	Engineering Science	Tinkering Lab	0	0	2	1	
10		Evaluation of Community Service Internship	Community Service Internship	-	-	-	2	
		Total		15	0	10	23	
	MC		Minor Course (Student may select from the same specialized minors pool)				3	0
	MC		Minor Course through SWAYAM / NPTEL (Minimum 12 Week, 3 credit course)				3	0
	HC		Honors Course (Student may select from the same Honors pool)				3	0
	HC		Honors Course (Student may select from the same Honors Pool)				3	0

Professional Elective – I

- 1) Design for Manufacturing
- 2) Conventional and futuristic vehicle technology
- 3) Renewable Energy Technologies
- 4) Non-destructive Evaluation

Dr. B. Balakrishna
 (University nominee)



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B.Tech. III Year II Semester

S.No.	Subject Code	Category	Title	L	T	P	C
1	B23ME61	Professional Core	Heat Transfer	3	0	0	3
2	B23ME62	Professional Core	Artificial Intelligence and Machine Learning	3	0	0	3
3	B23ME63	Professional Core	Finite Element Methods	3	0	0	3
4	B23ME64	Professional Elective	Professional Elective-II	3	0	0	3
5	B23ME65	Professional Elective	Professional Elective-III	3	0	0	3
6	B23ME66A	Open Elective - II	1.Introduction to Industrial Robotics	3	0	0	3
	B23ME66B		2. Industrial Management				
	B23ME66C		3. Additive Manufacturing				
	B23ME66D		4.Vehicle Technology				
	B23ME66E		5. Industrial Safety				
7	B23ME67	Professional Core	Heat Transfer Lab	0	0	3	1.5
8	B23ME68	Professional Core	Artificial Intelligence and Machine Learning Lab	0	0	3	1.5
9	B23ME69	Skill Enhancement course	Robotics and Drone Technologies Lab	0	0	4	2
10	B23CC6A	Audit Course	Technical paper writing and IPR	2	0	0	-
Total				20	0	10	23
Mandatory Industry Internship of 08 weeks duration during summer vacation							

MC	Student may select from the same minors pool	3	0	3	4.5
MC	Minor Course (Student may select from the same specialized minors pool)	3	0	0	3
HC	Student may select from the same honors pool	3	0	0	3
HC	Honors Course (Student may select from the honors pool)	3	0	0	3

Dr. B. Babu
(Chairman)

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Professional Elective-II

1. Mechanical Vibrations
2. Advanced Manufacturing Processes
3. Micro Electro Mechanical Systems
4. Sensors and Instrumentation

Professional Elective-III

1. Energy Storage Technologies
2. Industrial Hydraulics and Pneumatics
3. Industrial Robotics
4. Refrigeration & Air-Conditioning

Professional Elective-IV

1. Mechatronics
2. Computational Fluid Dynamics
3. Advanced Material Science
4. Embedded Systems and Programming

Professional Elective-V

1. Hydrogen and Fuel Cell Technology
2. Smart manufacturing
3. Cryogenics
4. Electrical drives and actuators

For Honors:

I. Mechanical Engineering design and Robotics (Any 5 theory and 2 Labs)

1. Advanced Mechanics of solids
2. Design of Machine Members
3. Theory of machines
4. Advanced Finite element methods
5. Mechanical vibrations
6. Robotics
7. Product design
8. Design for manufacturing
9. CAD Lab
10. Mechanisms and Robotics Lab

II. Smart Manufacturing(Any 5 theory and 2 Labs)

1. Automation in manufacturing
2. MEMS
3. Mechatronics
4. CIM
5. Smart manufacturing
6. Robotics
7. Manufacturing processes
8. Artificial intelligence and Machine learning
9. AI & ML Lab



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10. Mechatronics Lab

III. Thermal Systems Engineering(Any 5 theory and 2 Labs)

1. Advanced Thermodynamics
2. Thermal Engineering
3. Advanced Heat transfer
4. Refrigeration and Air-conditioning
5. Power plant engineering
6. Advanced Fluid mechanics
7. Automobile Engineering
8. Computation fluid dynamics
9. Heat transfer Lab
10. Advanced Thermal Engineering Lab

For Minors(Any 5 theory and 2 Labs):

1. Advanced Mechanics of Solids
2. Advanced Finite Element Methods
3. Advanced CAD
4. Advanced Manufacturing Processes
5. Advanced Fluid Mechanics
6. Advanced Heat Transfer
7. Advanced Mechanisms & Robotics
8. Optimization & Reliability
9. Mechanisms and Robotics Lab
10. Advanced Manufacturing Processes lab
11. Modeling & Simulation of Manufacturing Systems Lab
12. Computational Fluid Dynamics Lab



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III YearI Semester	MACHINE TOOLS & METROLOGY	L	T	P	C
		3	0	0	3

Course objectives:

1. To learn the fundamental knowledge and principles of material removal processes.
2. To understand the basic principles of lathe, shaping, slotting and planning machines
3. To demonstrate the fundamentals of drilling, milling and boring processes.
4. To discuss the concepts of super finishing processes and limits and fits.
5. To understand the concepts of surface roughness and optical measuring instruments

UNIT – 1

FUNDAMENTALS OF MACHINING:

Elementary treatment of metal cutting theory – element of cutting process – Single point cutting tools, nomenclature, tool signature, mechanism of metal cutting, types of chips, mechanics of orthogonal and oblique cutting –Merchant's force diagram, cutting forces, Taylor's tool life equation, simple problems - Tool wear, tool wear mechanisms, machinability, economics of machining, coolants, tool materials and properties.

UNIT – 2

LATHE MACHINES:

Introduction- types of lathe - Engine lathe – principle of working - construction - specification of lathe - accessories and attachments – lathe operations – taper turning methods and thread cutting – drilling on lathes.

SHAPING, SLOTTING AND PLANNING MACHINES: Introduction - principle of working – principle parts – specifications - operations performed - slider crank mechanism - machining time calculations.

UNIT – 3

DRILLING & BORING MACHINES: Introduction – construction of drilling machines – types of drilling machines - principles of working – specifications- types of drills - operations performed – machining time calculations - Boring Machines – types.

MILLING MACHINES: Introduction - principle of working – specifications – milling methods - classification of Milling Machines –types of cutters - methods of indexing- machining time calculations

UNIT – 4

FINISHING PROCESSES: Classification of grinding machines- types of abrasives- bonds, specification and selection of a grinding wheel- Lapping, Honing & Broaching operations- comparison to grinding.

SYSTEMS OF LIMITS AND FITS: Types of fits -Unilateral and bilateral tolerance system, hole and shaft basis systems- interchangeability & selective assembly- International standard system of tolerances, simple problems related to limits and fits, 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.



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UNIT – 5

ANGULAR MEASUREMENT: Bevel protractor, angle slip gauges- angle dekkor- spirit levels- sine bar- sine table.

SURFACE ROUGHNESS MEASUREMENT: Differences between surface roughness and surface waviness –Numerical assessment of surface finish, Profilograph, Talysurf, ISI symbols.

OPTICAL MEASURING INSTRUMENTS: Tools maker's microscope, Autocollimators, Optical projector, Optical flats-working principle, construction, merits, demerits and their uses. optical comparators.

TEXT BOOKS:

1. Manufacturing Processes / JP Kaushish/ PHI Publishers-2nd Edition
2. Manufacturing Technology Vol-II/P.N Rao/Tata McGraw Hill
3. Engineering Metrology – R.K. Jain/Khanna Publishers

REFERENCES:

1. Metal cutting and machine tools /Geoffrey Boothroyd, Winston A.Knight/ Taylor & Francis
2. Production Technology / H.M.T. Hand Book (Hindustan Machine Tools).
3. Production Engineering/K.C Jain & A.K Chitale/PHI Publishers
4. Technology of machine tools/S.F.Krar, A.R. Gill, Peter SMID/ TMH
5. Manufacturing Processes for Engineering Materials-Kalpak Jian S & Steven R Schmid/Pearson Publications 5th Edition

Course Outcomes: At the end of the course, student will be able to

CO1	Learned the fundamental knowledge and principals in material removal process.
CO2	Acquire the knowledge on operations in conventional, automatic, Capstan and turret lathes
CO3	Capable of understanding the working principles and operations of shaping, slotting, planning , drilling and boring machines.
CO4	able to make gear and keyway in milling machines and understand the indexing mechanisms
CO5	Understand the different types of Surface roughness and Optical measuring instruments



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III Year I Semester	THERMAL ENGINEERING	L	T	P	C
		3	0	0	3

Course Objectives:

- 1) To give insight into basic principles of air standard cycles.
- 2) To impart knowledge about IC engines and Boilers
- 3) To make the students learn the working principles of steam nozzles, turbines and compressors
- 4) To impart the knowledge about the various types of compressors and gas turbines
- 5) To make the students gain insights about, rockets and jet propulsion and solar engineering.

UNIT- I

Air standard Cycles: Otto, diesel and dual cycles, its comparison, Brayton cycle

Actual Cycles and their Analysis: Introduction, Comparison of Air Standard and Actual Cycles, Time Loss Factor, Heat Loss Factor, Exhaust Blowdown-Loss due to Gas exchange process, Volumetric Efficiency. Loss due to Rubbing Friction, Actual and Fuel-Air Cycles of CI Engines.

UNIT-II

I.C Engines: Classification - Working principles of SI and CI engines, Valve and Port Timing Diagrams, -Engine systems – Fuel, Carburetor, Fuel Injection System, Ignition, Cooling and Lubrication, principles of supercharging and turbocharging, Measurement, Testing and Performance.

Boilers : Principles of L.P & H.P boilers, mountings and accessories, Draught- induced and forced.

UNIT -III

Steam nozzles: Functions, applications, types, flow through nozzles, condition for maximum discharge, critical pressure ratio, criteria to decide nozzle shape, Wilson line.

Steam turbines: Classification – impulse turbine; velocity diagram, effect of friction, diagram efficiency, De-leval turbine - methods to reduce rotor speed, combined velocity diagram.

Reaction turbine: Principle of operation, velocity diagram, Parson's reaction turbine – condition for maximum efficiency.

Steam condensers: Classification, working principles of different types – vacuum efficiency and condenser efficiency.

UNIT -IV

Compressors: Classification, Reciprocating type - Principle, multi-stage compression, Rotary type – Lysholm compressor – principle and efficiency considerations.

Centrifugal Compressors: Principle, velocity and pressure variation, velocity diagrams.

Axial flow Compressors: Principle, pressure rise and efficiency calculations.

Gas Turbines: Simple gas turbine plant – ideal cycle, components – regeneration, inter cooling and reheating.



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UNIT -V

Jet Propulsion: Principle, classification, t-s diagram - turbo jet engines – thermodynamic cycle, performance evaluation.

Rockets: Principle, solid and liquid propellant rocket engines.

Solar Engineering: Solar radiation, Solar collectors, PV cells, storage methods and applications

Text Books:

1. Thermal Engineering - Mahesh Rathore- McGraw Hill publishers
2. Heat Engineering /V.PVasandani and D.S Kumar/Metropolitan Book Company, New Delhi.

References:

1. I.C. Engines - V. Ganesan- Tata McGraw Hill Publishers
2. Thermal Engineering-M.L.Mathur& Mehta/Jain bros. Publishers
3. Thermal Engineering-P.L.Ballaney/ Khanna publishers.
4. Thermal Engineering / RK Rajput/ Lakshmi Publications
5. Thermal Engineering-R.SKhurmi, &J S Gupta/S.Chand.

Course Outcomes: At the end of the course, student will be able to

- CO1: Explain the basic concepts of air standard cycles.
CO2: Get knowledge about IC Engines and Biolers.
CO3: Discuss the concepts of steam nozzles and steam turbines and steam condensers.
CO4: Gain knowledge about the concepts of compressors and gas turbines.
CO5: Acquire insights about jet propulsion, rockets and solar engineering.



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III Year-I Semester	DESIGN OF MACHINE ELEMENTS	L	T	P	C
		3	0	0	3

Course Objectives:

- Familiarize with fundamental approaches to failure prevention for static and dynamic loading.
- Provide an introduction to design of bolted and welded joints.
- Explain design procedures for shafts and couplings.
- Discuss the principles of design for clutches and brakes and springs.
- Explain design procedures for bearings and gears.

UNIT-I: Introduction, Design for Static and Dynamic loads

Mechanical Engineering Design: Design process, design considerations, codes and standards of designation of materials, selection of materials.

Design for Static Loads: Modes of failure, design of components subjected to axial, bending, torsional and impact loads. Theories of failure for static loads.

Design for Dynamic Loads: Endurance limit, fatigue strength under axial, bending and torsion, stress concentration, notch sensitivity. Types of fluctuating loads, fatigue design for infinite life. Soderberg, Goodman and modified Goodman criterion for fatigue failure. Fatigue design under combined stresses.

UNIT-II: Design of Bolted and Welded Joints

Design of Bolted Joints: Threaded fasteners, preload of bolts, various stresses induced in the bolts. Torque requirement for bolt tightening, gasketed joints.

Welded Joints: Strength of lap and butt welds, Joints subjected to bending and torsion.

UNIT-III: Power transmission shafts and Couplings

Power Transmission Shafts: Design of shafts subjected to bending, torsion and axial loading. Shafts subjected to fluctuating loads using shock factors.

Couplings: Design of flange and bushed pin couplings, universal coupling.

UNIT-IV: Design of Clutches, Brakes and Springs

Friction Clutches: Torque transmitting capacity of disc and centrifugal clutches. Uniform wear theory and uniform pressure theory.

Brakes: Different types of brakes. Concept of self-energizing and self-locking of brake. Band and block brakes, disc brakes.

Springs: Design of helical compression, tension, torsion and leaf springs.

UNIT-V: Design of Bearings and Gears

Design of Sliding Contact Bearings: Lubrication modes, bearing modulus, McKee's equations, design of journal bearing. Bearing Failures.

Design of Rolling Contact Bearings: Static and dynamic load capacity, Stribeck's Equation, equivalent bearing load, load-life relationships, load factor, selection of bearings from manufacturer's catalogue.

Design of Gears: Spur gears, beam strength, Lewis equation, design for dynamic and wear loads.

Note: Data book is not allowed.



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Textbooks:

1. R.L. Norton, Machine Design an Integrated approach, 2/e, Pearson Education, 2004.
2. V.B.Bhandari, Design of Machine Elements, 3/e, Tata McGraw Hill, 2010.
3. Dr. N. C. Pandya &Dr. C. S. Shah, Machine design, 17/e, Charotar Publishing House Pvt. Ltd, 2009.

Reference Books:

1. R.K. Jain, Machine Design, Khanna Publications, 1978.
2. J.E. Shigley, Mechanical Engineering Design, 2/e, Tata McGraw Hill, 1986.
3. M.F.Spotts and T.E.Shoup, Design of Machine Elements, 3/e, Prentice Hall (Pearson Education), 2013.

Online Learning Resources:

<https://www.yumpu.com/en/document/view/18818306/lesson-3-course-name-design-of-machine-elements-1-npte>
<https://www.digimat.in/nptel/courses/video/112105124/L01.html>
<https://dokumen.tips/documents/nptel-design-of-machine-elements-1.html>
<http://www.nitttrc.edu.in/nptel/courses/video/112105124/L25.html>

Course Outcomes:

At the end of the course the students will be able to

- Design the machine members subjected to static and dynamic loads.
- Design shafts and couplings for power transmission
- Learn how to design bolted and welded joints.
- Know the design procedures of clutches, brakes and springs.
- Design bearings and gears.



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III Year-I Semester	DESIGN FOR MANUFACTURING (Professional Elective-I)	L	T	P	C
		3	0	0	3

Course Objectives: The students will acquire the knowledge:

- 1) To understand the basic concepts of design for manual assembly
- 2) To interpret basic design procedure of machining processes
- 3) To understand design considerations metal casting, extrusion and sheet metal work
- 4) To interpret the design considerations of various metal joining process.
- 5) To interpret the basic design concepts involved in the assembly automation

UNIT-1

Introduction to DFM, DFMA: How Does DFMA Work? Reasons for Not Implementing DFMA, What Are the Advantages of Applying DFMA During Product Design? Typical DFMA Case Studies, Overall Impact of DFMA on Industry.

Design for Manual Assembly: General Design Guidelines for Manual Assembly, Development of the Systematic DFA Methodology, Assembly Efficiency, Effect of Part Symmetry, Thickness, weight on Handling Time, Effects of Combinations of Factors and application of the DFA Methodology.

UNIT- 2

Machining processes: Overview of various machining processes-general design rules for machining dimensional tolerance and surface roughness-Design for machining – ease –redesigning of components for machining ease with suitable examples. General design recommendations for machined parts.

UNIT – 3

Metal casting: Appraisal of various casting processes, selection of casting process,- general design considerations for casting-casting tolerance-use of solidification, simulation in casting design product design rules for sand casting.

Extrusion & Sheet metal work: Design guide lines extruded sections-design principles for punching, blanking, bending, and deep drawing-Keeler Goodman forging line diagram – component design for blanking.

UNIT- 4

Metal joining: Appraisal of various welding processes, factors in design of weldments – general design guidelines-pre and post treatment of welds-effects of thermal stresses in weld joints-design of brazed joints. **Forging:** Design factors for forging – closed die forging design – parting lines of dies –drop forging die design – general design recommendations.

UNIT- 5

Design for Assembly Automation: Fundamentals of automated assembly systems, System configurations, parts delivery system at workstations, various escapement and placement devices used in automated assembly systems, Quantitative analysis of Assembly systems, Multi station assembly systems, and single station assembly lines.



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Design for Additive Manufacturing:

Introduction to AM, DFMA concepts and objectives, AM unique capabilities, exploring design freedoms, Design tools for AM, Part Orientation, Removal of Supports, Hollowing out parts, Inclusion of Undercuts and Other Manufacturing Constraining Features, Interlocking Features, Reduction of Part Count in an Assembly, Identification of markings/ numbers.

TEXT BOOKS:

1. Design for manufacture, John Cobert, Adisson Wesley. 1995
2. Design for Manufacture by Boothroyd,
3. Design for manufacture, James Bralla,

REFERENCE:

1. Molloy, E.A. Warman, S. Tilley, Design for Manufacturing and Assembly: Concepts, Architectures and Implementation, Springer, 1998
2. ASM Hand book Vol.20

Course Outcomes: At the end of the course, student will be able to

CO1: Understand the basic concepts of design for manual assembly

CO2: Identify basic design procedure of various machining processes.

CO3: Illustrate the design considerations metal casting, extrusion and sheet metal work

CO4: Interpret the design considerations of various metal joining process.

CO5: Understand the basic design concepts involved in the assembly automation



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III Year I Semester	CONVENTIONAL AND FUTURISTIC VEHICLE TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- 1.To study the advanced engine technologies
- 2.To learn various advanced combustion technologies and its benefits
- 3.To learn the methods of using low carbon fuels and its significance
- 4.To learn and understand the hybrid and electric vehicle configurations
- 5.To study the application of fuel cell technology in automotive

UNIT – I: ADVANCED ENGINE TECHNOLOGY

Gasoline Direct Injection, Common Rail Direct Injection, Variable Compression Ratio Turbocharged Engines, Electric Turbochargers, VVT, Intelligent Cylinder De-activation, After Treatment Technologies, Electric EGR, Current EMS architecture.

UNIT – II: COMBUSTION TECHNOLOGY

Spark Ignition combustion, Compression Ignition Combustion, Conventional Dual Fuel Combustion, Low Temperature Combustion Concepts– Controlled Auto Ignition, Homogeneous Charge Compression Ignition, Premixed Charge Compression Ignition, Partially Premixed Compression Ignition, Reactivity Controlled Compression Ignition, Gasoline Direct Injection Compression Ignition.

UNIT – III: LOW CARBON FUEL TECHNOLOGY

Alcohol Fuels, Ammonia Fuel and Combustion, Methane Technology, Dimethyl Ether, Hydrogen Fuel Technology, Challenges, and way forward

UNIT – IV: HYBRID AND ELECTRIC VEHICLE (BATTERY POWERED)

Conventional Hybrids (Conventional ICE + Battery), Modern Hybrids (RCCI/GDCI Engine + Battery), Pure Electric Vehicle Technology – Challenges and Way forward

UNIT – V: FUEL CELL TECHNOLOGY

Fuel cells for automotive applications - Technology advances in fuel cell vehicle systems - Onboard hydrogen storage - Liquid hydrogen and compressed hydrogen - Metal hydrides, Fuel cell control system - Alkaline fuel cell - Road map to market.

TEXT BOOKS:

- 1.Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
- 2.Rakesh Kumar Maurya, Characteristics and Control of Low Temperature Combustion Engines. ISBN 978-3-319-68507-6 , SPRINGER

REFERENCES:

- 1.Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
- 2.James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003
- 3.Rand D.A.J, Woods, R & Dell RM Batteries for Electric vehicles, John Wiley & Sons, 1998



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4. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
5. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003

Course Outcomes: At the end of the course the students would be able to

1. Discuss the latest trends in engine technology
2. Discuss the need of advanced combustion technologies and its impact on reducing carbon foot-print on the environment.
3. Analyzing the basic characteristics of low carbon fuels, its impact over conventional fuels and in achieving sustainable development goals.
4. Discuss the working and energy flow in various hybrid and electric configurations.
5. Analyzing the need for fuel cell technology in automotive applications.



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III Year I Semester	RENEWABLE ENERGY TECHNOLOGIES	L	T	P	C
		3	0	0	3

Course objectives:

1. To demonstrate the importance the impact of solar radiation, solar PV modules
2. To understand the principles of storage in PV systems
3. To discuss solar energy storage systems and their applications.
4. To get knowledge in wind energy and bio-mass
5. To gain insights in geothermal energy, ocean energy and fuel cells.

UNIT – 1

SOLAR RADIATION: Role and potential of new and renewable sources, the solar energy option, Environmental impact of solar power, structure of the sun, the solar constant, sun-earth relationships, coordinate systems and coordinates of the sun, extraterrestrial and terrestrial solar radiation, solar radiation on tilted surface, instruments for measuring solar radiation and sun shine, solar radiation data, numerical problems.

SOLAR PV MODULES AND PV SYSTEMS:

PV Module Circuit Design, Module Structure, Packing Density, Interconnections, Mismatch and Temperature Effects, Electrical and Mechanical Insulation, Lifetime of PV Modules, Degradation and Failure, PV Module Parameters, Efficiency of PV Module, Solar PV Systems-Design of Off Grid Solar Power Plant. Installation and Maintenance.

UNIT – 2

STORAGE IN PV SYSTEMS:

Battery Operation, Types of Batteries, Battery Parameters, Application and Selection of Batteries for Solar PV System, Battery Maintenance and Measurements, Battery Installation for PV System.

UNIT – 3

SOLAR ENERGY COLLECTION: Flat plate and concentrating collectors, classification of concentrating collectors, orientation.

SOLAR ENERGY STORAGE AND APPLICATIONS: Different methods, sensible, latent heat and stratified storage, solar ponds, solar applications- solar heating/cooling technique, solar distillation and drying, solar cookers, central power tower concept and solar chimney.

UNIT – 4

WIND ENERGY: Sources and potentials, horizontal and vertical axis windmills, performance characteristics, betz criteria, types of winds, wind data measurement.

BIO-MASS: Principles of bio-conversion, anaerobic/aerobic digestion, types of bio-gas digesters, gas yield, utilization for cooking, bio fuels, I.C. engine operation and economic aspects.

UNIT – 5

GEOTHERMAL ENERGY: Origin, Applications, Types of Geothermal Resources, Relative Merits



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OCEAN ENERGY: Ocean Thermal Energy; Open Cycle & Closed Cycle OTEC Plants, Environmental Impacts, Challenges

FUEL CELLS: Introduction, Applications, Classification, Different Types of Fuel Cells Such as Phosphoric Acid Fuel Cell, Alkaline Fuel Cell, PEM Fuel Cell, MC Fuel Cell.

Text Books:

1. Solar Energy – Principles of Thermal Collection and Storage/Sukhatme S.P. and J.K.Nayak/TMH
2. Non-Conventional Energy Resources- Khan B.H/ Tata McGraw Hill, New Delhi, 2006
3. Green Manufacturing Processes and Systems - J. Paulo Davim/Springer 2013

References:

1. Principles of Solar Engineering - D.YogiGoswami, Frank Krieth& John F Kreider / Taylor & Francis
2. Non-Conventional Energy - Ashok V Desai /New Age International (P) Ltd
3. Renewable Energy Technologies -Ramesh & Kumar /Narosa
4. Non-conventional Energy Source- G.D Roy/Standard Publishers

Course Outcomes: At the end of the course, student will be able to

CO1	Illustrate the importance of solar radiation and solar PV modules.
CO2	Discuss the storage methods in PV systems
CO3	Explain the solar energy storage for different applications
CO4	Understand the principles of wind energy, and bio-mass energy.
CO5	Attain knowledge in geothermal energy, ocean energy and fuel cells.



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III Semester	Year I	NON- DESTRUCTIVE EVALUATION	L	T	P	C
			3	0	0	3

Course Objectives:

1. To learn basic concepts of non-destructive testing and industrial applications
2. To understand the elements of ultrasonic test and limitations of ultrasonic test
3. To learn the concepts involved in the liquid penetrant test and eddy current test
4. To know the basic principles and operating procedures of magnetic particle testing
5. To understand the basic concepts involved in the infrared and thermal testing

UNIT – 1

Introduction to non-destructive testing and industrial Applications of NDE: Span of NDE Activities Railways, Nuclear, Non-nuclear and Chemical Industries, Aircraft and Aerospace Industries, Automotive Industries, Offshore Gas and Petroleum Projects, Coal Mining Industry, NDE of pressure vessels, castings, welded constructions. Radiographic test, Sources of X and Gamma Rays and their interaction with Matter, Radiographic equipment, Radiographic Techniques, Safety Aspects of Industrial Radiography, neutron ray radiography

UNIT – 2

Ultrasonic test: Principle of Wave Propagation, Reflection, Refraction, Diffraction, Mode Conversion and Attenuation, Sound Field, Piezo-electric Effect, Ultrasonic Transducers and their Characteristics, Ultrasonic Equipment and Variables Affecting Ultrasonic Test, Ultrasonic Testing, Interpretations and Guidelines for Acceptance, Rejection - Effectiveness and Limitations of Ultrasonic Testing.

UNIT – 3

Liquid Penetrant Test: Liquid Penetrant Test, Basic Concepts, Liquid Penetrant System, Test Procedure, Effectiveness, DPI, FPI, Limitations of Liquid Penetrant Testing.

Eddy Current Test: Principle of Eddy Current, Eddy Current Test System, Applications of Eddy Current Testing Effectiveness of Eddy Current Testing

UNIT – 4

Magnetic Particle Test: Magnetic Materials, Magnetization of Materials, Demagnetization of Materials, Principle of Magnetic Particle Test, Magnetic Particle Test Equipment, Magnetic Particle Test Procedure, Standardization and Calibration, Interpretation and Evaluation, Effective Applications and Limitations of the Magnetic Particle Test

UNIT – 5

Infrared And Thermal Testing: Introduction and fundamentals to infrared and thermal testing—Heat transfer—Active and passive techniques—Lock in and pulse thermography, tomography—Contact and non-contact thermal inspection methods—Heat sensitive paints—Heat sensitive papers—thermally quenched phosphors liquid crystals—techniques for applying liquid crystals—other temperature sensitive coatings



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–Inspection methods –Infrared radiation and infrared detectors–thermo mechanical behaviour of materials–IR imaging in aerospace applications, electronic components, Honey comb and sandwich structures–Case studies.

TextBooks:

1. Nondestructive test and evaluation of Materials/J Prasad, GCK Nair/TMH Publishers
2. Ultrasonic testing of materials/ H KrautKramer/Springer
3. Nondestructive testing/Warren, J Mc Gonnagle / Godan and Breach Science publishers
4. Nondestructive evaluation of materials by infrared thermography / X. P. V. Maldague, Springer-Verlag, 1st edition, (1993)

References:

CO1	Understand the concepts of various NDE techniques and the requirements of radiography techniques and safety aspects.
CO2	Interpret the principles and procedure of ultrasonic testing
CO3	Understand the principles and procedure of Liquid penetration and eddy current testing
CO4	Illustrate the principles and procedure of Magnetic particle testing
CO5	Interpret the principles and procedure of infrared testing and thermal testing

1. Ultrasonic inspection training for NDT/E.A.Gingel/PrometheusPress,
2. ASTMStandards, Vol3.01, Metalsandalloys
3. Non-destructive Evaluation, Hand Book – R. HamChand

Course Outcomes: At the end of the course, student will be able to



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III Year I Semester	SUSTAINBLE ENERGY TECHNOLOGIES	L	T	P	C
		3	0	0	3

Course objectives:

1. To demonstrate the importance the impact of solar radiation, solar PV modules
2. To understand the principles of storage in PV systems
3. To discuss solar energy storage systems and their applications.
4. To get knowledge in wind energy and bio-mass
5. To gain insights in geothermal energy, ocean energy and fuel cells.

UNIT – 1

SOLAR RADIATION: Role and potential of new and renewable sources, the solar energy option, Environmental impact of solar power, structure of the sun, the solar constant, sun-earth relationships, coordinate systems and coordinates of the sun, extraterrestrial and terrestrial solar radiation, solar radiation on tilted surface, instruments for measuring solar radiation and sun shine, solar radiation data, numerical problems.

SOLAR PV MODULES AND PV SYSTEMS:

PV Module Circuit Design, Module Structure, Packing Density, Interconnections, Mismatch and Temperature Effects, Electrical and Mechanical Insulation, Lifetime of PV Modules, Degradation and Failure, PV Module Parameters, Efficiency of PV Module, Solar PV Systems-Design of Off Grid Solar Power Plant. Installation and Maintenance.

UNIT – 2

STORAGE IN PV SYSTEMS:

Battery Operation, Types of Batteries, Battery Parameters, Application and Selection of Batteries for Solar PV System, Battery Maintenance and Measurements, Battery Installation for PV System.

UNIT – 3

SOLAR ENERGY COLLECTION: Flat plate and concentrating collectors, classification of concentrating collectors, orientation.

SOLAR ENERGY STORAGE AND APPLICATIONS: Different methods, sensible, latent heat and stratified storage, solar ponds, solar applications- solar heating/cooling technique, solar distillation and drying, solar cookers, central power tower concept and solar chimney.

UNIT – 4

WIND ENERGY: Sources and potentials, horizontal and vertical axis windmills, performance characteristics, betz criteria, types of winds, wind data measurement.

BIO-MASS: Principles of bio-conversion, anaerobic/aerobic digestion, types of bio-gas digesters, gas yield, utilization for cooking, bio fuels, I.C. engine operation and economic aspects.

UNIT – 5

GEOTHERMAL ENERGY: Origin, Applications, Types of Geothermal Resources, Relative Merits

OCEAN ENERGY: Ocean Thermal Energy; Open Cycle & Closed Cycle OTEC Plants, Environmental Impacts, Challenges



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FUEL CELLS: Introduction, Applications, Classification, Different Types of Fuel Cells Such as Phosphoric Acid Fuel Cell, Alkaline Fuel Cell, PEM Fuel Cell, MC Fuel Cell.

Text Books:

1. Solar Energy – Principles of Thermal Collection and Storage/Sukhatme S.P. and J.K.Nayak/TMH
2. Non-Conventional Energy Resources- Khan B.H/ Tata McGraw Hill, New Delhi, 2006
3. Green Manufacturing Processes and Systems - J. Paulo Davim/Springer 2013

References:

1. Principles of Solar Engineering - D.YogiGoswami, Frank Krieth& John F Kreider / Taylor & Francis
2. Non-Conventional Energy - Ashok V Desai /New Age International (P) Ltd
3. Renewable Energy Technologies -Ramesh & Kumar /Narosa
4. Non-conventional Energy Source- G.D Roy/Standard Publishers

Course Outcomes: At the end of the course, student will be able to

CO1	Illustrate the importance of solar radiation and solar PV modules.
CO2	Discuss the storage methods in PV systems
CO3	Explain the solar energy storage for different applications
CO4	Understand the principles of wind energy, and bio-mass energy.
CO5	Attain knowledge in geothermal energy, ocean energy and fuel cells.



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III Year I Semester	APPLIED OPERATIONS RESEARCH	L	T	P	C
		3	0	0	3

Course Objectives: To

1. Understand Linear Programming models
2. Learn Transportation and sequencing problems
3. Solve replacement problems and analyze games theory models
4. Understand waiting line and project management problems
5. Learn dynamic programming and simulation.

UNIT – 1

INTRODUCTION - definition– characteristics and phases – types of operation research models – applications.

Linear programming: Problem formulation – graphical solution – simplex method – artificial variables techniques -two–phase method, big-M method – duality principle.

UNIT – 2

TRANSPORTATION PROBLEM: Formulation – optimal solution, unbalanced transportation problem – degeneracy, assignment problem – formulation – optimal solution - variants of assignment problem- travelling salesman problem.

SEQUENCING – Introduction – flow –shop sequencing – n jobs through two machines – n jobs through three machines – job shop sequencing – two jobs through 'm' machines.

UNIT – 3

REPLACEMENT THEORY: Introduction – replacement of items that deteriorate with time – when money value is not counted and counted – replacement of items that fail completely, group replacement.

GAME THEORY: Introduction – mini. max (max. mini) – criterion and optimal strategy – solution of games with saddle points – rectangular games without saddle points – 2×2 games – dominance principle – $m \times 2$ & $2 \times n$ games -graphical method.

UNIT – 4

WAITING LINES: Introduction – single channel – poisson arrivals – exponential service times – with infinite population and finite population models– multichannel – poisson arrivals – exponential service times with infinite population single channel.

PROJECT MANAGEMENT: Basics for construction of network diagram, Program Evaluation and Review Technique (PERT), Critical Path Method (CPM) – PERT Vs. CPM, determination of floats- Project crashing and its procedure.

UNIT – 5

DYNAMIC PROGRAMMING: Introduction – Bellman's principle of optimality – applications of dynamic programming-shortest path problem – linear programming problem.



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SIMULATION: Definition – types of simulation models – phases of simulation– applications of simulation – inventory and queuing problems – advantages and disadvantages

Text Books:

1. Operations Research-An Introduction/Hamdy A Taha/Pearson publishers
2. Operations Research –Theory & publications / S.D.SharmaKedarnath/McMillan publishers India Ltd

References:

1. Introduction to O.R/Hiller &Libermann/TMH
2. Operations Research /A.M. Natarajan, P. Balasubramani, A. Tamilarasi /Pearson Education.
3. Operations Research: Methods & Problems / Maurice Saseini, ArhurYaspan& Lawrence Friedman/Wiley
4. Operations Research / R.Panner selvam/ PHI Publications.
5. Operations Research / Wagner/ PHI Publications.
6. Operation Research /J.K.Sharma/Macmillan Publ.
7. Operations Research/ Pai/ Oxford Publications
8. Operations Research/S Kalavathy / Vikas Publishers
9. Operations Research / DS Cheema/University Science Press
10. Operations Research / Ravindran, Philips, Solberg / Wiley publishers

Course Outcomes: At the end of the course, student will be able to

- CO1** Understand Linear Programming models
- CO2** Interpret Transportation and sequencing problems
- CO3** Solve replacement problems and analyze queuing models
- CO4** Understand game theory and inventory problems
- CO5** Interpret dynamic programming and simulation.



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III Semester	Year I	NANO TECHNOLOGY	L	T	P	C
			3	0	0	3

Course Objectives:

1. To understand the classification of Nano structured Materials
2. To understand the unique properties of Nano materials
3. To interpret the Synthesis Routes - Bottom up and Top down approaches
4. To identify the tools to characterize Nano materials
5. To understand the applications of Nano materials

UNIT – 1

INTRODUCTION: History and Scope, Classification of Nano structured Materials, Fascinating Nanostructures, and applications of nano-materials, challenges and future prospects.

UNIT – 2

UNIQUE PROPERTIES OF NANO MATERIALS: Microstructure and Defects in Nano crystalline Materials: Dislocations, Twins, stacking faults and voids, Grain Boundaries, triple and disclinations. Effect of Nano-dimensions on Materials Behavior: Elastic properties, Melting Point, Diffusivity, Grain growth characteristics, enhanced solid solubility. Magnetic Properties: Soft magnetic nanocrystalline alloy, Permanent magnetic nanocrystalline materials, Giant Magnetic Resonance, Electrical Properties, Optical Properties, Thermal Properties and Mechanical Properties.

UNIT – 3

SYNTHESIS ROUTES: Bottom up approaches: Physical Vapor Deposition, Inert Gas Condensation, Laser Ablation, Chemical Vapor Deposition, Molecular Beam Epitaxy, Sol-gel method, Self-assembly. Top down approaches: Mechanical alloying, Nano-lithography. Consolidation of Nano powders: Shock wave consolidation, Hot iso-static pressing and Cold iso-static pressing, Spark plasma sintering.

UNIT – 4

TOOLS TO CHARACTERIZE NANOMATERIALS: X-Ray Diffraction (XRD), Small Angle X-ray scattering, Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Atomic Force Microscopy (AFM), Scanning Tunneling Microscope (STM), Field Ion Microscope (FEM), Three-dimensional Atom Probe (3DAP), Nano indentation.

UNIT – 5

APPLICATIONS OF NANO MATERIALS: Nano-electronics, Micro- and Nano-electromechanical systems (MEMS/NEMS), Nano sensors, Nano catalysts, Food and



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Agricultural Industry, Cosmetic and Consumer Goods, Structure and Engineering, Automotive Industry, Water- Treatment and the environment, Nano-medical applications, Textiles, Paints, Energy, Defense and Space Applications, Concerns and challenges of Nanotechnology

TEXT BOOKS:

1. Introduction to Nano Technology by Charles. P. Poole Jr& Frank J. Owens.Wiley India Pvt. Ltd.
2. Nano Materials- A.K.Bandyopadhyay/ New Age Publishers.
3. Nano Essentials- T.Pradeep/TMH

REFERENCE BOOKS:

1. Solid State physics by Pillai, Wiley Eastern Ltd.
2. Introduction to solid state physics 7th edition by Kittel. John Wiley & sons (Asia) Pvt Ltd.

Course Outcomes: At the end of the course, student will be able to

- CO1** Understand the classification of nanostructured Materials
- CO2** Understand the unique properties of nano materials
- CO3** Interpret the Synthesis Routes - Bottom up and Top down approaches
- CO4** Identify the tools to characterize nano materials
- CO5** Understand the applications of nano materials



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III Year I Semester	THERMAL MANAGEMENT OF ELECTRONIC SYSTEMS	L	T	P	C
		3	0	0	3

Course Objective:

1. To understand the basics of heat transfer and analyze heat transfer through fins
2. To acquire the knowledge on Free and forced convective systems.
3. To understand the air cooling and single phase liquid cooling systems with case studies.
4. To demonstrate the concepts of two phase cooling and heat pipes.
5. To understand thermo electric coolers, mini and micro channels.

UNIT – 1

Introduction of Heat Transfer: Modes – Conduction, Convection and Radiation – Basic Laws – Applications of Heat Transfer.

Basics of Conduction –Conduction equation – Thermal analogy – Lumped heat capacity analysis - Heat conduction with phase change - Thermal Resistance – Extended Surfaces – Uniform cross section fins – Fin efficiency – Selection and design of fins

UNIT – 2

Forced and Free Convection – Heat transfer coefficient - Parameters effecting heat transfer – Thermal Properties of fluids - Combined Modes.

Radiation – Stefan- Boltzmann Law – Kirchoff's law and Emissivity – Radiation between Black Isothermal Surfaces – Radiation between Grey Isothermal Surfaces – Extreme Climatic conditions - Radiation at normal ambient Temperature measurement and its Instrumentation.

UNIT – 3

Printed Circuit boards – Chip packaging – thermal Resistance – Board Cooling methods – Board thermal Analysis – Equivalent thermal Conductivity.

Air Cooling – Fans – Heat transfer Enhancement – Air handling systems - Blowers

Single Phase Cooling – Coolant Selection – Natural Convection – Forced Convection - Air Cooling - Convective cooling in Small systems – Forced cooling in medium and large systems – Liquid cooling in high power modules – Case Studies.

UNIT – 4

Two Phase Cooling – Direct Immersion Cooling – Basics of Pool Boiling – Enhancement of Pool Boiling – Flow Boiling.

Heat Pipes – Operation Principles – Useful Characteristics – Operating Limits and Temperatures – Operation Methods – Applications – Micro Heat Pipes.



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UNIT – 5

Thermo Electric coolers: Basics theories – Thermo electric effect – Operation Principles.

Phase change materials, Thermal Interface materials, Heat Spreaders and Heat Sinks – Working Principles

Mini and Micro Channels. Use of nano fluids in electronic cooling.

Text Books:

1. Thermal Analysis and Control of Electronic Equipment – Allan D. Kraus and AvramBarCohen, McGraw Hill, New York, NY, 1983.
2. Fundamentals of Microelectronics Packaging – Ed: Rao Tummala, McGraw Hill, New York, NY, 2001.
3. Packaging of Electronic Systems – James W. Dally, McGraw Hill, New York, NY, 1990.

Course Outcomes: At the end of the course, student will be able to

CO1	Understand the basics of heat transfer and analyze heat transfer through fins
CO2	Acquire the knowledge on Free and forced convective systems
CO3	Understand the air cooling and single phase liquid cooling systems with case studies
CO4	Demonstrate the concepts of Two phase cooling and heat pipes
CO5	Understand thermo electric coolers, mini and micro channels



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III YearI Semester	ENTREPRENEURSHIP	L	T	P	C
		3	0	0	3

Course objective:

- 1) To develop and strengthen entrepreneurial quality and motivation in students.
- 2) To impart basic entrepreneurial skills and understandings to run a business efficiently and effectively.

UNIT-I : ENTREPRENEURIAL COMPETENCE

Entrepreneurship concept – Entrepreneurship as a Career – Entrepreneurial Personality - Characteristics of Successful, Entrepreneur – Knowledge and Skills of Entrepreneur.

UNIT-II: ENTREPRENEURIAL ENVIRONMENT

Business Environment - Role of Family and Society - Entrepreneurship Development Training and Other Support Organisational Services.

UNIT-III: INDUSTRIAL POLACIES

Central and State Government Industrial Policies and Regulations - International Business.

UNIT-IV: BUSINESS PLAN PREPARATION

Sources of Product for Business - Prefeasibility Study - Criteria for Selection of Product - Ownership - Capital - Budgeting Project Profile Preparation - Matching Entrepreneur with the Project - Feasibility Report Preparation and Evaluation Criteria.

UNIT- V: LAUNCHING OF SMALL BUSINESS

Finance and Human Resource Mobilization Operations Planning - Market and Channel Selection - Growth Strategies - Product Launching – Incubation, Venture capital, IT startups.

Monitoring and Evaluation of Business - Preventing Sickness and Rehabilitation of Business Units- Effective Management of small Business.

TEXT BOOKS

1. Hisrich, Entrepreneurship, Tata McGraw Hill, New Delhi, 2001.
2. S.S.Khanka, Entrepreneurial Development, S.Chand and Company Limited, NewDelhi, 2001.



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REFERENCES

1. Mathew Manimala, Entrepreneurship Theory at the Crossroads, Paradigms & Praxis, Biztrantra ,2nd Edition ,2005
2. Prasanna Chandra, Projects – Planning, Analysis, Selection, Implementation and Reviews, Tata McGraw-Hill, 1996.
3. P.Saravanavel, Entrepreneurial Development, Ess Pee kay Publishing House, Chennai -1997.
4. Arya Kumar. Entrepreneurship. Pearson. 2012 5. Donald F Kuratko, T.V Rao. Entrepreneurship: A South Asian perspective. Cengage Learning. 2012

III Year I Semester	THERMAL ENGINEERING LAB	L	T	P	C
		0	0	3	1.5

COURSE OUTCOME: Students will gain knowledge and skills needed to run a business.

Course objectives:

- 1) To demonstrate the characteristics of two stroke and four stroke compression and spark ignition engines.
- 2) To determine flash point, fire point, calorific value of different fuels using various apparatus.
- 3) To find out engine friction, and conduct load test of petrol and diesel engines.
- 4) To demonstrate performance test on petrol and diesel engines.
- 5) To conduct performance test and determine efficiency of air compressor.

Experiments:

1. To determine the actual Valve Timing diagram of a four stroke Compression/Spark Ignition Engine.
2. To determine the actual Port Timing diagram of a two stroke Compression/Spark Ignition Engine.
3. Determination of Flash & Fire points of Liquid fuels / Lubricants using (i) Abels Apparatus; (ii) Pensky Martin's apparatus and (iii) Cleveland's apparatus.
4. Determination of Viscosity of Liquid lubricants/Fuels using (i) Saybolt Viscometer and (ii) Redwood Viscometer.
5. Evaluation of engine friction by conducting Morse test on 4-stroke multi cylinder petrol/diesel engine.
6. To perform the Heat Balance Test on Single Cylinder four Stroke Petrol/Diesel Engine.
7. To conduct a load test on a single cylinder Petrol/Diesel engine to study its performance under various loads.
8. To conduct a performance test on a VCR engine, under different compression ratios and determine its heat balance sheet.
9. To conduct a performance test on an air compressor and determine its different efficiencies.



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10. Study of boilers with accessories and mountings
11. Experimentation on installation of Solar PV Cells
12. Demonstration of electronic controls in an automobile.

Course outcomes: At the end of the course, student will be able to

CO1: Experiment with two stroke and four stroke compression and spark ignition engines for various characteristics.

CO2: Determine flash point, fire point, calorific value of different fuels using various apparatus.

CO3: Perform engine friction, heat balance test, load test of petrol and diesel engines.

CO4: Conduct performance test on petrol and diesel engines

CO5: Perform test and determine efficiency of air compressor

III YearI Semester	THEORY OF MACHINES LAB	L	T	P	C
		0	0	3	1.5

Course Objectives

- To demonstrate the motion of a gyroscope
- To study the characteristics of governors
- To find the frequencies of damped and undamped free and forced vibrations
- To analyze different mechanisms
- To demonstrate various types of gears

List of Experiments:

1. To determine whirling speed of shaft theoretically and experimentally.
2. To determine the position of sleeve against controlling force and speed of a Hartnell governor and to plot the characteristic curve of radius of rotation.
3. To analyse the motion of a motorized gyroscope when the couple is applied along its spin axis
4. To determine the frequency of undamped free vibration of an equivalent spring mass system.
5. To determine the frequency of damped force vibration of a spring mass system
6. To study the static and dynamic balancing using rigid blocks.
7. To find the moment of inertia of a flywheel
8. To plot follower displacement vs cam rotation for various Cam Follower systems.
9. To plot slider displacement, velocity and acceleration against crank rotation for single slider crank mechanism/Four bar mechanism
10. To find the coefficient of friction between the belt and pulley.
11. To study simple and compound screw jack and determine the mechanical advantage, velocity ratio, and efficiency
12. To study various types of gears- Spur, Helical, Worm and Bevel Gears

Course Outcomes:

- Get knowledge about the motion of a gyroscope
- Discuss the characteristics of governors
- Find the frequencies of damped and undamped free and forced vibrations



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- Analyze different mechanisms
- Demonstrate various types of gears

III Year I Semester	MACHINE TOOLS & METROLOGY LAB	L	T	P	C
		0	0	4	2

Course Objectives:

- 1.To understand the parts of various machine tools and about different shapes of products that can be produced on them.
2. To measure bores, angles and tapers
3. To perform alignment tests on various machines

Note: The students have to conduct at least 6 experiments from each lab

MACHINE TOOLS LAB

- 1.Introduction of general purpose machines -Lathe, Drilling machine, Milling machine, Shaper, Planing machine, Slotting machine, Cylindrical grinder, Surface grinder and Tool and cutter grinder.
2. Operations on Lathe machines- Step turning, Knurling, Taper turning, Thread cutting and Drilling
3. Operations on Drilling machine - Drilling, reaming, tapping, Rectangular drilling, circumferential drilling
4. Operations on Shaping machine - (i) Round to square(ii) Round to Hexagonal
5. Operations on Slotter - (i) Keyway (T –slot) (ii) Keyway cutting
6. Operations on milling machines - (i) Indexing (ii) Gear manufacturing

METROLOGY LAB

1. Calibration of vernier calipers, micrometers, vernier height gauge and dialgauges.
2. Measurement of bores by internal micrometers and dial bore indicators.
3. Use of gear tooth vernier caliper for tooth thickness inspection and flange micrometer for checking the chordal thickness of spur gear.
4. Machine tool alignment test on the lathe.



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5. Machine tool alignment test on drilling machine.
6. Machine tool alignment test on milling machine.
7. Angle and taper measurements with bevel protractor, Sine bar, rollers and balls.
8. Use of spirit level in finding the straightness of a bed and flatness of a surface.
9. Thread inspection with two wire/ three wire method & tool makers microscope.
10. Surface roughness measurement with roughness measuring instrument.

Course Outcomes: At the end of the course, student will be able to

1. Gain knowledge about the parts of various machine tools and about different shapes of products that can be produced on them.
2. Learn measure bores, angles and tapers
3. Perform alignment tests on various machines



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III YearI Semester	TINKERING LAB	L	T	P	C
		0	0	2	1

The aim of tinkering lab for engineering students is to provide a hands-on learning environment where students can explore, experiment, and innovate by building and testing prototypes. These labs are designed to demonstrate practical skills that complement theoretical knowledge.

Course Objectives: To

1. **Encourage Innovation and Creativity**
2. **Provide Hands-on Learning**
3. **Impart Skill Development**
4. **Foster Collaboration and Teamwork**
5. **Enable Interdisciplinary Learning**
6. **Impart Problem-Solving mind-set**
7. **Prepare for Industry and Entrepreneurship**

These labs bridge the gap between academia and industry, providing students with the practical experience. Some students may also develop entrepreneurial skills, potentially leading to start-ups or innovation-driven careers. Tinkering labs aim to cultivate the next generation of engineers by giving them the tools, space, and mind-set to experiment, innovate, and solve real-world challenges.

List of experiments:

- 1) Make your own parallel and series circuits using breadboard for any application of your choice.
- 2) Demonstrate a traffic light circuit using breadboard.
- 3) Build and demonstrate automatic Street Light using LDR.
- 4) Simulate the Arduino LED blinking activity in Tinkercad.
- 5) Build and demonstrate an Arduino LED blinking activity using Arduino IDE.
- 6) Interfacing IR Sensor and Servo Motor with Arduino.
- 7) Blink LED using ESP32.
- 8) LDR Interfacing with ESP32.
- 9) Control an LED using Mobile App.
- 10) Design and 3D print a Walking Robot
- 11) Design and 3D Print a Rocket.
- 12) Build a live soil moisture monitoring project, and monitor soil moisture levels of a remote plan in your computer dashboard.
- 13) Demonstrate all the steps in design thinking to redesign a motor bike.

Students need to refer to the following links:

- 1) <https://aim.gov.in/pdf/equipment-manual-pdf.pdf>
- 2) <https://atl.aim.gov.in/ATL-Equipment-Manual/>
- 3) <https://aim.gov.in/pdf/Level-1.pdf>
- 4) <https://aim.gov.in/pdf/Level-2.pdf>
- 5) <https://aim.gov.in/pdf/Level-3.pdf>

Course Outcomes: The students will be able to experiment, innovate, and solve real-



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world challenges.

III Year I Semester	COMMUNITY SERVICE INTERNSHIP	L	T	P	C
		--	--	--	2



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III Year II Semester	HEAT TRANSFER	L	T	P	C
		3	0	0	3

Course Objectives:

1. To learn the different modes of heat transfer and conduction heat transfer through various solid bodies
2. To learn the one dimensional steady state heat conduction heat transfer and one dimensional transient heat conduction
3. To learn the basic concepts of convective heat transfer and forced convection heat transfer of external flows and internal flows
4. To learn the free convection heat transfer concepts and heat transfer processes in heat exchangers
5. To learn the concepts of radiation heat transfer.

UNIT – 1

Introduction

Modes and mechanisms of heat transfer – Basic laws of heat transfer –General discussion about applications of heat transfer.

Conduction Heat Transfer

Fourier rate equation – General heat conduction equation in Cartesian, Cylindrical and Spherical coordinates – simplification and forms of the field equation – steady, unsteady and periodic heat transfer – Initial and boundary conditions

One Dimensional Steady State Conduction Heat Transfer

Homogeneous slabs, hollow cylinders and spheres- Composite systems– overall heat transfer coefficient – Electrical analogy – Critical radius of insulation. Variable Thermal conductivity – systems with heat sources or Heat generation-Extended surface (fins) Heat Transfer – Long Fin, Fin with insulated tip and Short Fin, Application to error measurement of Temperature.

UNIT – 2

One Dimensional Transient Conduction Heat Transfer

Systems with negligible internal resistance – Significance of Biot and Fourier Numbers –Infinite bodies- Chart solutions of transient conduction systems- Concept of Semi-infinite body.

Convective Heat Transfer

Classification of systems based on causation of flow, condition of flow, configuration of flow and medium of flow – Dimensional analysis as a tool for experimental investigation – Buckingham π Theorem and method, application for developing semi – empirical non- dimensional correlation for convection heat transfer – Significance of non-dimensional numbers – Concepts of Continuity, Momentum and Energy Equations

UNIT – 3

Forced convection: External Flows:

Concepts about hydrodynamic and thermal boundary layer and use of empirical correlations for convective heat transfer -Flat plates and Cylinders.

Internal Flows:

Concepts about Hydrodynamic and Thermal Entry Lengths – Division of internal flow



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based on this –Use of empirical relations for Horizontal Pipe Flow and annulus

flow.

Free Convection:

Development of Hydrodynamic and thermal boundary layer along a vertical plate - Use of empirical relations for Vertical plates and pipes.

UNIT – 4

Heat Transfer with Phase Change:

Boiling: – Pool boiling – Regimes – Calculations on Nucleate boiling, Critical Heat flux and Film boiling

Condensation: Film wise and drop wise condensation –Nusselt's Theory of Condensation on a vertical plate - Film condensation on vertical and horizontal cylinders using empirical correlations.

Heat Exchangers:Classification of heat exchangers – overall heat transfer Coefficient and fouling factor – Concepts of LMTD and NTU methods - Problems using LMTD and NTU methods.

UNIT – 5

Radiation Heat Transfer: Emission characteristics and laws of black-body radiation – Irradiation – total and monochromatic quantities – laws of Planck, Wien, Kirchhoff, Lambert, Stefan and Boltzmann– heat exchange between two black bodies – concepts of shape factor – Emissivity – heat exchange between grey bodies – radiation shields – electrical analogy for radiation networks

Note: Heat transfer data book by C P Kothandaraman and Subrahmanyam is allowed.

TEXT BOOKS:

1. Heat Transfer by HOLMAN, Tata McGraw-Hill
2. Heat Transfer by P.K.Nag, TMH

REFERENCE BOOKS:

1. Fundamentals of Heat Transfer by Incropera & Dewitt, John Wiley
2. Fundamentals of Engineering, Heat & Mass Transfer by R.C.Sachdeva, NewAge.
3. Heat & Mass Transfer by Amit Pal – Pearson Publishers
4. Heat Transfer by Ghoshadastidar, Oxford University press.
5. Heat Transfer by a Practical Approach, Yunus Cengel, Boles, TMH
6. Engineering Heat and Mass Transfer by Sarit K. Das, Dhanpat Rai Pub

Course Outcomes: At the end of the course, student will be able to

CO1	Find heat transfer rate for 1D, steady state composite systems with heat generation and performance of pins.
CO2	Understand the concepts transient heat conduction and basic laws involved in the convection heat transfer.



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CO3	Apply the empirical equations for forced convection and free convection problems
CO4	Examine the rate of heat transfer with phase change and in the heat exchangers.
CO5	Illustrate the concepts of radiation heat transfer



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III Year II Semester	ARTIFICIAL INTELLIGENCE & MACHINE LEARNING	L	T	P	C
		3	0	0	3

Course objectives:

- 1) To impart the basic concepts of artificial intelligence and the principles of knowledge representation and reasoning.
- 2) To introduce the machine learning concepts and supervised learning methods
- 3) To enable the students gain knowledge in unsupervised learning method and Bayesian algorithms.
- 4) To make the students learn about neural networks and genetic algorithms.
- 5) To understand the machine learning analytics and deep learning techniques.

UNIT– I:

Introduction: Definition of Artificial Intelligence, Evolution, Need, and applications in real world. Intelligent Agents, Agents and Environments; Good Behaviour - concept of rationality, the nature of environments, structure of agents.

Knowledge–Representation and Reasoning: Logical Agents: Knowledge-based agents, the Wumpus world, logic. Patterns in Propositional Logic, Inference in First-Order Logic-Propositional vs first order inference, unification.

UNIT– II:

Introduction to Machine Learning (ML): Definition, Evolution, Need, applications of ML in industry and real-world, regression and classification problems, performance metrics, differences between supervised and unsupervised learning paradigms, bias, variance, overfitting and under fitting.

Supervised Learning: Linear regression, logistic regression, Distance-based methods, Nearest-Neighbours, Decision Trees, Support Vector Machines, Nonlinearity and Kernel Methods.

UNIT– III:

Unsupervised Learning: Clustering, K-means, Dimensionality Reduction, PCA and Kernel.

Bayesian and Computational Learning: Bayes theorem, concept learning, maximum likelihood of normal, binomial, exponential, and Poisson distributions, minimum description length principle, Naïve Bayes Classifier, Instance-based Learning- K-Nearest neighbour learning.

UNIT– IV:

Neural Networks and Genetic Algorithms: Neural network representation, problems, perceptron, multilayer networks and backpropagation, steepest descent method, Convolutional neural networks and their applications Recurrent Neural Networks and their applications, Local vs Global optima, Genetic algorithms- binary coded GA, operators, convergence criteria.



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UNIT– V:

Deep Learning: Deep generative models, Deep Boltzmann Machines, Deep auto-encoders, Applications of Deep Networks.

Machine Learning Algorithm Analytics: Evaluating Machine Learning algorithms, Model, Selection, Ensemble Methods - Boosting, Bagging, and Random Forests.

TEXT BOOKS:

- 1) Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, 2/e, Pearson Education, 2010.
- 2) Tom M. Mitchell, Machine Learning, McGraw Hill, 2013.
- 3) EthemAlpaydin, Introduction to Machine Learning (Adaptive Computation and Machine Learning), The MIT Press, 2004.

REFERENCE BOOKS:

- 1) Elaine Rich, Kevin Knight and Shivashankar B. Nair, Artificial Intelligence, 3/e, McGraw Hill Education, 2008.
- 2) Dan W. Patterson, Introduction to Artificial Intelligence and Expert Systems, PHI Learning, 2012.

ONLINE RESOURCES:

<https://www.tpointtech.com/artificial-intelligence-ai>

<https://www.geeksforgeeks.org/>

Course outcomes: At the end of the course, student will be able to

- CO1: Explain the basic concepts of artificial intelligence
- CO2: Learn about the principles of supervised learning methods
- CO3: Gain knowledge in unsupervised learning method and Bayesian algorithms
- CO4: Get knowledge about neural networks and genetic algorithms.
- CO5: Understand the machine learning analytics and apply deep learning techniques.



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III Year II Semester	FINITE ELEMENT METHODS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To learn basic principles of finite element analysis procedure
2. To learn how to solve the bar and truss problems
3. To learn how to solve beam problems
4. To understand the formulation of 2D problems
5. To get knowledge in heat transfer analysis and dynamic analysis.

UNIT – 1

Introduction to finite element method, stress and equilibrium, strain–displacement relations, stress–strain relations, plane stress and plane strain conditions, variational and weighted residual methods, concept of potential energy, one-dimensional problems.

UNIT – 2

Bar element formulation, Discretization of domain, element shapes, discretization procedures, assembly of stiffness matrix, band width, node numbering, mesh generation, interpolation functions, local and global coordinates, convergence requirements, treatment of boundary conditions.

Analysis of Trusses: Finite element modeling, coordinates and shape functions, assembly of global stiffness matrix and load vector, finite element equations, treatment of boundary conditions, stress, strain and support reaction calculations

UNIT – 3

Analysis of Beams: Element stiffness matrix for Hermite beam element, derivation of load vector for concentrated and UDL, simple problems on beams.

UNIT – 4

Finite element modeling of two dimensional stress analysis with constant strain triangles and treatment of boundary conditions, formulation of axisymmetric problems. Higher order and iso-parametric elements: One dimensional, quadratic and cubic elements in natural coordinates, two dimensional four node iso-parametric elements and numerical integration.

UNIT – 5

Steady state heat transfer analysis: one dimensional analysis of a fin.

Dynamic Analysis: Formulation of finite element model, element consistent and lumped mass matrices, evaluation of eigen values and eigen vectors, free vibration analysis.

TEXTBOOK:

1. Introduction to Finite Elements in Engineering, Second Edition/ Tirupati Reddy Chandrupatla/Prentice-Hall.
2. The Finite Element Methods in Engineering /S.S.Rao/Pergamon.

REFERENCES:



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1. Finite Element Method with applications in Engineering / YM Desai, Eldho& Shah /Pearson publishers
2. An introduction to Finite Element Method /JNReddy/McGraw-Hill
3. The Finite Element Method for Engineers–Kenneth H. Huebner, Donald L. Dewhirst, DouglasE. Smith andTedG. By rom/John Wiley & sons (ASIA) PvtLtd.
4. Finite Element Analysis: Theory and Application with Ansys, Saeed Moaveniu, Pearson Education
5. Finite Element Analysis: for students & Practicing Engineers / G.LakshmiNarasaiah

Course Outcomes: At the end of the course, student will be able to

- CO1** Understand the concepts behind variational methods and weighted residual methods in FEM
- CO2** Solve bar and truss problems.
- CO3** Solve beam problems.
- CO4** Apply suitable boundary conditions for 2D stress analysis and develop the formulation for axi-symmetric problems and higher order iso-parametric elements
- CO5** Evaluate the concepts of steady state heat transfer analysis and dynamic analysis



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III YearII Semester	MECHANICAL VIBRATIONS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To learn basic principles of mathematical modeling of vibrating systems
2. To understand the basic concepts free and forced multi degree freedom systems
3. To get concepts involved in the torsional vibrations
4. To learn the principles involved in the critical speed of shafts
5. To understand the basic concepts of Laplace transformations response to different inputs

UNIT – 1

Relevance of and need for vibrational analysis – Basics of SHM - Mathematical modelling of vibrating systems - Discrete and continuous systems - single-degree freedom systems - free and forced vibrations, damped and undamped systems.

UNIT – 2

Free and forced vibrations of multi-degree freedom systems in longitudinal, torsional and lateral modes - Matrix methods of solution- normal modes - Orthogonality principle-Energy methods, Eigen values and Eigen vectors, modal analysis.

UNIT – 3

Torsional vibrations - Longitudinal vibration of rods - transverse vibrations of beams – Governing equations of motion - Natural frequencies and normal modes - Energy methods, Introduction to non- linear and random vibrations.

UNIT – 4

Vibration Measuring Instruments and Critical Speeds of Shafts: Vibrometers, Accelerometer, Frequency measuring instruments and Problems. Critical speed of a light shaft having a single disc without damping and with damping, critical speeds of shaft having multiple discs, secondary critical speed, critical speeds light cantilever shaft with a large heavy disc at its end.

UNIT – 5

Laplace transformations response to an impulsive input, response to a step input, response to pulse (rectangular and half sinusoidal pulse), phase plane method

Text books:

1. S.S.Rao, “Mechanical Vibrations”, 5th Edition, Prentice Hall, 2011.
2. L.Meirovitch, “Elements of vibration Analysis”, 2nd Edition, McGraw-Hill, New York, 1985.

References:

1. W.T. Thomson, M.D. Dahleh and C Padmanabhan, “Theory of Vibration with Applications”, 5th Edition, Pearson Education, 2008.
2. M.L.Munjial, “Noise and Vibration Control”, World Scientific, 2013.
3. Beranek and Ver, “Noise and Vibration Control Engineering: Principles and



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Applications”, John Wiley and Sons, 2006.

4. Randall F. Barron, “Industrial Noise Control and Acoustics”, Marcel Dekker, Inc., 2003.

Course Outcomes: At the end of the course, student will be able to

CO1	Understand the concepts of vibrational analysis
CO2	Understand the concepts of free and forced multi degree freedom systems
CO3	Summarize the concepts of torsional vibrations
CO4	Solve the problems on critical speed of shafts
CO5	Apply and Analyze the systems subjected to Laplace transformations response to different inputs



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III YearII Semester	ADVANCED MANUFACTURING PROCESSES	L	T	P	C
		3	0	0	3

Course Objectives:

- To learn the basic principle of advanced machining processes
- To know about the various additive manufacturing processes
- To understand the principles of coating and processing of ceramics.
- To get insights about processing of composites and nanomaterials
- To know the fabrication of microelectronic components.

UNIT – 1

ADVANCED MACHINING PROCESSES: Introduction, Need, AJM, WJM, Wire-EDM, ECM, LBM, EBM, PAM – Principle, working, advantages, limitations, Process Parameters & capabilities and applications.

UNIT – 2

ADDITIVE MANUFACTURING: Working Principles, Methods, Stereo Lithography, LENS, LOM, Laser Sintering, Fused Deposition Method, 3DP Applications and Limitations, Direct and Indirect Rapid tooling techniques.

UNIT – 3

SURFACE TREATMENT: Scope, Cleaners, Methods of cleaning, Surface coating types, Electro forming, Chemical vapour deposition, Physical vapour deposition, thermal spraying methods, Ion implantation, diffusion coating, ceramic and organic methods of coating, and cladding methods.

PROCESSING OF CERAMICS: Applications, characteristics, classification Processing of particulate ceramics, Powder preparations, consolidation, hot compaction, drying, sintering, and finishing of ceramics, Areas of application.

UNIT – 4

PROCESSING OF COMPOSITES: Composite Layers, Particulate and fiber reinforced composites, Elastomers, Reinforced plastics, processing methods for MMC, CMC, Polymer matrix composites.

PROCESSING OF NANOMATERIALS: Introduction, Top down Vs Bottom up techniques-Ball milling, Lithography, Plasma Arc Discharge, Pulsed Laser Deposition, Sputtering, Sol-Gel, Molecular beam Epitaxy.

UNIT – 5

FABRICATION OF MICROELECTRONIC DEVICES:

Crystal growth and wafer preparation, Film Deposition, oxidation, lithography, bonding and packaging, reliability and yield, Printed Circuit boards, surface mount technology, Integrated circuit economics.

TEXT BOOKS:

1. Manufacturing Engineering and Technology/Kalpakijian / AdissonWesley, 1995.



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2. Process and Materials of Manufacturing / R. A. Lindburg / 1th edition, PHI 1990.

REFERENCES:

- 1 Microelectronic packaging handbook / Rao. R. Thummala and Eugene, J. Rymaszewski / Van NostrandRenihold,
- 2 MEMS & Micro Systems Design and manufacture / Tai — Run Hsu / TMGH
- 3 Advanced Machining Processes / V.K.Jain / Allied Publications.
- 4 Introduction to Manufacturing Processes / John A Schey/McGraw Hill.
- 5 Introduction to Nanoscience and NanoTechnology/ Chattopadhyay K.K/A.N.Banerjee/ PHI Learning

Course Outcomes: At the end of the course, student will be able to

CO1: Explain the working principle of various nonconventional machining processes and their applications.

CO2: Explain the working principles of additive manufacturing methods.

CO3: Understand various laser material processing techniques.

CO4: Gainon Advanced coating processes

CO5: Describe various fabrication methods for microelectronic devices



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III Year II Semester	MICROELECTROMECHANICALSYSTEMS	L	T	P	C
		3	0	0	3

Course Objectives:

- 1) To understand basics of Micro Electro Mechanical Systems (MEMS), mechanical sensors and actuators
- 2) To illustrate thermal sensors and actuators used in MEMS.
- 3) To apply the principle and various devices of Micro-Opto-Electro Mechanical Systems (MOEMS), magnetic sensors and actuators.
- 4) To analyze applications and considerations on microfluidic systems.
- 5) To illustrate the principles of chemical and biomedical microsystems.

UNIT-I:

INTRODUCTION: Definition of MEMS, MEMS history and development, micromachining, lithography principles & methods, structural and sacrificial materials, thin film deposition, impurity doping, etching, surface micromachining, wafer bonding, LIGA.

MECHANICAL SENSORS AND ACTUATORS: Principles of sensing and actuation: beam and cantilever, capacitive, piezo-electric, strain, pressure, flow, pressure measurement by micro phone, MEMS gyroscopes, shear mode piezo actuator, gripping piezo actuator, Inch worm technology.

UNIT-II:

THERMAL SENSORS AND ACTUATORS: Thermal energy basics and heat transfer processes, thermistors, thermo devices, thermo couple, micro machined thermo couple probe, Peltier effect heat pumps, thermal flow sensors, micro hot plate gas sensors, MEMS thermovessels, pyroelectricity, shape memory alloys (SMA), U-shaped horizontal and vertical electro thermal actuator, thermally activated MEMS relay, micro spring thermal actuator, data storage cantilever.

UNIT-III:

MICRO-OPTO-

ELECTROMECHANICAL SYSTEMS: Principle of MOEM technology, properties of light, light modulators, beam splitter, micro lens, micro mirrors, digital micro mirror device (DMD), light detectors, grating light valve (GLV), optical switch, wave guide and tuning, shear stress measurement.

MAGNETIC SENSORS AND ACTUATORS: Magnetic materials for MEMS and properties, magnetic sensing and detection, magneto resistive sensor, more on hall effect, magneto diodes, magnet transistor, MEMS magnetic sensor, pressure sensor utilizing MOKE, magneto MEMS actuators, by directional micro actuator, feedback circuit integrated magnetic actuator, large force reluctance actuator, magnetic probe based storage device.



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UNIT– IV:

MICRO FLUIDIC SYSTEMS: Applications, considerations on micro scale fluid, fluid actuation methods, dielectrophoresis (DEP), electro wetting, electro thermal flow, thermo capillary effect, electro osmosis flow, opto electro wetting (OEW), tuning using micro fluidics, typical microfluidic channel, microfluidic dispenser, microneedle, molecular gate, micropumps. **RA DIO FREQUENCY (RF) MEMS:** RF – based communication systems, RF MEMS, MEMS inductors, tuner/filter, resonator, clarification of tuner, filter, resonator, MEMS switches, phase shifter.

UNIT– V:

CHEMICAL AND BIOMEDICAL MICROSYSTEMS: Sensing mechanism & principle, membrane-transducer materials, chem.-lab-on-a-chip (CLOC) chemo-resistors, chemo-capacitors, chemo-transistors, electronic nose (E-nose), mass sensitive chemosensors, fluorescence detection, calorimetric spectroscopy.

TEXTBOOK:

1. MEMS, Nitaigour Premchand Mahalik, TMH

REFERENCE BOOKS:

1. Foundation of MEMS, Chang Liu, Prentice Hall Ltd.
2. MEMS and NEMS, Sergey Edward Lyshevski, CRC Press, Indian Edition.
3. MEMS and Micro Systems: Design and Manufacture, Tai-Ran Hsu, TMH Publishers.
4. Introductory MEMS, Thomas M Adams, Richard A Layton, Springer International Publishers.

Course Outcomes: At the end of the course, student will be able to

CO1: To understand basics of Micro Electro Mechanical Systems (MEMS), mechanical sensors and actuators.

CO2: Illustrate thermal sensors and actuators used in MEMS.

CO 3: To apply the principle and various devices of Micro-Opto-Electro Mechanical Systems (MOEMS), magnetic sensors and actuators.

CO 4: Analyze applications and considerations on micro fluidic systems.

CO5: Illustrate the principles of chemical and biomedical microsystems.



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III Year-II Semester	SENSORS AND INSTRUMENTATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To understand the concepts of measurement technology.
2. To learn the various sensors used to measure various physical parameters.
3. To learn the fundamentals of signal conditioning, data acquisition and communication systems used in mechatronics system development
4. To learn about the optical, pressure and temperature sensor
5. To understand the signal conditioning and DAQ systems

UNIT I

INTRODUCTION

Basics of Measurement – Classification of errors – Error analysis – Static and dynamic characteristics of transducers – Performance measures of sensors – Classification of sensors – Sensor calibration techniques – Sensor Output Signal Types.

UNIT II

MOTION, PROXIMITY AND RANGING SENSORS

Motion Sensors – Potentiometers, Resolver, Encoders – Optical, Magnetic, Inductive, Capacitive, LVDT – RVDT – Synchro – Microsyn, Accelerometer – GPS, Bluetooth, Range Sensors – RF beacons, Ultrasonic Ranging, Reflective beacons, Laser Range Sensor (LIDAR).

UNIT III

FORCE, MAGNETIC AND HEADING SENSORS

Strain Gage, Load Cell, Magnetic Sensors –types, principle, requirement and advantages: Magneto resistive – Hall Effect – Current sensor Heading Sensors – Compass, Gyroscope, Inclometers.

UNIT IV

OPTICAL, PRESSURE AND TEMPERATURE SENSORS

Photo conductive cell, photo voltaic, Photo resistive, LDR – Fiber optic sensors – Pressure – Diaphragm, Bellows, Piezoelectric – Tactile sensors, Temperature – IC, Thermistor, RTD, Thermocouple. Acoustic Sensors – flow and level measurement, Radiation Sensors - Smart Sensors - Film sensor, MEMS & Nano Sensors, LASER sensors.

UNIT V

SIGNAL CONDITIONING AND DAQ SYSTEMS

Amplification – Filtering – Sample and Hold circuits – Data Acquisition: Single channel and multi-channel data acquisition – Data logging - applications - Automobile, Aerospace, Home appliances, Manufacturing, Environmental monitoring.

TEXT BOOKS:



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1. Ernest O Doebelin, “Measurement Systems – Applications and Design”, Tata McGraw- Hill, 2009.
2. Sawney A K and PuneetSawney, “A Course in Mechanical Measurements and Instrumentation and Control”, Dhanpat Rai & Co, 12th edition New Delhi, 2013.

REFERENCES

1. C. Sujatha ... Dyer, S.A., Survey of Instrumentation and Measurement, John Wiley & Sons, Canada, 2001.
2. Hans Kurt Tönshoff (Editor), Ichiro, “Sensors in Manufacturing” Volume 1, Wiley-VCH April 2001.
3. John Turner and Martyn Hill, “Instrumentation for Engineers and Scientists”, Oxford Science Publications, 1999.
4. Patranabis D, “Sensors and Transducers”, 2nd Edition, PHI, New Delhi, 2011.
5. Richard Zurawski, “Industrial Communication Technology Handbook” 2nd edition, CRC Press, 2015.

COURSE OUTCOMES: Upon successful completion of the course, students should be able to:

CO1: Recognize with various calibration techniques and signal types for sensors.

CO2: Describe the working principle and characteristics of force, magnetic, heading, pressure and temperature, smart and other sensors and transducers.

CO3: Apply the various sensors and transducers in various applications

CO4: Select the appropriate sensor for different applications.

CO5: Acquire the signals from different sensors using Data acquisition systems.



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III B.Tech II Semester	ENERGY STORAGE TECHNOLOGIES	L	T	P	C
		3	0	0	3

Course Objectives: To

- Get the insights into importance of energy storage systems
- Understand the chemical and electromagnetic storage systems
- Know the principles of electrochemical storage systems
Learn the working of supercapacitors and fuel cells
- Know how to design batteries for transportation

UNIT 1:

Energy storage systems overview - Scope of energy storage, needs and opportunities in energy storage, Technology overview and key disciplines, comparison of time scale of storages and applications, Energy storage in the power and transportation sectors. Importance of energy storage systems in electric vehicles, Current electric vehicle market. Thermal storage system-heat pumps, hot water storage tank, solar thermal collector, application of phase change materials for heat storage-organic and inorganic materials, efficiencies, and economic evaluation of thermal energy storage systems.

UNIT 2:

Chemical storage system- hydrogen, methane etc., concept of chemical storage of solar energy, application of chemical energy storage system, advantages and limitations of chemical energy storage, challenges, and future prospects of chemical storage systems.

Electromagnetic storage systems - double layer capacitors with electrostatically charge storage, superconducting magnetic energy storage (SMES), concepts, advantages and limitations of electromagnetic energy storage systems, and future prospects of electrochemical storage systems.

UNIT 3:

Electrochemical storage system

Batteries-Working principle of battery, primary and secondary (flow) batteries, battery performance evaluation methods, major battery chemistries and their voltages- Li-ion battery & Metal hydride battery vs lead-acid battery

UNIT 4:

Supercapacitors- Working principle of supercapacitor, types of supercapacitors, cycling and performance characteristics, difference between battery and supercapacitors, Introduction to Hybrid electrochemical supercapacitors

Fuel cell- Operational principle of a fuel cell, types of fuel cells, hybrid fuel cell-battery systems, hybrid fuel cell-supercapacitor systems.



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UNIT 5:

Battery design for transportation, Mechanical Design and Packaging of Battery

Packs for Electric Vehicles, Advanced Battery, Assisted Quick Charger for Electric Vehicles, Charging Optimization Methods for Lithium-Ion Batteries, Thermal runaway for battery systems, Thermal management of battery systems, State of Charge and State of Health Estimation Over the Battery Lifespan, Recycling of Batteries from Electric Vehicles.

Text books:

1. Frank S. Barnes and Jonah G. Levine, Large Energy Storage Systems Handbook (Mechanical and Aerospace Engineering Series), CRC press (2011)
2. Ralph Zito, Energy storage: A new approach, Wiley (2010)

References:

1. Pistoia, Gianfranco, and Boryann Liaw. Behaviour of Lithium-Ion Batteries in Electric Vehicles: Battery Health, Performance, Safety, and Cost. Springer International Publishing AG, 2018.
2. Robert A. Huggins, Energy storage, Springer Science & Business Media (2010)

Course Outcomes: At the end of the course, students will be able to

- Learn the importance of energy storage systems
- Gain knowledge on chemical and electromagnetic storage systems
- Understand the principles of electrochemical storage systems
- Know the working of supercapacitors and fuel cells
- Learn how to design batteries for transportation



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III Year-II Semester	INDUSTRIAL HYDRAULICS AND PNEUMATICS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To learn basic concepts of fluid power
2. To understand the functions and working of basic elements of Hydraulic and Pneumatic system
3. To get knowledge about the basic components and their functions of Hydraulic and Pneumatic circuits
4. To learn the operating principles and working of hydraulic and pneumatic devices
5. To gain knowledge about the procedures of installation, maintenance and troubleshooting of Hydraulic and pneumatic systems

UNIT – 1

Fluid Power: Power transmission modes, hydraulic systems, pneumatic systems, laws governing fluid flow: Pascal's law, continuity equation, Bernoulli's theorem, Boyle's, Charles', Gay-Lussec' laws, flow through pipes - types, pressure drop in pipes, Working fluids used in hydraulic and pneumatic systems- types, ISO/BIS standards and designations, properties.

UNIT – 2

Hydraulic and Pneumatic Elements: Hydraulic pipes-Types, standards, designation methods and specifications, pressure ratings, applications and selection criteria, pumping theory, Hydraulic Pumps - types, construction, working principle, applications, selection criteria and comparison, hydraulic Actuators, Control valves, Accessories - their types, construction and working, pneumatic Pipes - materials, designations, standards, properties and piping layout, air compressors, Air receivers, air dryers, Air Filters, Regulators, Lubricators (FRL unit): their types, construction, working, specifications and selection criteria of following air preparation and conditioning elements, pneumatic Actuators and Control valves - types, construction, working, materials and specifications

UNIT – 3

Hydraulic and Pneumatic Circuits:

ISO symbols used in hydraulic and pneumatic circuit, basic Hydraulic Circuits – types (such as intensifier, regenerative, synchronizing, sequencing, speed control, safety), circuit diagram, components, working and applications, basic Pneumatic Circuits – types (such as speed control, two step feed control, automatic cylinder reciprocation, time delay, quick exhaust), circuit diagram, components, working and applications, pneumatic Logic circuit design - classic method, cascade method, step counter method, Karnaugh- veitch maps and combinational circuit design.



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UNIT – 4

Hydraulic and Pneumatic Devices:

Hydraulic and Pneumatic devices – Concept and applications, construction, working principle, major elements, performance variables of: Automotive hydraulic brake, Industrial Fork lift, Hydraulic jack, Hydraulic press, Automotive power steering, Automotive pneumatic brake, Automotive air suspension, Pneumatic drill, Pneumatic gun.

UNIT – 5

Installation, Maintenance and Trouble-Shooting:

Installation of hydraulic and pneumatic system causes and remedies for common troubles arising in hydraulic elements, maintenance of hydraulic systems, causes and remedies for troubles arising in pneumatic elements, maintenance of pneumatic systems.

Textbooks:

1. Majumdar, S.R. Oil Hydraulic Systems Tata McGraw-Hill Publication, New Delhi, 3/e, 2013
2. Majumdar, S.R. Pneumatic Systems Tata McGraw-Hill Publication, New Delhi, 3/e, 2013

References:

1. Srinivasan, R. Hydraulic and Pneumatic Controls Vijay Nicole Imprints Private, New Delhi, Limited, 2/e, 2008
2. Jagadeesha, T. Fluid Power Generation, Transmission and Control Universities Press (India) Private Limited, New Delhi, 1/e, 2014
3. Jagadeesha, T. Pneumatics Concepts, Design and Applications Universities Press (India) Private Limited, New Delhi, 1/e, 2014
4. Parr, Andrew Hydraulic and Pneumatics, A Technician's and Engineer's Guide, Jaico Publishing House, New Delhi, 2/e, 2013
5. Shanmuga Sundaram, K. Hydraulic and Pneumatics Controls - Understanding Made Easy S. Chand Company Ltd., New Delhi, 1/e, 2006

Course Outcomes: At the end of the course, student will be able to

CO1	Illustrate the basic concepts of fluid power
CO2	Understand the functions of elements of Hydraulic and Pneumatic systems
CO3	Analyze the functions of hydraulic and Pneumatic circuits
CO4	Illustrate the working of various hydraulic and pneumatic devices.
CO5	Interpret the procedure of installation, maintenance of hydraulic and pneumatic systems.



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III Semester	Year II	INDUSTRIAL ROBOTICS	L	T	P	C
			3	0	0	3

Course Objectives: The Students will acquire the knowledge to

1. Discuss various applications and components of industrial robot systems
2. Learn about the types of actuators used in robotics
3. Calculate the forward kinematics and inverse kinematics.
4. Learn about programming principles and languages for a robot control system
5. Discuss the applications of image processing and machine vision in robotics.

UNIT – 1

INTRODUCTION: Automation and Robotics, CAD/CAM and Robotics –
An overview of Robotics – present and future applications –
classification by coordinate system and control system.

COMPONENTS OF THE INDUSTRIAL ROBOTICS:

Robot anatomy, work volume, components, number of degrees of freedom - robot drive systems, functional diagram representation of robot arms, common types of arms – requirements and challenges of end effectors, determination of the end effectors.

UNIT – 2

ROBOT ACTUATORS AND FEEDBACK COMPONENTS:

Actuators: Pneumatic, Hydraulic actuators, electric & stepper motors. Comparison of Electric, Hydraulic and Pneumatic types of actuation devices.

Feedback components: position sensors – potentiometers, resolvers, encoders – Velocity sensors.

UNIT – 3

MOTION ANALYSIS: Homogeneous transformations as applicable to rotation and translation – problems.

MANIPULATOR KINEMATICS: Specification of matrices, D-H notation joint coordinates and world coordinates Forward and inverse kinematics – problems.

UNIT – 4

GENERAL CONSIDERATIONS IN PATH DESCRIPTION AND GENERATION: Trajectory planning and avoidance of obstacles, path planning, Skew motion, joint integrated motion – straight line motion – Robot programming, languages and software packages – description of paths with a robot



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programming language.

UNIT – 5

IMAGE PROCESSING AND MACHINE VISION: Introduction to Machine Vision, Sensing and Digitizing function in Machine Vision, Training and Vision System, Robotic Applications.

TEXTBOOKS:

1. IndustrialRobotics/GrooverMP/Pearson Edu.
2. RoboticsandControl /MittalR K &Nagrathi J /TMH.

REFERENCES:

1. Robotics/Fu KS/ McGrawHill.
2. RoboticEngineering /RichardD. Klafter, PrenticeHall
3. Robot AnalysisandControl/ H. Asada and J.J.E. Slotine/BSP Books Pvt.Ltd.
4. IntroductiontoRobotics/John JCraig/PearsonEdu.

Course Outcomes: At the end of the course, student will be able to

CO1 Discuss various applications and components of industrial robot systems

CO2 Learn about the types of actuators used in robotics

CO3 Calculate the forward kinematics and inverse kinematics.

CO4 Learn about programming principles and languages for a robot control system

CO5 Discuss the applications of image processing and machine vision in robotics.



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III Semester	Year II	REFRIGERATION & AIR- CONDITIONING	L	T	P	C
			3	0	0	3

Course Objectives:

1. To illustrate the operating cycles and different systems of refrigeration
2. To analyze cooling capacity and coefficient of performance of vapour compression refrigeration systems and understand the fundamentals of cryogenics
3. To calculate coefficient of performance by conducting test on vapour absorption and steam jet refrigeration system and understand the properties refrigerants.
4. To calculate cooling load for air conditioning systems and identify the requirements of comfort air conditioning
5. To describe different component of refrigeration and air conditioning systems

UNIT – 1

INTRODUCTION TO REFRIGERATION: Necessity and applications – unit of refrigeration and C.O.P. – Mechanical refrigeration – types of ideal cycles of refrigeration. air refrigeration: Bell Coleman cycle - open and dense air systems – refrigeration systems used in air crafts and problems.

UNIT – 2

VAPOUR COMPRESSION REFRIGERATION SYSTEM & COMPONENTS: Working principle and essential components of the plant – simple vapour compression refrigeration cycle – COP – representation of cycle on T-S and p-h charts – effect of sub cooling and super heating – cycle analysis – actual cycle influence of various parameters on system performance – use of p-h charts – numerical problems.

INTRODUCTION TO CRYOGENICS: Joule-Thomson expansion, refrigerant mixtures, multi stage vapour compression refrigeration.

UNIT – 3

REFRIGERANTS– Desirable properties – classification - refrigerants –green refrigerants- nomenclature – ozone depletion – global warming.

VAPOR ABSORPTION SYSTEM: Calculation of maximum COP – description and working of NH₃ – water system and Li Br –water (Two shell



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& Four shell) System, principle of operation three fluid absorption system, salient features.

STEAM JET REFRIGERATION SYSTEM: Working Principle and basic components, principle and operation of thermoelectric refrigerator and vortex tube.

UNIT – 4

INTRODUCTION TO AIR CONDITIONING: Psychometric properties & processes – characterization of sensible and latent heat loads — need for ventilation, consideration of infiltration – load concepts of RSHF, GSHF- problems, concept of ESHF and ADP temperature.

Requirements of human comfort and concept of effective temperature- comfort chart –comfort air conditioning – requirements of industrial air conditioning, air conditioning load calculations.

UNIT – 5

AIR CONDITIONING SYSTEMS: Classification of equipments, cooling, heating humidification and dehumidification, filters, grills and registers, fans and blowers. heat pump – heat sources – different heat pump circuits.

Note: Refrigeration and Psychrometric tables and charts are allowed.

Text Books:

1. A Course in Refrigeration and Air conditioning / SC Arora & Domkundwar / Dhanpatrai
2. Refrigeration and Air Conditioning / CP Arora / TMH.

References:

1. Refrigeration and Air Conditioning / Manohar Prasad / New Age.
2. Principles of Refrigeration /Dossat / Pearson Education.
3. Basic Refrigeration and Air-Conditioning / Ananthanarayanan / TMH

Course Outcomes: At the end of the course, student will be able to

CO1	Illustrate the operating cycles and different systems of refrigeration.
CO2	Analyze cooling capacity and coefficient of performance of vapour compression refrigeration systems and understand the fundamentals of cryogenics
CO3	Calculate coefficient of performance by conducting test on vapour absorption and steam jet refrigeration systems and understand the properties of refrigerants
CO4	Solve cooling load for air conditioning systems and identify the requirements of comfort air conditioning.
CO5	Demonstrate different components of refrigeration and air conditioning systems.



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III YearII Semester	INTRODUCTION TO INDUSTRIAL ROBOTICS	L	T	P	C
		3	0	0	3

Course Objectives: To

1. Discuss various applications and components of industrial robot systems
2. Learn about the types of actuators used in robotics
3. Calculate the forward kinematics and inverse kinematics.
4. Learn about programming principles and languages for a robot control system
5. Discuss the applications of image processing and machine vision in robotics.

UNIT – 1

INTRODUCTION: Automation and Robotics, CAD/CAM and Robotics –
An overview of Robotics – present and future applications –
classification by coordinate system and control system.

COMPONENTS OF THE INDUSTRIAL ROBOTICS:

Robot anatomy, work volume, components, number of degrees of freedom - robot drive systems, function line diagram representation of robot arms, common types of arms – requirements and challenges of end effectors, determination of the end effectors.

UNIT – 2

ROBOT ACTUATORS AND FEEDBACK COMPONENTS:

Actuators: Pneumatic, Hydraulic actuators, electric & stepper motors. Comparison of Electric, Hydraulic and Pneumatic types of actuation devices.

Feedback components: position sensors – potentiometers, resolvers, encoders – Velocity sensors.

UNIT – 3

MOTION ANALYSIS: Homogeneous transformations as applicable to rotation and translation – problems.

MANIPULATOR KINEMATICS: Specification of matrices, D-H notation joint coordinates and world coordinates Forward and inverse kinematics – problems.



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UNIT – 4

GENERAL CONSIDERATIONS IN PATH DESCRIPTION AND

GENERATION: Trajectory planning and avoidance of obstacles, path planning, Skewed motion, joint integrated motion –straight line motion–Robot programming, languages and software packages-description of paths with a robot programming language.

UNIT – 5

IMAGE PROCESSING AND MACHINE VISION: Introduction to Machine Vision, Sensing and Digitizing function in Machine Vision, Training and Vision System, Robotic Applications.

TEXTBOOKS:

1. Industrial Robotics/Groover MP/Pearson Edu.
2. Robotics and Control /Mittal R K & Nagrathi J /TMH.

REFERENCES:

1. Robotics/Fu KS/ McGrawHill.
2. Robotic Engineering /Richard D. Klafter, Prentice Hall
3. Robot Analysis and Control/ H. Asada and J.J.E. Slotine/BSP Books Pvt.Ltd.
4. Introduction to Robotics/John J Craig/Pearson Edu.

Course Outcomes: At the end of the course, student will be able to

- CO1** Discuss various applications and components of industrial robot systems
- CO2** Learn about the types of actuators used in robotics
- CO3** Calculate the forward kinematics and inverse kinematics.
- CO4** Learn about programming principles and languages for a robot control system
- CO5** Discuss the applications of image processing and machine vision in robotics.



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III YearII Semester	INDUSTRIAL MANAGEMENT	L	T	P	C
		3	0	0	3

Course Objectives: The objectives of the course are to

- 1) Introduce the scope and role of industrial engineering and the techniques for optimal design of layouts.
- 2) Illustrate how work study is used to improve productivity
- 3) Explain TQM and quality control techniques



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- 4) Introduce financial management aspects and
- 5) Discuss human resource management and value analysis.

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

WORK STUDY: Importance, types of production, applications, work study, 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.

UNIT–III

STATISTICAL QUALITY CONTROL: Quality control, Quality assurance and its importance, SQC, attribute sampling inspection with single and double sampling, Control charts – $\bar{X}$ and R – charts $\bar{X}$ 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

FINANCIAL MANAGEMENT: Scope and nature of financial management, Sources of finance, Ratio analysis, Management of working capital, estimation of working capital requirements, stock management, Cost accounting and control, budget and budgetary control, Capital budgeting – Nature of Investment Decisions – Investment Evaluation criteria- NPV, IRR, PI, Payback Period, and ARR, numerical problems.

UNIT–V

HUMAN 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, and types.

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



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Text Books:

1. Industrial Engineering and Management/ O.P Khanna /Khanna Publishers.
2. Industrial Engineering and Production Management/Mart and Telsang / S.Chand&Company Ltd. New Delhi.

Reference Books:

- 1) Industrial Management/ Bhattacharya DK/ Vikas publishers
- 2) Operations Management/ J.GMonks / McGrawHilPublishers.
- 3) Industrial Engineering and Management Science/T.R. Banga, S.C.Sharma, N. K. Agarwal /Khanna Publishers
- 4) Principles of Management / KoontzO'Donnel/ McGraw Hill Publishers.
- 5) Statistical Quality Control / Gupta/ Khanna Publishers
- 6) Industrial Engineering and Management/ NVSRaju/ CengagePublishers

Course Outcomes: After completing this course, students will be able to:

- 1) Learn about how to design the optimal layout
- 2) Demonstrate work study methods
- 3) Explain Quality Control techniques
- 4) Discuss the financial management aspects and
- 5) Understand the human resource management methods.

III Year IISemester	ADDITIVE MANUFACTURING	L	T	P	C
		3	0	0	3

Course Objectives:

1. To understand the principles of prototyping, classification of RP processes and liquid-based RP systems



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2. To understand and apply different types of solid-based RP systems.
3. To understand and apply powder-based RP systems.
4. To understand and apply various rapid tooling techniques.
5. To understand different types of data formats and to explore the applications of AM processes in various fields.

UNIT – 1

INTRODUCTION: Prototyping fundamentals, historical development, fundamentals of rapid prototyping, advantages and limitations of rapid prototyping, commonly used terms, classification of RP process.

LIQUID-BASED RAPID PROTOTYPING SYSTEMS: Stereo lithography Apparatus (SLA): models and specifications, process, working principle, photopolymers, photo polymerization, layering technology, laser and laser scanning, applications, advantages and disadvantages, case studies. Solid Ground Curing (SGC): models and specifications, process, working principle, applications, advantages and disadvantages, case studies.

UNIT – 2

SOLID-BASED RAPID PROTOTYPING SYSTEMS: Laminated object manufacturing (LOM) - models and specifications, process, working principle, applications, advantages and disadvantages, case studies. Fused deposition modelling (FDM) - models and specifications, process, working principle, applications, advantages and disadvantages, case studies.

UNIT – 3

POWDER BASED RAPID PROTOTYPING SYSTEMS: Selective laser sintering (SLS): models and specifications, process, working principle, applications, advantages and disadvantages, case studies. three dimensional printing (3DP): models and specifications, process, working principle, applications, advantages and disadvantages, case studies.

UNIT – 4

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 process. Direct rapid tooling: Direct AIM, LOM Tools, and Direct Metal Tooling using 3DP.

UNIT – 5

RAPID PROTOTYPING DATA FORMATS: STL Format, STL File Problems, consequence of building valid and invalid tessellated models, STL file Repairs: Generic Solution, other Translators, and Newly Proposed Formats.

RP APPLICATIONS: Application in engineering, analysis and planning, aerospace industry, automotive industry, jewelry industry, coin industry, GIS application, RP medical and bioengineering applications: customized implants and prosthesis, forensic sciences.

Text Books:



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1.Rapid prototyping: Principles and Applications /Chua C.K., Leong K.F. and LIM C.S/World Scientific publications

References:

1. Rapid Manufacturing / D.T. Pham and S.S. Dimov/Springer
2. Wohlers Report 2000 /Terry T Wohlers/Wohlers Associates
3. Rapid Prototyping & Manufacturing / Paul F.Jacobs/ASME Press
4. Rapid Prototyping / Chua and Liou

Course Outcomes: At the end of the course, student will be able to

CO1	Understand the principles of prototyping, classification of RP processes and liquid-based RP systems.
CO2	Understand and apply different types of solid-based RP systems.
CO3	Apply powder-based RP systems.
CO4	Analyze and apply various rapid tooling techniques.
CO5	Understand different types of data formats and explore the applications of AM processes in various fields.

III Year I Semester	VEHICLE TECHNOLOGY	L	T	P	C
		3	0	0	3



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COURSE OBJECTIVES

- 1.To study the advanced engine technologies
- 2.To learn various advanced combustion technologies and its benefits
- 3.To learn the methods of using low carbon fuels and its significance
- 4.To learn and understand the hybrid and electric vehicle configurations
- 5.To study the application of fuel cell technology in automotives

UNIT – I: ADVANCED ENGINE TECHNOLOGY

Gasoline Direct Injection, Common Rail Direct Injection, Variable Compression Ratio Turbocharged Engines, Electric Turbochargers, VVT, Intelligent Cylinder De-activation, After Treatment Technologies, Electric EGR, Current EMS architecture.

UNIT – II: COMBUSTION TECHNOLOGY

Spark Ignition combustion, Compression Ignition Combustion, Conventional Dual Fuel Combustion, Low Temperature Combustion Concepts– Controlled Auto Ignition, Homogeneous Charge Compression Ignition, Premixed Charge Compression Ignition, Partially Premixed Compression Ignition, Reactivity Controlled Compression Ignition, Gasoline Direct Injection Compression Ignition.

UNIT – III: LOW CARBON FUEL TECHNOLOGY

Alcohol Fuels, Ammonia Fuel and Combustion, Methane Technology, Dimethyl Ether, Hydrogen Fuel Technology, Challenges, and way forward

UNIT – IV: HYBRID AND ELECTRIC VEHICLE (BATTERY POWERED)

Conventional Hybrids (Conventional ICE + Battery), Modern Hybrids (RCCI/GDCI Engine + Battery), Pure Electric Vehicle Technology – Challenges and Way forward

UNIT – V: FUEL CELL TECHNOLOGY

Fuel cells for automotive applications - Technology advances in fuel cell vehicle systems - Onboard hydrogen storage - Liquid hydrogen and compressed hydrogen - Metal hydrides, Fuel cell control system - Alkaline fuel cell - Road map to market.

TEXT BOOKS:

- 1.Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
- 2.Rakesh Kumar Maurya, Characteristics and Control of Low Temperature Combustion Engines. ISBN 978-3-319-68507-6 , SPRINGER

REFERENCES:

- 1.Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
- 2.James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003
- 3.Rand D.A.J, Woods, R & Dell RM Batteries for Electric vehicles, John Wiley & Sons, 1998
- 4.Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.



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5.James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003

Course Outcomes: At the end of the course the students would be able to

- 1.Discuss the latest trends in engine technology
- 2.Discuss the need of advanced combustion technologies and its impact on reducing carbon foot-print on the environment.
- 3.Analyzing the basic characteristics of low carbon fuels, its impact over conventional fuels and in achieving sustainable development goals.
- 4.Discuss the working and energy flow in various hybrid and electric configurations.
- 5.Analyzing the need for fuel cell technology in automotive applications.



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III YearII Semester	INDUSTRIAL SAFETY	L	T	P	C
		3	0	0	3

Courseobjectives:

- 1) To understand the concepts of industrial safety and management.
- 2) To demonstrate the accident prevention and protective equipment.
- 3) To understand and apply the knowledge of safety acts
- 4) To have the knowledge about fire prevention and protection systems
- 5) To understand and apply fire safety principles in buildings

UNIT-I

INTRODUCTION TO THE DEVELOPMENT OF INDUSTRIAL SAFETY AND

MANAGEMENT: History and development of Industrial safety: Implementation of factories act, Safety and productivity, Safety organizations. Safety committees and structure, Role of management and role of Govt. in industrial safety.

UNIT-II

ACCIDENT PREVENTIONS AND PROTECTIVE EQUIPMENT: Personal protective equipment, Survey the plant for locations, Part of body to be protected, Education and training in safety, Prevention causes and cost of accident, Housekeeping, First aid, Accident reporting, Investigations. Industrial psychology in accident prevention, Safety trials, Safety related to operations.

UNIT-III

SAFETY ACTS: Features of Factory Act, Introduction of Explosive Act, Boiler Act, ESI Act, Workman's compensation Act, Industrial hygiene, Occupational safety, Diseases prevention, Ergonomics, Occupational diseases, stress, fatigue, health, safety and the physical environment, Engineering methods of controlling chemical hazards, safety and the physical environment, Control of industrial noise and protection against it, Code and regulations for worker safety and health, codes for safety of systems.

UNIT-IV

FIRE PREVENTION AND PROTECTION: Sources of ignition – fire triangle – principles of fire extinguishing – active and passive fire protection systems – various classes of fires – A, B, C, D, E-Fire extinguishing agents- Water, Foam, Dry chemical powder, Carbon-dioxide Halon alternatives Halocarbon compounds-Inert gases, dry powders – types of fire extinguishers – fire stoppers – hydrant pipes – hoses – monitors – fire watchers – layout of stand pipes – fire station-fire alarms and sirens – maintenance of fire trucks – foam generators – escape from fire rescue operations – fire drills – first aid for burns.

UNIT-V



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BUILDINGFIRESAFETY: Objectives of fire safebuilding design,Fireload,fire resistantmaterial and fire testing – structural fire protection – structural integrity – concept of egress design -exit– widthcalculations –firecertificates – firesafetyrequirementsfor highrisebuildings.

TEXT BOOKS:

1. IndustrialMaintenanceManagementSrivastava,S.K.-S.ChandandCo.
2. OccupationalSafetyManagementandEngineeringWillieHammer–PrenticeHall
3. PurandareD.D&AbhayD.Purandare,“HandbookonIndustrialFireSafety”P&Apublications,NewDelhi,2006.
4. McElroy,FrankE.,“AccidentPreventionManualforIndustrialOperations”,NSC,Chicago,1988.
5. Green, A.E.,“HighRiskSafetyTechnology”, JohnWileyandSons, 1984.

REFERENCEBOOKS:

1. Installation,ServicingandMaintenanceBhattacharya, S.N.-S.ChandandCo.
2. JainVK“FireSafetyinBuilding”NewAgeInternational1996.
3. Reliability,MaintenanceandSafetyEngineeringbyDr.A. K.Guptha
4. ATextbookofReliabilityand MaintenanceEngineering byAlakeshManna

Courseoutcomes:

- CO1:Studentslearntheconceptsofindustrialsafetyandmanagement.
- CO2: Learnaboutthesmartmachinesandsmartsensors
- CO3: Apply IoTto Industry 4.0 and they are able to make a system tailor-made as perrequirementoftheindustry
- CO4: Students learn about fire prevention and protection systems.
- CO5:Studentslearnand applythefiresafetyprinciplesinbuildings



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III YearII Semester	HEAT TRANSFER LAB	L	T	P	C
		0	0	3	1.5

Course Objective: The laboratory course is aimed to provide the practical exposure to the students with regard to the determination of amount of heat exchange in various modes of heat transfer including condensation & boiling for several geometries.

PART-A

1. Determination of overall heat transfer co-efficient of a composite slab
2. Determination of heat transfer rate through a lagged pipe.
3. Determination of heat transfer rate through a concentric sphere
4. Determination of thermal conductivity of a metal rod.
5. Determination of efficiency of a pin-fin
6. Determination of heat transfer coefficient in natural and forced convection
7. Determination of effectiveness of parallel and counter flow heat exchangers.
8. Determination of emissivity of a given surface.
9. Determination of Stefan-Boltzmann constant.
10. Determination of heat transfer rate in drop and film wise condensation.
11. Determination of critical heat flux.
12. Determination of Thermal conductivity of liquids and gases.
13. Investigation of Lambert's cosine law.

PART-B

Virtual labs (<https://mfts-iitg.vlabs.ac.in/>) on

- (i) Conduction Analysis of a Single Material Slab
- (ii) Conduction Analysis of a single Material Sphere
- (iii) Conduction Analysis of a single Material Cylinder
- (iv) Conduction Analysis of a Double Material Slab
- (v) Conduction Analysis of a Double Material Sphere
- (vi) Conduction Analysis of Double Material Cylinder
- (vii) To determine the overall heat transfer coefficient (U) in the (i) parallel flow heat exchanger and (ii) Counter flow heat exchanger
- (viii) To investigate the Lambert's distance law.
- (ix) To investigate the Lambert's direction law (cosine law).

Note: Virtual labs are only for learning purpose, and are not for external examination.



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III Year II Semester	ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING LAB	L	T	P	C
		0	0	3	1.5

Course Objectives: Students will acquire the knowledge of artificial intelligence and machine learning models using various software tools.

Course Objectives: To enable the students write coding for various artificial intelligence and machine learning algorithms.

1. Learning of Python libraries – Numpy, Pandas, Matplotlib, Seaborn and TensorFlow
2. Numerical examples on Python libraries
3. Data Preprocessing and data cleaning using Python
4. Write a program for Linear regression
5. Write a program for Logistic regression
6. Write a program for ANN
7. Write a program for CNN
8. Write a program for RNN
9. Write a program to build a Decision tree
10. Write a program to build a Naïve Bayes classifier
11. Write a program for SVM
12. Write a program for Auto-encoder

Course Outcomes: Students at the end of the course will be able to

CO1: Learn various Python libraries.

CO2: Do programming for regression methods

CO3: Write coding for different types of neural networks

CO4: Write a program for decision tree, Naïve Bayes and SVM

CO4: Generate code for autoencoders

Course Outcomes: At the end of the course, student will be able to apply the knowledge of artificial intelligence and machine learning models along with image classifiers using various software tools.

Note: Databases can be taken from <https://www.kaggle.com/datasets>.



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III Year II Semester	ROBOTICS AND DRONE TECHNOLOGIES LAB	L	T	P	C
		0	0	4	2

Course Objective: Robotics and Drone Technologies Laboratory offers the students hands-on experience in robotics, and unmanned aerial systems.

List of experiments:

Robotics:

- 1) Simulation of Mathematical Model of Robot.
- 2) Forward and Inverse Dynamic Analysis of a 2-DOF Robotic Manipulator using Software Tools.
- 3) Building and Programming a Simple Arduino-Based Robot for basic movement.
- 4) Build a robot that can navigate through a maze or an environment by using sensors to detect obstacles and avoid them.
- 5) Construct a robotic arm using servo motors or stepper motors and program the arm to perform various tasks, such as picking up objects, sorting the colour, or drawing shapes.
- 6) Build a robot that follows a black line on a contrasting surface using line-following sensors.
- 7) Designing a 3D Model of a Robotic Arm and Grippers Using Software
- 8) Implement a PID controller for a robotic arm or mobile robot and simulate its performance in tracking a desired trajectory.

Drone technologies:

- 1) Demonstration of parts and functions of a drone.
- 2) Demonstration of effects of forces, manoeuvres of a drone by roll, pitch and yaw.
- 3) Demonstration of various sensors and battery management used in drones.
- 4) Build a prototype drone to record videos and photos.
- 5) Make a drone for a certain payload.

Students need to refer to the following links:

- 1) <https://aim.gov.in/pdf/equipment-manual-pdf.pdf>
- 2) <https://atl.aim.gov.in/ATL-Equipment-Manual/>
- 3) <https://aim.gov.in/pdf/Level-1.pdf>
- 4) <https://aim.gov.in/pdf/Level-2.pdf>
- 5) <https://aim.gov.in/pdf/Level-3.pdf>
- 6) https://aim.gov.in/pdf/ATL_Drone_Module.pdf



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Course outcome: Students at the end of the course will get enough knowledge and knowhow about how to design a variety of robots and drones for diversified applications.

III Year II Semester	TECHNICAL PAPER WRITING AND IPR	L	T	P	C
		2	0	0	--

Course objectives:

- 1) To understand the structure of the technical paper and its components.
- 2) To review the literature and acquire the skills to write a technical paper for first submission.
- 3) To understand the process and development of IPR.
- 4) To create awareness about the scope of patent rights.
- 5) To analyze the new developments in IPR include latest software.

UNIT-I: Planning and preparation

Planning and Preparation, Word Order, breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness. Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction.

UNIT-II: Literature review

Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

Key skills needed when writing a Title, Abstract, Introduction, a Review of the Literature, the Methods, the Results, the Discussion, and the Conclusions. Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission

UNIT-III: Process and Development

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, patenting under PCT.

UNIT-IV: Patent Rights

Scope of Patent Rights. Licensing and transfer of technology, Patent information and databases, Geographical Indications.

UNIT-V: New Developments In IPR

New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies.



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Text Books:

1. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press.
2. Halbert, “Resisting Intellectual Property”, Taylor & Francis Ltd, 2007.

References:

- 1) Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
- 2) Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book.
- 3) Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011
- 4) Mayall, “Industrial Design”, McGraw Hill, 1992.
- 5) Robert P. Merges, Peter S. Menell, Mark A. Lemley, “Intellectual Property in New Technological Age” 2016.
- 6) T. Ramappa, “Intellectual Property Rights Under WTO”, S. Chand, 2008.

Course outcomes: Upon completion of course, students will be able to:

- 1) Understand the structure of the technical paper and its components.
- 2) Review the literature and acquire the skills to write a technical paper for first submission.
- 3) Understand the process and development of IPR.
- 4) Create awareness about the scope of patent rights.
- 5) Analyze the new developments in IPR include latest software.



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III Year II Semester	INDUSTRY INTERNSHIP				



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MINORS



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Minors Course	MECHANICS OF SOLIDS (Mechanical Engineering Design and Robotics)	L	T	P	C
		3	0	0	3

Course Objectives: The objectives of the course are to

- 1) Understand the behavior of basic structural members subjected to uni-axial loads.
- 2) Apply the concept of stress and strain to analyze and design structural members and machine parts under axial, shear and bending loads, and moment.
- 3) Students will learn all the methods to analyze beams, frames for normal, shear to solve deflection problems in preparation for the design of such structural components. Students are able to analyze beams and draw correct and complete shear and bending moment diagrams for beams.
- 4) Students attain a deeper understanding of the loads, stresses, and strains acting on a structure and their relations in the elastic behavior
- 5) Design and analysis of industrial components like pressure vessels.

UNIT– I

SIMPLE STRESSES & STRAINS : Elasticity and plasticity – Types of stresses & strains – Hooke's law – stress-strain diagram for mild steel – Working stress – Factor of safety – Lateral strain, Poisson's ratio & volumetric strain – Bars of varying section – composite bars – Temperature stresses – Relation between elastic constants, Strain energy – Resilience – Gradual, sudden, impact and shock loadings.

UNIT–II

SHEAR FORCE AND BENDING MOMENT : Definition of beam – Types of beams – Concept of shear force and bending moment – S.F and B.M diagrams for cantilever, simply supported and overhanging beams subjected to point loads, u.d.l, uniformly varying loads and combination of these loads – Point of contra flexure –



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Relation between S.F., B.M and rate of loading at a section of a beam.

UNIT-III

FLEXURAL STRESSES : Theory of simple bending – Assumptions – Derivation of bending equation: $M/I = f/y = E/R$ Neutral axis – Determination bending stresses – section modulus of rectangular and circular sections (Solid and Hollow), I, T, Angle and Channel sections

SHEAR STRESSES: Derivation of formula – Shear stress distribution across various beam sections like rectangular, circular, triangular, I, T, Angle sections.

UNIT-IV

DEFLECTION OF BEAMS : Bending into a circular arc – slope, deflection and radius of curvature – Differential equation for the elastic line of a beam – Double integration and Macaulay's methods – Determination of slope and deflection for cantilever and simply supported beams subjected to point loads, - U.D.L uniformly varying load. Mohr's theorems – Moment area method – application to simple cases including overhanging beams.

UNIT- V

THIN AND THICK CYLINDERS: Thin seamless cylindrical shells – Derivation of formula for longitudinal and circumferential stresses – hoop, longitudinal and Volumetric strains – changes in dia, and volume of thin cylinders – Riveted boiler shells – Thin spherical shells. Wire wound thin cylinders. Lamé's equation – cylinders subjected to inside & outside pressures - compound cylinders.

TEXTBOOKS:

1. Strength of materials/GH Ryder/McMillan publishers India Ltd.
2. Strength of materials by B.C. Punmia, Lakshmi publications Pvt. Ltd, New Delhi.

REFERENCES:

1. Mechanics of Materials by Gere & Timoshenko
2. Strength of Materials - By Jindal, Umesh Publications.
3. Strength of Materials by S. Timoshenko - PHI Publishers
4. Strength of Materials by Andrew Pytel and Ferdinand L. Singer Longman-Harper Collins College Division
5. Solid Mechanics by Popov
6. Mechanics of Materials/Gere and Timoshenko, CBS Publishers

Course outcomes:

On the completion of the course the student will be able to

CO1: Model & Analyze the behavior of basic structural members subjected to various loading and support conditions based on principles of equilibrium.

CO2: Understand and apply the concept of stress

and strain to analyze and design structural members and machine parts under axial, shear and bending loads, and moment.

CO3: Students will learn all the methods to analyze beams, columns, frames for normal, s



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Minors Course	DESIGN OF MACHINE MEMBERS (Mechanical Engineering Design and Robotics)	L	T	P	C
		3	0	0	3

hear, to solve deflection problems in preparation for the design of such structural components. Students are able to analyse beams and draw correct and complete shear and bending moment diagrams for beams.

CO4: Students attain a deeper understanding of the loads, stresses, and strains acting on a structure and their relations in the elastic behavior

Course Objectives:

- Familiarize with fundamental approaches to failure prevention for static and dynamic loading.
- Provide an introduction to design of bolted and welded joints.
- Explain design procedures for shafts and couplings.
- Discuss the principles of design for clutches and brakes and springs.
- Explain design procedures for bearings and gears.

UNIT-I: Introduction, Design for Static and Dynamic loads

Mechanical Engineering Design: Design process, design considerations, codes and standards of designation of materials, selection of materials.

Design for Static Loads: Modes of failure, design of components subjected to axial, bending, torsional and impact loads. Theories of failure for static loads.

Design for Dynamic Loads: Endurance limit, fatigue strength under axial, bending and torsion, stress concentration, notch sensitivity. Types of fluctuating loads, fatigue design for infinite life. Soderberg, Goodman and modified Goodman criterion for fatigue failure. Fatigue design under combined stresses.

UNIT-II: Design of Bolted and Welded Joints

Design of Bolted Joints: Threaded fasteners, preload of bolts, various stresses induced in the bolts. Torque requirement for bolt tightening, gasketed joints.

Welded Joints: Strength of lap and butt welds, Joints subjected to bending and torsion.

UNIT-III: Power transmission shafts and Couplings

Power Transmission Shafts: Design of shafts subjected to bending, torsion and axial loading. Shafts subjected to fluctuating loads using shock factors.

Couplings: Design of flange and bushed pin couplings, universal coupling.



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UNIT-IV: Design of Clutches, Brakes and Springs

Friction Clutches: Torque transmitting capacity of disc and centrifugal clutches. Uniform wear theory and uniform pressure theory.

Brakes: Different types of brakes. Concept of self-energizing and self-locking of brake. Band and block brakes, disc brakes.

Springs: Design of helical compression, tension, torsion and leaf springs.

UNIT-V: Design of Bearings and Gears

Design of Sliding Contact Bearings: Lubrication modes, bearing modulus, McKee's equations, design of journal bearing. Bearing Failures.

Design of Rolling Contact Bearings: Static and dynamic load capacity, Stribeck's Equation, equivalent bearing load, load-life relationships, load factor, selection of bearings from manufacturer's catalogue.

Design of Gears: Spur gears, beam strength, Lewis equation, design for dynamic and wear loads.

Note: Data book is not allowed.

Textbooks:

1. R.L. Norton, Machine Design an Integrated approach, 2/e, Pearson Education, 2004.
2. V.B.Bhandari, Design of Machine Elements, 3/e, Tata McGraw Hill, 2010.
3. Dr. N. C. Pandya &Dr. C. S. Shah, Machine design, 17/e, Charotar Publishing House Pvt. Ltd, 2009.

Reference Books:

1. R.K. Jain, Machine Design, Khanna Publications, 1978.
2. J.E. Shigley, Mechanical Engineering Design, 2/e, Tata McGraw Hill, 1986.
3. M.F.Spotts and T.E.Shoup, Design of Machine Elements, 3/e, Prentice Hall (Pearson Education), 2013.

Online Learning Resources:

<https://www.yumpu.com/en/document/view/18818306/lesson-3-course-name-design-of-machine-elements-1-npte>
<https://www.digimat.in/nptel/courses/video/112105124/L01.html>
<https://dokumen.tips/documents/nptel-design-of-machine-elements-1.html>
<http://www.nitttrc.edu.in/nptel/courses/video/112105124/L25.html>

Course Outcomes:

At the end of the course the students will be able to

- Design the machine members subjected to static and dynamic loads.
- Design shafts and couplings for power transmission



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- Learn how to design bolted and welded joints.
- Know the design procedures of clutches, brakes and springs.
- Design bearings and gears.



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Minors Course	THEORY OF MACHINES (MECHANICAL ENGINEERING DESIGN AND ROBOTICS)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To identify and enumerate different link based mechanisms with basic understanding of motion
2. To interpret and analyze various velocity and acceleration diagrams for various mechanisms
3. To understand about balancing of masses
4. To learn about governors and gyroscope
5. To design and evaluate the performance of different cams and followers.

UNIT-I

Links and Mechanisms:

Definitions Link or Element, Kinematic Pairs, Degrees of Freedom, Grubler's Criterion (without derivation), Kinematic Chain, Mechanism, Structure, Mobility of Mechanism, Inversion, Machine. Kinematic Chains and Inversions: Inversions of Four Bar Chain; Single Slider Crank Chain and Double Slider Crank Chain.

Static force analysis: Introduction: Static equilibrium. Equilibrium of two and three force members. Members with two forces and torque, free body diagrams, principle of virtual work. Static force analysis of four bar mechanism and slider-crank mechanism with and without friction.

UNIT-II

Force principle:

Alembert's principle, Inertia force, inertia torque, Dynamic force analysis of four-bar mechanism and slider crank mechanism.

Friction and Belt Drives: Definitions: Types of friction: laws of friction, Friction in pivot bearings. Belt drives: Flat belt drives, ratio of belt tensions, centrifugal tension, and power transmitted.

Turning moment diagrams: Turning moment diagrams – fluctuation of energy – fly wheels and their design.

UNIT-III

Balancing of Rotating Masses:

Static and dynamic balancing, balancing of single rotating mass by balancing masses in same plane and in different planes. Balancing of several rotating masses by balancing masses in same plane and in different planes.

Balancing of Reciprocating Masses: Inertia effect of crank and connecting rod, single cylinder engine

UNIT-IV

Governors: Types of governors; force analysis of Porter and Hartnell governors. Controlling force, stability, sensitiveness, isochronism, effort and power.

Gyroscope: Vectorial representation of angular motion, gyroscopic couple. Effect of gyro



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oscopic couple on ship, planed disc, aeroplane, stability of two wheelers.

UNIT- 5

Cams:

Types of Cams, Types of Followers. Displacement, Velocity & Acceleration Time Curves for Cam Profiles. Disc Cam with Reciprocating Follower Having Knife- Edge, Roller & Flat-Face Follower, Disc Cam With Oscillating Roller Follower. Follower Motions including, SHM, Uniform Velocity, Uniform Acceleration & Retardation and Cycloidal Motion.

TEXTBOOKS:

1. "Theory of Machines", Rattan S.S, Tata McGraw-Hill Publishing Company Ltd., New Delhi, and 3rd Ed-2009
2. "Theory of Machines", Sadhu Singh, Pearson Education (Singapore) Pvt. Ltd, Indian Branch New Delhi, 2nd Ed 2006/

REFERENCE BOOKS

1. "Theory of Machines & Mechanisms", J.J. Uicker, G.R. Pennock, J.E. Shigley, OXFORD 3rd Ed. 2009.
2. "Theory of Machines" by Thomas Bevan, CBS Publication 1984.
3. "Design of Machinery" by Robert L. Norton, McGraw Hill, 2001.
4. "Mechanisms and Dynamics" of Machinery by J. Srinivas, Scitech Publications, Chennai, 2002.
5. "Dynamics of machinery" by J.B.K. Das & P.L.S. Murthy.

COURSE OUTCOMES: At the end of the course, students will be able

1. To learn different link based mechanisms
2. To analyse various velocity and acceleration diagrams for various mechanisms
3. To learn about how to balance the masses
4. To gain knowledge in governors and gyroscope.
5. To design and evaluate the performance of different cams and followers.



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Minors Course	FINITE ELEMENT METHODS (MECHANICAL ENGINEERING DESIGN AND ROBOTICS)	L	T	P	C
		3	0	0	3

Course Objectives:

- To learn basic principles of finite element analysis procedure
- To learn how to solve the bar and truss problems
- To learn how to solve beam problems
- To understand the formulation of 2D problems
- To get knowledge in heat transfer analysis and dynamic analysis.

UNIT – 1

Introduction to finite element method, stress and equilibrium, strain–displacement relations, stress–strain relations, plane stress and plane strain conditions, variational and weighted residual methods, concept of potential energy, one-dimensional problems.

UNIT – 2

Bar element formulation, Discretization of domain, element shapes, discretization procedures, assembly of stiffness matrix, band width, node numbering, mesh generation, interpolation functions, local and global coordinates, convergence requirements, treatment of boundary conditions.

Analysis of Trusses: Finite element modeling, coordinates and shape functions, assembly of global stiffness matrix and load vector, finite element equations, treatment of boundary conditions, stress, strain and support reaction calculations

UNIT – 3

Analysis of Beams: Element stiffness matrix for Hermite beam element, derivation of load vector for concentrated and UDL, simple problems on beams.

UNIT – 4

Finite element modeling of two dimensional stress analysis with constant strain triangles and treatment of boundary conditions, formulation of axisymmetric problems. Higher order and iso-parametric elements: One dimensional, quadratic and cubic elements in natural coordinates, two dimensional four node iso-parametric elements and numerical integration.

UNIT – 5

Steady state heat transfer analysis: one dimensional analysis of a fin. Dynamic Analysis: Formulation of finite element model, element consistent and lumped mass matrices, evaluation of eigen values and eigen vectors, free vibration analysis.

TEXTBOOK:

1. Introduction to Finite Elements in Engineering, Second Edition/
Tirupati Reddy Chandrupatla/Prentice-Hall.



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2. The Finite Element Methods in Engineering /S.S.Rao/Pergamon.

REFERENCES:

1. Finite Element Method with applications in Engineering / YM Desai, Eldho & Shah /Pearson publishers
2. An introduction to Finite Element Method /JN Reddy/McGraw-Hill
3. The Finite Element Method for Engineers–Kenneth H. Huebner, Donald L. Dewhurst, Douglas E. Smith and Ted G. Byrom/John Wiley & sons (ASIA) Pvt Ltd.
4. Finite Element Analysis: Theory and Application with Ansys, Saeed Moaveni, Pearson Education

Course Outcomes: At the end of the course, student will be able to

- CO1** Understand the concepts behind variational methods and weighted residual methods in FEM
- CO2** Solve bar and truss problems.
- CO3** Solve beam problems.
- CO4** Apply suitable boundary conditions for 2D stress analysis and develop the formulation for axis-symmetric problems and higher order iso-parametric elements
- CO5** Evaluate the concepts of steady state heat transfer analysis and dynamic analysis



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Minors Course	MECHANICAL VIBRATIONS (Mechanical Engineering Design and Robotics)	L	T	P	C
		3	0	0	3

Course Objectives:

- 1) To learn basic principles of mathematical modeling of vibrating systems
- 2) To learn the basic concepts of free and forced multi-degree of freedom systems
- 3) To learn concepts involved in the torsional vibrations
- 4) To learn the principles involved in the critical speed of shafts
- 5) To learn the basic concepts of Laplace transformations
response to different inputs

UNIT-I:

Relevance of and need for vibrational analysis– Basics of SHM - Mathematical modeling of vibrating systems - Discrete and continuous systems - single-degree freedom systems - free and forced vibrations, damped and undamped systems.

UNIT-II:

Free and forced vibrations of multi-degree freedom systems in longitudinal, torsional and lateral modes - Matrix methods of solution- normal modes - Orthogonality principle-Energy methods, Eigenvalues and Eigenvectors, modal analysis.

UNIT-III:

Torsional vibrations - Longitudinal vibration of rods - transverse vibrations of beams – Governing equations of motion - Natural frequencies and normal modes - Energy methods, Introduction to non-linear and random vibrations.

UNIT-IV:

Vibration Measuring Instruments and Critical Speeds of Shafts: Vibrometers, Accelerometer, Frequency measuring instruments and Problems. Critical speed of a light shaft having a single disc without damping and with damping, critical speeds of shaft having multiple discs, secondary critical speed, critical speeds of light cantilever shaft with a large heavy disc at its end.

UNIT-V:

Laplace transformations response to an impulsive input, response to a step input, response to pulse (rectangular and half sinusoidal pulse), phase plane method.

TEXTBOOKS:

1. S.S.Rao, "Mechanical Vibrations", 5th Edition, Prentice Hall, 2011.



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2. L.Meirovitch,“ElementsofvibrationAnalysis”,2ndEdition,McGraw-Hill,NewYork,1985.

REFERENCES:

1. W.T.Thomson,M.D. Dahlehand
CPadmanabhan,“TheoryofVibrationwithApplications”,5th
Edition,PearsonEducation,2008.
2. M.L.Munjal, “NoiseandVibrationControl”, WorldScientific,2013.
3. BeranekandVer,“NoiseandVibrationControlEngineerin
g:PrinciplesandApplications”,JohnWileyandSons,2006.
4. RandallF.Barron,“IndustrialNoiseControlandAcoustics”,MarcelDekker,
Inc.,2003.

CourseOutcomes: At theendofthecourse, student willbeableto

- CO1:Understand theconceptsofvibrationalanalysis
CO2:UnderstandtheconceptsoffreeandforcedmultidegreefreedomsystemsCO3:Summa
rizethe conceptsoftorsionalvibrations
CO4: Solvetheproblemsoncriticalspeed ofshafts
CO5:ApplyandAnalyzethesystemssubjectedtoLaplacetransformations
responsetodifferentinputs



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Minors Course	ROBOTICS (Mechanical Engineering Design and Robotics)	L	T	P	C
		3	0	0	3

Course Objectives: The Students will acquire the knowledge to

1. Discuss various applications and components of industrial robot systems
2. Learn about the types of actuators used in robotics
3. Calculate the forward kinematics and inverse kinematics.
4. Learn about programming principles and languages for a robot control system
5. Discuss the applications of image processing and machine vision in robotics.

UNIT – 1

INTRODUCTION: Automation and Robotics, CAD/CAM and Robotics – An overview of Robotics –present and future applications – classification by coordinate system and control system.

COMPONENTS OF THE INDUSTRIAL ROBOTICS:

Robot anatomy, work volume, components, number of degrees of freedom - robot drive systems, function line diagram representation of robot arms, common types of arms – requirements and challenges of end effectors, determination of the end effectors.

UNIT – 2

ROBOT ACTUATORS AND FEEDBACK COMPONENTS:

Actuators: Pneumatic, Hydraulic actuators, electric & stepper motors. Comparison of Electric, Hydraulic and Pneumatic types of actuation devices.

Feedback components: position sensors–potentiometers, resolvers, encoders–Velocity sensors.

UNIT – 3

MOTION ANALYSIS: Homogeneous transformations as applicable to rotation and translation –problems.

MANIPULATOR KINEMATICS: Specifications of matrices, D-H notation joint coordinates and world coordinates Forward and inverse kinematics–problems.

UNIT – 4

GENERAL CONSIDERATIONS IN PATH DESCRIPTION AND GENERATION: Trajectory planning and avoidance of obstacles, path planning, Skew motion, joint integrated motion –straight line motion –Robot programming, languages and software packages-description of paths with a robot programming language.

UNIT – 5

IMAGE PROCESSING AND MACHINE VISION: Introduction to Machine Vision, Sensing and Digitizing function in Machine Vision, Training and Vision System, Robotic Applications.

TEXTBOOKS:

1. Industrial Robotics/GrooverMP/Pearson Edu.
2. Robotics and Control /Mittal R K &Nagrathi J /TMH.

REFERENCES:

1. Robotics/Fu KS/ McGrawHill.
2. Robotic Engineering /RichardD. Klafter, Prentice Hall



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3. Robot Analysis and Control/ H. Asada and J.J.E. Slotine/BSP Books Pvt. Ltd.
4. Introduction to Robotics/John JCraig/Pearson Edu.

Course Outcomes: At the end of the course, student will be able to

- CO1** Discuss various applications and components of industrial robot systems
- CO2** Learn about the types of actuators used in robotics
- CO3** Calculate the forward kinematics and inverse kinematics.
- CO4** Learn about programming principles and languages for a robot control system
- CO5** Discuss the applications of image processing and machine vision in robotics.



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Minors Course	PRODUCT DESIGN (Mechanical Engineering Design and Robotics)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- Understanding of materials, processes, ergonomics, human behaviour and systems with reference to product design.
- To develop conceptual thinking, and workshop and computer skills for modelling and simulation of a variety of individual and group projects ranging from basic to the complex.
- To understand various risks involved through various techniques and perform reliability analysis.
- To acquaint with different product testing procedures under thermal, vibration, electrical and combined environments.
- To learn about how to design a component for manufacturability

UNIT – I:

PRODUCT DESIGN PROCESS:

Design Process Steps, Morphology of Design. Problem Solving and Decision Making Problem-Solving Process, Creative Problem Solving, Invention, Brainstorm Morphological Analysis, Behavioural Aspects of Decision Making, Decision The Decision Matrix, Decision Trees.

MODELING AND SIMULATION:

Triz, Role of Models in Engineering Design, Mathematical Modeling, Similitude and Models, Computer Simulation, Geometric Modeling on Computer, Finite-Element Anal

UNIT – II:

PRODUCT MANAGEMENT:

The operation of product management: Customer focus of product management, product planning process, Levels of strategic planning, Wedge analysis, Opportunity search, Product life cycle Life cycle theory and practice.

PRODUCT DEVELOPMENT:

Managing new products, generating ideas, Sources of product innovation, Selecting best ideas, the political dimension of product design, Managing the product launch customer feedback.

PRODUCT MANAGERS AND MANUFACTURING:

Need for effective relationships, Impact of manufacturing processes on product decisions, Prototype planning, Productivity potentials, Management of product quality, Customer service levels.

UNIT – III:

RISK AND RELIABILITY:

Risk and Reliability: Risk and Society, Hazard Analysis, Fault Tree Analysis. Failure Analysis and Quality: Causes of Failures, Failure Modes, Failure Mode and Effect Analysis, FMEA Procedure, Classification of Severity, Computation of Criticality



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Index, Determination of Corrective Action, Sources of Information, Copyright and Copying. Patent Literature.

UNIT – IV:

PRODUCT TESTING:

Thermal, vibration, electrical, and combined environments, temperature testing, vibration testing, test effectiveness. Accelerated testing and data analysis, accelerated factors. Weibull probability plotting, testing with censored data.

UNIT – V:

DESIGN FOR MANUFACTURABILITY:

Maintenance Concepts and Procedures, Component Reliability, Maintainability Availability, Fault Isolation in design and Self-Diagnostics.

Product Design for Safety, Product Safety and User Safety Concepts, Examples of Safe Designs.

DESIGN STANDARDIZATION AND COST REDUCTION:

Standardization Methodology, Benefits of Product Standardization; International, National, Association and Company Level Standards; Parts Modularization

TEXTBOOKS:

1. Engineering Design, George E. Dieter, McGraw-Hill
2. Product Integrity and Reliability in Design, John W. Evans and Jillian Y. Evans, Springer Verlag.

REFERENCE BOOKS:

1. The Product Management Handbook, Richard S. Handscombe, McGraw-Hill
2. New Product Design, Ulrich Eppinger
3. Product Design, Kevin Otto.

COURSE OUTCOMES:

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

- CO1 Apply creative thinking skills for idea generation
- CO2 Translate conceptual ideas into clear sketches
- CO3 Able to identify causes of failure through fault free analysis and perform failure analysis
- CO4 Test a product under thermal, vibration, electrical and combined environments.
- CO5 Know how to design for manufacturability



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Minors Course	DESIGN FOR MANUFACTURING (Mechanical Engineering Design and Robotics)	L	T	P	C
		3	0	0	3

Course Objectives: The students will acquire the knowledge:

- 1) To understand the basic concepts of design for manual assembly
- 2) To interpret basic design procedure of machining processes
- 3) To understand design considerations metal casting, extrusion and sheet metal work
- 4) To interpret the design considerations of various metal joining process.
- 5) To interpret the basic design concepts involved in the assembly automation

UNIT-1

Introduction to DFM, DFMA: How Does DFMA Work? Reasons for Not Implementing DFMA, What Are the Advantages of Applying DFMA During Product Design? Typical DFMA Case Studies, Overall Impact of DFMA on Industry.

Design for Manual Assembly: General Design Guidelines for Manual Assembly, Development of the Systematic DFA Methodology, Assembly Efficiency, Effect of Part Symmetry, Thickness, weight on Handling Time, Effects of Combinations of Factors and application of the DFA Methodology.

UNIT- 2

Machining processes: Overview of various machining processes-general design rules for machining dimensional tolerance and surface roughness-Design for machining – ease –redesigning of components for machining ease with suitable examples. General design recommendations for machined parts.

UNIT – 3

Metal casting: Appraisal of various casting processes, selection of casting process,-general design considerations for casting-casting tolerance-use of solidification, simulation in casting design product design rules for sand casting. Extrusion & Sheet metal work: Design guide lines extruded sections-design principles for punching, blanking, bending, and deep drawing-Keeler Goodman forging line diagram – component design for blanking

UNIT- 4

Metal joining: Appraisal of various welding processes, factors in design of weldments – general design guidelines-pre and post treatment of welds-effects of thermal stresses in weld joints-design of brazed joints. Forging: Design factors for forging – closed die forging design – parting lines of dies –drop forging die design – general design recommendations.

UNIT- 5

Design for Assembly Automation: Fundamentals of automated assembly systems, System configurations, parts delivery system at workstations, various escapement and placement devices used in automated assembly systems, Quantitative analysis of Assembly systems, Multi station assembly systems, and single station assembly lines.

Design for Additive Manufacturing: Design considerations, allowances

TEXT BOOKS:

1. Design for manufacture, John cobert, Adisson Wesley. 1995
2. Design for Manufacture by Boothroyd,



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3. Design for manufacture, James Bralla

REFERENCE:

1. ASM Hand book Vol.20

Course Outcomes: At the end of the course, student will be able to

CO1: Understand the basic concepts of design for manual assembly

CO2: Identify basic design procedure of various machining processes.

CO3: Illustrate the design considerations metal casting, extrusion and sheet metal work

CO4: Interpret the design considerations of various metal joining process.

CO5: Understand the basic design concepts involved in the assembly automation



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Minor Course	MECHANISMS AND ROBOTICS (Mechanical Engineering Design and Robotics)	L	L	T	T	P	PC	C
		0			0		3	1.5

Course Objectives:

- To develop skill to use software to create 2D models.
- To learn how to use software 3D models.
- To use software Assembly.

LIST OF EXPERIMENT:

1. **DRAFTING:** Development of part drawings for various components in the form of orthographic and isometric. Representation of dimensioning and tolerances, Study of DXE, IGES files.

2. **SURFACE MODELING** - Generation of various Surfaces using surface modeling.

A) DRAFTING: Development of part drawings for various components in the form of orthographic and isometric. Representation of dimensioning and tolerances, Study of DXE, IGES files.

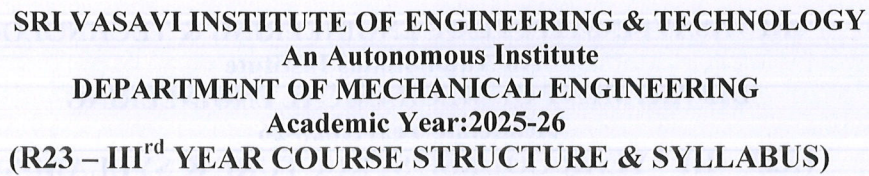
B) SURFACE MODELING - Generation of various Surfaces using surface modeling.

C) The following contents to be done by any 3D software package:

(i) PART MODELING: Generation of various 3D models through Pad, revolve, shell, sweep, parent child relation, Boolean operations and various standard translators.

(ii) Assembly drawings: (Any four of the following using solid model software) Generation of various Parts/assemblies: like Screw Jack, Oldham's Coupling, Foot step bearing, Couplings, knuckle and cotter joints, Crankshaft, Connecting Rod, Piston and Cylinder.

Course Outcomes: At the end of the course, students learn drafting, surface modeling and 3D modeling



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CO3 Design planar mechanisms using procedures for path generation and rigid body guidance and simulate the motions using ADAMS software



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Minors Course	AUTOMATION IN MANUFACTURING (Smart Manufacturing)	L	T	P	C
		3	0	0	3

Course Objectives:

1. To understand the types and strategies and various components in Automated Systems
2. To classify the types of automated flow lines and analyze automated flow lines
3. To solve the line balancing problems in the various flow line systems with and without buffer storage
4. To interpret different automated material handling systems, storage and retrieval systems and automated inspection systems
5. To understand the principles of Adaptive Control systems and recognize the types of automated inspection techniques and their applications

UNIT – 1

INTRODUCTION: Types and strategies of automation, pneumatic and hydraulic components, circuits, automation in machine tools, power transmission in CNC machines, optical encoders, other sensors, mechanical feeding and tool changing and machine tool control.

UNIT – 2

AUTOMATED FLOW LINES: Methods of part transport, transfer mechanism, buffer storage, control function, design and fabrication considerations. Analysis of automated flow lines - General terminology and analysis of transfer lines without and with buffer storage, partial automation, implementation of automated flow lines.

UNIT – 3

ASSEMBLY SYSTEM AND LINE BALANCING: Assembly process and systems, assembly line, line balancing methods, ways of improving line balance, flexible assembly lines.

AUTOMATED INSPECTION: Fundamentals, types of inspection methods and equipment, Coordinate Measuring Machines, Machine Vision

UNIT – 4

AUTOMATED MATERIAL HANDLING AND STORAGE SYSTEMS:

Types of equipment, functions, analysis and design of material handling systems, conveyor systems, automated guided vehicle systems. Automated storage and retrieval systems; work in process storage, interfacing handling and storage with manufacturing.

UNIT – 5

ADAPTIVE CONTROL SYSTEMS: Introduction, adaptive control with



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optimization, adaptive control with constraints, application of adaptive control in machining operations. Consideration of various parameters such as cutting force, temperatures, vibration and acoustic emission in the adaptive controls systems.

TEXT BOOK:

Automation, Production Systems and Computer Integrated Manufacturing: M.P. Groover/ PE/PHI.

Automation by W. Buekinsham.

REFERENCES:

1. Computer Control of Manufacturing Systems by YoramCoren.
2. CAD / CAM/ CIM by Radhakrishnan.

Course Outcomes: At the end of the course, student will be able to

- CO1** Understands the types and strategies and various components in Automated Systems.
- CO2** Classify the types of automated flow lines and analyze automated flow lines
- CO3** Solves the line balancing problems in the various flow line systems with and without buffer storage
- CO4** Interpret different automated material handling systems, storage and retrieval systems and automated inspection systems
- CO5** Understand the principles of Adaptive Control systems and recognize the types of automated inspection techniques and their applications



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Minors Course	MICRO ELECTRO MECHANICAL SYSTEMS (Smart Manufacturing)	L	T	P	C
		3	0	0	3

Course Objectives:

- 1) To understand basics of Micro Electro Mechanical Systems (MEMS), mechanical sensors and actuators
- 2) To illustrate thermal sensors and actuators used in MEMS.
- 3) To apply the principle and various devices of Micro-Opto-Electro Mechanical Systems (MOEMS), magnetic sensors and actuators.
- 4) To analyze applications and considerations on micro fluidic systems.
- 5) To illustrate the principles of chemical and bio medical micro systems.

UNIT – I: INTRODUCTION:

Definition of MEMS, MEMS history and development, micro machining, lithography principles & methods, structural and sacrificial materials, thin film deposition, impurity doping, etching, surface micro machining, wafer bonding, LIGA. MECHANICAL SENSORS AND ACTUATORS: Principles of sensing and actuation: beam and cantilever, capacitive, piezo-electric, strain, pressure, flow, pressure measurement by micro phone, MEMS gyroscopes, shear mode piezo actuator, gripping piezo actuator, Inchworm technology.

UNIT – II: THERMAL SENSORS AND ACTUATORS:

Thermal energy basics and heat transfer processes, thermistors, thermo devices, thermo couple, micro machined thermo couple probe, Peltier effect heat pumps, thermal flow sensors, micro hot plate gas sensors, MEMS thermo vessels, pyro electricity, shape memory alloys (SMA), U-shaped horizontal and vertical electro thermal actuator, thermally activated MEMS relay, micro spring thermal actuator, data storage cantilever.

UNIT – III: MICRO-OPTO-ELECTRO MECHANICAL SYSTEMS:

Principle of MOEMS technology, properties of light, light modulators, beam splitter, micro lens, micro mirrors, digital micro mirror device (DMD), light detectors, grating light valve (GLV), optical switch, wave guide and tuning, shear stress measurement. MAGNETIC SENSORS AND ACTUATORS: Magnetic materials for MEMS and properties, magnetic sensing and detection, magneto resistive sensor, more on hall effect, magneto diodes, magneto transistor, MEMS magnetic sensor, pressure sensor utilizing MOKE, mag MEMS actuators, by directional micro actuator, feedback circuit integrated magnetic actuator, large force reluctance actuator, magnetic probe based storage device.

UNIT – IV: MICRO FLUIDIC SYSTEMS:

Applications, considerations on micro scale fluid, fluid actuation methods, dielectrophoresis (DEP), electro wetting, electro thermal flow, thermo capillary effect, electro osmosis flow, opto electro wetting (OEW), tuning using micro fluidics, typical micro fluidic channel, micro fluid dispenser, micro needle, molecular gate, micro pumps. RADIO FREQUENCY (RF) MEMS: RF – based communication systems, RF



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MEMS, MEMS inductors, tuner/filter, resonator, clarification of tuner, filter, resonator, MEMS switches, phase shifter.

UNIT – V:

CHEMICAL AND BIO MEDICAL MICRO SYSTEMS: Sensing mechanism & principle, membrane-transducer materials, chem.-lab-on-a-chip (CLOC) chemo-resistors, chemo-capacitors, chemo-transistors, electronic nose (E-nose), mass sensitive chemo-sensors, fluorescence detection, calorimetric spectroscopy.

TEXT BOOK:

1.MEMS, NitaigourPremchandMahalik, TMH

REFERENCE BOOKS:

1. Foundation of MEMS, Chang Liu, Prentice Hall Ltd.
2. MEMS and NEMS, Sergey Edward Lyshevski, CRC Press, Indian Edition.
3. MEMS and Micro Systems: Design and Manufacture, Tai-Ran Hsu, TMH Publishers.
4. Introductory MEMS, Thomas M Adams, Richard A Layton, Springer International Publishers.

Course Outcomes: At the end of the course, student will be able to

CO 1: To understand basics of Micro Electro Mechanical Systems (MEMS), mechanical sensors and actuators.

CO 2: Illustrate thermal sensors and actuators used in MEMS.

CO 3: To apply the principle and various devices of Micro-Opto-Electro Mechanical Systems (MOEMS), magnetic sensors and actuators.

CO 4: Analyze applications and considerations on micro fluidic systems.

CO 5: Illustrate the principles of chemical and bio medical micro systems.



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Minors Course	MECHATRONICS (Smart Manufacturing)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- Understand various elements of a mechatronics system
- Model and simulate simple physical systems
- Suggest appropriate sensors and actuators for an engineering application
- Write simple microcontroller programs
- Build simple homemade projects using electronic devices integrating with mechanical systems

UNIT WISE SYLLABUS AND CONTACT HOURS (Total: 48):

UNIT – I:

Mechatronics systems, elements, levels of mechatronics system, Mechatronics design process, measurement systems, control systems, microprocessor-based controllers, advantages and disadvantages of mechatronics systems. Sensors and transducers, types, 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 and TRIAC. Analog signal conditioning, amplifiers, filtering. Introduction to MEMS & typical applications.

UNIT – III:

Hydraulic and pneumatic actuating systems, Fluid systems, Hydraulic and pneumatic systems, components, control valves, electro-pneumatic, hydro-pneumatic, electrohydraulic servo systems. Mechanical actuating systems and electrical actuating systems.

UNIT – IV:

Digital electronics and systems, digital logic control, microprocessors and microcontrollers, programming, process controllers, programmable logic controllers, PLC versus computers, application of PLCs for control.

UNIT – V:

System and interfacing and data acquisition, DAQS, SCADA, A-D and D-A conversions; Dynamic models and analogies, System response. Design of mechatronics systems & future trends.

TEXTBOOKS:

1. Mechatronics Integrated Mechanical Electronics Systems/KP Ramachandran & G K VijayaRaghavan/WILEY India Edition/2008
2. Mechatronics Electronics Control Systems in Mechanical and Electrical Engineering by W Bolton, Pearson Education Press, 3rd edition, 2005.



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REFERENCE BOOKS:

1. Mechatronics Source Book by Newton C Braga, Thomson Publications, Chennai.
2. Mechatronics – N. Shanmugam / Anuradha Agencies Publishers.
3. Mechatronics System Design / Devdas Shetty/Richard/Thomson.
4. Mechatronics/M. D. Singh/J. G. Joshi/PHI.

COURSE OUTCOMES:

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

Course Outcome

- CO1 Identification and demonstration of key elements of mechatronics system representation in terms of block diagram.
- CO2 Describe the use of solid-state electronic devices, diodes, amplifiers, designing the mechatronics systems and MEMS.
- CO3 Illustrate the applications of various hydraulic, pneumatic, mechanical, electro-actuating systems and valves in designing the mechatronic systems.
- CO4 Develop the PLC ladder programming for the creation of real-time mechatronic system.
- CO5 Develop dynamic models using system interfacing and data acquisition method design mechatronics systems for future applications.



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Minors Course	CIM (SMART MANUFACTURING)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- Understand the basic fundamentals of computer aided manufacturing.
- To understand the principles of flexible manufacturing systems
- To understand the different geometric modeling techniques like solid modeling, surface modeling, feature based modeling etc. and to visualize how the components look like before its manufacturing or fabrication
- To learn the overall configuration and elements of computer integrated manufacturing systems.
- To learn the part programming, importance of group technology, computer aided process planning, computer aided quality control

UNIT- 1

MANUFACTURING IN A COMPETITIVE ENVIRONMENT: Automation of manufacturing process - Numerical control - Adaptive control - material handling and movement - Industrial robots - Sensor technology - flexible fixtures - Design for assembly, disassembly and service.

UNIT- 2

GROUP TECHNOLOGY & FLEXIBLE MANUFACTURING SYSTEMS: Part families - classification and coding - Production flow analysis - Machine cell design - Benefits. Components of FMS - Application work stations - Computer control and functions - Planning, scheduling and control of FMS - Scheduling - Knowledge based scheduling - Hierarchy of computer control - Supervisory computer.

UNIT- 3

COMPUTER SOFTWARE, SIMULATION AND DATABASE OF FMS: System issues - Types of software - specification and selection - Trends - Application of simulation - software - Manufacturing data systems - data flow - CAD/CAM considerations - Planning FMS database.

UNIT- 4

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

UNIT- 5

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.



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REFERENCES:

1. Groover M.P., " Automation, Production Systems and Computer Integrated Manufacturing ", Third Edition, Prentice-Hall, 2007.
2. Jha, N.K. "Handbook of Flexible Manufacturing Systems ", Academic Press Inc., 1991.
3. Kalpkjian, "Manufacturing Engineering and Technology ", Addison-Wesley Publishing Co., 1995.
4. Pascal Dennis, "Lean Production Simplified: A Plain-Language Guide to the World's Most Powerful Production System", (Second edition), Productivity Press, New York, 2007.
5. Taiichi Ohno, Toyota, " Production System Beyond Large-Scale production Productivity Press (India) Pvt.Ltd. 1992.

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

- Gain knowledge about the fundamentals of computer aided manufacturing.
- Learn the principles of flexible manufacturing systems
- Gain knowledge about different geometric modeling techniques like solid modeling, surface modeling, feature based modeling etc. and to visualize how the components look like before its manufacturing or fabrication
- Learn the overall configuration and elements of computer integrated manufacturing systems.
- Understand the part programming, importance of group technology, computer aided process planning, computer aided quality control



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Minors Course	SMART MANUFACTURING (Smart Manufacturing)	L	T	P	C
		3	0	0	3

Course objectives:

1. To apply knowledge of smart manufacturing systems' components in the context of Industry 4.0
2. To understand the concepts of smart machines and smart sensors
3. To understand and apply the concepts of IoT connectivity to Industry 4.0
4. To understand the concepts of Digital Twin and apply Machine Learning and Artificial Intelligence concepts in Manufacturing
5. To understand the concepts of Metaverse platform

UNIT – 1

Concepts of Smart Manufacturing: Definition and key characteristics of smart manufacturing, Corporate adaptation processes, manufacturing challenges, challenges vs technologies, Stages in smart manufacturing. Minimizing Six big losses in manufacturing with Industry 4.0, and their benefits.

UNIT – 2

Smart Machines and Smart Sensors: Concept and Functions of a Smart, Machine Salient features and Critical Subsystems of a Smart Machine, Smart sensors; smart sensors ecosystem, need, benefits and applications of sensors in industry, Introduction to IoT, IIoT, and Cyber physical systems, Sensing for Manufacturing Process in IIoT, Block Diagram of an IoT Sensing Device, Sensors in IIoT Applications, Smart Machine Interfaces,

UNIT – 3

IoT connectivity for Industry 4.0: Industrial communication requirement and its infrastructure, an overview of different types of networks, mesh network in industrial IoT, IoT protocols and the internet, TCP/IP (transmission control protocol/internet protocol) model, IoT connectivity standards: common protocols, application layer protocols, internet/network layer protocols, physical layer IoT protocols, choosing the right IoT connectivity protocol.

UNIT – 4

Digital Twin: Introduction, applications of digital twins, impact zones of digital twins in manufacturing (factories/plants and OEMs), advantages of digital twins, basic steps of digital twin technology

Machine Learning (ML) and Artificial Intelligence (AI) in Manufacturing: Introduction, benefits and applications of ML in industries, common approaches of ML; supervised and unsupervised, semi-supervised and reinforced ML.

UNIT – 5

Metaverse – Basic concepts, AR/VR, Social Metaverse, Industrial Metaverse, How Web 3.0 is changing the Internet, Asset Classes Inside the Metaverse, Land, Coins, Characters/ Avatars, Skins, Utility, Industries Disrupted by the Metaverse, Smart



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wearables,

TEXT BOOKS:

1. Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, 2/e, Pearson Education, 2010.
2. Tom M. Mitchell, Machine Learning, McGraw Hill, 2013.
3. EthemAlpaydin, Introduction to Machine Learning (Adaptive Computation and Machine Learning), The MIT Press, 2004.
4. AurélienGéron, Hands on Machine Learning with Scikit-Learn and TensorFlow [Concepts, Tools, and Techniques to Build Intelligent Systems], Published by O'Reilly Media, 2017.
5. Artificial Intelligence and Machine Learning, Principles and applications by Vinod Chandra S.S., AnandHareendran S., PHI

REFERENCE BOOKS:

1. Elaine Rich, Kevin Knight and Shivashankar B. Nair, Artificial Intelligence, 3/e, McGraw Hill Education, 2008.
2. Dan W. Patterson, Introduction to Artificial Intelligence and Expert Systems, PHI Learning, 2012.
3. M.C. Trivedi, A Classical Approach to Artificial Intelligence, Khanna Publishing House, New Delhi, 2018.
4. S. Kaushik, Artificial Intelligence, Cengage Learning India, 2011.

Course Outcomes: At the end of the course, student will be able to

- CO1** Learn about smart manufacturing systems' components and can handle it more effectively in context of Industry 4.0
- CO2** Learn about the smart machines and smart sensors
- CO3** Apply IoT to Industry 4.0 and they are able to make a system tailor-made as per requirement of the industry
- CO4** Learn about concepts of Digital Twin and able to apply Machine Learning and Artificial Intelligence concepts in Manufacturing
- CO5** Learn the concepts of AR/VR and Metaverse platform



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Minors Course	ROBOTICS (Smart Manufacturing)	L	T	P	C
		3	0	0	3

Course Objectives: To

1. Discuss various applications and components of industrial robot systems
2. Learn about the types of actuators used in robotics
3. Calculate the forward kinematics and inverse kinematics.
4. Learn about programming principles and languages for a robot control system
5. Discuss the applications of image processing and machine vision in robotics.

UNIT – 1

INTRODUCTION: Automation and Robotics, CAD/CAM and Robotics – An overview of Robotics –present and future applications – classification by coordinate system and control system.

COMPONENTS OF THE INDUSTRIAL ROBOTICS:

Robot anatomy, work volume, components, number of degrees of freedom - robot drive systems, function line diagram representation of robot arms, common types of arms – requirements and challenges of end effectors, determination of the end effectors.

UNIT – 2

ROBOT ACTUATORS AND FEEDBACK COMPONENTS:

Actuators: Pneumatic, Hydraulic actuators, electric & stepper motors. Comparison of Electric, Hydraulic and Pneumatic types of actuation devices.

Feedback components: position sensors–potentiometers, resolvers, encoders–Velocity sensors.

UNIT – 3

MOTION ANALYSIS: Homogeneous transformations as applicable to rotation and translation –problems.

MANIPULATOR KINEMATICS: Specifications of matrices, D-H notation joint coordinates and world coordinates Forward and inverse kinematics–problems.

UNIT – 4

GENERAL CONSIDERATIONS IN PATH DESCRIPTION AND GENERATION: Trajectory planning and avoidance of obstacles, path planning, Skew motion, joint integrated motion –straight line motion –Robot programming, languages and software packages–description of paths with a robot programming language.

UNIT – 5

IMAGE PROCESSING AND MACHINE VISION: Introduction to Machine Vision, Sensing and Digitizing function in Machine Vision, Training and Vision System, Robotic Applications.

TEXTBOOKS:

1. Industrial Robotics/GrooverMP/Pearson Edu.
2. Robotics and Control /Mittal R K &Nagrathi J /TMH.

REFERENCES:

1. Robotics/Fu KS/ McGrawHill.



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2. Robotic Engineering /RichardD. Klafter, Prentice Hall
3. Robot Analysis and Control/ H. Asada and J.J.E. Slotine/BSP Books Pvt. Ltd.
4. Introduction to Robotics/John JCraig/Pearson Edu.

Course Outcomes: At the end of the course, student will be able to

CO1	Discuss various applications and components of industrial robot systems
CO2	Learn about the types of actuators used in robotics
CO3	Calculate the forward kinematics and inverse kinematics.
CO4	Learn about programming principles and languages for a robot control system
CO5	Discuss the applications of image processing and machine vision in robotics.



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Minors Course	MANUFACTURING PROCESSES (Smart Manufacturing)	L	T	P	C
		3	0	0	3

CourseObjective:

To impart basic knowledge and understanding about the primary manufacturing processes such as casting, welding, bulk forming, sheet metal forming, and additive manufacturing and their relevance in the current manufacturing industry.

UNIT– I

Casting: Steps involved in making a casting – Advantage of casting and its applications. Patterns and Pattern making – Types of patterns – Materials used for patterns, pattern allowances and their construction, Molding, different types of cores, Principles of Gating, Risers, casting design considerations. Methods of melting and types of furnaces, Solidification of castings and Casting defects. Basic principles and applications of special casting processes - Centrifugal casting – True, semi and centrifugal, Die casting, Investment casting and shell molding.

UNIT–II

Welding: Classification of welding processes, types of welded joints and their characteristics, Gas welding, Different types of flames and uses, Oxy – Acetylene Gas cutting. Basic principles of Arc welding, power characteristics, Manual metal arc welding, submerged arc welding, TIG & MIG welding. Electro-slag welding. Resistance welding, Friction welding, Friction stir welding, Forge welding, Explosive welding; Thermit welding, Plasma Arc welding, Laser welding, electron beam welding, Soldering & Brazing. Heat affected zones in welding; pre & post heating, Weldability of metals, welding defects – causes and remedies – destructive and non-destructive testing of welds.

UNIT–III

Bulk Forming: Plastic deformation in metals and alloys-recovery, recrystallization and grain growth.

Hot working and Cold working-Strain hardening and Annealing. Bulk forming processes: Forging -Types of Forging, Smith forging, Drop Forging, Roll forging, Forging hammers, Rotary forging, forging defects; Rolling – fundamentals, types of rolling mills and products, Forces in rolling and power requirements. Extrusion and its characteristics. Types of extrusion, Impact extrusion, Hydrostatic extrusion; Wire drawing and Tube drawing

UNIT– IV

Sheet metal forming-

Blanking and piercing, Forces and power requirement in these operations, Deep drawing, Stretch forming, Bending, Spring back and its remedies, Coining, Spinning, Types of presses and press tools.

High energy rate forming processes: Principles of explosive forming, electromagnetic



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forming, Electrohydraulic forming, rubber pad forming, advantages and limitations.

UNIT -V

Additive manufacturing - Steps in Additive Manufacturing (AM), Classification of AM processes, Advantages of AM, and types of materials for AM, VAT photopolymerization AM Processes, Extrusion - Based AM Processes, Powder Bed Fusion AM Processes, Directed Energy Deposition AM Processes, Post Processing of AM Parts, Applications

TEXTBOOKS:

1. Manufacturing Processes for Engineering Materials – Kalpakjian and Steven R Schmid-Pearson Publ, 5th Edn.
2. Manufacturing Technology-Vol II-P.N.Rao-TMH

REFERENCES:

1. Manufacturing Science – A. Ghosh & A. K. Malik – East West Press Pvt. Ltd
2. Process and materials of manufacture- Lindberg-PHI
3. Production Technology-R.K.Jain-Khanna
4. Production Technology-PC Sharma-S.Chand
5. Manufacturing Processes-H.S.Shaun-Pearson
6. Manufacturing Processes-J.P.Kaushish-PHI
7. Workshop Technology-WAJ Chapman/CBS Publishers & Distributors Pvt.Ltd.
8. Production Technology-HMT-Tata Mc Graw Hill
9. Ian Gibson, David W Rosen, Brent Stucker., “Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing”, 2nd Edition, Springer, 2015

Course Outcomes:

Students will be able to

- CO1: design the patterns and core boxes for metal casting processes
- CO2: understand the different welding processes
- CO3: know the different types of bulk forming processes
- CO4: understand sheet metal forming processes
- CO5: learn about the different types of additive manufacturing processes.



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Minors Course	ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING (Smart Manufacturing)	L	T	P	C
		3	0	0	3

Course objectives:

- 1) To impart the basic concepts of artificial intelligence and the
- 2) principles of knowledge representation and reasoning.
- 3) To introduce the machine learning concepts and supervised learning methods
- 4) To enable the students gain knowledge in unsupervised learning method and Bayesian algorithms.
- 5) To make the students learn about neural networks and genetic algorithms.
- 6) To understand the machine learning analytics and deep learning techniques.

UNIT– I:

Introduction: Definition of Artificial Intelligence, Evolution, Need, and applications in real world. Intelligent Agents, Agents and Environments; Good Behaviour - concept of rationality, the nature of environments, structure of agents.

Knowledge–Representation and Reasoning: Logical Agents: Knowledge-based agents, the Wumpus world, logic. Patterns in Propositional Logic, Inference in First-Order Logic-Propositional vs first order inference, unification.

UNIT– II:

Introduction to Machine Learning (ML): Definition, Evolution, Need, applications of ML in industry and real-world, regression and classification problems, performance metrics, differences between supervised and unsupervised learning paradigms, bias, variance, overfitting and under fitting.

Supervised Learning: Linear regression, logistic regression, Distance-based methods, Nearest-Neighbours, Decision Trees, Support Vector Machines, Nonlinearity and Kernel Methods.

UNIT– III:

Unsupervised Learning: Clustering, K-means, Dimensionality Reduction, PCA and Kernel.

Bayesian and Computational Learning: Bayes theorem, concept learning, maximum likelihood of normal, binomial, exponential, and Poisson distributions, minimum description length principle, Naïve Bayes Classifier, Instance-based Learning- K-Nearest neighbour learning.

UNIT– IV:

Neural Networks and Genetic Algorithms: Neural network representation, problems, perceptron, multilayer networks and backpropagation, steepest descent method, Convolutional



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neural networks and their applications Recurrent Neural Networks and their applications, Local vs Global optima, Genetic algorithms- binary coded GA, operators, convergence criteria.

UNIT– V:

Deep Learning: Deep generative models, Deep Boltzmann Machines, Deep auto-encoders, Applications of Deep Networks.

Machine Learning Algorithm Analytics: Evaluating Machine Learning algorithms, Model, Selection, Ensemble Methods - Boosting, Bagging, and Random Forests.

TEXT BOOKS:

- 1) Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, 2/e, Pearson Education, 2010.
- 2) Tom M. Mitchell, Machine Learning, McGraw Hill, 2013.
- 3) Ethem Alpaydin, Introduction to Machine Learning (Adaptive Computation and Machine Learning), The MIT Press, 2004.

REFERENCE BOOKS:

- 1) Elaine Rich, Kevin Knight and Shivashankar B. Nair, Artificial Intelligence, 3/e, McGraw Hill Education, 2008.
- 2) Dan W. Patterson, Introduction to Artificial Intelligence and Expert Systems, PHI Learning, 2012.

ONLINE RESOURCES:

<https://www.tpointtech.com/artificial-intelligence-ai>

<https://www.geeksforgeeks.org/>

Course outcomes: At the end of the course, student will be able to

CO1: Explain the basic concepts of artificial intelligence

CO2: Learn about the principles of supervised learning methods

CO3: Gain knowledge in unsupervised learning method and Bayesian algorithms

CO4: Get knowledge about neural networks and genetic algorithms.

CO5: Understand the machine learning analytics and apply deep learning techniques.



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Minors Course	Artificial Intelligence and Machine Learning Lab (Smart Manufacturing)	L	T	P	C
		0	0	3	1.5

Course Objectives: To enable the students write coding for various artificial intelligence and machine learning algorithms.

- Learning of Python libraries – Numpy, Pandas, Matplotlib, Seaborn and TensorFlow
- Numerical examples on Python libraries
- Data Preprocessing and data cleaning using Python
- Write a program for Linear regression
- Write a program for Logistic regression
- Write a program for ANN
- Write a program for CNN
- Write a program for RNN
- Write a program to build a Decision tree
- Write a program to build a Naïve Bayes classifier
- Write a program for SVM
- Write a program for Auto-encoder

Course Outcomes: Students at the end of the course will be able to

CO1: Learn various Python libraries.

CO2: Do programming for regression methods

CO3: Write coding for different types of neural networks

CO4: Write a program for decision tree, Naïve Bayes and SVM

CO4: Generate code for autoencoders

Course Outcomes: At the end of the course, student will be able to apply the knowledge of artificial intelligence and machine learning models along with image classifiers using various software tools.

Note: Databases can be taken from <https://www.kaggle.com/datasets>.



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Minors Course	MECHATRONICS LAB (Smart Manufacturing)	L	T	P	C
		0	0	3	1.5

Course Objectives:

- 1) Measure load, displacement and temperature using analogue and digital sensors.
- 2) Develop PLC programs for control of traffic lights, water level, lifts and conveyor belts.
- 3) Simulate and analyze PID controllers for a physical system using MATLAB.
- 4) Develop pneumatic and hydraulic circuits using Automation studio.

List of Experiments

1. Transducers Kit :-
 - a. Characteristics of LVDT
 - b. Principle & Characteristics of Strain Gauge
 - c. Characteristics of Summing Amplifier
 - d. Characteristics of Reflective Opto Transducer
2. PLC PROGRAMMING & Simulation of Allen Bradley, Siemens or IEC Ladder Using Automation Studio
 - a. Ladder programming on Logic gates ,Timers (TON,TOFF) &counters (UP,DOWN)
 - b. Ladder Programming for digital &Analogy sensors
 - c. Ladder programming & Simulations of Virtual System such as Traffic Light control, Washing machine, Garage Door, Water level control, Lift control, Conveyor Belt etc.
 - d. Ladder programming to control circuits such as single solenoid spring return latch circuit, double solenoid Hydraulic / Pneumatic circuits, Self-Reciprocating Hydraulic / Pneumatic Circuit.
3. AUTOMATION STUDIO SOFTWARE (Design, Simulate &Analyze)
 - a. Introduction to Automation studio & its control.
 - b. Draw& Simulate Hydraulic circuits for series ¶llel cylinders connection, Accumulator circuit, Pressure intensifier circuit, Simple Electro- Hydraulic Electro - Pneumatic circuits (Plot Waveforms for different parameters).
 - c. Design & Simulate Meter-in, Meter-out, Regenerative circuit, sequencing circuit, traverse and feed hydraulic circuit, hydraulic press and clamping.
 - d. Position Control of Proportional Servo Valve Circuit using PID Feedback controller.
4. MATLAB Programming
 - a. Sample programs on Mat lab
 - b. Simulation and analysis of PID controller using SIMULINK

Course Outcomes: At the end of the course, student will be able to.

CO1: Understand the Characteristics of LVDT

CO2: Measure load, displacement and temperature using analogue and digital sensors.

CO3: Develop PLC programs for control of traffic lights, water level, lifts and conveyor belts. CO4: Simulate and analyze PID controllers for a physical system using MATLAB.

CO4: Develop pneumatic and hydraulic circuits using Automaton studio.



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Minors Course	THERMODYNAMICS (THERMAL SYSTEMS ENGINEERING)	L	T	P	C
		3	0	0	3

Course Objectives:

To impart the knowledge of the thermodynamic laws and principles so as to enable the student to prepare an energy audit of any mechanical system that exchange heat and work with the surroundings.

UNIT-I

Introduction: Basic Concepts : System, boundary, Surrounding, Universe, control volume, Types of Systems, Macroscopic and Microscopic viewpoints, Concept of Continuum, Thermodynamic Equilibrium, State, Property, Process - Reversible, Quasistatic & Irreversible Processes, cycle, Causes of Irreversibility. Energy in State and in Transition- Types, Work and Heat, Point and Path function. Zeroth Law of Thermodynamics – Concept of Temperature – Principles of Thermometry – Reference Points – Const. Volume gas Thermometer – Scales of Temperature.

UNIT-II

Joule's Experiments – First law of Thermodynamics – Corollaries – First law applied to a Process – applied to a flow system – Energy balance for closed systems- Specific heats- Internal energy, Enthalpy and Specific heats of Solids, liquids and Ideal gases, Some steady flow energy equation applied to Nozzle, Turbine, Compressor and heat exchanger devices, PMM-I.

UNIT III

Limitations of the First Law – Thermal Reservoir, Heat Engine, Heat pump, Parameters of performance, Second Law of Thermodynamics, Kelvin-Planck and Clausius Statements and their Equivalence, Corollaries, PMM of Second kind, Carnot cycle and its specialties, Carnot's theorem, Thermodynamic scale of Temperature. Clausius Inequality, Entropy, Principle of Entropy Increase, Availability and Irreversibility (Basic definitions) – Thermodynamic Potentials, Gibbs and Helmholtz Functions, Maxwell Relations – Elementary Treatment of the Third Law of Thermodynamics.

UNIT IV

Pure Substances, P-V-T- surfaces, T-S and h-s diagrams, Mollier Charts, Phase Transformations – Triple point and critical point, properties during change of phase, Dryness Fraction – Clausius – Clapeyron Equation, Property tables. Various Thermodynamic processes and energy Transfer – Steam Calorimetry.

UNIT-V



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Ideal Gas equation of state- Compressibility factor- Van der Waals equation of state- Beattie- Bridgeman equation of state- Benedict-Webb-Rubin equation of state- Virial equation of state- compressibility charts – variable specific heats .

Mixtures of perfect Gases – Dalton's Law of partial pressure, Avogadro's Laws of additive volumes- Equivalent Gas constant and Molecular Internal Energy, Enthalpy, Specific Heat and Entropy of Mixture of Perfect Gases and Vapour.

Psychrometric Properties – Dry bulb Temperature, Wet Bulb Temperature, Dew point Temperature, Thermodynamic Wet Bulb Temperature, Specific Humidity, Relative Humidity, Saturated Air, Vapour pressure, Degree of saturation – Adiabatic Saturation, Carrier's Equation – Psychrometric chart.

TEXTBOOKS:

1. Engineering Thermodynamics, P.K. Nag 6th Edn, McGraw Hill.
2. Fundamentals of Thermodynamics – Sonntag, Borgnakke, Van Wylen, 6th Edn, Wiley

REFERENCES:

1. Thermodynamics by Prasanna Kumar, Pearson Publishers
2. Engineering Thermodynamics – Jones & Dugan PHI
3. Thermodynamics, an Engineering Approach, Yunus A. Cengel, Michael A. Boles, 8th Edn in SI Units, McGraw Hill.
4. Thermodynamics – J.P. Holman, McGraw Hill
5. An Introduction to Thermodynamics – Y.V.C. Rao – Universities Press.
6. Thermodynamics – W.Z. Black & J.G. Hartley, 3rd Edn Pearson Publ.
7. Engineering Thermodynamics – D.P. Misra, Cengage Publ.
8. Engineering Thermodynamics – P. Chattopadhyay – Oxford Higher Edn Publ.

COURSE OUTCOMES:

After undergoing the course the student is expected to learn

CO1: Basic concepts of thermodynamics

CO2: Laws of thermodynamics

CO3: Concept of entropy

CO4: Property evaluation of vapors and their depiction in tables and charts

CO5: Evaluation of properties of perfect gas mixtures.



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Minors Course	THERMALENGINEERING (Thermal Systems Engineering)	L	T	P	C
		3	0	0	3

Course Objectives:

- 1) To give insight into basic principles of air standard cycles.
- 2) To impart knowledge about IC engines and Boilers
- 3) To make the students learn the working principles of steam nozzles, turbines and compressors
- 4) To impart the knowledge about the various types of compressors and gas turbines
- 5) To make the students gain insights about, rockets and jet propulsion and solar engineering.

UNIT– I

Air standard Cycles: Otto, diesel and dual cycles, its comparison, Brayton cycle

Actual Cycles and their Analysis: Introduction, Comparison of Air Standard and Actual Cycles, Time Loss Factor, Heat Loss Factor, Exhaust Blowdown-Loss due to Gas exchange process, Volumetric Efficiency. Loss due to Rubbing Friction, Actual and Fuel-Air Cycles of CI Engines.

UNIT–II

I.C Engines: Classification - Working principles of SI and CI engines, Valve and Port Timing Diagrams, -Engine systems – Fuel, Carburettor, Fuel Injection System, Ignition, Cooling and Lubrication, principles of supercharging and turbocharging, Measurement, Testing and Performance.

Boilers : Principles of L.P & H.P boilers, mountings and accessories, Draught-induced and forced.

UNIT -III

Steam nozzles: Functions, applications, types, flow through nozzles, condition for maximum discharge, critical pressure ratio, criteria to decide nozzle shape, Wilson line.

Steam turbines: Classification – impulse turbine; velocity diagram, effect of friction, diagram efficiency, De-leval turbine - methods to reduce rotor speed, combined velocity diagram.

Reaction turbine: Principle of operation, velocity diagram, Parson's reaction turbine – condition for maximum efficiency.

Steam condensers: Classification, working principles of different types – vacuum efficiency and condenser efficiency.

UNIT -IV



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Compressors: Classification, Reciprocating type - Principle, multi-stage compression, Rotary type – Lysholm compressor –principle and efficiency considerations.

Centrifugal Compressors: Principle, velocity and pressure variation, velocity diagrams.

Axial flow Compressors: Principle, pressure rise and efficiency calculations.

Gas Turbines: Simple gas turbine plant – ideal cycle, components –regeneration, inter cooling and reheating.

UNIT -V

Jet Propulsion: Principle, classification, t-s diagram - turbo jet engines – thermodynamic cycle, performance evaluation.

Rockets: Principle, solid and liquid propellant rocket engines.

Solar Engineering: Solar radiation, Solar collectors, PV cells, storage methods and applications

Text Books:

1. Thermal Engineering - Mahesh Rathore- McGraw Hill publishers
2. Heat Engineering /V.P.Vasandani and D.S Kumar/Metropolitan Book Company, New Delhi.

References:

1. I.C. Engines - V. Ganesan- Tata McGraw Hill Publishers
2. Thermal Engineering-M.L.Mathur& Mehta/Jain bros. Publishers
3. Thermal Engineering-P.L.Ballaney/ Khanna publishers.
4. Thermal Engineering / RK Rajput/ Lakshmi Publications
5. Thermal Engineering-R.SKhurmi, &J S Gupta/S.Chand.

Course Outcomes: At the end of the course, student will be able to

CO1: Explain the basic concepts of air standard cycles.

CO2: Get knowledge about IC Engines and Biomers.

CO3: Discuss the concepts of steam nozzles and steam turbines and steam condensers.

CO4: Gain knowledge about the concepts of compressors and gas turbines.

CO5: Acquire insights about jet propulsion, rockets and solar engineering.



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Minors Course	HEAT TRANSFER (Thermal Systems Engineering)	L	T	P	C
		3	0	0	3

Course objectives:

- 1) To gain knowledge about mechanism and modes of heat transfer.
- 2) To understand the concepts of conduction and convective heat transfer.
- 3) To gain knowledge about the forced and free convection.
- 4) To understand the concepts of heat transfer with phase change and condensation along with heat exchangers.
- 5) To gain knowledge about radiation mode of heat transfer.

UNIT-I:

Introduction: Modes and mechanisms of heat transfer – Basic laws of heat transfer – General discussion about applications of heat transfer.

Conduction Heat Transfer: Fourier rate equation – General heat conduction equation in Cartesian, Cylindrical and Spherical coordinates – simplification and forms of the field equation – steady, unsteady and periodic heat transfer – Initial and boundary conditions

One Dimensional Steady State Conduction Heat Transfer: Homogeneous slabs, hollow cylinders and spheres- Composite systems– overall heat transfer coefficient – Electrical analogy – Critical radius of insulation. Variable Thermal conductivity – systems with heat sources or Heat generation-Extended surface (fins) Heat Transfer – Long Fin, Fin with insulated tip and Short Fin, Application to error measurement of Temperature.

UNIT-II:

One Dimensional Transient Conduction Heat Transfer: Systems with negligible internal resistance – Significance of Biot and Fourier Numbers – Infinite bodies- Chart solutions of transient conduction systems- Concept of Semi-infinite body.

Convective Heat Transfer: Classification of systems based on causation of flow, condition of flow, configuration of flow and medium of flow – Dimensional analysis as a tool for experimental investigation – Buckingham π Theorem and method, application for developing semi – empirical non- dimensional correlation for convection heat transfer – Significance of non-dimensional numbers – Concepts of Continuity, Momentum and Energy Equations

UNIT-III:

Forced convection: External Flows: Concepts about hydrodynamic and thermal boundary layer and use of empirical correlations for convective heat transfer -Flat plates and Cylinders.



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Internal Flows: Concepts about Hydrodynamic and Thermal Entry Lengths – Division of internal flow based on this – Use of empirical relations for Horizontal Pipe Flow and annulus flow.

Free Convection: Development of Hydrodynamic and thermal boundary layer along a vertical plate – Use of empirical relations for Vertical plates and pipes.

UNIT–IV:

Heat Transfer with Phase Change: Boiling: – Pool boiling – Regimes – Calculations on Nucleate boiling, Critical Heat flux and Film boiling

Condensation: Filmwise and dropwise condensation –

Nusselt's Theory of Condensation on a vertical plate - Film condensation on vertical and horizontal cylinders using empirical correlations. **Heat Exchangers:** Classification of heat exchangers – overall heat transfer Coefficient and fouling factor – Concepts of LMTD and NTU methods - Problems using LMTD and NTU methods.

UNIT–V:

Radiation Heat Transfer: Emission characteristics and laws of black-body radiation – Irradiation – total and monochromatic quantities – laws of Planck, Wien, Kirchhoff, Lambert, Stefan and Boltzmann – heat exchange between two black bodies – concept of shape factor – Emissivity – heat exchange between grey bodies – radiation shields – electrical analogy for radiation networks.

Note: Heat transfer data book is allowed.

TEXTBOOKS:

- 1) Heat Transfer by HOLMAN, Tata McGraw-Hill.
- 2) Heat Transfer by P.K. Nag, TMH.

REFERENCE BOOKS:

- 1) Fundamentals of Heat Transfer by Incropera & Dewitt, John Wiley.
- 2) Fundamentals of Engineering, Heat & Mass Transfer by R.C. Sachdeva, New Age.
- 3) Heat & Mass Transfer by Amit Pal – Pearson Publishers.
- 4) Heat Transfer by Ghoshadastidar, Oxford University Press.
- 5) Heat Transfer by a Practical Approach, Yunus Cengel, Boles, TMH.
- 6) Engineering Heat and Mass Transfer by Sarit K. Das, Dhanpat Rai Pub.

Note: Heat and Mass transfer Data Book by C.P. Kothandaraman and Subrahmanyam is used to design and analyze various thermal processes and thermal equipment.

Course outcomes: At the end of the course, student will be able to CO1: Apply knowledge about mechanism and modes of heat transfer. CO2: Understand the concepts of conduction and convective heat transfer. CO3: Learn about forced and free convection. CO4: Analyze the concepts of heat transfer with phase change and condensation along with heat exchangers. CO5: Interpret the knowledge about radiation mode of heat transfer.



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Minors Course	REFRIGERATION&AIR- CONDITIONING (Thermal Systems Engineering)	L	T	P	C
		3	0	0	3

Course Objectives:

- 1) To illustrate the operating cycles and different systems of refrigeration
- 2) To analyze cooling capacity and coefficient of performance of vapour compression refrigeration systems and understand the fundamentals of cryogenics
- 3) To calculate coefficient of performance by conducting test on vapour absorption and steam jet refrigeration system and understand the properties of refrigerants.
- 4) To calculate cooling load for air conditioning systems and identify the requirements of comfort air conditioning
- 5) To describe different components of refrigeration and air conditioning systems

UNIT-I:

INTRODUCTION TO REFRIGERATION: Necessity and applications – unit of refrigeration and C.O.P. – Mechanical refrigeration – types of ideal cycles of refrigeration. air refrigeration: Bell Coleman cycle - open and dense air systems – refrigeration systems used in air crafts and problems.

UNIT-II:

VAPOUR COMPRESSION REFRIGERATION SYSTEM & COMPONENTS: Working principle and essential components of the plant – simple vapour compression refrigeration cycle – COP – representation of cycle on T-S and p-h charts – effect of sub cooling and super heating – cycle analysis – actual cycle influence of various parameters on system performance – use of p-h charts – numerical problems.

INTRODUCTION TO CRYOGENICS: Joule-Thomson expansion, refrigerant mixtures, multi stage vapour compression refrigeration.

UNIT-III:

REFRIGERANTS – Desirable properties – classification - refrigerants – green refrigerants - nomenclature – ozone depletion – global warming.

VAPOR ABSORPTION SYSTEM: Calculation of maximum COP – description and working of NH₃– water system and LiBr –water (Two shell & Four shell) System, principle of operation three fluid absorption system, salient features.

STEAM JET REFRIGERATION SYSTEM: Working Principle and basic components, principle and operation of thermoelectric refrigerator and vortex tube.



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UNIT-IV:

INTRODUCTION TO AIR CONDITIONING: Psychometric properties & processes – characterization of sensible and latent heat loads – need for ventilation, consideration of infiltration – load concepts of RSHF, GSHF- problems, concept of ESHF and ADP temperature.

Requirements of human comfort and concept of effective temperature- comfort chart – comfort air conditioning – requirements of industrial air conditioning, air conditioning load calculations.

UNIT-V:

AIR CONDITIONING SYSTEMS: Classification of equipment, cooling, heating humidification and dehumidification, filters, grills and registers, fans and blowers. heat pump – heat sources – different heat pump circuits.

TEXTBOOKS:

1. A Course in Refrigeration and Air conditioning / S C Arora & Domkundwar / Dhan patrai
2. Refrigeration and Air Conditioning / C P Arora / TMH.

REFERENCES:

1. Refrigeration and Air Conditioning / Manohar Prasad / New Age.
2. Principles of Refrigeration / Dossat / Pearson Education.
3. Basic Refrigeration and Air-Conditioning / Ananthanarayanan / TMH

Course Outcomes: At the end of the course, student will be able to

CO1: Illustrate the operating cycles and different systems of refrigeration.

CO2: Analyze cooling capacity and coefficient of performance of vapour compression refrigeration systems and understand the fundamentals of cryogenics

CO3: Calculate coefficient of performance by conducting test on vapour absorption and steam jet refrigeration systems and understand the properties of refrigerants.

CO4: Solve cooling load for air conditioning systems and identify the requirements of comfort air conditioning.

CO5: Demonstrate different components of refrigeration and air conditioning systems.



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Minors Course	POWERPLANTENGINEERING (Thermal Systems Engineering)	L	T	P	C
		3	0	0	3

Course Objectives:

- 1) To understand the sources of energy and concepts of steam power plant.
- 2) To design of components of steam, gas and diesel power plants.
- 3) To explain the principles of hydro power plant and nuclear power station.
- 4) To apply the concepts of nuclear reactors and understand the operation of different power plants.
- 5) To understand the principles and concepts relevant to power plant instrumentation, control, economics and environmental considerations.

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 handling equipments, types of coals, coal handling, choice of handling equipment, coal storage, ash handling systems. Combustion: properties of coal – overfeed and underfeed fuel beds, traveling grate stokers, spreader stokers, retort stokers, pulverized fuel burning system and its components,

UNIT– II

STEAM POWER PLANT: Combustion needs and draught system, cyclone furnace, design and Construction, dust collectors, cooling towers and heat rejection. Corrosion and feed water treatment. **INTERNAL COMBUSTION AND GAS TURBINE POWER PLANTS:**

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

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

UNIT– III

HYDRO ELECTRIC POWER PLANT: Water power – hydrological cycle / flow measurement – drainage area characteristics – hydrographs – storage and pondage – classification of dams and spillways.

HYDRO PROJECTS AND PLANT: Classification – typical layouts – plant auxiliaries – plant operation pumped storage plants.

NUCLEAR POWER STATION: Nuclear fuel – breeding and fertile materials – nuclear reactor – reactor operation.

UNIT– IV

TYPES OF NUCLEAR REACTORS: Pressurized water reactor, boiling water reactor, sodium-graphite reactor, fast breeder reactor, homogeneous reactor, gas cooled reactor, radiation hazards and shielding – radioactive waste disposal.



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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– V

POWER PLANT INSTRUMENTATION AND CONTROL: Importance of measurement and instrumentation in power plant, measurement of water purity, gas analysis, O₂ and CO₂ measurements, measurement of smoke and dust, measurement of moisture in carbon dioxide circuit, nuclear measurements, smart grids, power plant control room.

POWER PLANT ECONOMICS AND ENVIRONMENTAL CONSIDERATION S: 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

REFERENCES:

1. Power Plant Engineering: P.K.Nag/II Edition/TMH.
2. Power station Engineering – El Wakil/McGraw-Hill.
3. An Introduction to Power Plant Technology/G.D.Rai/Khanna Publishers

Course outcomes: At the end of the course, students will be able to

CO1: Illustrate the functions of different components of steam power plant

CO2:

Describe basic working principles, performance characteristics and components of gas turbine and diesel power plants

CO3:

Illustrate basic working principles of hydroelectric power plants and analyze the importance of hydrological cycles, measurements and drainage characteristics

CO4: Learn about the principal components and types of nuclear reactors

CO5: Analyze the working of power plant instrumentation and estimate the economics of power plants



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Minors Course	FLUID MECHANICS (Thermal Systems Engineering)	L	T	P	C
		3	0	0	3

Course Objectives:

- 1) To understand the general concepts of inviscid flow of incompressible fluids.
- 2) To apply the concepts of viscous flow.
- 3) To analyze the boundary layer concepts and expressions for local and mean drag coefficients for different velocity profiles.
- 4) To understand fundamental concept of turbulence.
- 5) To illustrate the compressible fluid flow and supersonic wave drag

UNIT– I:

Introduction: Basics of Fluid Mechanics – Continuity Equation – Euler’s Equation – Bernoulli’s equation

Viscous Flow: Derivation of Navier-Stoke’s Equations for viscous compressible flow – Exact solutions to certain simple cases: Plain Poiseuille flow, Couette flow with and without pressure gradient, Hagen Poiseuille flow

UNIT– II:

Boundary Layer Concepts: Prandtl contribution to real fluid flows – Prandtl boundary layer theory, Boundary layer thickness for flow over a flat plate – Blasius solution. Von-Karman momentum integral equation for laminar boundary layer — Expressions for local and mean drag coefficients for different velocity profiles.

UNIT– III:

Introduction to Turbulent Flow: Fundamental concept of turbulence – Time Averaged Equations – Boundary Layer Equations, Prandtl Mixing Length Model - Universal Velocity Distribution Law - Van Driest Model – k-epsilon model, boundary layer separation and form drag – Karman Vortex Trail, Boundary layer control, lift on circular cylinders.

UNIT– IV:

Internal Flow: Smooth and rough boundaries – Equations for Velocity Distribution and frictional Resistance in smooth and rough Pipes – Roughness of Commercial Pipes – Moody’s diagram.

Compressible Fluid Flow – I: Thermodynamic basics – Equations of continuity, Momentum and Energy , Acoustic Velocity, Derivation of Equation for Mach Number – Flow Regimes – Mach Angle – Mach Cone – Stagnation State.

UNIT– V:



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Compressible Fluid Flow – II: Area Variation, Property Relationships in

terms of Mach number, Nozzles, Diffusers – Fanno and Rayleigh Lines, Property Relations – Isothermal Flow in Long Ducts – Normal Compressible Shock, Oblique Shock: Expansion and Compressible Shocks – Supersonic Wave Drag.

TEXTBOOKS:

1. Fluid Mechanics/L. Victor Streeter/TMH
2. Fluid Mechanics/Frank M. White/MGH

REFERENCES:

1. Fluid Mechanics and Machines/ Modi and Seth/Standard Book House
2. Fluid Mechanics/Cohen and Kundu/Elsevier/5th edition
3. Fluid Mechanics/Potter/Cengage Learning
4. Fluid Mechanics/William S. Janna/CRC Press
5. Fluid Mechanics/ Y. A. Cengel and J. M. Cimbala/MGH
6. Boundary Layer Theory/Schlichting H/Springer Publications
7. Dynamics & Theory and Dynamics of Compressible Fluid Flow/ Shapiro.
8. Fluid Dynamics/William F. Hughes & John A. Brighton/TMH
9. Fluid Mechanics/K. L. Kumar/S Chand & Co.

Course Outcomes: At the end of the course, student will be able to

- CO1: Understand the general concepts of inviscid flow of incompressible fluids. CO 2: Apply the concepts of viscous flow.
- CO3: Analyse the boundary layer concepts and expressions for local and mean drag coefficients for different velocity profiles.
- CO4: Understand fundamental concept of turbulence.
- CO5: Illustrate the compressible fluid flow and supersonic wave drag.



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Minors Course	AUTOMOBILEENGINEERING (Thermal Systems Engineering)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- 1.To study the advanced engine technologies
- 2.To learn various advanced combustion technologies and its benefits
- 3.To learn the methods of using low carbon fuels and its significance
- 4.To learn and understand the hybrid and electric vehicle configurations
- 5.To study the application of fuel cell technology in automotive

UNIT – I: ADVANCED ENGINE TECHNOLOGY

Gasoline Direct Injection, Common Rail Direct Injection, Variable Compression Ratio Turbocharged Engines, Electric Turbochargers, VVT, Intelligent Cylinder De-activation, After Treatment Technologies, Electric EGR, Current EMS architecture.

UNIT – II: COMBUSTION TECHNOLOGY

Spark Ignition combustion, Compression Ignition Combustion, Conventional Dual Fuel Combustion, Low Temperature Combustion Concepts– Controlled Auto Ignition, Homogeneous Charge Compression Ignition, Premixed Charge Compression Ignition, Partially Premixed Compression Ignition, Reactivity Controlled Compression Ignition, Gasoline Direct Injection Compression Ignition.

UNIT – III: LOW CARBON FUEL TECHNOLOGY

Alcohol Fuels, Ammonia Fuel and Combustion, Methane Technology, Dimethyl Ether, Hydrogen Fuel Technology, Challenges, and way forward

UNIT – IV: HYBRID AND ELECTRIC VEHICLE (BATTERY POWERED)

Conventional Hybrids (Conventional ICE + Battery), Modern Hybrids (RCCI/GDCI Engine + Battery), Pure Electric Vehicle Technology – Challenges and Way forward

UNIT – V: FUEL CELL TECHNOLOGY

Fuel cells for automotive applications - Technology advances in fuel cell vehicle systems - Onboard hydrogen storage - Liquid hydrogen and compressed hydrogen - Metal hydrides, Fuel cell control system - Alkaline fuel cell - Road map to market.

TEXT BOOKS:

- 1.Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.



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2.Rakesh Kumar Maurya, Characteristics and Control of Low Temperature Combustion Engines. ISBN 978-3-319-68507-6 , SPRINGER

REFERENCES:

- 1.Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
- 2.James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003
- 3.Rand D.A.J, Woods, R & Dell RM Batteries for Electric vehicles, John Wiley & Sons, 1998

4.Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.

5.James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003

Course Outcomes: At the end of the course the students would be able to

- 1.Discuss the latest trends in engine technology
- 2.Discuss the need of advanced combustion technologies and its impact on reducing carbon foot-print on the environment.
- 3.Analyzing the basic characteristics of low carbon fuels, its impact over conventional fuels and in achieving sustainable development goals.
- 4.Discuss the working and energy flow in various hybrid and electric configurations.
- 5.Analyzing the need for fuel cell technology in automotive applications.



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Minors Course	COMPUTATIONAL FLUID DYNAMICS (Thermal Systems Engineering)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- Develop an understanding of introductory concepts in computational fluid mechanics with emphasis on the numerical solution of ordinary and partial differential equations
- Able to find solution of ODEs by numerical integration; finite difference and finite volume methods for parabolic, elliptic, and hyperbolic PDEs (techniques for single and multi-dimensional problems); numerical linear algebra
- Able to implement and utilize various numerical methods and basic mathematical analysis for canonical problems in fluid mechanics.
- Able to understand formulation of 2D & 3D problems using FVM
- To get acquainted with the application of standard variational problems

UNIT – I:

INTRODUCTION:

Finite difference method, finite volume method, finite element method, govern equations and boundary conditions. Derivation of finite difference equations.

SOLUTION METHODS:

Solution methods of elliptical equations – finite difference formulations, interactive solution methods, direct method with Gaussian elimination.

UNIT – II:

PARABOLIC EQUATIONS:

Explicit schemes and Von Neumann stability analysis, implicit schemes, alternating direction implicit schemes, approximate factorization, fractional step methods, direct method with tridiagonal matrix algorithm.

HYPERBOLIC EQUATIONS:

Explicit schemes and Von Neumann stability analysis, implicit schemes, multi-step methods, nonlinear problems, second order one-dimensional wave equations.



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BURGERS EQUATIONS:

Explicit and implicit schemes, Runge-Kutta method.

UNIT – III:

FORMULATIONS OF INCOMPRESSIBLE VISCOUS FLOWS:

Formulations of incompressible viscous flows by finite difference methods, pressure correction methods, vortex methods.

FORMULATIONS OF COMPRESSIBLE FLOWS:

Potential equation, Euler equations-Central schemes, Navier-stokes system of

equations, boundary conditions, example problems..

UNIT – IV:

FINITE VOLUME METHOD:

Finite volume method via finite difference method, formulations for two and three-dimensional problems.

UNIT – V:

FINITE ELEMENT METHODS:

Introduction to Finite Element Methods, Finite Element Interpolation Functions, Linear Problems-Steady-State Problems – Standard Galerkin's Methods, Transient Problems – Generalized Galerkin's Methods, Example Problems.

TEXTBOOKS:

1. Computational fluid dynamics, T. J. Chung, Cambridge University press, 2002.

REFERENCE BOOKS:

1. Text book of fluid dynamics, Frank Chorlton, CBS Publishers & distributors, 1985.
2. Patankar, S. V., 2017, Numerical Heat Transfer and Fluid Flow, Special Indian ed., CRC Press.
3. Muralidhar K., and Sundararajan T. (Editors), 2017, Computational Fluid Flow and Heat Transfer, 2nd ed. tenth reprint, Narosa.
4. Anderson Jr., J. D., 2017, Computational Fluid Dynamics: The Basics with Applications, Indian ed., McGraw Hill Education.
5. Donea, J., and Huerta, A., 2003, Finite Element Methods for Flow Problems, John Wiley & Sons, Ltd.
6. Zienkiewicz, O. C, Nithiarasu, P., and Taylor, R. L, 2013, The Finite Element Method for Fluid Dynamics, 7th ed., Butterworth-Heinemann Ltd.

COURSE OUTCOMES:

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



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Minors Course	HEAT TRANSFER LAB (Thermal Systems Engineering)	L	T	P	C
		0	0	3	1.5

Course Outcome

- CO1 Explain classification of PDEs and differential solutions and methods for parabolic and hyperbolic equations.
- CO2 Explain basic principles and Derive governing equations of CFD
- CO3 Apply finite differential method for incompressible viscous flow problems and compressible flow problems.
- CO4 Apply finite volume formulations for two dimensional and three dimensional problems
- CO5 Apply finite element methods for steady state and transient fluid flow problems

Course objectives:

- 1) To determine the heat transfer rate and coefficient.
- 2) To determine the thermal conductivity, efficiency and effectiveness.
- 3) To determine the emissivity and Stefan-Boltzmann constant.
- 4) To determine critical heat flux and investigate Lambert's cosine law.
- 5) To experiment with Virtual labs and analyze conduction, HT coefficient.
- 6) To experiment with Virtual labs and investigate Lambert's laws.

PART-A

- 1. Determination of overall heat transfer coefficient of a composite slab
- 2. Determination of heat transfer rate through a lagged pipe.
- 3. Determination of heat transfer rate through a concentric sphere
- 4. Determination of thermal conductivity of a metal rod.
- 5. Determination of efficiency of a pin-fin
- 6. Determination of heat transfer coefficient in natural and forced convection
- 7. Determination of effectiveness of parallel and counter flow heat exchangers.
- 8. Determination of emissivity of a given surface.
- 9. Determination of Stefan-Boltzmann constant.
- 10. Determination of heat transfer rate in drop and film wise condensation.
- 11. Determination of critical heat flux.
- 12. Determination of Thermal conductivity of liquids and gases.
- 13. Investigation of Lambert's cosine law.

PART-B

Virtual labs (<https://mfts-iitg.vlabs.ac.in/>) on

- 1) Conduction Analysis of a Single Material Slab
- 2) Conduction Analysis of a Single Material Sphere
- 3) Conduction Analysis of a Single Material Cylinder
- 4) Conduction Analysis of a Double Material Slab



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- 5) Conduction Analysis of a Double Material Sphere
- 6) Conduction Analysis of Double Material Cylinder
- 7) To determine the overall heat transfer coefficient (U) in the (i) parallel flow heat exchanger and (ii) Counter flow heat exchanger
- 8) To investigate the Lambert's distance law.
- 9) To investigate the Lambert's direction law (cosine law).

Note: Virtual labs are only for learning purpose, and are not for external examination

Course outcomes: Students are expected to learn the concepts and to

CO1: Determine the heat transfer rate and coefficient.

CO2: Determine the thermal conductivity, efficiency and effectiveness. CO3: Determine the emissivity and Stefan-Boltzmann constant.

CO4: Determine critical heat flux and investigate Lambert's cosine law.

CO5: Experiment with Virtual labs and analyze conduction, HT coefficient.

CO6: Experiment with Virtual labs and investigate Lambert's laws.



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Minors Course	THERMAL ENGINEERING LAB (Thermal Systems Engineering)	L	T	P	C
		0	0	3	1.5

Course objectives:

- 1) To demonstrate the characteristics of two stroke and four stroke compression and spark ignition engines.
- 2) To determine flash point, fire point, calorific value of different fuels using various apparatus.
- 3) To determine engine friction, heat balance test, volumetric efficiency, load test of petrol and diesel engines.
- 4) To demonstrate speed test, performance test and cooling temperature on petrol and diesel engines.
- 5) To demonstrate performance test and determine efficiency of air compressor.
- 6) To understand the principle through assembly and disassembly of 2/3 wheelers, 2/4 stroke engines, tractor, heavy duty engines and boilers and their mountings and accessories.

Experiments :

1. To determine the actual Valve Timing diagram of a four stroke Compression/Spark Ignition Engine.
2. To determine the actual Port Timing diagram of a two stroke Compression/Spark Ignition Engine.
3. Determination of Flash & Fire points of Liquid fuels / Lubricants using (i) Abels Apparatus; (ii) Pensky Martin's apparatus and (iii) Cleveland's apparatus.
4. Determination of Viscosity of Liquid lubricants/Fuels using (i) Saybolt Viscometer and (ii) Redwood Viscometer.
5. Determination of Calorific value of Gaseous Fuels using Junkers Gas Calorimeter.
6. Evaluation of engine friction by conducting Morse test on 4-stroke multi cylinder petrol/diesel engine.
7. Evaluation of Engine Friction by Motoring/Retardation Test on a Single Cylinder 4 Stroke Petrol/Diesel Engine.
8. To perform the Heat Balance Test on Single Cylinder four Stroke Petrol/Diesel Engine.
9. Determination of Air/Fuel Ratio and Volumetric Efficiency on a four Stroke Petrol/Diesel Engine.
10. To conduct a load test on a single cylinder Petrol/Diesel engine to study its performance under various loads.
11. To determine the optimum cooling temperature of a Petrol/Diesel engine.
12. To conduct economical speed test on a four stroke Petrol/Diesel engine.
13. To conduct a performance test on a VCR engine, under different compression ratios and determine its heat balance sheet.
14. To conduct a performance test on an air compressor and determine its different efficiencies.
15. Dis-assembly / assembly of different parts of two wheelers, 3 wheelers & 4 wheelers. Tractor & Heavy duty engines covering 2-stroke and 4 stroke, SI and CI engines. Study of Boilers with mountings and accessories.



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Course outcomes: At the end of the course, student will be able to

Honors Course	ADVANCED SOLIDS	MECHANICS	OFL	T	P	C
			3	0	0	3

- CO1: Experiment with two stroke and four stroke compression and spark ignition engines for various characteristics.
- CO2: Perceive flash point, fire point, calorific value of different fuels using various apparatus.
- CO3: Perform engine friction, heat balance test, volumetric efficiency, load test of petrol and diesel engines.
- CO4: Perform speed test, performance test and cooling temperature on petrol and diesel engines.
- CO5: Utilize air compressor for its performance test and to determine efficiency.
- CO6: Discuss the principles through assembly and disassembly of 2/3 wheelers, 2/4 stroke engines, tractor, heavy duty engines, boilers and their mountings and accessories.

HONORS

Course Objectives: To

- CO1** Learn about how to calculate stresses in the machine components and analyzing the failure modes.
- CO2** Identify the failure modes of different structural members and applying



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various energy methods for statically determinant and indeterminate structures

- CO3** Calculate bending stresses in curved beams and beams subjected to non symmetrical bending
- CO4** Compute torsional stresses in circular and non circular cross section members and multi walled thin walled tubes
- CO5** Analyze contact stresses when two bodies are in contact.

UNIT – 1 Theories of stress and strain, Definition of stress at a point, stress notation, principal stresses, other properties, differential equations of motion of a deformable body, deformation of a deformable body, strain theory, principal strains, strain of a volume element, small displacement theory.

Stress –strain temperature relations, Elastic response of a solid, Hooke's Law, isotropic elasticity, Anisotropic elasticity, initiation of Yield, Yield criteria.

UNIT – 2 **Failure criteria:** Modes of failure, Failure criteria, Excessive deflections, Yield initiation, fracture, Progressive fracture, High Cycle fatigue for number of cycles $N > 10^6$, buckling.

Application of energy methods: Elastic deflections and statically indeterminate members and structures: Principle of stationary potential energy, Castiglione's theorem on deflections, Castiglione's theorem on deflections for linear load deflection relations, deflections of statically determinate structures.

UNIT – 3 **Unsymmetrical bending:** Bending stresses in Beams subjected to Nonsymmetrical bending; Deflection of straight beams due to nonsymmetrical bending.

Curved beam theory: Winkler Bach formula for circumferential stress – Limitations – Correction factors –Radial stress in curved beams – closed ring subjected to concentrated and uniform loads-stresses in chain links.

UNIT – 4 **Torsion :** Linear elastic solution; Prandtl elastic membrane (Soap-Film) Analogy; Narrow rectangular cross Section ;Hollow thin wall torsion members ,Multiply connected Cross Section.

UNIT – 5 **Contact stresses:** Introduction; problem of determining contact stresses; Assumptions on which a solution for contact stresses is based; Expressions for principal stresses; Method of computing contact stresses; Deflection of bodies in point contact; Stresses for two bodies in contact over narrow rectangular area (Line contact), Loads normal to area; Stresses for two bodies in line contact, Normal and Tangent to contact area.



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Text Books:

1. Advanced Mechanics of materials by Boresi & Sidebottom-Wiley International.
2. Theory of elasticity by Timoshenko S.P. and Goodier J.N. McGraw-Hill Publishers 3rd Edition
3. Advanced Mechanics of Solids, L.S Srinath

Reference Books:

1. Advanced strength of materials by Den Hartog J.P.
2. Theory of plates – Timoshenko.
3. Strength of materials & Theory of structures (Vol I & II) by B.C Punmia
4. Strength of materials by Sadhu singh

Course Outcomes: At the end of the course, student will be able to

- CO1** Able to calculate stresses in the machine components and analyzing the failure modes.
- CO2** Able to identify the failure modes of different structural members and applying various energy methods for statically determinant and indeterminate structures
- CO3** Able to calculate bending stresses in curved beams and beams subjected to non symmetrical bending
- CO4** Able to calculate torsional stresses in circular and non circular cross section members and multi walled thin walled tubes
- CO5** Able to calculate and analyze contact stresses when two bodies are in contact.



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Honors Course	ADVANCED FINITE ELEMENT	L	T	P	C
	METHODS	3	0	0	3

Course Objectives: To

- Learn the methodology, applications and types of finite element method.
- Solve the problems of bars, trusses, beams and frames
- Solve plates and axisymmetric problems
- Learn about isoparametric formulation
- Solve the dynamic problems

UNIT – Formulation Techniques: Methodology, Engineering problems and governing differential equations, finite elements., Variational methods- potential energy method, Raleigh Ritz method, strong and weak forms, Galerkin and weighted residual methods, calculus of variations, Essential and natural boundary conditions.

UNIT – One-dimensional elements: Bar, trusses, beams and frames, displacements, stresses and temperature effects.

UNIT – Two dimensional problems: CST, LST, four noded and eight noded rectangular elements, Lagrange basis for triangles and rectangles, serendipity interpolation functions. Axisymmetric Problems: Axisymmetric formulations, Element matrices, boundary conditions. Heat Transfer problems: Conduction and convection, examples: - two-dimensional fin.

UNIT – Isoparametric formulation: Concepts, sub parametric, super parametric elements, numerical integration, Requirements for convergence, h-refinement and p-refinement, complete and incomplete interpolation functions, Pascal's triangle, Patch test.

Finite elements in Structural Analysis: Static and dynamic analysis, eigen value problems, and their solution methods, case studies using commercial finite element packages.

UNIT – Introduction to Non-linear finite element Analysis (Syllabus from Ref. 3)

Nonlinear Material Problems(Syllabus from Ref. 2): Introduction ,General procedure for solutions of Non- linear Discrete Problems, Nonlinear Constitutive problems in solid mechanics. Non-linear elasticity, Plasticity.

Geometrically Non-linear problems(Syllabus from Ref. 2): General considerations



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TEXT BOOKS:

1. Chandrubatla&Belagondur,Finite element methods .
2. S.S. Rao ,The Finite Element Method in Engineering, Fifth Edition

REFERENCES:

- 1.J.N. Reddy, Finite element method in Heat transfer and fluid dynamics, CRC press, 1994.
2. Zienkiwicz O.C. Finite Element Method, McGraw-Hill,Third Edition, 1977.
3. K. J. Bathe, Finite element procedures, Prentice-Hall, 1996.

Course Outcomes: At the end of the course, student will be able to

CO1	Understand the methodology, applications and types of finite element method.
CO2	Solve the problems of bars, trusses, beams and frames using finite element method
CO3	Apply the finite element method to plates and axisymmetric problem
CO4	Understand the isoparametric formulation and requirements for convergence.
CO5	Solve the dynamic problems and learn about the commercial finite element packages.



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Course Objectives: To

Honors Course	ADVANCED CAD	L	T	P	C
		3	0	0	3

CO1 Write parametric equations for simple geometric entities, formulate algebraic and geometric form of a cubic spline.

CO2 Learn about Bezier curve.

CO3 Know about B-Spline curve

CO4 Develop parametric representation of analytic and synthetic surfaces

CO5 Learn various schemes used for construction of solid models

UNIT – 1	Introduction: Definition, Explicit and implicit equations, parametric equations.
UNIT – 2	Cubic Splines-1: Algebraic and geometric form of cubic spline, tangent vectors, parametric space of a curve, blending functions, four point form, reparametrization, truncating and subdividing of curves. Graphic construction and interpretation, composite pc curves.
UNIT – 3	Bezier Curves: Bernstein basis, equations of Bezier curves, properties, derivatives. B-Spline Curves: B-Spline basis, equations, knot vectors, properties, and derivatives.
UNIT – 4	Surfaces: Bicubic surfaces, Coon's surfaces, Bezier surfaces, B-Spline surfaces, surfaces of revolutions, Sweep surfaces, ruled surfaces, tabulated cylinder, bilinear surfaces, Gaussian curvature.
UNIT – 5	Solids: Tricubic solid, Algebraic and geometric form. Solid modeling concepts: Wire frames, Boundary representation, Half space modeling, spatial cell, cell decomposition, classification problem.

TEXT BOOKS:

1. CAD/CAM by Ibrahim Zeid, Tata McGraw Hill.
2. Elements of Computer Graphics by Roger & Adams Tata McGraw Hill.

REFERENCES:

1. Geometric Modeling by Micheal E. Mortenson, McGraw Hill Publishers
2. Computer Aided Design and Manufacturing, K.Lalit Narayan, K.MallikarjunaRao, MMM Sarcar, PHI Publishers



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Honors Course	ADVANCED	MANUFACTURING	L	T	P	C
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Course Outcomes: At the end of the course, student will be able to

CO1 Develop parametric equations for simple geometric entities, formulate algebraic and geometric form of a cubic spline.

CO2 Develop equations for Bezier curve.

CO3 Develop equations for B-Spline curve

CO4 Develop parametric representation of analytic and synthetic surfaces

CO5 Understand and implement various schemes used for construction of solid models



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		3	0	0	3
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Course Objectives:

- To learn the basic principle of advanced machining processes
- To know about the various additive manufacturing processes
- To understand the principles of coating and processing of ceramics.
- To get insights about processing of composites and nanomaterials
- To know the fabrication of microelectronic components.

UNIT – 1

ADVANCED MACHINING PROCESSES: Introduction, Need, AJM, WJM, Wire-EDM, ECM, LBM, EBM, PAM – Principle, working, advantages, limitations, Process Parameters & capabilities and applications.

UNIT – 2

ADDITIVE MANUFACTURING: Working Principles, Methods, Stereo Lithography, LENS, LOM, Laser Sintering, Fused Deposition Method, 3DP Applications and Limitations, Direct and Indirect Rapid tooling techniques.

UNIT – 3

SURFACE TREATMENT: Scope, Cleaners, Methods of cleaning, Surface coating types, Electro forming, Chemical vapour deposition, Physical vapour deposition, thermal spraying methods, Ion implantation, diffusion coating, ceramic and organic methods of coating, and cladding methods.

PROCESSING OF CERAMICS: Applications, characteristics, classification Processing of particulate ceramics, Powder preparations, consolidation, hot compaction, drying, sintering, and finishing of ceramics, Areas of application.

UNIT – 4

PROCESSING OF COMPOSITES: Composite Layers, Particulate and fiber reinforced composites, Elastomers, Reinforced plastics, processing methods for MMC, CMC, Polymer matrix composites.

PROCESSING OF NANOMATERIALS: Introduction, Top down Vs Bottom up techniques- Ball milling, Lithography, Plasma Arc Discharge, Pulsed Laser Deposition, Sputtering, Sol-Gel, Molecular beam Epitaxy.

UNIT – 5

FABRICATION OF MICROELECTRONIC DEVICES:

Crystal growth and wafer preparation, Film Deposition, oxidation, lithography, bonding and packaging, reliability and yield, Printed Circuit boards, surface mount technology, Integrated circuit economics.

TEXT BOOKS:

- 1.Manufacturing Engineering and Technology/Kalpakijian / Adisson Wesley, 1995.
- 2.Process and Materials of Manufacturing / R. A. Lindburg / 1th edition, PHI 1990.

REFERENCES:

- 1.Microelectronic packaging handbook / Rao. R. Thummala and Eugene, J. Rymaszewski / Van NostrandRenihold,
- 2.MEMS & Micro Systems Design and manufacture / Tai — Run Hsu / TMGH



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3.Advanced Machining Processes / V.K.Jain / Allied Publications.

4.Introduction to Manufacturing Processes / John A Schey/McGraw Hill.

Honors Course	ADVANCED FLUID MECHANICS	L	T	P	C
		3	0	0	3

5.Introduction to Nanoscience and NanoTechnology/ Chattopadhyay K.K/A.N.Banerjee/
PHI Learning

Course Outcomes: At the end of the course, student will be able to

CO1: Explain the working principle of various nonconventional machining processes and their applications.

CO2: Explain the working principles of additive manufacturing methods.

CO3: Understand various laser material processing techniques.

CO4: Gainon Advanced coating processes

CO5: Describe various fabrication methods for microelectronic devices

CourseObjectives: To



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- Learn the principles of Inviscid flow of incompressible fluid flow
- Transform the physics of viscous fluid flow problems into its equivalent mathematical model.
- Solve laminar boundary layer problems for the flow over a flat plate.
- Solve fundamental problems of turbulent flows
- Understand principles and techniques for solving compressible flow problems.

UNIT -I:

INVISCID FLOW OF INCOMPRESSIBLE FLUIDS: Lagrangian and Eulerian descriptions of fluid motion, Path lines, Streamlines, Streak lines, stream tubes – velocity of a fluid particle, types of flows, Equations of three-dimensional continuity equation, Stream and Velocity potential functions, Condition for irrotationality, circulation & vorticity, accelerations in Cartesian systems, normal and tangential accelerations.

UNIT -II:

VISCOUS FLOW: Derivation of Navier-Stoke's Equations for viscous compressible flow – Exact solutions to certain cases: Plain Poiseuille flow, Couette flow with and without pressure gradient, Hagen Poiseuille flow.

UNIT -III:

BOUNDARY LAYER CONCEPTS :Prandtl's contribution to real fluid flows – Prandtl's boundary layer theory, Boundary layer thickness for flow over a flat plate, Blasius solution – Approximate solutions, Von-Karman momentum integral equation for laminar boundary layer — Expressions for local and mean drag coefficients for different velocity profiles.

UNIT- IV:

INTRODUCTION TO TURBULENT FLOW: Fundamental concept of turbulence – Time Averaged Equations – Boundary Layer Equations, Prandtl Mixing Length Model, Universal Velocity Distribution Law: Van Driest Model, k-epsilon model, boundary layer separation and form drag – Karman Vortex Trail, Boundary layer control, lift on circular cylinders.

INTERNAL FLOW: Smooth and rough boundaries – Equations for Velocity Distribution and frictional Resistance in smooth and rough Pipes – Roughness of Commercial Pipes – Moody's diagram.

UNIT -V:

COMPRESSIBLE FLUID FLOW: Thermodynamic basics – Equations of continuity, Momentum and Energy, Acoustic Velocity, Derivation of Equation for Mach Number – Flow Regimes – Mach Angle – Mach Cone – Stagnation State, Area Variation, Property Relationships in terms of Mach number, Nozzles, Diffusers – Fanno and Raleigh Lines– Normal Compressible Shock, Oblique Shock: Expansion and Compressible Shocks – Supersonic Wave Drag.

TEXT BOOKS:

1. L. Victor Steeter, Fluid Mechanics, 10th Edition, Tata McGraw-Hill, 1996.
2. Frank M. White, Fluid Mechanics, 8th Edition, McGraw-Hill Education, 2016.

REFERENCES:

1. Modi and Seth, Fluid Mechanics and Machines, Standard Book House



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2. Pijush K. Kundu, Ira M. Cohen, and David R. Dowling, Fluid Mechanics, 5th Edition, Elsevier

Honors Course	ADVANCED HEAT TRANSFER	L	T	P	C
		3	0	0	3

3. David R. Dowling, Ira M. Cohen, and Pijush K. Kundu, Fluid Mechanics, 5th Edition, Cengage Learning, 2011

4. William S Janna, Fluid Mechanics, CRC Press, 3rd Edition, 2019

5. Y.A Cengel and J.M Cimbala, Fluid Mechanics, MGH, 4th Edition, 2018

6. Schlichting H, Boundary Layer Theory, Springer Publications, 9th Edition, 2017

7. Shapiro, Dynamics & Theory and Dynamics of Compressible Fluid Flow, 2nd Edition

8. William F. Hughes & John A. Brighton, Fluid Dynamics, TMH, 2nd Edition, 2018

Course Outcomes: At the end of the course, student will be able to

CO1	Understand the principles of Inviscid flow of incompressible fluid flow
CO2	Develop the capability to transform the physics of viscous fluid flow problems into its equivalent mathematical model.
CO3	Attain the ability to solve laminar boundary layer problems for the flow over a flat plate.
CO4	Develop an ability to solve fundamental problems of turbulent flows
CO5	Understand principles and techniques for solving compressible flow problems.

Course Objectives: To

- Transform the physics of any heat conduction/thermal radiation problem into its equivalent mathematical model.
- Solve external forced and natural convection problems using analytical methods
- Analyze internal forced convection problems using analytical methods.
- Apply the concepts of LMTD and NTU to solve Heat Exchanger Problems.
- Evaluate radiant energy exchange.



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UNIT-I:

INTRODUCTION: Review of basic concepts of conduction. Method of formulation: lumped, differential and integral formulations. Initial and boundary conditions

TRANSIENT HEAT CONDUCTION:

Differential formulation of transient heat conduction problems with time independent boundary conditions in different geometries and their analytical solutions: method of separation of variables, method of Laplace transforms. Differential formulation of steady two-dimensional heat conduction problems in different geometries and their analytical solutions: method of separation of variables, method of superposition.

UNIT II:

CONVECTION: Review of basics concepts and different non-dimensional numbers; Three-dimensional differential energy equation in Cartesian and Cylindrical coordinates.

FORCED CONVECTION: External flow:

External laminar forced convection for flow over a semi-infinite flat plate; Integral and similarity solutions for different thermal boundary conditions; Viscous dissipation effects in laminar boundary layer flow over a semi-infinite flat plate.

UNIT III:

FORCED CONVECTION: Internal flow:

Internal laminar forced convection: exact solutions to solution for rectilinear flows, axisymmetric rectilinear flows, and axisymmetric torsional flows; Solution for fully developed flow through a pipe with different thermal boundary conditions, Flow in the thermal entrance region of a circular duct: Graetz solution for uniform velocity, Graetz solution for parabolic velocity profile.

UNIT IV:

FREE CONVECTION:

External laminar free convection: integral and similarity solutions for semi-infinite vertical plate with different thermal boundary conditions

HEAT EXCHANGERS: Classification, LMTD and NTU methods

UNIT V:

RADIATION:

Basic definitions, Radiant energy exchange between two differential area elements. Radiation shape factor: properties and algebra. Radiant energy exchange between two surfaces. Reradiating surfaces. Radiation Shield.

Radiant energy exchange in enclosures: enclosures composed of black and diffuse-grey surfaces. Electrical network analogy. Radiation in participating media: Radiative heat transfer equation, Radiant energy exchange in presence of absorbing and transmitting media, radiant energy exchange in presence of transmitting, reflecting, and absorbing media.

TEXT BOOKS:

1. Myers, G.E., 1971, Analytical methods in conduction heat transfer, McGraw Hill, New York.
2. Kays, W. M. and Crawford, M. E., 2005, Convective Heat and Mass Transfer, 3rd ed., McGraw Hill.
3. Howell, J.R., Mengüç, M.P., Daun, K., and Siegel, R., 2020, Thermal radiation heat transfer, CRC press, New York.

REFERENCES:



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1. Arpaci, V.S.,1966, Conduction heat transfer, Addison-Wesley,Reading, Massachusetts.

Honors Course	ADVANCED MECHANISMS AND ROBOTICS	L	T	P	C
		3	0	0	3

2. Janna, W.S., 2018, Engineering heat transfer, CRC press, Boca Raton.

3. Fundamentals of Heat and Mass Transfer,5th Ed. / Frank P. Incropera/John Wiley

4. Sparrow, E.M., 2018, Radiation heat transfer, Routledge, New York.

5. Modest, M.F., and Mazumder, S., 2021, Radiative heat transfer, Academic press, New York.

6. Introduction to Heat Transfer/SK Som/PHI

7. Oostuizen, P. H. and Naylor, D., 1999, Introduction to Convective Heat Transfer Analysis, International ed., McGraw Hill.

8. Kakac, S. Yener, Y., and Pramuanjaroenkij. A., 2014, Convective Heat Transfer, 3rd ed., CRC Press

Course Outcomes: At the end of the course, student will be able to

CO1	Develop the capacity to transform the physics of any heat conduction/thermal radiation problem into its equivalent mathematical model.
CO2	Demonstrate the ability to solve external forced and natural convection problems using analytical methods.
CO3	Develop the ability to analyze internal forced convection problems using analytical methods.
CO4	Apply the concepts of LMTD and NTU to solve Heat Exchanger Problems.
CO5	Evaluate radiant energy exchange in the presence of a participating medium.

Course Objectives: To

- Find the degree of freedom of various mechanisms.
- Develop the Euler-Savary equations
- locate the relative rotocentre
- Design the Freudenstein's equation
- Study the kinematics of different manipulators

UNIT – Advanced Kinematics of plane motion- I: The Inflection circle; Euler – Savary Equation; Analytical and graphical determination of d_i ; Bobillier's Construction; Collineationaxis ; Hartmann's Construction.

1

Advanced Kinematics of plane motion - II: Polode curvature; Hall's Equation; Polode curvature in the four bar mechanism; coupler motion; relative motion of the output and input links; Determination of the output angular acceleration and its Rate of change.



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UNIT – Introduction to Synthesis-Graphical Methods - I: The Four bar linkage;
2 Guiding a body through Two distinct positions; Guiding a body through Three distinct positions; The Rotocentertriangle ; Guiding a body through Four distinct positions; Burmester's curve.

Introduction to Synthesis-Graphical Methods - II: Function generation- General discussion; Function generation: Overlay's method; Path generation: Roberts's theorem.

UNIT – Introduction to Synthesis - Analytical Methods: Function Generation:
3 Freudenstien's equation, Precision point approximation, Precision – derivative approximation; Path Generation: Synthesis of Four-bar Mechanisms for specified instantaneous condition; Method of components; Synthesis of Four-bar Mechanisms for prescribed extreme values of the angular velocity of driven link; Method of components.

UNIT – Manipulator Kinematics: D-H transformation matrix ; Direct and Inverse
4 kinematic analysis of Serial manipulators: Articulated, spherical & industrial robot manipulators- PUMA, SCARA,STANFORD ARM, MICROBOT

UNIT – Differential motions and Velocities:
5 Introduction, differential relationship, Jacobian, differential motions of a frame-translations, rotation, rotating about a general axis, differential transformations of a frame. Differential changes between frames, differential motions of a robot and its hand frame, calculation of Jacobian, relation between Jacobian and the differential operator, Inverse Jacobian.

TEXT BOOKS:

1. Jeremy Hirschhorn, Kinematics and Dynamics of plane mechanisms, McGraw-Hill, 1962.
2. L.Sciavicco and B.Siciliano, Modelling and control of Robot manipulators, Second edition , Springer -Verlag, London, 2000.
3. Amitabh Ghosh and Ashok Kumar Mallik, Theory of Mechanisms and Machines. E.W.P.Publishers.

REFERENCES:

1. Allen S.Hall Jr., Kinematics and Linkage Design, PHI, 1964.
2. J.E Shigley and J.J . Uicker Jr., Theory of Machines and Mechanisms , McGraw-Hill, 1995.
3. Joseph Duffy, Analysis of mechanisms and Robot manipulators, Edward Arnold, 1980

Course Outcomes: At the end of the course, student will be able to

CO1	Develop the mobility criteria and use the criteria to find the degree of freedom of various mechanisms.
CO2	Develop the Euler savary equations using Hartmanns construction to determine the centre of curvature
CO3	To locate the relative rotocentre using the function generation approach for 2-positions and 3-positions scenarios.



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Honors Course		OPTIMIZATION AND RELIABILITY	L	T	P	C
			3	0	0	3
CO4	Design the Freudenstein's equation to find the lengths of the links in a four bar mechanism					
CO5	To study the kinematics of different manipulators in daily life applications					

Course Objectives: To

- Understand the classical optimization techniques
- Learn numerical methods for optimization
- Get insights into genetic algorithm and its variants
- Know the applications of optimization in mechanical engineering
- Understand the concept of reliability

- UNIT – CLASSICAL OPTIMIZATION TECHNIQUES:** Single variable optimization with and without constraints, multi – variable optimization without constraints, multi – variable optimization with constraints – method of Lagrange multipliers, Kuhn-Tucker conditions, merits and demerits of classical optimization techniques.
- UNIT – NUMERICAL METHODS FOR OPTIMIZATION:** Nelder Mead's Simplex search method, Gradient of a function, Steepest descent method, Newton's method, Pattern search methods, conjugate method, types of penalty methods for handling constraints, advantages of numerical methods.
- UNIT – GENETIC ALGORITHM (GA) :** Differences and similarities between conventional and evolutionary algorithms, working principle,



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reproduction, crossover, mutation, termination criteria, different reproduction and crossover operators, GA for constrained optimization, draw backs of GA,

GENETIC PROGRAMMING (GP): Principles of genetic programming, terminal sets, functional sets, differences between GA & GP, random population generation, solving differential equations using GP.

MULTI-OBJECTIVE GA: Pareto's analysis, Non-dominated front, multi – objective GA, Non-dominated sorted GA, convergence criterion, applications of multi-objective problems .

UNIT – 4 APPLICATIONS OF OPTIMIZATION IN DESIGN AND MANUFACTURING SYSTEMS: Some typical applications like optimization of path synthesis of a four-bar mechanism, minimization of weight of a cantilever beam, optimization of springs and gears, general optimization model of a machining process, optimization of arc welding parameters, and general procedure in optimizing machining operations sequence.

UNIT – 5 RELIABILITY: Concepts of Engineering Statistics, risk and reliability, probabilistic approach to design, reliability theory, design for reliability, numerical problems, hazard analysis.

TEXT BOOKS:

1. Optimization for Engineering Design – Kalyanmoy Deb, PHI Publishers
2. Engineering Optimization – S.S.Rao, New Age Publishers
3. Reliability Engineering by L.S.Srinath
4. Multi objective genetic algorithm by Kalyanmoy Deb, PHI Publishers.

REFERENCES:

1. Genetic algorithms in Search, Optimization, and Machine learning – D.E.Goldberg, Addison-Wesley Publishers
2. Multi objective Genetic algorithms - Kalyanmoy Deb, PHI Publishers
3. Optimal design – Jasbir Arora, Mc Graw Hill (International) Publishers
4. An Introduction to Reliability and Maintainability Engineering by CE Ebeling, Waveland Printers Inc., 2009
5. Reliability Theory and Practice by I Bazovsky, Dover Publications, 2013

Course Outcomes: Students will be able to

- Learn the classical optimization techniques
- Understand numerical methods for optimization
- Gain knowledge about genetic algorithm and its variants
- Solve the applications of optimization in mechanical engineering
- Design for reliability



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Honors Course	MECHANISMS AND ROBOTICS LAB	L	T	P	C
		3	0	0	3

Course Objectives: To enable the students get practical knowledge about various mechanisms and robotic configurations

ROBOTICS LAB

1. To demonstrate Forward and inverse Kinematics of articulated robot
2. To program and perform the following operation by using an articulated robot.
 - Pick and place operation
 - To traverse given path (for arc welding)

KINEMATICS AND DYNAMICS OF MECHANISMS LABORATORY

Design the following mechanisms and simulate using CATIA Software /ADAMS Software

1. RRRR mechanism whose coupler curve will pass through 3 given point .
2. RRRR mechanism whose coupler will guide a straight line segment through at least three given positions .
3. RRRR mechanism whose input and output motion are coordinated at least three given positions.
4. RRRP mechanism whose coupler will guide a straight-line segment through at least three given positions.
5. RRRP mechanism whose input and output motion are coordinated at at least two given positions



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6. RRRP mechanism whose input and output motion are coordinated at at least three given

Honors Course	ADVANCED MANUFACTURING LAB	L	T	P	C
		3	0	0	3

positions.

7. RRRR mechanism whose input and output motion are coordinated at at least two given positions.

8. RRRR mechanism whose coupler curve will pass through 4 given points.

9. RRRR mechanism whose coupler curve will pass through 3 given points

Course Outcomes: The students will be able to understand the kinematics and dynamics of a variety of mechanisms and robots.

Course Objectives: The students will acquire knowledge about the various manufacturing processes and also the advanced characterization of materials.

Experiments (Any 10 out of 16):

- 1) To prepare the cup/ hole shape from the given work piece using deep drawing press
- 2) study of cutting ratio/chip thickness ratio in orthogonal cutting with different materials
- 3) Determination of cutting Forces and roughness on machined surface in orthogonal cutting with different materials
- 4) Study of arc, and spot welding processes
- 5) Study of TIG, MIG welding and Friction stir welding processes
- 6) Study of sintered density and relative density of given samples using Archimedes principle
- 7) Study of simple parts in 3D printing
- 8) Study of MRR and roughness on Wire EDM
- 9) Estimation of particle size using top down approaches and image analyser.
- 10) To find the ultimate tensile strength of given specimen using UTM
- 11) To find the Vickers/ Rockwell hardness of given specimen using hardness tester
- 12) To find the wear rate of a given specimen using Pin-on Disc apparatus
- 13) Study of roughness on machines surfaces for different materials using abrasive flow finishing.
- 14) To find the fatigue strength of a given specimen using fatigue-testing machine
- 15) To find the crystallite size and miller indices planes of a given specimen using X-ray diffractometer.
- 16) Study of Raman/FTIR spectroscopy

Course Outcomes: At the end of the course, student will be able to



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CO1	Perform different manufacturing operations such as joining and forming
CO2	Determine the chip thickness ratio, shear angle, cutting forces, temperatures and surface roughness of machined surface during orthogonal turning operation
CO3	Determine Green Density and sintering density of P/M samples
CO4	Produce simple parts using a 3D printing machine
CO5	Perform destructive testing methods of materials to determine Brinell, Vickers Micro hardness, Tensile strength, bending strength and wear resistance, Fatigue strength.
CO6	Demonstrate different characterization methods for bulk materials (polymers, ceramics, composites etc.) using XRD, spectroscopic methods – UV-Vis, FTIR, Raman, microscopic – optical, SEM etc.



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Honors Course	MODELLING AND SIMULATION OF MANUFACTURING SYSTEMS LAB	L	T	P	C
		3	0	0	3

Honors Course	COMPUTATIONAL FLUID DYNAMICS LAB	L	T	P	C
		3	0	0	3

Course Objectives: To make the students learn how to model various manufacturing processes using Finite Element software.

Students shall carry out the modeling and FE analysis of the following:

1. Casting processes - Study of Solidification, temperatures, Residual stresses, metallurgical phases etc.
2. Forging processes - Study of cold working and hot working processes for extrusion, drawing, rolling, etc.
3. Forming Processes – Study of blanking, bending, deep drawing, etc.
4. Welding Processes – Study of arc, spot, laser welding, etc

Course Outcomes: Students at the end of the course will get knowledge about the analysis of manufacturing processes using pertinent FE tools.

Course Objectives: To make the students learn about how to analyze real-life engineering applications using CFD methods using Python coding.

Using any Programming Language, code the following methods with an example:

1. Solution of 1-D parabolic equations
Explicit (FTCS, DuFort-Frankel)
Implicit (Laasonen)
2. Fin problem with insulated and Convective end
3. Couette Problem with and without pressure Gradient
4. Solution of Elliptic Equations
With Point Gauss-Seidel method
With Point Successive Over Relaxation Method
 - Examples: (i) Temperature Distribution over a rectangular plate with different Boundary conditions on the sides.
5. Solution of Parabolic Equations
6. Solution of Linear Hyperbolic Equations.
Using upwind and Lax explicit methods
Using BTCS and Crank-Nicolson implicit methods
 - Examples: Wave propagation at a high altitude
7. Solution of Nonlinear Hyperbolic Equations.
Lax Method
MacCormack Method
 - Examples: Shock Tube Problem ➤ Solution of Incompressible NSEs Vorticity-Stream function formulation
8. Primitive Variable Formulation
 - Examples:



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- Lid Driven Cavity Problem
- Mass entering and leaving a square chamber

Course Outcomes: At the end of the course, student will be able to

CO1	Develop codes for solution of algebraic and differential equations
CO2	Develop skills in the actual implementation of CFD methods with their own codes
CO3	Analyze real-life engineering applications with the help of CFD.
CO4	Design thermal engineering equipment using CFD
CO5	Design and analysis of Industrial components like pressure vessels



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ORDER:

The Hon'ble Principal, SVIET is pleased to approve the following guidelines for B.Tech Minors in Engineering applicable from the academic year 2023-24 (R23 regulations) as furnished by the Committee.

- I. A student has to acquire 18 more credits, in addition to 160 credits required, for the award of the minor by fulfilling at least THREE credits must be earned from NPTEL/SWAYAM MOOC Course and the remaining 15 credits by doing FIVE Theory/Integrated courses of 03 credits each (or) Four Theory courses of 03 credits each along with 2 Laboratory Courses of each 1.5 Credits either through MOOCs/Regular. The department concerned will determine the required courses for award of minor. The subjects in minor programme would be a combination of mostly core and some electives.
- II. The objectives of initiating the minor certification are:
 - (a) To diversify the knowledge of the undergraduates.
 - (b) To make the undergraduates more employable.
 - (c) To have more educational and professional skills after the completion of his undergraduate courses.
 - (d) To give a scope to specialize students in other streams of engineering in addition to the ones they are currently pursuing.
- III. Applicability and Enrolment:
 - (a) To all B.Tech (Regular and Lateral Entry) students admitted in Engineering & Technology
 - (b) There shall be no limit on the number of programs offered under Minor. The minor programs in emerging technologies are based on expertise in the respective departments and may also be offered in collaboration with the relevant industries/agencies.
 - (c) If a minimum enrolments criterion is not met, then the students may be permitted to register for the equivalent MOOC courses as approved by the concerned Head of the department in consultation with BoS.
 - (d) For applicability of minor, both regular B Tech and minor courses shall be successfully completed.
 - (e) Transfer of credits from a particular minor to regular B.Tech or another major degree and vice-versa shall not be permitted.
- IV. Entry level:
 - (a) The D. Tech students (both Regular and Lateral Entry) pursuing a major degree programme can register for minor at their choice in any other department offering minor from IV semester onwards.
 - (b) Students registering for minor shall select the subjects from other branches. For example, if a student pursuing major degree in Electrical & Electronics Engineering shall select the subjects specified for minor in Civil Engineering and he/she will get major degree of Electrical & Electronics Engineering with minor of Civil Engineering.
 - (c) Student pursuing major degree in any engineering branch is eligible to register for minor in any other engineering branch. However, students pursuing major degree in a particular Engineering are not allowed to register for minor in the same engineering branch.



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- (d) Separate CGPA shall be shown on semester and final transcripts of regular B. Tech and minor.
- (e) Students shall be permitted to select a maximum of two subjects per semester from the list of subjects specified for minor.
- (f) Minor shall not be awarded at any circumstances without completing the regular major B.Tech programme in which a student got admitted
- (g) If a student is detained due to lack of attendance, he/she shall not be permitted to register the courses of minor.
- (h) Students completed their degree shall not be permitted to register for minor.

V. Structure of Minor in B. Tech

- (a) The student shall learn additional 18 Credits for award of minor from other branch/department/discipline registered for major degree.
- (b) Students can complete minor courses either in the college or in online from platforms like NPTEL/SWAYAM etc.
- (c) The overall attendance in each semester of regular B.Tech courses and minor courses shall be computed separately
- (d) Student having less than 65% Attendance in minor courses shall not be permitted for appearing “Minor course(s) end semester examinations”.
- (e) A student detained due to lack of attendance in a regular B.Tech programme shall not be permitted to continue minor programme
- (f) The teaching, examinations (internal and external) and evaluation procedure of minor courses offered in offline is similar to regular B.Tech courses.
- (g) The students may choose theory or practical courses to fulfil the minimum credit requirement.
- (h) The students may be allowed to take maximum of two subjects per semester pertaining to their minor
- (i) Students shall not be permitted to register for minor degree after completion of VI semester.
- (j) The students are permitted to opt for only a single minor course in his/her entire tenure of B.Tech (Engineering).
- (k) The students registered for B.Tech (Hons) shall not be permitted to register for minor
- (l) The student is not permitted to take the electives courses from the parent department to fulfil the minimum credit requirement.

VI. Credits requirement:

- (a) A Student will be eligible to get minor along with major degree engineering, if he/she completes an additional 18 credits. These may be acquired either in offline or online like NPTEL/SWAYAM etc.,
- (b) Additional credits shall also be acquired through NPTEL Courses, which shall be domain specific, with a minimum duration of 8/12/16 weeks (2/3/4 credits) as recommended by the Board of studies.
- (c) Students shall produce a certificate issued by the NPTEL/SWAYAM etc., conducting agency as a proof of credit attainment.
- (d) The colleges offering minor courses shall be ready to teach the courses in offline at their college in the concerned departments. Curriculum and the syllabus of the courses shall be approved by the Board of Studies.



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- (e) After successful completion of all major and minor courses with specified CGPA the University will award both major and minors.

VII. Procedure to Applying for the Minor:

- (a) The department offering the minor will announce specialization and courses before the start of the session.
- (b) The interested students shall apply through the HOD of his/her parent department.
- (c) The concerned department will announce the list of the selected students for the minor.
- (d) The whole process should be completed within one week before the start of every session.
- (e) Selected students shall be permitted to register the courses for minor.

VIII. Registering for minor courses:

- (a) Each department offering the minor will submit the final list of selected students to the principal.
- (b) The selected students shall submit a joining letter to the principal through the concerned HOD offering the minor. The student shall inform same to the HOD of his/her parent department.
- (c) Both parent department and department offering minor shall maintain the record of student pursuing the minor
- (d) With the approval of Principal and suggestion of advisor, students can choose courses from the approved list and shall register the courses within a week as per the conditions laid down in the structure for the minor.
- (e) Each department shall communicate the minor courses registered by the students to the time table drafting committee and accordingly time table will be drafting. Time table drafting committee shall see that no clash in time tables.
- (f) If the student wishes to withdraw/change the registration of subject/course, he/she shall inform the same to advisor, subject teacher, HODs of minor department and parent department and Principal within two weeks after registration of the course.

IX. Procedure for Monitoring the Progress of the Scheme:

The students enrolled in the minor courses will be monitored continuously at par with the prevailing practices and examination standards. An advisor/mentor from parent department shall be assigned to a group of students to monitor the progress.

X. Allocation of seats for minor:

- (a) The university/institute/colleges will notify the number of the seats for minor in the concerned department well in advance before the start of the semester
- (b) Total number of seats offered for a minor programme shall be a maximum of 60 (based on merit).
- (c) The list of the electives for minor will be offered from the list of running majors in the concerned subjects.
- (d) There is no fee for registration of subjects for minor degree programme offered in offline at the respective colleges.
- (e) Examinations:
 - (a) The examination for the minor courses offered in offline shall be conducted along with regular B. Tech programme.
 - (b) The examinations (internal and external) and evaluation procedure of minor courses offered in offline is similar to regular B. Tech courses.
 - (c) A separate transcript shall be issued for the minor subjects passed in each semester.



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- (d) It may be noted that both major and minor courses (from IVSem to VII Sem) are to be completed in 4 Years for Regular students and 3 Years for lateral entry admitted students.
- (e) Examination Fees : Examination Fees will be as per the JNTUK norms
- (f) For awarding the class, CGPA obtained in Major Degree only will be considered.
- (g) For awarding the Minor. Obtained credits only will be considered.

//ISSUEDBY ORDER//



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ORDER:

The Hon'ble Vice-Chancellor(i/c), JNTUK is pleased to approve the following guidelines for B.Tech Honors in Engineering applicable from the academic year 2023-24 (R23 regulations) as furnished by the Committee vide ref (2) read above:

- I. A student has to acquire 18 more credits, in addition to 160 credits (without backlog history and meeting other guidelines) required, for the award of the B.Tech Honors degree. Out of the 18 extra credits required to obtain the Honors degree, at least SIX Credits (i.e., two courses of 3 credits each) must be earned from NPTEL/SWAYAM MOOC Courses. The additional courses shall be advanced subjects in the concerned department/discipline. The department concerned will determine required courses for award of Honors degree. The subjects in the Honors degree would be a combination of core (theory and lab) and some electives.
- II. The objectives of initiating the B.Tech (Honors) degree certification are:
 - a) To encourage the undergraduates towards higher studies and research.
 - b) To prepare the students to specialize in core Engineering streams.
 - c) To attain the high-level competence in the specialized area of Under Graduate programme
 - d) To learn the best educational and professional skills in the specialized area after the completion of his undergraduate courses.
 - e) To provide the opportunity to learn the advanced courses in the specified undergraduate programme.
- III. Applicability and Enrolment:
 - (a) To all B. Tech (Regular and Lateral Entry) students admitted in Engineering & Technology with CGPA of 7.0 up to III Semester, without any backlogs and backlog history.
 - (b) It may be noted that both regular degree and Honors degree are to be completed in 4 Years for Regular students and 3 Years for lateral entry admitted students, without any backlog history.
 - (c) The department offering Honors shall have at least one M.Tech in concerned stream, for B.Tech (Honors) registration.
 - (d) For applicability of Honors degree, both regular B Tech and Honors degree courses shall be successfully completed.
 - (e) Transfer of credits from a particular minor to regular B.Tech or another major degree and vice-versa shall not be permitted.



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IV. Entry Level:

- (a) The B.Tech students (both Regular and Lateral Entry) pursuing a major degree programme can register for Honors degree at their choice in the same department/allied (as mentioned in AICTE Handbook) offering major degree from IV semester onwards.
- (b) Students registering for Honors degree shall select the subjects from same branches/department based on the recommendations of BOS committee. For example, if a student pursuing major degree in Electrical & Electronics Engineering, select
- (c) subjects in Electrical & Electronics Engineering only and he/she will get major and Honors degree in Electrical & Electronics Engineering.
- (d) Students shall not be permitted to register for Honors degree after completion of VI semester.
- (e) Students shall be permitted to select a maximum of two subjects per semester from the list of subjects specified for Honors degree other than lab courses.
- (f) The students shall complete Honors degree without supplementary appearance within stipulated period as notified by JNTUK for the completion of regular major B. Tech programme.
- (f) Honors degree shall not be awarded at any circumstances without completing the regular major B. Tech programme in which a student got admitted
- (g) If a student is detained due to lack of attendance, he/she shall not be permitted to register the courses for Honors degree
- (h) The subjects completed under Honors degree programme shall not be considered as equivalent subjects in case the student fails to complete the major degree programme
- (i) Students completed their degree shall not be permitted to register for Honors degree

V. Structure of Honors in B.Tech:

- (a) The student shall earn additional 18 credits for award of Honors degree from same branch/department/allied (as mentioned in AICTE Handbook) registered for major degree
- (b) Students can complete Honors degree courses either in the college or online from platforms like NPTEL/SWAYAM etc.
- (c) The overall attendance in each semester of regular B. Tech courses and Honors degree courses shall be computed separately.
- (d) Student having less than 65% attendance in Honors courses shall not be permitted for "Honors Course(s) semester end examinations".
- (e) A student detained due to lack of attendance in regular B.Tech programme shall not be permitted to continue Honors programme
- (f) The teaching, examinations (internal and external) and evaluation procedure of Honors degree courses offered in offline is similar to regular B. Tech courses
- (g) Students may choose theory or practical courses to fulfil the minimum credit requirement.
- (h) Students shall be allowed to take maximum two subjects per semester pertaining to their Honors degree other than lab courses
- (i) The students registered form in or shall not be permitted to register for B.Tech(Honors).



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VI. Credits requirement:

- (a) A Student will be eligible to get B.Tech (Honors), if he/she completes an additional 18 credits. These may be acquired either in offline or online like NPTEL/SWAYAM etc by doing 8/12/16 week courses covering 2/3/4 credits.
- (b) The colleges offering Honors degree courses shall be ready to teach the courses in offline at their college in the concerned departments. Curriculum and the syllabus of the courses shall be approved by the Board of Studies
- (c) Students shall produce a certificate issued by the NPTEL/SWAYAM etc., conducting agency as a proof of credit attainment.
- (d) The teaching and evaluation procedure of Honors courses offering in offline mode shall be similar to that of regular B. Tech courses
- (e) After successful completion of all major and Honors degree courses with specified CGPA the University will award B. Tech (Honors).

VII. Procedure to Applying for Honors degree:

- (a) The department offering the Honors will announce courses required before the start of the session.
- (b) The interested students shall apply for the Honors course to the HOD of the concerned department.
- (c) The whole process should be completed within one week before the start of every session.
- (d) Selected students shall be permitted to register the courses for Honors degree.

VIII. Joining in Honors Program:

- (a) Each department offering the Honors degree shall submit the final list of selected students to the principal.
- (b) The selected students shall submit a joining letter to the Principal through the concerned HOD.
- (c) The department offering Honors shall maintain the record of student pursuing the Honors degree
- (d) With the approval of Principal and suggestion of advisor/mentor, students can choose courses from the approved list and shall register the courses within a week as per the conditions laid down in the structure for the Honor degree.
- (e) Each department shall communicate the Honors courses registered by the students to the time table drafting committee and accordingly time table will be drafting. Time table drafting committee shall see that no clash in time tables.
- (f) If the student wishes to withdraw/change the registration of subject/course, he/she shall inform the same to advisor/mentor, subject teacher, HODs of minor department and parent department and Principal within two weeks after registration of the course.

IX. Procedure for Monitoring the Progress of the Scheme:

The students enrolled in the Honor courses will be monitored continuously at par with the prevailing practices and examination standards. An advisor/mentor from parent department shall be assigned to a group of students to monitor the progress.

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- X. Allocation of seats for Honors degree:
- (a) Total number of seats offered for Honors degree shall be a maximum of 60 (based on merit).
- XI. Course Fees for registration of subjects in Major degree:
- There is no fee for registration of subjects for major degree programme offered in offline at the respective colleges.
- XII. Examinations:
- (a) The examination for the Honors degree courses offered in offline shall be conducted along with regular B. Tech programme.
- (b) The examinations (internal and external) and evaluation procedure of Honors degree courses offered in offline is similar to regular B. Tech courses.
- (c) A separate transcript shall be issued for the minor subjects passed in each semester
- (d) It may be noted that both major and Honors courses (from IV Sem to VII Sem) are to be completed in 4 Years for Regular students and 3 Years for lateral entry admitted students.

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- (e) There is no supplementary examination for the failed subjects in an Honors degree programme.
- (f) Examination Fees : Examination Fees will be as per the JNTUK norms
- (g) For awarding the class, CGPA obtained in Major Degree only will be considered.
- (h) For awarding the Honor's obtained credits only will be considered.

//ISSUEDBYORDER//

~~2021~~
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