

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
B.Tech. in MECHANICAL ENGINEERING
COURSE STRUCTURE (R25 Regulations)
Applicable from A.Y. 2025-26 Batch
(For University Constituent Colleges only)

II YEAR**I SEMESTER**

S. No.	Course Code	Course Title	L	T	P	Credits
1	BSC	Probability, Statistics and Complex Variables	3	0	0	3
2	ME302PC	Fluid Mechanics and Hydraulic Machines	3	0	0	3
3	ME303PC	Mechanics of Solids	3	0	0	3
4	ME304PC	Production Technology	3	0	0	3
5	ME305PC	Thermodynamics	3	0	0	3
6	ME306CS	Computational Mathematics Laboratory	0	0	2	1
7	ME307PC	Production Technology Laboratory	0	0	2	1
8	ME308PC	Material Science and Mechanics of Solids Laboratory	0	0	2	1
9	ME309PC	Fluid Mechanics and Hydraulic Machines Laboratory	0	0	2	1
10	MESDC1	Design Thinking and Ideation (Skill Development Course – 1)	0	0	2	1
		Total Credits	15	0	10	20

II YEAR**II SEMESTER**

S. No.	Course Code	Course Title	L	T	P	Credits
1	ME401PC	Kinematics of Machinery	3	0	0	3
2	ME402PC	Thermal Engineering - I	3	0	0	3
3	ME403PC	Design of Machine Elements	3	0	0	3
4	ME404PC	Instrumentation and Control Systems	3	0	0	3
5	ME405PC	Operations Research	3	0	0	3
6	ME406PC	Innovation and Entrepreneurship	2	0	0	2
7	ME407PC	Conventional and Computer Aided Machine Drawing	0	0	2	1
8	ME408PC	Instrumentation and Control Systems Laboratory	0	0	2	1
9	ME409PC	Thermal Engineering-I Laboratory	0	0	2	1
10	MESDC2	Data Analytics and Python for Engineers (Skill Development Course – 2)	0	0	2	1
11	MC410	Indian Knowledge System	1	0	0	0
		Total Credits	18	0	8	21

#Note: Students who wish to exit after II Year II Semester has to register for this optional course and acquire the credits allotted by doing 6 weeks Work-based Vocational Course/ Internship or Apprenticeship. Please refer R25 Academic Regulations for more information. (Refer to III Year I Semester Course Structure)

L	T	P	C
3	0	0	3

Pre-requisites: Mathematics courses of first year of study.

Objectives: To learn

- The ideas of probability and random variables and various discrete and continuous probability distributions and their properties.
- The basic ideas of statistics including measures of central tendency, correlation and regression.
- The statistical methods of studying data samples.
- Differentiation and integration of complex valued functions.
- Evaluation of integrals using Cauchy's integral formula and Cauchy's residue theorem.
- Expansion of complex functions using Taylor's and Laurent's series.

Course outcomes:

After learning the contents of this paper the student must be able to

- Formulate and solve problems involving random variables and apply statistical methods for analysing experimental data.
- Apply concept of estimation and testing of hypothesis to some case studies.
- Analyse the complex function with reference to their analyticity, integration using Cauchy's integral and residue theorems
- Taylor's and Laurent's series expansions of complex function

UNIT-I: Basic Probability

Probability spaces, conditional probability, independent events, and Bayes' theorem.

Random variables: Discrete and continuous random variables, Expectation of Random Variables, Variance of random variables

UNIT-II: Probability Distributions

Binomial, Poisson, evaluation of statistical parameters for these distributions, Poisson approximation to the binomial distribution, Continuous random variables and their properties, distribution functions and density functions,

Normal and exponential, evaluation of statistical parameters for these distributions

UNIT-III: Estimation & Tests of Hypothesis

Introduction, Statistical Inference, Classical Methods of Estimation.: Estimating the Mean, Standard Error of a Point Estimate, Prediction Intervals, Estimating a Proportion for single sample, Difference between Two Means, difference between two proportions for two Samples.

Statistical Hypotheses: General Concepts, Testing a Statistical Hypothesis, Tests Concerning a Single Mean, Tests on Two Means, Test on a Single Proportion, Two Samples: Tests on Two Proportions.

UNIT-IV: Complex Differentiation

Limit, Continuity and Differentiation of Complex functions, Analyticity, Cauchy-Riemann equations (without proof), finding harmonic conjugate; elementary analytic functions (exponential, trigonometric, logarithm) and their properties.

UNIT-V: Complex Integration

Line integral, Cauchy's theorem, Cauchy's Integral formula, Zeros of analytic functions, Singularities, Taylor's series, Laurent's series; Residues, Cauchy Residue theorem, Conformal mappings, Mobius transformations and their properties. (All theorems without Proof)

Text Books

1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 35th Edition, 2010.
2. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers, keying Ye, Probability And Statistics For Engineers And Scientists, 9th Edition, Pearson Publications.
3. A First Course In Complex Analysis, D Zill.

References

1. Fundamentals of Mathematical Statistics, Khanna Publications, S C Guptha and V.K. Kapoor.
2. Miller and Freund's, Probability and Statistics for Engineers, 8th Edition, Pearson Educations
3. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, LaxmiPublications, Reprint, 2010.
4. J. W. Brown and R. V. Churchill, Complex Variables and Applications, 7th Ed., Mc-Graw Hill, 2004.

L	T	P	C
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Course Objectives: To enable the student:

1. To understand the basic principles of fluid mechanics.
2. To identify various types of flows.
3. To understand boundary layer concepts and flow through pipes.
4. To evaluate the performance of hydraulic turbines.
5. To understand the functioning and characteristic curves of pumps.

Course Outcomes:

1. Able to explain the effect of fluid properties on a flow system.
2. Able to identify type of fluid flow patterns and describe continuity equation.
3. To analyze a variety of practical fluid flow and measuring devices and utilize Fluid Mechanics principles in design.
4. To select and analyze an appropriate turbine with reference to given situation in power plants.
5. To estimate performance parameters of a given Centrifugal and Reciprocating pump.
6. Able to demonstrate boundary layer concepts.

UNIT – I: Fluid statics

Dimensions and units: physical properties of fluids- specific gravity, viscosity, and surface tension - vapour pressure and their influence on fluid motion- atmospheric, gauge and vacuum pressures – measurement of pressure- Piezometer, U-tube and differential manometers.

UNIT – II: Fluid kinematics

Stream line, path line and streak lines and stream tube, classification of flows-steady & unsteady, uniform & non-uniform, laminar & turbulent, rotational & irrotational flows-equation of continuity for one dimensional flow and three-dimensional flows.

Fluid dynamics: Surface and body forces –Euler's and Bernoulli's equations for flow along a stream line, momentum equation and its application on force on pipe bend.

UNIT – III: Boundary Layer Concepts

Definition, thicknesses, characteristics along thin plate, laminar and turbulent boundary layers (No derivation) boundary layer in transition, separation of boundary layer, submerged objects – drag and lift.

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. Measurement of flow: Pitot tube, venturi meter, and orifice meter, Flow nozzle

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

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.

UNIT – V: Centrifugal pumps

Classification, working, work done – barometric head- losses and efficiencies specific speed-performance characteristic curves, NPSH.

Reciprocating pumps: Working, Discharge, slip, indicator diagrams.

TEXT BOOKS:

1. Hydraulics, Fluid mechanics and Hydraulic Machinery, Modi and Seth, standard Book House, 21st Edition, 2019.
2. Fluid Mechanics and Hydraulic Machines, Er. R. K. Rajput, S. Chand, 2019.

REFERENCE BOOKS:

1. Fluid Mechanics and Fluid Power Engineering by D.S. Kumar, S.K. Kataria & Sons, 22nd Edition, 2018.
2. Fluid Mechanics and Machinery, D. Rama Durgaiah, New Age International publishers, 1st Edition, 2002.
3. Hydraulic Machines, T.R. Banga and S.C. Sharma, Khanna Publishers, 7th Edition, Rpt. 2019.

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Pre-Requisites: Engineering Mechanics

Course Objectives: The objectives of this course are to:

1. Understand the concepts of internal forces, moments, stress, strain, and deformation of solids with applications to bars, beams, and columns.
2. Learn the fundamentals of applying equilibrium, compatibility, and force-deformation relationships to structural elements.
3. Study twisting of circular bars and hollow shafts acted on by torsional moments.
4. Define the state of stress at a point on a body and to develop stress transformations.
5. Introduce the concept of theories of elastic failure and their significance in the design.

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

1. Evaluate the internal forces, moments, stresses, strains, and deformations in structures made of various materials acted on by a variety of loads.
2. Draw axial force, shear force and bending moment diagrams for beams and frames.
3. Develop the Bending and Torsion formula and apply to the design of beams and shafts.
4. Use the stress transformation equations to find the state of stress at a point for various rotated positions of the stress element and display the same in graphical form as Mohr's circle.
5. Understand the different criteria for the safety of the component by applying the theories of elastic failure.

UNIT – I: Stress & Strain

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 – Elastic moduli & the relationship between them – Bars of varying section – composite bars – Temperature stresses. 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 – 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 – Design of simple beam sections.

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

UNIT – IV: Principal Stresses and Strains

Introduction – Stresses on an inclined section of a bar under axial loading – compound stresses – Normal and tangential stresses on an inclined plane for biaxial stresses – Two perpendicular normal stresses accompanied by a state of simple shear – Mohr's circle of stresses – Principal stresses and strains – Analytical and graphical solutions.

Theories of Failure: Introduction – Various theories of failure - Maximum Principal Stress Theory, Maximum Principal Strain Theory, Strain Energy and Shear Strain Energy Theory (Von Mises Theory).

UNIT – V: Torsion of Circular Shafts

Theory of pure torsion – Derivation of Torsion equations: $T, J = q, r = N\theta, L$ – Assumptions made in the theory of pure torsion – Torsional moment of resistance – Polar section modulus – Power transmitted by shafts – Combined bending and torsion and end thrust – Design of shafts according to theories of failure.

Columns and Struts: Euler's Theory, Limitations of Euler's theory, Equivalent Length, Rankine's Formula, Secant Formula.

TEXT BOOKS:

1. Mechanics of Materials, Barry J. Goodno and James M. Gere, Cengage, 9th Edition, 2018.
2. Strength of Materials, S. S. Rattan, Tata McGraw Hill, 2nd Edition, 2011.

REFERENCE BOOKS:

1. Strength of Materials, U. C. Jindal, Pearson Education India, 1st Edition, 2012.
2. Engineering Mechanics of Solids, Egor P. Popov and Toader A. Balan, PHI Learning, 2nd Edition, 2010.
3. Strength of Materials, G. H. Ryder, Macmillan Long Man Publications, 3rd Edition, 1961.
4. Strength of Materials, W. A. Nash and M. C. Potter, McGraw Hill, 5th Edition, 2011.

L	T	P	C
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Pre-requisites: Engineering workshop

Course Objectives:

1. To expose the students to understand the concept of basic casting processes & furnaces.
2. To provide a technical understanding of various joining processes used in the manufacturing industry.
3. To impart the students to the concepts of solid-state welding processes.
4. To teach the concepts of rolling and various press working operations.
5. To provide a technical understanding of different metal forming processes like extrusion, forging and high energy rate forming processes.

Course Outcomes: Student will be able to:

1. Elaborate the fundamentals of various moulding, casting techniques and furnaces.
2. Identify the importance of permanent joining and principle behind different welding processes.
3. Explain the concepts of solid-state welding processes.
4. Understand the concepts of rolling and sheet metal operations in metal working.
5. Elaborates the uniqueness of extrusion, forging and high energy rate forming processes in metal working.

UNIT – I: Casting

Steps involved in making a casting – Advantage of casting and its applications; Patterns - Pattern making, Types, Materials used for patterns, pattern allowances; Properties of moulding methods. Methods of Melting - Crucible melting and cupola operation – Defects in castings; Principles of Gating – Requirements – Types of gates, Design of gating systems – Riser – Function, types of Riser and Riser design. Casting processes – Types – Sand moulding, Centrifugal casting, die- casting, Investment casting, shell moulding.

UNIT – II: Arc Welding

Classification – Types of welds and welded joints and their characteristics, Welding Positions - Arc welding, shielded metal arc welding, submerged arc welding, Resistance welding, Thermit welding.

UNIT – III: Gas Welding

Gas welding - Types, oxy-fuel gas cutting – standard time and cost calculations. Inert Gas Welding _ TIG Welding, MIG welding, Friction welding, Friction Stir Welding, induction welding, explosive welding, Laser Welding.

Soldering, Brazing, Heat affected zone in welding. Welding defects – causes and remedies; destructive and non- destructive testing of welds

UNIT – IV: Hot Working and Cold Working

Strain hardening, recovery, recrystallisation and grain growth. Sheet metal Operations: Stamping, Blanking and piercing, Coining, Strip layout, Hot and cold spinning – Bending and deep drawing. Rolling fundamentals – theory of rolling, types of Rolling mills and products. Forces in rolling and power requirements. Drawing and its types – wire drawing and Tube drawing –Types of presses and press tools. Forces and power requirement in the above operations.

UNIT – V: Extrusion of Metals

Basic extrusion process and its characteristics. Hot extrusion and cold extrusion - Forward extrusion and backward extrusion – Impact extrusion – Extruding equipment – Tube extrusion, Hydrostatic extrusion. Forces in extrusion

Forging Processes: Forging operations and principles – Tools – Forging methods – Smith forging, Drop Forging – Roll forging – Forging hammers: Rotary forging – forging defects – cold forging, swaging, Forces in forging operations.

High Energy Rate Forming Processes: Principles of Explosive Forming, Electro-hydraulic Forming, Electro-magnetic forming and rubber pad Forming.

TEXT BOOKS:

1. Manufacturing Technology, P.N. Rao, Vol.1, Mc Graw Hill Education, 5th Edition, 2018.
2. Manufacturing Engineering and Technology, Serope Kalpakjian and Steven R. Schmidt, Pearson, 7th Edition, 2014.

REFERENCE BOOKS:

1. Production Technology Vol.: 1, Sreeramulu, WILEY, 1st Edition, 2018
2. A Text book of Production Technology (Manufacturing Processes), Dr. P.C. Sharma, S. Chand Publications, 1st Edition, 2006.
3. Manufacturing processes H. S. Shan, Cambridge University Press, 2nd Edition, 2017.
4. Production Technology: Manufacturing Processes, Technology and Automation Vol.1, R. K. Jain, Khanna Publishers, 19th Edition, 2009.
5. Elements of Workshop Technology Vol.1, S.K. Hajra Choudhury, A.K. Hajra Choudhury and Nirjhar Roy, Media Publishers & Promoters Pvt. Ltd., 1st Edition, 2008.

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Pre-requisite: Engineering Chemistry and Physics

Course Objective: To understand the treatment of classical Thermodynamics and to apply the First and Second laws of Thermodynamics to engineering applications

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

1. Understand and differentiate between different thermodynamic systems and processes and apply First Law of Thermodynamics to different open and closed systems.
2. Able to differentiate between a heat engine and heat pump, refrigerator and determine their performance parameters as well as able to determine the availability of systems and processes.
3. Able to determine the properties of pure substances and perfect gases and apply them to evaluate the performance of the processes involving these substances and gases.
4. Determine the properties of the mixtures and use them to determine performance parameters.
5. Able to determine the psychrometric properties as well as determine the performance parameters of power and refrigeration cycles.

Tables, Codes: Steam Tables and Mollier Chart, Refrigeration Tables

UNIT – I: Basic Concepts and First Law of Thermodynamics

System, Control Volume, Surrounding, Boundaries, Universe, Types of Systems, Macroscopic and Microscopic viewpoints, Concept of Continuum, Thermodynamic Equilibrium, State, Property, Process, Exact & Inexact Differentials, Cycle – Reversibility – Quasi – static Process, Irreversible Process, Causes of Irreversibility – Energy in State and in Transition, Types, Displacement & Other forms of Work, Heat, Point and Path functions, Zeroth Law of Thermodynamics – Concept of Temperature – Principles of Thermometry – Reference Points – Const. Volume gas Thermometer – Scales of Temperature, Ideal Gas Scale PMM I - Joule's Experiments – First law of Thermodynamics – Corollaries – First law applied to a Process – applied to a flow system – Steady Flow Energy Equation.

UNIT – II: Second Law of Thermodynamics and Availability

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'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 – III: Pure Substance and Perfect Gas

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.

Perfect Gas Laws – Equation of State, specific and Universal Gas constants – various Non-flow processes, properties, end states, Heat and Work Transfer, changes in Internal Energy – Throttling and Free Expansion Processes – Flow processes

UNIT – IV: Real Gas models and Perfect Gas Mixtures

Deviations from perfect Gas Model – Vander Waals Equation of State – Compressibility charts – variable specific Heats – Gas Tables, Mixtures of perfect Gases – Mole Fraction, Mass fraction Gravimetric and volumetric Analysis – Dalton's Law of partial pressure, Avogadro's Laws of additive volumes – Mole fraction, Volume fraction and partial pressure, Equivalent Gas const. And Molecular Internal Energy, Enthalpy, sp. Heats and Entropy of Mixture of perfect Gases and Vapour.

UNIT – V: Psychrometry and Thermodynamic Cycles

Atmospheric air - 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.

Thermodynamic Cycles: Sterling Cycle, Atkinson Cycle, Ericsson Cycle, Lenoir Cycle – Description and representation on P–V and T-S diagram, Thermal Efficiency, Mean Effective Pressures on Air standard basis – comparison of Cycles, Refrigeration Cycles: Bell-Coleman cycle, Vapour compression cycle, Ammonia - Water Vapor Absorption Cycle -performance Evaluation.

TEXTBOOKS:

1. Engineering Thermodynamics, PK Nag, Mc Graw Hill, 6th Edition, 2017.
2. Thermodynamics, Yunus A Cengel, Michael A Boles, Mehmet Kanoglu, Mc Graw Hill, 9th Edition, 2019.

REFERENCE BOOKS:

1. Engineering Thermodynamics, Chattopadhyay, Oxford, 2nd Edition, 2015.
2. Engineering Thermodynamics, Rogers, Pearson, 4th Edition, 1996.
3. Engineering Thermodynamics, M Achuthan, PHI, 2nd Edition, 2009.
4. Thermodynamics for Engineers, Kenneth A. Kroos, Merle C. Potter, Cengage, 1st Edition, 2014.

Computational Mathematics Laboratory ME306CS
(Using Python/MATLAB software)
(Common for All Branches)

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Pre-requisites: Matrices, Iterative methods and ordinary differential equations

Objectives:

To learn

- Solve problems of Eigen values and Eigen Vectors using Python/MATLAB.
- Solution of Algebraic and Transcendental Equations using Python/MATLAB
- Solve problems of Linear system of equations
- Solve problems of **First-Order ODEs Higher order linear differential equations with constant coefficients**

*** Visualize all solutions graphically through programmes**

UNIT-I: Eigen values and Eigenvectors:

6P

Programs:

- Finding real and complex Eigen values.
- Finding Eigen vectors.

UNIT-II: Solution of Algebraic and Transcendental Equations

6P

Bisection method, Newton Raphson Method

Programs:

- Root of a given equation using Bisection method.
- Root of a given equation Newton Raphson Method.

UNIT-III: Linear system of equations:

6P

Jacobi's iteration method and Gauss-Seidal iteration method

Programs:

- Solution of given system of linear equations using Jacobi's method
- Solution of given system of linear equations using Gauss-Seidal method

UNIT-IV: First-Order ODEs

8P

Exact and non exact equations, Applications: exponential growth/decay, Newton's law of cooling.

Programs:

- Solving exact and non-exact equations
- Solving exponential growth/decay and Newton's law of cooling problems

UNIT-V: Higher order linear differential equations with constant coefficients

6P

Programs:

- Solving homogeneous ODEs
- Solving non homogeneous ODEs

Course outcomes:

After learning the contents of this paper, the student must be able to

- Develop the code to find the Eigen values and Eigen Vectors using Python/MATLAB.
- Develop the code find solution of Algebraic and Transcendental Equations and Linear system of equations using Python/MATLAB
- Write the code to solve problems of **First-Order ODEs Higher order linear differential equations with** constant coefficients

Text Books

1. MATLAB and its Applications in Engineering, Rajkumar Basal, Ashok Kumar Geo, Manoj Kumar Sharama, Pearson publication.
2. Kenneth A. Lambert, The fundamentals of Python: First Programs, 2011, Cengage Learnings.
3. Think Python First Edition, by Allen B. Downey, Orielly publishings.
4. Introduction to Python Programming, William Mitchell, Povel Solin, Martin Novak et al., NCLab Public Computing, 2012.
5. Introduction to Python Programming, ©Jacob Fredslund, 2007.

References

1. An Introduction to Python, John C. Luth, The University of Alabama, 2011.
2. Introduction to Python, ©Dave Kuhlman, 2008.

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Pre-requisites: Production Technology

Course Objectives:

- Know about the basic Physical, Chemical Properties of materials
- Learn the basic operation of various manufacturing processes
- Design and fabricate a simple product

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

CO 1: Analyze the given problem and conducts investigation on the experimental setup.

CO 2: Operate different types of welding machines

CO 3: Perform operations on mechanical press.

CO 4: get familiarity with processing of Plastics.

CO 5: Effectively communicate and explain the experimental analysis.

Minimum of 12 Exercises need to be performed

I. Metal Casting Lab:

1. Pattern Design and making - for one casting drawing.
2. Sand properties testing - Exercise -for strengths, and permeability – 1
3. Moulding Melting and Casting - 1 Exercise

II. Welding Lab:

1. ARC Welding Lap & Butt Joint - 2 Exercises
2. Spot Welding - 1 Exercise
3. TIG Welding - 1 Exercise
4. Plasma welding and Brazing - 2 Exercises (Water Plasma Device)

III. Mechanical Press Working:

1. Blanking & Piercing operation and study of simple, compound and progressive press tool.
2. Hydraulic Press: Deep drawing and extrusion operation.
3. Bending and other operations

IV. Processing Of Plastics

1. Injection Moulding
2. Blow Moulding

REFERENCE BOOK:

1. Dictionary of Mechanical Engineering – G.H.F. Naylor, Jaico Publishing House.

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Pre-Requisites: Material Science and Metallurgy; Mechanics of Solids

Material Science:

Course Objective: The Objective is to make the students learn the concepts of Metallurgy and Material Science in manufacturing processes, which convert raw materials into useful products. Students will be able to understand basic structure and crystal arrangements of materials and classify and distinguish different microstructures of steels, cast irons and non-ferrous alloys.

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

1. Design different crystal structures and their models.
2. Infer the microstructures developed for different ferrous and non-ferrous metals.
3. Correlate the microstructures, properties, performance and processing of alloys.

MECHANICS OF SOLIDS LAB:

Course Objectives: The objective is to learn the fundamental concepts of stress, strain, and deformation of solids with applications to bars, beams, and columns. Detailed study of engineering properties of materials is also of interest. Fundamentals of applying equilibrium, compatibility, and force-deformation relationships to structural elements are emphasized. The students are introduced to advanced concepts of flexibility and stiffness method of structural analysis. The course builds on the fundamental concepts of engineering mechanics course.

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

1. Analyze the behavior of the solid bodies subjected to various types of loading.
2. Apply knowledge of materials and structural elements to the analysis of simple structures.
3. Undertake problem identification, formulation and solution using a range of analytical methods
4. Analyze and interpret laboratory data relating to behavior of structures and the materials they are made of, and undertake associated laboratory work individually and in teams.
5. Expectation and capacity to undertake lifelong learning.

Material Science

List of Experiments:

1. Preparation and study of crystal models for simple cubic, body centred cubic, face centred cubic and hexagonal close packed structures.
2. Preparation and study of the Microstructure of pure metals like Iron, Cu and Al.
3. Preparation and study of the Microstructure of Mild steels, low carbon steels, high Carbon steels.
4. Study of the Microstructures of Various Cast Irons.
5. Study of the Microstructures of Non-Ferrous alloys. (Al, Cu, Mg)
6. Hardenability of steels by Jominy End Quench Test.

MECHANICS OF SOLIDS LAB

List of Experiments:

1. Tension test
2. Bending test
3. Torsion test
4. Brinell's hardness test, Rockwell hardness test
5. Test on springs
6. Izod Impact test, Charpy Impact test

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Course Objectives:

1. To understand the basic principles of fluid mechanics.
2. To identify various types of flows.
3. To understand boundary layer concepts and flow through pipes.
4. To evaluate the performance of hydraulic turbines.
5. To understand the functioning and characteristic curves of pumps.

Course Outcomes:

1. Able to explain the effect of fluid properties on a flow system.
2. Able to identify type of fluid flow patterns and describe continuity equation.
3. To analyze a variety of practical fluid flow and measuring devices and utilize fluid mechanics principles in design.
4. To select and analyze an appropriate turbine with reference to given situation in power plants.
5. To estimate performance parameters of a given Centrifugal and Reciprocating pump.
6. Able to demonstrate boundary layer concepts.

List of Experiments:**Fluid Mechanics:**

1. Venturimeter.
2. Orifice meter.
3. Friction factor for a given pipe line.
4. Loss of head due to sudden contraction in a pipeline.
5. Application of Bernoulli's Theorem.

Hydraulic Machinery:

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.

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UNIT I: FUNDAMENTALS OF DESIGN THINKING

Design Thinking Process: Types of the thinking process, Common methods to change the human thinking process, Design thinking: Definition, Origin of design thinking, Importance of design thinking, Design vs Design thinking, Problem solving, the need of design thinking; An approach to design thinking, Design thinking Process model, Design thinking tools.

Case Studies: General, Engineering and Service applications

Activities: Identify an Opportunity and Scope of the Project Explore the possibilities and prepare a design brief.

UNIT II: EMPATHIZE AND UNDERSTANDING USER NEEDS

Design thinking phases, how to empathize, Role of empathy in design thinking, the purpose of empathy maps, Things to be done prior to empathy mapping, Activities during and after the session, Understanding empathy tools: Customer Journey Map, Personas.

Define: Methods of Define Phase: Storytelling, Critical items diagrams, Define success

Activities: Apply the methods of empathizing and Define Phases Finalize the problem Statement (User Interview practice, empathy mapping, shadowing or observation study)

UNIT III: IDEATION AND GENERATING SOLUTIONS

Challenges in idea generation, Visualize, Empathize, and Ideate method, Importance of visualizing and empathizing before ideating, Applying the method, Create Thinking, Generating Design Ideas, Lateral Thinking, Analogies, Brainstorming, Mind mapping, National Group Technique, Synectic's, Development of work, Analytical Thinking, Group Activities. Ideation Tools: How Might We? (HMW), Storyboard, Brainstorming. What is design innovation? A mindset for innovation, and asking "What if?" asking "What wows?" and "What works?"

Activities- Apply the methods of Ideate Phase: Generate Lots of Ideas (Brain Storming Sessions, SCAMPER Technique Activity and Rapid Sketching).

UNIT IV: PROTOTYPING AND BUILDING THE SOLUTION

What is a prototype? - Prototyping as a mindset, prototype examples, prototyping for products; Why we prototype? Fidelity for prototypes, Process of prototyping- Minimum Viable prototype.

Activities: Apply the Methods of the Prototype Phase: Create prototypes for selected ideas (Paper prototyping, digital prototyping and story board creation).

UNIT V: TESTING PROTOTYPES AND VALIDATION

Prototyping for digital products: What's unique for digital products, Preparation; Prototyping for physical products: What's unique for physical products, Preparation; Testing prototypes with users. Create a Pitch-Plan for scaling up-Road map for Implementation, Fine tuning and Submission of the project report

Activities: Collect feedback; iterate and improve the ideas Present your solution using the Storytelling method (Usability testing, Feedback Grid Exercise and Iteration Activity)

Capstone Activity:

Mini Design Challenge: Apply all stages of design thinking on a real-world problem provided by industry/community.

Text Books:

1. Tim Brown, Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation, Harper Collins Publishers Ltd.
2. Idris Mootee, Design Thinking for Strategic Innovation, 2013, John Wiley & Sons Inc

Tools and Techniques Used:

Sticky Notes, Whiteboards, Canva, Figma, Tinker CAD, Mind Mapping tools, Sketching Kits, Empathy Maps, Journey Maps and related softwares.