COURSE STRUCTURE (R23)
AND
DETAILED SYLLABUS
(II YEAR)

MECHANICAL ENGINEERING

For
B.Tech., Four Year Degree Course
(Applicable for the batches admitted from 2023-24)

LENDI INSTITUTE OF ENGINEERING AND TECHNOLOGY
An Autonomous Institution
Approved by AICTE & Permanently Affiliated to JNTUGV, Vizianagaram
Accredited by NAAC with "A" Grade and NBA (CSE,ECE, EEE & ME)
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COURSE STRUCTURE AND DETAILED SYLLABUS
B.TECH- MECHANICAL ENGINEERING

II Year I Semester						
S.No	**Course Code**	**Course Name**	**L**	**T**	**P**	**Credits**
1.	R23BSH-MA2102	Mathematical Methods and Transform Techniques	3	0	0	3
2.	R23BSH-HM2101	Universal Human Values: Understanding Harmony and Ethical humanconduct	2	1	0	3
3.	R23MEC-ES2101	Thermodynamics	3	0	0	3
4.	R23MEC-PC2101	Mechanics of Solids	3	0	0	3
5.	R23MEC -PC2102	Material Science and Metallurgy	3	0	0	3
6.	R23MEC-PC2103	Mechanics of Solids and Materials Science Lab	0	0	3	1.5
7.	R23MEC-PC2104	Computer-aided Machine Drawing	0	0	3	1.5
8.	R23CSE-SC2102	Python programming Lab (Skill Oriented Course)	1	0	2	2
9	R23BSH-MC2101	Environmental Science (Mandatory Course)	2	0	0	0
		Total	**17**	**1**	**8**	**20**

II Year II Semester						
S.No	**Course Code**	**Course Name**	**L**	**T**	**P**	**Credits**
1.	R23BSH-HM2202	Industrial Management	2	0	0	2
2.	R23BSH-MA2202	Complex Variables and Statistical Methods	3	0	0	3
3.	R23MEC-PC2201	Manufacturing processes	3	0	0	3
4.	R23MEC -PC2202	Fluid Mechanics & Hydraulic Machines	3	0	0	3
5.	R23MEC -PC2203	Kinematics of Machinery	3	0	0	3
6.	R23MEC -PC2204	Fluid Mechanics & Hydraulic Machines Lab	0	0	3	1.5
7.	R23MEC -PC2205	Manufacturing processes Lab	0	0	3	1.5
8.	R23BSH-SC2201	English for Employability Skills (Skill Oriented Course)	0	1	2	2
9.	R23MEC-ES2201	Design Thinking & Innovation	1	0	2	2
		Total	**15**	**1**	**10**	**21**
Honor Course-1						
Community Service Project (During the Summer Vacation after Second Year & Evaluated in III-I Semester)						

II Year–I Semester

Course code	Course Title	L	T	P	Credits
R23BSH-MA2102	**Mathematical Methods and Transform Techniques**	3	0	0	3

Course Objectives:

- To develop a solid understanding of fundamental mathematical concepts essential for engineering, including Numerical methods, and transform techniques.
- To provide students sufficient knowledge and skills enabling them to undertake further studies in engineering and its allied areas on multiple disciplines concerned with mathematics.
- To foster critical thinking and logical reasoning skills to approach and solve engineering challenges methodically.
- To develop teamwork skills by engaging in collaborative projects and group problem-solving activities, simulating real-world engineering environments.
- To encourage a mindset of continuous learning and adaptation, preparing students to stay current with evolving mathematical methods and engineering practices.
- To improve the ability to communicate mathematical ideas and solutions effectively in written and oral forms within the context of engineering.
- To enhance analytical and problem-solving abilities by applying mathematical methods to solve engineering problems.

Course Outcomes:

At the end of the course, the student will be able to

1. Apply suitable numerical methods to find the roots for given equation and interpolating formula for given data.
2. Apply suitable numerical methods to find the definite integral and solve real world problems when modeled into differential equations.
3. Analyze the data by fitting into regression lines using least square methods.
4. Apply Laplace transforms to solve the real world problems when modeled into differential equations.
5. Analyze various functions using Fourier series and Fourier transforms.

Unit I

Solution of Algebraic and Transcendental Equations: Numerical solutions of linear and non-linear algebraic equations: Intermediate value theorem (Statement only). Geometrical representation of root of an equation. Bisection Method**,** Regula - Falsi method, Iterative Method, Newton- Raphson method for one variable.

Interpolation: Finite differences. Relations between∇, Δ, E, D, δ and μ. Missing terms using forward difference operator. Newton's forward interpolation formula, Newton Backward interpolation formula, Lagrange's difference formula, Gauss Forward difference formula.

UNIT-II

Numerical Integration: Trapezoidal and Simpson's rules($1/3^{rd}$ &$3/8^{th}$)

Solutions of Ordinary differential equations: Taylor series method, Picard's method, Euler's method. Modified Euler's methods and Runge-Kutta method of fourth order, Milne's Predictor and Corrector Method.

UNIT-III

Curve Fitting: Method of Least square Method- Linear curve fitting: Straight line fit. Nonlinear curve fitting: Parabolic fit.

Correlation and Regression: Correlation, correlation coefficient, rank correlation. Linear regression coefficients, regression lines.

Student Activity: Analyze the data using correlation and Regression with any software tools

such as R, Python, or Excel.

Unit IV

Laplace transforms: Definition, existence conditions, properties, Laplace transforms of derivatives and integrals, multiplication by t^n, division by t, periodic functions, unit step function and impulse function. Inverse Laplace transforms and convolution theorem.

Applications: improper integrals, ordinary differential equations.

Unit V

Fourier Series: Fourier series, Dirichlet's conditions, even and odd functions, Fourier series of functions in an arbitrary interval, Half-range series,
Applications: Practical Harmonic Analysis.
Fourier transforms: Fourier integrals, Fourier cosine and sine integrals, Fourier transform, sine and cosine transform, properties.

Text Books

1. B. S. Grewal, Higher Engineering Mathematics, 45th edition, Khanna publishers, 2023.

References

1. B.S. Grewal, Numerical Methods in Engineering & Science, Khanna Publishers, 2014.
2. S.S.Sastry, Introductory Methods of Numerical Analysis, 5th Edition, 2012
3. Erwin Kreyszig, Advanced Engineering Mathematics, 10/e, John Wiley & Sons, 2011.
4. Dennis G. Zill and Warren S. Wright, Advanced Engineering Mathematics, Jones and Bartlett, 2011.
5. Michael Greenberg, Advanced Engineering Mathematics, 2/e, Pearson, 2018.

Course code	Course Title	L	T	P	Credits
R23BSH-HM2101	Universal Human Values: Understanding Harmony and Ethical Human Conduct	2	1	0	3

Course Objectives:

- Development of a holistic perspective based on value education and right understanding.
- Build harmony in the human being, Outline and strengthening of self-reflection.
- Develop Harmony in the family and society and interconnectedness with universal human order.
- Make use of mutual fulfilment relate to orders of nature and holistic perception of societal aspects.
- Integrate the humanistic constitution and humanistic universal order.

Course Outcomes:

1. Implement elements and process of value education.
2. Recognize thoughts, emotions and physical sensations of the self and the body and harmonizing their relationship.
3. Analyze human relations and their role in ensuring harmonious society.
4. Develop interconnected nature of existence encourages actions that contribute to global peace, justice and sustainability.
5. Make use of humanistic constitution, mutual respect and universal human order with holistic technologies.

UNIT-I

Introduction to Value Education: Understanding Value Education- Self-exploration as the Process for Value Education- Continuous Happiness and Prosperity – Basic Human Aspirations - Right Understanding, Relationship and Physical Facility - Happiness and Prosperity – Current Scenario.

UNIT-II

Harmony in the Human Being : Understanding Human being as the Co-existence of the Self and the Body- Distinguishing between the Needs of the Self and the Body-The Body as an Instrument of the Self -Understanding Harmony in the Self - Harmony of the Self with the Body.

UNIT-III

Harmony in the Family and Society: Harmony in the Family – Basic Unit of Human Interaction - Values in Human-to-Human Relationship - 'Trust' – Foundational Value in Relationship - 'Respect' – Right Evaluation -Understanding Harmony in the Society -Vision for the Universal Human Order.

UNIT-IV

Harmony in the Nature/Existence: Understanding Harmony in the Nature - Interconnectedness, self-regulation and Mutual Fulfilment among theFour Orders of Nature - Realizing Existence as Co-existence at All Levels - The Holistic Perception of Harmony in Existence.

UNIT-V

Implications of the Holistic Understanding – a Look at Professional Ethics: Natural Acceptance of Human Values - Definitiveness of (Ethical) Human Conduct - A Basis for Humanistic Education, Humanistic Constitution andUniversal Human Order - Competence in Professional Ethics - Holistic Technologies, Production Systems and Management Models.

Text Books

1. A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana,
2. G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN978-93-87034-47-1

Reference Books

1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi, Publisher : Prabhat Prakashan; 1st edition (1 January 2018); Prabhat Prakashan Pvt. Ltd, New Delhi-110002
4. Small is Beautiful - E. F Schumacher. Blond & Briggs (1973–2010), HarperCollins (2010)
5. Slow is Beautiful - Cecile Andrews, New Society Publishers (1 October 2006)
6. Economy of Permanence - J C Kumarappa, Publisher : Sarva Seva Sangh Prakashan (1 January 2017)
7. India Wins Freedom - Maulana Abdul Kalam Azad, Publisher : Orient BlackSwan; 1st Edition (1 January 1988)
8. Vivekananda - Romain Rolland (English), Publisher : Advaita Ashrama, India; Fourth Impression edition (30 March 2010)

Subject Code	Subject Name	L	T	P	C
R23MEC-ES2101	Thermodynamics	3	0	0	3

Course Objectives

The objectives of the course are to

- Familiarize with the fundamental thermodynamic principles and their application to solve engineering problems.
- Able to apply thermodynamics principles to real world problems including energy conversion and storage.
- Able to design thermodynamic systems including Heat Exchanger, Refrigeration and power generation systems.
- Analyze energy balance and efficiencies of thermodynamic process.
- Apply the principles of working of the gas power cycles, refrigeration/air conditioning systems in engineering contexts.

Course Outcomes:

At the end of the course, the student will be able to

1. Explain the fundamental concepts of Engineering thermodynamics
2. Analyze energy balance and efficiencies for non-flow process.
3. Apply the Second Law of Thermodynamics for thermal reservoirs, heat engines, refrigerators, entropy analysis, and T-ds relations.
4. Apply the working principle of vapor power cycles for calculating the efficiency of a Rankine cycle
5. Analyse the efficiency characteristics of thermodynamic Gas power cycles, refrigeration, and air conditioning systems

Unit - I

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

Temperature and Zeroth Law of Thermodynamics: Introduction, Zeroth law of thermodynamics, Measurement of temperature, Temperature Scales

Energy Interaction:

Energy Transfer by Heat and Work, Work and Heat Transfer for Various Processes, Point and Path function.

Applications: Thermometers, IC Engines, Thermo flask, Piston Cylinder arrangement without valves

Unit -II

First law of Thermodynamics: First law of Thermodynamics for a cyclic process (Closed Systems), PMM-I, Joule's Experiment, Limitations of the First Law of Thermodynamics, Specific Heat, Internal Energy, Enthalpy, First law of Thermodynamics for a flow process (Open Systems), Energy Analysis of Steady-Flow, Steady Flow Engineering Devices- Nozzles, Diffusers, Turbines, Compressors.

Applications: Nozzles, Diffusers, Turbines, Compressors.

Unit - III

Second Law of Thermodynamics: Thermal Reservoir, Heat Engine, Refrigerators, Heat pump, Kelvin-Planck and Clausius Statements, PMM-II, Carnot's principle- Carnot cycle and Carnot Engine,

Entropy: Clausius Theorem, Clausius Inequality, Energy Equation, Change of Entropy in Reversible Process, Principle of Entropy Increase, Temperature and Entropy Diagrams, Entropy Transfer, Entropy Generation, T-ds Relations, Third Law of Thermodynamics.

Applications: Refrigerators, Heat Pump and Heat Engines

Unit - IV

Properties of Pure Substance: Introduction, Phases of pure substance, p-v, p-T, T-s and h-s diagrams for pure substance, p-v-T Surface, Properties of steam, quality or dryness fraction, phase change processes, Mollier diagram for a pure substance.

Vapor Power Cycles: Carnot Vapor Cycle, Rankine Cycle, Deviation of Actual Vapor Power Cycles from Idealized Ones.

Applications: Steam Power Plants, Steam Engines.

Unit – V

Gas Power Cycles: Carnot Cycle, Otto Cycle, Diesel Cycle, Dual Cycle, Brayton Cycle

Refrigeration & Air Conditioning Systems: The Reversed Carnot Cycle, Bell-Coleman cycle, Vapour compression Refrigeration Cycle, COP of Refrigerators and Heat Pumps. Types of Air Conditioning Systems.

Applications: IC engines, Gas Turbines, Refrigerators and Air Conditioners.

Text Books:

1. P.K.Nag, Engineering Thermodynamics, 5/e, Tata McGraw Hill.
2. Mahesh M. Rathore, Thermal Engineering, Tata McGraw-Hill Education
3. P.Chattopadhyay, Engineering Thermodynamics, 1/e, Oxford University Press.

Reference Books

1. Yunus A. Cengel, Michaela A. Boles, Thermodynamics, 7/e, Tata McGraw Hill.
2. Claus Borgnakke Richard E. Sonntag, Fundamentals of Thermodynamics, 7/e, Wiley.
3. Moran, Michael J. and Howard N. Shapiro, Fundamentals of Engineering Thermodynamics, 3/e, Wiley.
4. J.B.Jones and G.A.Hawkins, Introduction to Thermodynamics, 2/e, John Wiley & Sons.

Subject Code	Subject Name	L	T	P	C
R23MEC-PC2101	Mechanics of Solids	3	0	0	3

Course Objectives: The objectives of the course are to

- Understand the basic concepts of simple stresses and principal stresses induced in material under different loads to analysing the strength of structural elements.
- Analyse the variation of shear force and bending moments over the beams in different loading conditions.
- Evaluate the bending stresses and shear stresses in beams under complex loading conditions.
- Analyse the deflection, slope of the beams and buckling, stability of columns for different loading conditions end support conditions.
- Evaluate the stresses, strains in thin shells to predict the dimensional changes and torsional behaviour of shafts in power transmission.

Course Outcomes:

At the end of the course, the student will be able to

1. Apply the basic concepts of simple stresses and strains, principal stresses and strains, thermal stresses for solving the fundamental problems related to solids and structures.
2. Analyze the shear force and bending moment diagrams for beams at given load conditions.
3. Apply the theory of bending stresses and shear stresses for understanding the nature of the stress distributions for rectangular, circular, triangular, I, and T sections.
4. Analyze the deflection and stability of beams and columns under various loading and support conditions
5. Apply the principles of stress, strain for thin shells and shafts for finding the stresses and strains produced in pressure vessels and torsional shear strength of the machine members.

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, Relation between elastic constants – 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, Strain energy – Resilience – Gradual, sudden, impact and shock loadings.

Applications: Marine, Aerospace, Automotive, and Civil Engineering structural components

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, uniformly distributed load, 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 abeam.

Applications: Beams, Frames, roof beams and other structural elements

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.

Applications: Shafts, Gears, Machine frames, Beams, Girders, and structural members in

buildings and bridges; bolts, pins, and fasteners

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, UDL and UVL. Mohr's theorem and Moment area method – application to simple cases.

COLUMNS:

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

Applications: Aircraft wings, Automobile chassis components, Dams, Retaining walls, Columns and Pillars in buildings

UNIT– V

THIN SHELLS: Thin seamless cylindrical shells – Derivation of formula for longitudinal and circumferential stresses – hoop, longitudinal and volumetric strains – changes in diameter, and volume of thin cylinders– Thin spherical shells, Thin cylinder with Hemispherical ends.

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

Applications: Pressure Vessels and Power Transmissions Elements

Text Books:

1. Strength of Materials by SS Rattan, McGraw Hill Education.
2. Mechanics of Materials by Dr. B.C. Punmia, Laxmi Publications.
3. Strength of Materials (Mechanics of Solids) by R.K. Rajput, S. Chand Publishing.
4. Strength of Materials by Dr. Sadhu Singh, Khanna. Publishers.
5. Strength of Materials by S. Ramamrutham, R. Narayanan , Dhanpat Rai Publishing Company (P) Ltd

Reference Books:

1. GH Ryder, Strength of materials, Palgrave Macmillan publishers India Ltd.
2. Gere & Timoshenko, Mechanics of materials, 2/e, CBS publications.
3. U.C. Jindal, Strength of Materials, 2/e, Pearson Education.
4. Timoshenko, Strength of Materials Part – I& II, 3/e, CBS Publishers.
5. Andrew Pytel and Ferdinand L. Singer, Strength of Materials, 4/e, Longman Pulications.
6. Popov, Mechanics of Solids, 2/e, New Pearson Education.

Subject Code	Subject Name	L	T	P	C
R23MEC-PC2102	Material Science & Metallurgy	3	0	0	3

Course Objective:

- To provide students with a solid foundation in the basic concepts of materials science, including atomic structure, bonding, and crystallography.
- To familiarize students with the principles of phase transformations and the use of phase diagrams in predicting the phases present in a material under different conditions.
- To enable students to understand and apply various heat treatment processes, including annealing, normalizing, hardening, tempering, and surface-hardening methods, to modify and enhance the properties of steel.
- To familiarize students with the structure and properties of various types of ferrous and nonferrous material.
- To introduce students to the basic principles and processes involved in powder metallurgy.

A Course Outcomes:

At the end of the course, the student will be able to

1. Identify the properties of metals with respect to crystal structure and grain size.
2. Apply the principles of constructing binary phase diagrams to predict phase behavior and microstructural changes in materials.
3. Select the appropriate heat treatment to get the desired properties of the steel component.
4. Compare ferrous and nonferrous materials, related to their properties and applications, for producing mechanical components for the given specification.
5. Select appropriate methods for producing metal powders based on specific applications.

UNIT– I

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

Application: Metal Casting, Metal Additive Manufacturing, Aerospace Industry.

UNIT–II

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-Fe_3C.

Application: Automotive Industry, Construction Industry.

UNIT–III

Heat treatment of Steels: Effect of alloying elements on Fe-Fe_3C system, annealing, normalizing, hardening, TTT diagrams, tempering, hardenability, surface - hardening methods, age hardening treatment, Cryogenic treatment.

Application: Cutting tools like drills and saw blades, aircraft landing gear, Automotive Industry

UNIT–IV

Ferrous metals and alloys: Structure and properties of White Cast iron, Malleable Cast iron,

grey cast iron, Spheriodal 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.

Nonferrous 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.

Application: Grinding balls, pipe fittings, engine blocks, cylinder heads, High-temperature turbine blades. cold headed fasteners and bolts

UNIT– V

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. Introduction to Nanomaterials and smart materials.

Application: Gears, bearings, and brake pads, turbine blades, dental materials

Text Books:

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

Reference Books:

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

Subject Code	Subject Name	L	T	P	C
R23MEC-PC2103	Mechanics of Solids & Material Science Lab	0	0	3	1.5

Course Objective: The objectives of the course are to

- 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.

Course Outcomes:

At the end of the course, the student will be able to

1. Find the Mechanical properties of materials through tension, compression, torsion, and hardness tests.
2. Compare the impact strength, hardness, and torsional strength of materials with various equipment.
3. Analyze the mechanical behaviour of springs, bricks by tension, compression tests.
4. Examine the microstructure of steels, cast irons, and non-ferrous alloys with Microscope.
5. Compare the Hardenability of Materials by conducting the Heat Treatment Processes.

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. Brick compression 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.

Virtual lab:

1. To investigate the principal stresses σa and σb 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).

Subject Code	Subject Name	L	T	P	C
R23MEC-PC2104	Computer-Aided Machine Drawing	0	0	3	1.5

Course Objectives

The objectives of the course are to

- Comprehend the standard symbols and representations used in technical drawings for various materials and machine components.
- Familiarize with thread profiles, riveted, welded and key joints
- Acquire Proficiency in Using CAD Software for 2D and 3D Modeling:
- Develop Detailed Manufacturing Drawings for Machine Parts for Industry requirements
- Create virtual models for solids and machine parts

Course Outcomes:

At the end of the course, the student will be able to

1. Interpret standard symbols and representations for various materials and machine components in technical drawings.
2. Construct models of riveted, welded, and key joints using computer-aided design (CAD) software.
3. Develop solid models and sectional views of machine components
4. Develop Assemble Machine Parts Using Solid Modeling software
5. Use CAD Software For Drawing 2-Dimensional machine Parts from The given 3-dimensional assemblies

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 (Fusion 360, CATIA, SolidWorks, Unigraphics etc.)

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, piston, connecting rod, eccentric, screw jack, plumber block, axle bearing, pipe vice, clamping device, 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.
2. Machine drawing by N.Sideshwar, P. Kannaiah, V.V.S.Sastry, TMH Publishers.

Reference Books:

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

Subject Code	Subject Name	L	T	P	C
R23CSE-SC2102	Python Programming Lab (Skill Oriented Course)	1	0	2	2

Course Objectives:

The main objectives of the course are to

- Introduce core programming concepts of Python programming language.
- Demonstrate about Python data structures like Lists, Tuples, Sets and dictionaries
- Implement Functions, Modules and Regular Expressions in Python Programming and to Create practical and contemporary applications using these.

Course Outcomes:

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

1. Implement and debug simple Python programs.
2. Implement Python programs with Conditionals and Loops and functions.
3. Implement Python Lists, Tuples and Dictionaries for representing compound data.
4. Interpret the concepts of Object-Oriented Programming as used in Python
5. 5.Appply the Module Concepts and Packages for Real Time Applications

UNTI-I:

History of Python Programming Language, Thrust Areas of Python, Installing Anaconda Python Distribution, Installing and Using Jupyter Notebook.

Parts of Python Programming Language: Dynamic and Strongly Typed Language, Identifiers, Keywords, Statements and Expressions, Variables, How to Running Python scripts, Basic Data Types, Indentation, Comments, Reading Input, Print Output, Operators, Type Conversions.

Sample Experiments:

1. Demonstrate the python script by running in Interactive and Script Mode.
2. Write a python script to read using input () and display using print () functions.
3. 3.Write a program to swap two numbers without using a temporary variable.
4. Write a Python Program to Convert Celsius To Fahrenheit
5. Write a Python program to compute area of triangle.
6. Write a program to calculate the circumference of the circle
7. Write a Python program to compute distance between two points in a 2-dimensional
8. Coordinate system.
9. Write a Python program that calculates number of seconds in a day
10. Write a python script to make use of all conversion functions.
11. Demonstrate the following Operators in Python with suitable examples. i) Arithmetic Operators ii) Relational Operators iii) Assignment Operators iv) Logical Operators v) Bit wise Operators vi) Membership Operators vii) Identity Operator.

UNIT-II:

Control Flow Statements: if statement, if-else statement, if...elif…else, Nested if statement, while Loop, for Loop, continue and break Statements.

Functions: Built-In Functions, Function Definition and Calling the function, return Statement and void Function, Scope and Lifetime of Variables, Default Parameters, Keyword Arguments, *args and **kwargs, Command Line Arguments. Anonymous Functions, Lambda, map, reduce and filter.

Sample Experiments:

1. Write a program to find the largest element among three Numbers.
2. Write a program to find the factorial of a given number
3. Write a Python program to find the given year is leap year or not
4. Write a Program to display all prime numbers within an interval
5. Write a python program to check whether given letter is vowels or not

6. 6.Write a python script to take five subject marks and print the grade for the student.
7. Program to check whether a person is eligible to vote or not
8. Write a Python program to calculate the sum of the first N natural numbers using a while loop. Take N as input from the user.
9. Write a program to take input as integer N and check whether N is Pronic Number or not. (Product of two consecutive numbers is pronic N(N+1): Eg 110 = 10*11)
10. 10.Write a python script to take input as amount in rupees R and find out the least number of notes N that can be possible to store in a Wallet. (Hint Notes: 2000,500,200,100,50,20,10) Eg: R=2589, N=5
11. Write a python script to implement map(), reduce() and filter() functions

UNIT-III

Strings & Data Structures: Strings**,** Lists, String and List Slicing, Tuple, Sets, Frozen Sets, Dictionaries, Comprehensions, Built-in methods of all sequences, File Handling: Reading and writing files, File modes and file objects

Sample Experiments:

1. Write a program to perform the given operations on a strings
   i) Creating the string ii) slicing the string iii) Delete character in the string
2. Write a program to perform the given operations on a list:
   i) Creating the list ii) slicing in the lists iii) Adding Elements in List iv) Deleting the list elements
3. Write a python script to take two string S1 and S2 and do the following:
   i)Check S1 and S2 are anagrams or not. ii) Check S1 is Sub string of S2 or not. iii)S1 is palindrome or not
4. Write a program to check if a given key exists in a dictionary or not.
5. Write a program to add a new key-value pair to an existing dictionary.
6. Write a program to take input as String S and print frequency of each character in S using List data structure.
7. Write a program to take input as String S contains characters and special symbols, reverse the String S such that special symbols remains at same position. (Eg. S=”m@d#u” , Output=”u@d#m”).
8. Write a python script to take input as String sentence S and print each word count using dictionary.
9. Write a program to sort words in a file and put them in another file. The output file should have only lower-case words, so any upper-case words from source must be lowered.
10. Python program to compute the number of characters, words and lines in a file.

UNIT-IV:

Object Oriented Programming OOP in Python: Classes, 'self- variable', Methods, Constructor, Inheritance, Polymorphism, and Data Abstraction.

Errors and Exceptions: Syntax Errors, Exceptions, Exception Handlers,

Sample Experiments:

1. Write program on create classes and objects.
2. Write a program on Default constructors, constructor with parameters
3. Write a program on class variables and instance variables.
4. Write a Python program to create a class that represents a shape. Include methods to calculate its area and perimeter. Implement subclasses for different shapes like circle, triangle, and square.
5. Write a Python program to create a person class. Include attributes like name, country and date of birth. Implement a method to determine the person's age.
6. Write a Python program to create a class representing a shopping cart. Include methods

for

7. adding and removing items, and calculating the total price.
8. Using Python OOPS, create a class, constructor, method, __str__ and __repr__ for
9. Employee, Student
10. Write a python program to implement Exceptions hierarchy.
11. Write a program to Catching Specific Exceptions in Python Python program to try with else clause.

UNIT-V

Modules: Creating modules, import statement, from import statement, random, Math, JSON, date, Request, RegEx. **Packages:** Introduction to PIP, Installing packages using PIP.
Introduction to Data Science: NumPy, Pandas,MatplotLib

1. Write a python script to take input as multi-line string and find the sum of all numbers in that string using re module. (Eg. S=”he11o they are 40students in97 room of 4th line” , Sum= 152)
2. Using RegEx object check whether given phone number, email address and password is valid or not.
3. Python program to check whether a JSON string contains complex object or not
4. Using date module, write a python script to take input as Date of birth (DOB) and current date(CD) and print age of the person.
5. Python Program to demonstrate NumPy arrays creation using array()function.
6. Python script to load data sets.
7. Write a python script to create a data frame.
8. Python program to demonstrate use of ndim, shape,size,dtype.
9. Using NumPy, implement different matrix operations in python.

APPLICATIONS:

- Web Application Development and Scraping
- Designing Games
- Machine Learning and AI based applications
- Embedded Systems and IoT Applications
- Data Science and Visualization
- Embedded and CAD Applications

Reference Books:

1. Gowri shankar S, VeenaA., Introduction to Python Programming, CRC Press.
2. Python Programming, S Sridhar, J Indumathi, V M Hariharan,2nd Edition, Pearson, 2024
3. Introduction to Programming Using Python, Y. Daniel Liang, Pearson.

Online Learning Resources/Virtual Labs:

1. https://www.coursera.org/learn/python-for-applied-data-scienceaihttps://www.coursera.org/learn/python?specialization=python#syllabus

Course Code	Course Name	L	T	P	Credits
R23BSH-MC2101	Environmental Science (Mandatory Course)	**2**	**0**	**0**	**0**

Course Objectives:

- To make the students to get awareness on environment.
- To understand the importance of protecting natural resources, ecosystems for futuregenerations and pollution causes due to the day-to-day activities of human life
- To save earth from the inventions by the engineers.

Course Outcomes:

1. Understand the significance of various natural resources, including renewable, non renewable water, minerals, forests and soil, in the environment and the problems associated with it in maintaining ecological balance and supporting human activities.
2. Apply strategies for mitigating different types of environmental pollution, managing solid waste effectively and adopt individual actions that contribute to pollution prevention and waste reduction.
3. Understand the structure, function, characteristic features of different kind of eco systems, value of biodiversity, threats to bio diversity and India's role and strategies in the conservation of biodiversity for sustainable development.
4. Apply the Air (Prevention and Control of Pollution) Act, Water (Prevention and Control of Pollution) Act, Wildlife Protection Act, and Forest Conservation Act to promote sustainable environmental development; Address related social issues and propose effective solutions, delving into the intersection of environmental policies and community welfare to achieve ultimate sustainability goals.
5. Identify the role of information technology in addressing population-related problems**,** focusing on resource management, environmental monitoring, urban planning, healthcare improvement, education to enhance sustainability and quality of life.

UNIT I

Multidisciplinary Nature of Environmental Studies: Definition, Scope and Importance – Need for Public Awareness.

Natural Resources: Renewable and non-renewable resources – Natural resources and associated problems – Forest resources – Use and over – exploitation, deforestation, case studies – Timber extraction – Mining, dams and other effects on forest and tribal people – Water resources – Use and over utilization of surface and ground water – Floods, drought, conflictsover water, dams – benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. – Energy resources:

UNIT II

Environmental Pollution: Definition, Cause, effects and control measures of:

a. Air Pollution.
b. Water pollution
c. Soil pollution
d. Marine pollution
e. Noise pollution
f. Thermal pollution

Solid Waste Management: Causes, effects and control measures of urban and industrial wastes – Role of an individual in prevention of pollution – Pollution case studies – Disaster management: floods, earthquake, cyclone, landslides and e-waste management.

UNIT III

Ecosystems: Concept of an ecosystem. – Structure and function of an ecosystem – Producers, consumers and decomposers – Energy flow in the ecosystem – Ecological succession – Food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the following ecosystem:

a. Forest ecosystem.
b. Grassland ecosystem
c. Desert ecosystem.
d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Biodiversity and its Conservation : Introduction: Definition: genetic, species and ecosystem diversity – Bio-geographical classification of India – Value of biodiversity: consumptive use, Productive use, social, ethical, aesthetic and option values – Biodiversity at global, National and local levels – India as a mega-diversity nation – Hot-spots of biodiversity – Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – Endangered and endemicspecies of India – Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

UNIT IV

Social Issues and the Environment: From Unsustainable to Sustainable development – Urban problems related to energy – Water conservation, rain water harvesting, watershed management Resettlement and rehabilitation of people; its problems and concerns. Case studies – **Environmental ethics:** Issues and possible solutions – Climate change- global warming, acid rain and ozone layer depletion. Case Studies – Wasteland reclamation. – Consumerism and waste products. – Environment Protection Act. – Air (Prevention and Control of Pollution) Act. – Water (Prevention and control of Pollution) Act – Wildlife Protection Act – Forest Conservation Act – Issues involved in enforcement of environmental legislation – Public awareness.

UNIT V

Human Population and the Environment: Population growth, variation among nations. Population explosion – Family Welfare Programmes – Environment and human health – Human Rights – Value Education – HIV/AIDS – Women and Child Welfare – Role of information Technology in Environment and human health – Case studies.

Field Work: Visit to a local area to document environmental assets River/forest grassland/hill/mountain – Visit to a local polluted site-Urban/Rural/Industrial/Agricultural Study of common plants, insects, and birds – river, hill slopes, etc.

Textbooks:

1. Textbook of Environmental Studies for Undergraduate Courses Erach Bharucha forUniversity Grants Commission, Universities Press
2. Palaniswamy, “Environmental Studies”, Pearson education.
3. S. Azeem Unnisa, “Environmental Studies” Academic Publishing Company.
4. K. Raghavan Nambiar, “Text book of Environmental Studies for Undergraduate Coursesas per UGC model syllabus”, Scitech Publications (India), Pvt. Ltd.

References:

1. Deeksha Dave and E.Sai Baba Reddy, “Textbook of Environmental Science”, CengagePublications
2. M. Anji Reddy, “Text book of Environmental Sciences and Technology”, B S Publication.
3. J. P. Sharma, Comprehensive Environmental studies, Laxmi publications.
4. J. Glynn Henry and Gary W. Heinke, “Environmental Sciences and Engineering”, Prentice Hall of India Private limited
5. G. R. Chatwal, “A Text Book of Environmental Studies” Himalaya Publishing House
6. Gilbert M. Masters and Wendell P. Ela, “Introduction to Environmental Engineering andScience, Prentice Hall of India Private limited.

II Year-II Semester

Course Code	Course Name	L	T	P	Credits
R23BSH-HM2202	Industrial Management	**2**	**0**	**0**	**2**

Course Objectives:

- Impart the concepts of managerial functions in manufacturing industries
- Understand principles of operations management from a general management perspective.
- Identify the strategies to control the materials in manufacturing industries
- Develop an understanding on quality control charts in manufacturing industries
- Apply the PERT/CPM techniques for better Project Management

Course Outcomes:

Understand the management functions and roles in manufacturing industries."

1. Explain heuristic methods for production systems, facility layouts, and work system design to enhance operational efficiency.
2. Identify material and purchase management functions, inventory control techniques JIT for resource optimization.
3. Develop quality management principles, control charts, acceptance sampling, and TQM
4. to improve product quality and reliability.
5. Apply PERT and CPM techniques to determine the critical path, estimate project completion, and optimize cost and duration for effective project management.

Unit I:

Managerial functions: Introduction to Management-Nature and importance of Management, Functions of Management in manufacturing industries, Principles of Management-Roles of Manager.

Application: Understand the core areas of management in manufacturing industries

Unit II:

Operations Management: Objectives- Types of production systems, characteristics, Make to order, Make to stock systems, facility layout – types, design of layouts-travel chart, CRAFT, assembly line balancing- exercise with heuristic method. Design of work system and work measurement

Application: Planning work stations for assembly lines, Layout preparation for job shops.

Unit III

Materials Management: Materials Management – Objectives of Material Management, Functions of Material Management, Functions of Purchase Management, Inventory Management : costs associated with inventory control, Economical Ordering Quantity, Infinite rate of replenishment model. Selective Inventory control methods , reorder level in inventory system, Just In Time System, Deming principles.

Application: Stores inventory management in manufacturing plants, Design the practical inventory control systems for cost optimization

Unit IV

Quality Management: Objectives, Inspection and Quality control, Variables - attributes, Shewart control chart for variables – Mean chart, Range chart – Attribute control charts, Acceptance Sampling- need for acceptance sampling, Single sampling plan, OC curve. Total Quality Management

Application: Quality management practices in manufacturing industries, Understand the

process capability for the manufacturing processes

Unit V

Project Management (PERT/CPM): Network Analysis, Programme Evaluation and Review Technique (PERT), Critical Path Method (CPM), identifying critical path, Probability of Completing the project within given time, Project Cost Analysis, Project Crashing

Application: Planning the time frame projects, Estimation of costs related to project planning

Text Books:

1. Industrial Engineering and management by O.P Khanna, Khanna Publishers.
2. Industrial Engineering and Production Management, Martand Telsang, S.Chand& Company Ltd. New Delhi.

Reference Books :

1. Management Science by Aryasri; Publisher: Tata McGraw Hill, 2009
2. Industrial Management by Bhattacharya DK, Vikas publishers
3. Production and *Operations Management*. R. *Panneerselvam,*. Prentice Hall India Pvt. Ltd

II Year - II Semester

Course code	Course Title	L	T	P	Credits
R23BSH-MA2202	Complex Variables and Statistical Methods	3	0	0	3

Course Objectives:

- To develop a solid understanding of fundamental mathematical concepts essential for engineering, including Complex variables and Statistical Methods.
- To provide students sufficient knowledge and skills enabling them to undertake further studies in engineering and its allied areas on multiple disciplines concerned with mathematics.
- To foster critical thinking and logical reasoning skills to approach and solve engineering challenges methodically.
- To develop teamwork skills by engaging in collaborative projects and group problem-solving activities, simulating real-world engineering environments.
- To encourage a mindset of continuous learning and adaptation, preparing students to stay current with evolving mathematical methods and engineering practices.
- To improve the ability to communicate mathematical ideas and solutions effectively in written and oral forms within the context of engineering.
- To enhance analytical and problem-solving abilities by applying mathematical methods to solve engineering problems.

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

1. Analyze various analytic functions using the Cauchy-Riemann equations
2. Apply various theorems of complex integration to solve engineering problems involving complex functions.
3. Analyze real-world engineering problems using the concepts of probability theory and statistical distributions in the process of assessment and decision-making under uncertainty.
4. Analyze data effectively to ensure accurate representation of populations in engineering studies and facilitate decision-making based on statistical inference using large sample tests.
5. Analyze data effectively to ensure accurate representation of populations in engineering studies and facilitate decision-making based on statistical inference using small sample tests.

UNIT I (8 Hours)

Complex Variables and Analytic Functions: Functions of a complex variable, continuity, differentiation, analytic functions, Cauchy-Riemann equations (without proof), Milne-Thompson method, harmonic functions, harmonic conjugate.

Applications: Flow problems

UNIT-II (10 Hours)

Complex Integration (All theorems without proofs): Contour integrals, Cauchy theorem, Cauchy integral formula, Taylor's series, Laurent's series, zeros of analytic functions, singularities, residues, and Cauchy residue theorem.

Applications: Evaluation of integrals of the type (a) Improper real integrals

$\int_0^{2\pi} f(\cos\theta, \sin\theta)\, d\theta$ (b) $\int_{-\infty}^{\infty} f(x)dx$ (c) $\int_{-\infty}^{\infty} e^{imx} f(x)dx$

UNIT III (10 Hours)

Probability Theory: Probability: Introduction, probability axioms, addition law and multiplicative law of probability, conditional probability, Baye's theorem.

Probability Distribution: Random variable concept, distribution function, density function, Binomial distribution, Poisson distribution, Normal (Gaussian) distribution.

Unit IV(10 Hours)

Estimation and Testing of Hypothesis: Introduction to Sampling, parameters, statistics, sampling distribution, point and interval estimation, formulation of null hypothesis, alternative hypothesis, the critical and acceptance regions, level of significance, two types of errors.

Large sample tests: Test for single proportion, difference of proportions, test for single mean and difference of means, confidence interval for parameters in one sample and two sample problems.

Unit V(10 Hours)

Small Sample Tests: Student t-distribution (single mean, two means and paired t-test), testing of equality of variances (F-test), χ^2 - test for single variance, χ^2 - test for goodness of fit, ANOVA(1-way).

Text Books:

1. B. S. Grewal, Higher Engineering Mathematics, 45th edition, Khanna publishers, 2023.
2. Veerarajan T., Probability, Statistics and Random Processes, 3rd edition, Tata McGraw-Hill, New Delhi, 2008.

References:

1. Erwin kreyszig, Advanced Engineering Mathematics, 10/e, John Wiley & Sons, 2011.
2. J. W. Brown and R. V. Churchill, Complex Variables and Applications, 7/e, Mc-Graw Hill, 2004.
3. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, 2008.
4. Murray R. Spiegel,SeymourLipschutz, John J. Schiller , Dennis Spellman, Schaum's Outline of Complex Variables, 2ed (Schaum's Outlines) 2nd Edition.
5. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers, Keying E. Ye, Probability and Statistics for Engineers and Scientists, 9th Edition, Pearson.
6. Miller and Freunds, Probability and Statistics for Engineers, 7/e, Pearson, 2008.
7. S. C. Guptha and V. K. Kapoor, Fundamentals of Mathematical Statistics, 11/e, SultanChand and Sons Publications, 2012.

Subject Code	Subject Name	L	T	P	C
R23MEC-PC2201	Manufacturing Processes	3	0	0	3

Course Objective:

- Explore the real-world applications of manufacturing technologies across various industries, including automotive, aerospace, healthcare, and consumer goods
- Demonstrate knowledge of manufacturing techniques and identify appropriate methods for different applications.
- Develop a mind-set of continuous learning and adaptation to technological advancements and evolving industry trends in manufacturing.
- Cultivate problem-solving skills and encourage innovation in addressing production challenges and improving manufacturing processes.
- Develop skills in selecting, setting up, and operating tools and equipment used in different manufacturing processes.

Course Outcomes:

At the end of the course, the student will be able to

1. Identify the most suitable casting process based on the material, complexity and application of the specified mechanical component.
2. Select the most appropriate welding technique for the given engineering tasks, material type, joint configuration and required weld quality.
3. Apply the principles of metal forming processes, including hot and cold working, forging, rolling, extrusion, wire drawing, and tube drawing, to optimize material properties and manufacturing efficiency in industrial applications.
4. Demonstrate comprehensive understanding in sheet metal forming processes, including blanking, piercing, deep drawing, stretch forming, bending, spring back management, coining, spinning, and press working operations to manufacture complex and precise components.
5. Classify additive manufacturing processes based on their operational principles, considering mechanical properties, compatibility and specific requirements.

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, 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.

Applications: Components in Automobiles, Components for Plumbing Works

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.

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.

Applications: House Hold Furniture, Ship Building

UNIT–III

Bulk Forming.

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.

Applications: Production of Tubes and Hollow pipes, Frames

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.

Applications: Ducts for Air Conditioning systems, Panels for Electronics Devices, Parts for Washing Machine and Refrigerators.

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

Applications: Prototype for Automobile Components, Parts for Aerospace Applications, Custom Prosthetics Design in Medical Industry.

Textbooks:

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

Reference Books:

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

Subject Code	Subject Name	L	T	P	C
R23MEC-PC2202	Fluid Mechanics & Hydraulic Machines	3	0	0	3

Course Objectives: The students completing this course are expected to

- Analyze the critical physical properties of fluids and the principles of fluid statics to design and optimize sustainable marine and underwater structures.
- Synthesize fluid kinematics and dynamics principles to innovate and enhance water distribution systems for urban sustainability.
- Develop strategies for managing boundary layer effects in transportation systems to improve fuel efficiency and reduce emissions.
- Integrate the principles of turbo machinery with sustainable energy practices to improve the design and performance of hydraulic turbines and renewable energy systems.
- Critically assess the operational performance of hydraulic machinery to innovate in the design of environmentally friendly irrigation and water management systems.

Course Outcomes:

At the end of the course, the student will be able to

1. Apply fluid statics principles to determine pressure, buoyancy, and stability of submerged and floating bodies.
2. Analyze different types of fluid flow using continuity, Bernoulli's, and momentum equations.
3. Apply boundary layer concepts and dimensional analysis to fluid mechanics problems.
4. Analyze hydrodynamic forces on surfaces and the performance of hydraulic turbines.
5. Analyze the efficiency, cavitation effects, and specific speed of hydraulic turbines and pumps.

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.

Applications: Marine Ship Design**,** Pressure Measurement in Industrial Devices

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, flow net.

Fluid dynamics: surface and body forces –Euler's and Bernoulli's equations for flow along a stream line, 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.

Applications: Automotive Aerodynamics and Design, Design and Analysis of Turbomachinery, Wind Turbine Aerodynamics

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 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.

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.

Applications: Municipal Water Supply and Treatment Systems, Hydropower Plant Operations and Management, Industrial Fluid Handling Systems

Text Books:

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

Reference Books:

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

Online Learning Resources:

- https://archive.nptel.ac.in/courses/112/105/112105206/
- https://archive.nptel.ac.in/courses/112/104/112104118/
- https://onlinecourses.nptel.ac.in/noc20_ce30/previewnptel.ac.in

Subject Code	Subject Name	L	T	P	C
R23MEC-PC2203	Kinematics of Machinery	3	0	0	3

Course Objectives: The students completing this course are expected to

- Analyze the motion of various linkages using graphical and analytical methods.
- Apply the kinematic principles to solve real-world engineering problems in various industries, including automotive, aerospace, and manufacturing.
- Design cam profiles for specific follower motions using displacement diagrams.
- Analyze the kinematics of gears and gear trains, including spur gears, bevel gears, and planetary gear systems.

Course outcomes:

After completion of this unit, students will be able to

1. Design the complex mechanical systems from the fundamental principles of kinematics and dynamics of machines.
2. Apply the knowledge of various mechanical linkages and steering gear mechanisms in practical engineering scenarios.
3. Apply the relative velocity method for four-bar chains and other common mechanisms, the theories involved in cams, applications of cams and their working principles.
4. Design of gears, power transmission through different types of gears and gear trains.
5. Apply theoretical and practical knowledge to design efficient and effective belt drive systems.

UNIT –I

MECHANISMS: Elements or Links – Classification – Rigid Link, flexible and fluid link – Types of kinematic pairs – sliding, turning, rolling, screw and spherical pairs – lower and higher pairs – closed and open pairs – constrained motion – completely, partially or successfully constrained and incompletely constrained. Grublers criteria, Grashoff's law, Degrees of freedom, Kutzbach criterion for planar mechanisms, Mechanism and machines – classification of machines – kinematic chain – inversion of mechanism – inversions of quadric cycle chain – single and double slider crank chains.

Applications: IC Engines, Lathe Machines.

UNIT –II

LOWER PAIR MECHANISM: Exact and approximate copiers and generated types – Peaucellier, Hart and Scott Russul – Grasshopper – Watt T. Chebicheff and Robert Mechanisms and straight line motion, Pantograph. Conditions for correct steering – Davis Steering gear, Ackermans steering gear – velocity ratio; Hooke's Joint: Single and double – Universal coupling– application–problems.

Applications: Locomotives, Four-Wheeler Steering gear Mechanisms

UNIT –III

KINEMATICS: Velocity and acceleration – Motion of a link in machine – Determination of Velocity and acceleration diagrams – Graphical method – Application of relative velocity method four bar chain. Velocity and acceleration analysis of a given mechanism, Plane motion of body: Instantaneous center of rotation, centrode and axode – Three centers in line theorem – Graphical determination of instantaneous centre, diagrams for simple mechanisms and determination of angular velocity of points and links.

CAMS Definitions of cam and followers – their uses – Types of followers and cams – Terminology –Types of follower motion: Uniform velocity, Simple harmonic motion and uniform acceleration and retardation. Maximum velocity and maximum acceleration during outward and return strokes in the above 3 cases.

Applications: IC Engine Valves, Reciprocating Steam Engines

UNIT –IV

GEARS: Higher pairs, friction wheels and toothed gears–types – law of gearing, condition for constant velocity ratio for transmission of motion, Form of teeth: cycloidal and involute profiles. Velocity of sliding – Basic concepts of interference, Condition for minimum number of teeth to avoid interference, expressions for arc of contact and path of contact.

GEAR TRAINS: Introduction to gear Trains, Train value, Types – Simple and reverted gear train – Epicyclicgear Train. Methods of finding train value or velocity ratio – Epicyclic gear trains.

Applications: Transmission Systems in Automobile

UNIT –V

Belt and Rope Drives: Introduction, Belt and rope drives, selection of belt drive- Types of belt drives, V-belts, materials used for belt and rope drives, velocity ratio of belt drives, slip of belt, creep of belt, tensions for flat belt drive, angle of contact, centrifugal tension, maximum tension of belt.

Applications: Air Compressors, Lathe Machine, Flour Mills

Text Books:

1. Theory of Machines / S.S Rattan/ Mc. Graw Hill Publ.
2. Theory of machines / Khurmi / S.Chand.
3. Theory of machines and Mechanisms – J. J Uicker, G.R.Pennock & J.E. Shigley - Oxfordpublishers.

References:

1. Theory of Machines Sadhu Singh Pearsons Edn
2. Theory of Machines / Shigley / MGH 3. Machine Drawing – Rajput
3. Kinematics of Machinery through Hyper Works – J.S. Rao – Springer Publ.

Subject Code	Subject Name	L	T	P	C
R23MEC-PC2204	Fluid Mechanics & Hydraulic Machinery Lab	0	0	3	1.5

Course Objective:

The students completing this course are expected to

- Apply principles of fluid mechanics to investigate the impact of jets on vanes and conduct experiments effectively.
- Evaluate the performance characteristics of Pelton, Francis, and centrifugal pumps through standardized tests to analyze their efficiency and operational parameters.
- Demonstrate proficiency in conducting performance tests on hydraulic machines like reciprocating pumps, interpreting results to optimize their operational efficiency.
- Analyze the accuracy of flow measurement devices such as Venturimeter and Orifice meter through calibration experiments, ensuring reliable data collection.
- Interpret experimental data to determine friction factors and head losses in pipelines, applying dimensional analysis and theoretical principles.

Course Outcomes:

At the end of the course, the student will be able to

1. Apply the principles of impact of jets to determine forces on stationary and moving vanes.
2. Analyze the performance of Pelton wheel and Franci's turbines under varying load conditions.
3. Apply experimental methods to determine the efficiency of centrifugal and reciprocating pumps.
4. Analyze flow measurement techniques by calibrating Venturimeters and Orifice meters.
5. Apply fundamental concepts of pipe flow to determine friction factor and head loss due to sudden contraction.

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 Single Stage Centrifugal Pump.
5. Performance Test on Multi Stage Centrifugal Pump.
6. Performance Test on Reciprocating Pump.
7. Calibration of Venturimeter.
8. Calibration of Orifice meter.
9. Determination of friction factor for a given pipeline.
10. Determination of loss of head due to sudden contraction in a pipeline.

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 venture meter. (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).

Subject Code	Subject Name	L	T	P	C
R23MEC-PC2205	Manufacturing Processes Lab	0	0	3	1.5

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

Course Outcomes:

At the end of the course, the student will be able to

1. Demonstrate pattern preparation and production of casting with sand casting technique.
2. Demonstrate metal forming operations for shaping materials.
3. Perform arc welding, gas welding and brazing operations for joining metals.
4. Make the engineering parts with given specifications using 3D printing techniques.
5. Identify suitable manufacturing processes for producing components with different materials.

List of Experiments

1. Design and making of pattern
    a. Single piece pattern
    b. Split pattern
2. Mould preparation
    a. Straight pipe
    b. Bent pipe
    c. Dumble
3. Gas cutting and welding
4. Manual metal arc welding
    a. Lap joint
    b. Butt joint
5. Injection Molding
6. Blow Molding
7. Simple models using sheet metal operations
8. Study of deep drawing /extrusion operations
9. To make weldments using TIG/MIG welding
10. To weld using Spot welding machine
11. To join using Brazing and Soldering
12. To make simple parts on a 3D printing machine
13. 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)
4. (https://3dpdei.vlabs.ac.in/exp/simulation-modelling-process)
5. https://altair.com/inspire-mold/
6. https://virtual-labs.github.io/exp-simulation-cartesian-system-dei/theory.html

Subject Code	Subject Name	L	T	P	C
R23BSH-SC2101	English for Employability Skills (Skill Oriented Course)	0	1	2	2

Course Objectives

- Aims to help learners develop their English language skills, particularly those planning to appear for Competitive Exams that test their English Language abilities.
- Gains the power of expression through rich Vocabulary.
- Imparts critical reading strategies for comprehension of complex texts.
- Provides training and opportunities to develop fluency in English through participation in formal group discussions and Self Introductions.
- Demonstrates good writing skills for effective Paragraph Writing, Essay Writing and formal correspondence through emails.
- Encourages the use of a wide range of grammatical structures, Phrases, Clauses and Idioms in speech and writing.

Course Outcomes

1. Enable students to identify Parts of Speech and use them flawlessly, write Emails in formal correspondence effectively, participate confidently by introducing oneself in any formal discussion.
2. Attain Language Proficiency & Accuracy through Contextualized Vocabulary, Verb forms, Tense and subject-verb agreement, produce coherent expressions for professional writing, and introduce themselves unhesitatingly with Task-Based Activities.
3. Develop the fluency and accuracy to write Technical Reports and Emails for professional communication by using appropriate vocabulary and participating confidently in formal discussions.
4. Assimilate lifelong reading habits to comprehend a passage for its gist. Avoid errors in both Speech & Writing and write Letters and Emails for official communication. Realise the technical communicative competence and attainment of grammatically correct structures for formal communication.

Unit I

Vocabulary: How to talk about actions. **Grammar: U**sing and Identifying Parts of Speech accurately**. Writing:** Paragraph Writing and formal correspondence through Emails**. Speaking:** Background to Group discussions & Self-introductions.

Unit II

Vocabulary: How to talk about various speech habits. **Grammar**: Learning Verb forms, Tenses and Subject-verb agreement and using them accurately in both Speaking and Writing contexts. **Writing :** Essay Writing and formal correspondence through Emails. **Speaking:** Four major areas -Subject Knowledge, Oral Communication Skills, Leadership Skills and Team Management-of GD;Real time GDs for Evaluation.

Unit III

Vocabulary: How to insult your enemies**. Grammar:** Sentence Analysis & Synthesis - Voice, Degrees of Comparison, Reported Speech and Types & Forms of sentences. **Writing:** Report writing and Emails for formal correspondence**. Speaking:** Roles in structured GDs; real-time GDs for practising the above roles.

Unit IV

Vocabulary: How to flatter your friends**. Grammar**: Common errors and Correction of Sentences **Reading:** Reading Comprehension passages through Skimming and Scanning and understanding the gist or the specific purpose of them. **Writing:** Letter writing and Emails. **Speaking:** Advantages of GDs for hiring process; real time GDs for evaluating.

Unit V

Vocabulary & Grammar: High-frequency words for all competitive exams, Clause, Phrase & Idioms**. Reading:** Reading for Comprehending **Writing:** Business Letters and Emails **Speaking:** Group Discussions for Evaluation

Reference Books

1. Bailey, Stephen. *Academic writing: A handbook for international students*. Routledge, 2014.
2. Chase, Becky Tarver. *Pathways: Listening, Speaking and Critical Thinking.* Heinley ELT; 2nd Edition, 2018.
3. Skilful Level 2 Reading & Writing Student's Book Pack (B1) Macmillan Educational.
4. Hewings, Martin. *Cambridge Academic English (B2)*. CUP, 2012. (Student Book, Teacher Resource Book, CD & DVD)
5. Word Power Made Easy by Norman Lewis

ASSESSMENT

The learners will demonstrate their knowledge and abilities through completion of the following required assessments while or at the end of this course. —2 Quizzes, 1 Professional Certificate, 3 Activities on LSRW skills.

Quiz: Quiz is conducted on Grammar & Vocabulary. Each Quiz consists of 50 questions and will be scaled down to 5 Marks. Two quizzes are conducted. One after the 3rd unit, the other, after the last unit. The duration of any quiz is 1hr 30 Min only. These Quizzes are Computer Based Tests (CBT)

Professional Certificate: An International Language Assessment Certificate secured on B1 of the Common European Framework for Reference (CEFR) scale.

Activities on LSRW skills:

Interviews: The candidate has to interview one celebrity of his/her own choice.

The recorded 5-7 min video of the candidate should be uploaded on the ELCS LABLendi Youtube Channel with the help of the concerned English Teacher

The Evaluation Parameters:

- Quality of the Questionnaire(3M)
- Body Language & Confidence of the candidate(5M)
- Youtube likes & Comments(2M)

E-mails:

Each student is required to submit 5 independently written Emails during the course. Specific requirements for each one are accessed on the following Link:
https://docs.google.com/document/d/1IXuzjjmfiOLI23t8xlbLwNefRzIIXi9aOi3XkSHIK_Q/edit?usp=sharing

Listen to Speak:

Students are expected to watch and listen to any one of the 10 given educational video and audio clips to express their point of view. After watching, they will have the opportunity to share their points of view about some of the everyday issues that they can relate to. They have to explain and justify their reasoning to a team of three peers to explore their verbal expressions and their points of view before an External Examiner.

The following is the link to access those clippings:
https://docs.google.com/document/d/1tFuQ_43AVAHKJGVs9AeOODHJTnQMoydqcodSgENaZ3o/edit?usp=drivesdk

Details of Peer Evaluation & Assessment Parameters are available on the following Link:
https://docs.google.com/document/d/16l_PUzaOONnjpvMYVzE3XAYUBNhqMK9PbdDOPGIef_8/edit?usp=sharing

Grading:

Assessment Model	Points

Quiz-1	**20**
Quiz-2	**20**
Professional Certificate with B1 or above or Activity of Interview	**20**
E-Mails	**20**
Listen to the Speak Activity	**20**
Total	**100**

Pass Criterion:

1. The student has to Secure 40 Marks to pass this examination
2. A student with a certificate of any International standard of English has to secure a Minimum of 30 Marks in this examination (Certificate+30 Marks) to pass the summative exam.
3. A student who does not have an English Proficiency Certificate has to clear the exam with 40 marks mandatorily.
4. Clearing all categories is mandatory. One needs to get 60% of each category.

Subject Code	Subject Name	L	T	P	C
R23MEC-ES2201	Design Thinking & Innovation	1	0	2	2

Course Objectives:

- To develop innovative strategies that better connect engineers with their end users
- To build mindset leading to flow of creative ideas, validating those ideas and prioritizing the best ones
- To incorporate tools that designers need to take a design project from inspiration and insights to ideation and implementation
- To instill full scope of organizational innovation and strategy through knowledge, insight and analytical skills
- Develop the students as a good designer by imparting creative and Conceptual skills

Course outcomes

Upon successful completion of the course the student will able to

1. Develop mind maps, empathy maps and journey maps for the design thinking process.
2. Develop mock-up models through ideation and innovation techniques.
3. Evaluate diverse methods employed in design thinking and establish a workable design thinking framework to use in their practices.
4. Analyze the methodology and present ideas clearly and coherently to specific audience in both the written and oral forms.
5. Create fabricated / virtual prototype model.

UNIT - I

Introduction To Design Thinking: Design Thinking, Need of design thinking, Seven characteristics of design thinking, comparison of design thinking to other ways of thinking, tools and resources, Five actions phases of Design thinking, Difference between engineering design and design thinking. Double Diamond Technique for Design thinking. Problem statement. Design principles.

Practical stage1:

Activities (Internal Assessment):

1. Case studies of General, engineering and service applications
2. Identify an opportunity and scope of the project and prepare the problem statement.

UNIT – II

Empathize Phases: Design Thinking Tools: Empathize -Methods of Empathize Phase: Ask 5x why, 5W+H questions, Stakeholder map, Emotional response cards, Empathy map, Peer observation, Trend analysis

Practical stage2:

Activities (Internal Assessment):

1. Apply the methods of empathize using empathy tools and summarize finding related to your problem for define phase.
2. Finalize the problem statement

UNIT – III

Define point of view & Ideate Phase: Design Thinking Tools: Define point of view : Context mapping, Vision cone, Critical items diagram

Ideate: Brainstorming, 2x2 Matrix, Dot voting, 6-3-5 Method, Special brainstorming, Analogies & benchmarking as inspiration.

Practical stage3:

Activities(Internal Assessment):

1.. Apply the define tools to the problem: Finalize the problem statement

2. Apply the ideate tools to your problem: Generate lots of Ideas

3. Iterate the process at any stage if required

UNIT – IV

Prototyping Phase: Methods and Tools: Prototypes, Critical Experience Prototype (CEP) & Critical Function Prototype (CFP), Dark horse prototype, Funky prototype, Vision prototype, functional (system) prototype, Solutions in detail - "X is finished", Final prototype, Exploration map, Prototype to test

Practical stage4:

Activities (Internal Assessment):

1. Create prototype for best idea to the problem using any prototype method.
2. Iterate the process at any stage if required

UNIT - V

Test Phase: Methods and Tools & Implementation: Test Phase: Methods and Tools Testing sheet, Feedback capture grid, Structured usability testing, A/B Testing

Implementation: Road map for implementation, Problem to growth & scale innovation funnel.

Practical stage5:

Activities (Internal Assessment):

1. Test the developed prototype by test phase tools and finalize the solution to the problem.
2. Iterate the process at any stage if required
3. Prepare the complete project report

Text Books

1. Idris Mootee, "Design Thinking for Strategic Innovation", John Wiley & Sons
2. "Change by design", Tim Brown, Harper Collins

Reference Books:

1. Michael Lewrick, Patrick Link, Larry Leifer, *The Design Thinking Toolbox*, John Wiley & Sons.
2. Michael Lewrick, Patrick Link, Larry Leifer, *The Design Thinking Playbook*, John Wiley& Sons.
3. Kristin Fontichiaro, *Design Thinking*, Cherry Lake Publishing, USA,
4. Walter Brenner, Falk Uebernickel, *Design Thinking for Innovation-Research and Practice*, Springer Series.
5. Gavin Ambrose, Paul Harris, *Design Thinking*, AVA Publishing
6. Muhammad Mashhood Alam, *Transforming an Idea into Business with Design Thinking*, First Edition, Taylor and Francis Group

Web References:

1. https://designthinking.ideo.com/
2. https://thinkibility.com/2018/12/01/engineering-vs-design-thinking/
3. https://www.coursera.org/learn/design-thinking-innovation
4. https://www.interaction-desiqn.ora/literature/topics/desiqn-thinking
5. https://www.interaction-desiqn.prq/literature/article/how-tq-<eve'op-an-empath\capproach-in-design- thinking
6. https://onlinecourses.nptel.ac.in/noc20_mg38/preview