

**SHADAN COLLEGE OF ENGINEERING and TECHNOLOGY**  
**B.Tech. in MECHANICAL ENGINEERING**  
**COURSE STRUCTURE and SYLLABUS (R23Regulations)**  
**Applicable from AY: 2023-24 Batch**

**II YEAR I SEMESTER**

S. No.	Course Code	Course Title	L	T	P	Credits
1.	MA301BS	Probability and Statistics	3	1	0	4
2.	ME302PC	Mechanics of Solids	3	0	0	3
3.	ME303PC	Metallurgy and Material Science	3	0	0	3
4.	ME304PC	Production Technology	3	0	0	3
5.	ME305PC	Thermodynamics	3	1	0	4
6.	ME306PC	Production Technology Laboratory	0	0	2	1
7.	ME307PC	Material Science and Mechanics of Solids Laboratory	0	0	2	1
8.	ME308PC	Computer-Aided Machine Drawing	0	0	2	1
9.	*MC309	Constitution of India	3	0	0	0
		<b>Total Credits</b>	<b>18</b>	<b>2</b>	<b>6</b>	<b>20</b>

**II YEAR II SEMESTER**

S. No.	Course Code	Course Title	L	T	P	Credits
1.	ME401PC	Basic Electrical and Electronics Engineering	3	0	0	3
2.	ME402PC	Kinematics of Machinery	3	0	0	3
3.	ME403PC	Fluid Mechanics and Hydraulic Machines	3	0	0	3
4.	ME404PC	IC Engines and Gas Turbines	3	0	0	3
5.	ME405PC	Instrumentation and Control Systems	3	0	0	3
6.	ME406PC	Basic Electrical and Electronics Engineering Laboratory	0	0	2	1
7.	ME407PC	Fluid Mechanics and Hydraulic Machines Laboratory	0	0	2	1
8.	ME408PC	Instrumentation and Control Systems Laboratory	0	0	2	1
9.	ME409PC	Real-time Research Project/ Field-Based Project	0	0	4	2
10.	*MC410	Gender Sensitization Lab	0	0	2	0
		<b>Total Credits</b>	<b>15</b>	<b>0</b>	<b>12</b>	<b>20</b>

**III YEAR I SEMESTER**

S. No.	Course Code	Course Title	L	T	P	Credits
1.	ME501PC	Dynamics of Machinery	3	0	0	3
2.	ME502PC	Design of Machine Elements-I	3	0	0	3
3.	ME503PC	Metrology and Machine Tools	3	0	0	3
4.	SM504MS	Business Economics and Financial Analysis	3	0	0	3
5.	ME506PC	CAD/CAM	3	0	0	3
6.	ME507PC	Thermal Engineering Laboratory	0	0	4	2
7.	ME508PC	Metrology and Machine Tools Laboratory	0	0	3	1.5
8.	ME509PC	Kinematics and Dynamics Machinery Laboratory	0	0	3	1.5
9.	*MC510	Intellectual Property Rights	3	0	0	0
		<b>Total Credits</b>	<b>20</b>	<b>0</b>	<b>6</b>	<b>20</b>

**III YEAR II SEMESTER**

S. No	Course Code	Course Title	L	T	P	Credits
1.	ME601PC	Design of Machine Elements II	3	0	0	3
2.	ME602PC	Heat Transfer	3	0	0	3
3.	ME603PC	Finite Element Methods	3	0	0	3
4.		Professional Elective - I	3	0	0	3
5.		Open Elective - I	3	0	0	3
6.	ME604PC	Heat Transfer Lab	0	0	2	1
7.	ME605PC	Computer-Aided Engineering Laboratory	0	0	2	1
8.	EN606HS	Advanced English Communication Skills Laboratory	0	0	2	1
9.	ME607PC	Industry-Oriented Mini Project/ Internship	0	0	4	2
10.	*MC609	Environmental Science	3	0	0	0
		<b>Total Credits</b>	<b>18</b>	<b>0</b>	<b>10</b>	<b>20</b>

**Environmental Science in III Yr II Sem Should be Registered by Lateral Entry Students Only.**

**IV YEAR I SEMESTER**

S. No.	Course Code	Course Title	L	T	P	Credits
1.	ME701PC	Industrial Management	2	0	0	2
2.	ME702PC	Refrigeration and Air Conditioning	3	0	0	3
3.		Professional Elective – II	3	0	0	3
4.		Professional Elective – III	3	0	0	3
5.		Professional Elective - IV	3	0	0	3
6.		Open Elective - II	3	0	0	3
7.	ME703PC	Project Stage - I	0	0	6	3
		<b>Total Credits</b>	<b>17</b>	<b>0</b>	<b>6</b>	<b>20</b>

**IV YEAR II SEMESTER**

S. No.	Course Code	Course Title	L	T	P	Credits
1.		Professional Elective – V	3	0	0	3
2.		Professional Elective - VI	3	0	0	3
3.		Open Elective - III	3	0	0	3
4.	ME801PC	Project Stage – II including seminar	0	0	22	11
		<b>Total Credits</b>	<b>9</b>	<b>0</b>	<b>22</b>	<b>20</b>

**\*MC – Satisfactory/Unsatisfactory**

**PROFESSIONAL ELECTIVES OFFERED IN R23****Professional Elective – I**

ME611PE	Unconventional Machining Processes
ME612PE	Production Planning and Control
ME613PE	Operations Research
ME614PE	Microprocessors in Automation

**Professional Elective – II**

ME721PE	Additive Manufacturing
ME722PE	Automation in Manufacturing
ME723PE	Artificial Intelligence in Mechanical Engineering
ME724PE	Mechatronics

**Professional Elective – III**

ME731PE	Power plant Engineering
ME732PE	Automobile Engineering
ME733PE	Non-Conventional Energy Sources
ME734PE	Solar Energy Technology

**Professional Elective – IV**

ME741PE	Re-Engineering
ME742PE	Computational Fluid Dynamics
ME743PE	Turbo Machinery
ME744PE	Fluid Power System

**Professional Elective – V**

ME851PE	Industrial Robotics
ME852PE	Mechanical Vibrations
ME853PE	Composite Materials
ME854PE	Energy Conservation and Management

**Professional Elective – VI**

ME861PE	Industry 4.0
ME862PE	Fuzzy Logic and ANN
ME863PE	Electric and Hybrid Vehicles
ME864PE	Total Quality Management

**Open Elective – I**

ME611OE	BASIC MECHANICAL ENGINEERING
ME612OE	RENEWABLE ENERGY SOURCES

**Open Elective – II**

ME721OE	QUANTITATIVE ANALYSIS FOR BUSINESS DECISIONS
ME722OE	INDUSTRIAL ENGINEERING and MANAGEMENT

**Open Elective – III**

ME831OE	ENTREPRENEURSHIP DEVELOPMENT
ME832OE	ELEMENTS OF ELECTRIC AND HYBRID VEHICLES

**MA301BS: PROBABILITY AND STATISTICS****B.Tech. II Year I Sem.**

L	T	P	C
3	1	0	4

**Pre-requisites:** Mathematics courses in the first year of study.**Course Objectives:** To learn

- The Theory of Probability, and probability distributions of single and multiple random variables
- The sampling theory and testing of hypothesis and making statistical inferences

**Course outcomes:** After learning the contents of this paper the student must be able to

- Apply the concepts of probability and distributions to some case studies.
- Correlate the concepts of one unit to the concepts in other units.

**UNIT - I: Probability****8 L**

Sample Space, Events, Counting Sample Points, Probability of an Event, Additive Rules, Conditional Probability, Independence, and the Product Rule, Baye's Rule.

**Random Variables and Probability Distributions:** Concept of a Random Variable, Discrete Probability Distributions, Continuous Probability Distributions.

**UNIT - II: Expectation and discrete distributions****10 L**

Mean of a Random Variable, Variance and Covariance of Random Variables, Means and Variances of Linear Combinations of Random Variables, Chebyshev's Theorem.

**Discrete Probability Distributions:** Binomial Distribution, Poisson distribution

**UNIT - III: Continuous Distributions and Sampling****10 L**

Uniform Distribution, Normal Distribution, Areas under the Normal Curve, Applications of the Normal Distribution, Normal Approximation to the Binomial Distributions.

**Fundamental Sampling Distributions:** Random Sampling, Some Important Statistics, Sampling Distributions, Sampling Distribution of Means and the Central Limit Theorem, t –Distribution, F-Distribution.

**UNIT - IV: Estimation & Tests of Hypotheses****10 L**

Introduction, Statistical Inference, Classical Methods of Estimation, Single Sample: Estimating the mean, standard error of a point estimate, prediction interval. Two sample: Estimating the difference between two means, Single sample: Estimating a proportion, Two samples: Estimating the difference between two proportions, Two samples: Estimating the ratio of two variances.

**Statistical Hypotheses:** General Concepts, Testing a Statistical Hypothesis, Single sample: Tests concerning a single mean, Two samples: tests on two means, One sample: test on a single proportion. Two samples: tests on two proportions, Two- sample tests concerning variances.

**UNIT - V: Applied Statistics****10 L**

Curve fitting by the method of least squares, fitting of straight lines, second-degree parabolas, and more general curves.

**TEXTBOOKS:**

1. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers, Keying Ye, Probability & Statistics for Engineers & Scientists, 9th Ed. Pearson Publishers.
2. S C Gupta and V K Kapoor, Fundamentals of Mathematical statistics, Khanna publications.

**REFERENCE BOOKS:**

1. T. T. Soong, Fundamentals of Probability and Statistics for Engineers, John Wiley & Sons, Ltd, 2004.
2. Sheldon M Ross, Probability and Statistics for Engineers and Scientists, academic press.

**ME302PC: MECHANICS OF SOLIDS****B.Tech. II Year I Sem.**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**Course 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 the 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 it 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:**

**Simple Stresses and Strains:** Elasticity and plasticity – Types of stresses and strains–Hooke's law–stress-strain diagram for mild steel – Working stress – Factor of safety – Lateral strain, Poisson's ratio, and volumetric strain – Elastic moduli and the relationship between them – Bars of varying section – composite bars – Temperature stresses. Strain energy – Resilience – Gradual, sudden, impact 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:**

**Theory of simple bending:** Assumptions – Derivation of the 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 sections.

**Shearing Stresses in Beams:** Introduction, Shearing Stress at a Section in a Loaded Beam, Distribution of Shearing Stress over a Rectangular, Triangular, Circular, I and T Section.

**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.

**TEXTBOOKS:**

1. Barry J. Goodno and James M. Gere, "Mechanics of Materials" Ninth Edition, Cengage Learning, 2018.
2. R. S. KHURMI, "Strength of Materials", Second Edition S. CHANDS & COMPANY Pvt. Ltd, New Delhi, 2008.
3. S. S. Rattan, "Strength of Materials", Second Edition Tata McGraw Hill Education Pvt. Ltd, New Delhi, 2011

**REFERENCE BOOKS:**

1. U. C. Jindal, "Strength of Materials", Pearson Education India, 2012
2. Egor P. Popov, Toader A. Balan, "Engineering Mechanics of Solids", PHI Learning, 2010
3. G. H. Ryder, "Strength of Materials", Macmillan Long Man Publications, 1961
4. W. A. Nash and M. C. Potter, "Strength of Materials", Fifth Edition, Schaum's Outline Series, 2011

**ME303PC: METALLURGY and MATERIAL SCIENCE****B.Tech. II Year I Sem.**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**Course Objectives:** Students will be able to

1. Learn the concepts of metallurgy and materials science in manufacturing processes.
2. Interpret phase diagrams of different alloy systems.
3. Describe the concept of heat treatment and other strengthening mechanisms.

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

1. Memorize the types of Crystal structures and their defects.
2. Learn the necessity of alloying and identify types of alloy phases.
3. Demonstrate the importance of a critical understanding of heat treatment in achieving the required properties.
4. Apply the knowledge of heat treatment to enhance surface properties.
5. Analyze the properties and microstructure of ferrous and non-ferrous alloys.
6. Develop new materials and enhance properties for advanced applications.

**UNIT – I**

Crystal Structure: Unit cells, Metallic and Ceramic crystal structures. Imperfection in solids: Point, line, surface and volume defects; dislocations, strengthening mechanisms, slip systems, critical resolved shear stress.

**UNIT – II**

Hume – Rothery Rules: Alloys, substitutional and interstitial solid solutions- Phase diagrams: Interpretation of binary phase diagrams and microstructure development; eutectic, peritectic, Eutectoid, peritectoid and monotectic reactions. Iron Iron-carbide phase diagram and microstructural aspects of ledeburite, austenite, pearlite, ferrite, and cementite.

**UNIT –III**

Heat treatment of steels: Isothermal transformation diagrams for Fe-C alloys and microstructures development. Martensite, Bainite. Annealing. Normalizing, Hardening, Tempering, and Spheroidising.

**UNIT – IV**

Continuous cooling curves and interpretation of final microstructures and properties - Thermo mechanical treatments like Austempering, martempering, surface hardening methods like case hardening, carburizing, nitriding, cyaniding, carbo-nitriding, flame and induction hardening, vacuum and plasma hardening

**UNIT – V**

Alloy steels, properties and applications of stainless steels and tool steels, maraging steels- Types of cast irons (grey, white, malleable, and spheroidal graphite cast irons), copper and its alloys (Brass and bronze)- Aluminum and its alloys (Al-Cu Alloys). Ceramics and Composites: Types, properties and applications.

**TEXTBOOKS:**

1. SIDNEY H AVNER, Introduction to Physical Metallurgy, McGraw Hill, 2017
2. V. Raghavan, "Material Science and Engineering", Prentice Hall of India Private Limited, Fifth Edition.
3. William. D. Callister, David G. Rethwisch, "Materials Science and Engineering: An Introduction", John Wiley and Sons, 2018.

**REFERENCE BOOKS:**

1. Kenneth G. Budinski and Michael K. Budinski, "Engineering Materials", Prentice Hall of India Private Limited, 9<sup>th</sup> Edition, Indian Reprint, 2009.
2. U. C. Jindal, "Engineering Materials and Metallurgy", Pearson, 2011.

**ME304PC: PRODUCTION TECHNOLOGY****B.Tech. II Year I Sem.****L T P C**  
**3 0 0 3****Pre-requisites:** None**Course Objectives:**

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

**Course Outcomes:** Students will be able to:

- Elaborate the fundamentals of various moulding, casting techniques, and furnaces.
- Identify the importance of permanent joining and the principle behind different welding processes.
- Explain the concepts of solid-state welding processes
- Understand the concepts of rolling and sheet metal operations in metal working.
- 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:**

**Welding processes - I:** Classification – Types of welds and welded joints and their characteristics, Welding Positions - Gas welding - Types, oxyfuel gas cutting – standard time and cost calculations. Arc welding, Shielded metal arc welding, submerged arc welding, Resistance welding, and Thermit welding.

**UNIT – III:**

**Welding Processes – II:** Inert Gas Welding \_ TIG Welding, MIG welding, Friction welding, Friction Stir Welding, induction welding, explosive welding, Laser Welding; Soldering and Brazing; Heat affected zone in welding. Welding defects – causes and remedies; destructive and non-destructive testing of welds.

**UNIT – IV:**

**Metal Working Processes:** Hot-working, cold working, strain hardening, recovery, recrystallization, 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 requirements 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.

**TEXTBOOKS:**

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

**REFERENCE BOOKS:**

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

**ME305PC: THERMODYNAMICS****B.Tech. II Year I Sem.**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>1</b>	<b>0</b>	<b>4</b>

**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 the basics of Thermodynamics
2. Apply the first and second laws of thermodynamics to different systems
3. Determine the feasibility of a process w.r.to entropy changes
4. Apply concepts of thermodynamic property relations to ideal gas and real gases
5. Evaluate the performance of power cycles and refrigeration cycles

**Tables/Codes: Steam Tables and Mollier Chart, Refrigeration Tables****UNIT – I:**

**Introduction:** Basic Concepts, System, Control Volume, Surrounding, Boundaries, Universe, Types of Systems, Macroscopic and Microscopic viewpoints, Concept of Continuum, Thermodynamic Equilibrium, State, Property, Process, Exact and Inexact Differentials, Cycle – Reversibility – Quasi-static Process, Irreversible Process, Causes of Irreversibility – Energy in State and Transition, Types, Displacement and 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

**UNIT – II:**

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. 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.

**UNIT – III:**

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:**

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, 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.

**UNIT – V:**

**Power Cycles:** Otto, Diesel, Dual Combustion 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, Brayton and Rankine cycles – Performance Evaluation.

**Refrigeration Cycles:** Bell-Coleman cycle, Vapour compression cycle-performance Evaluation.

**TEXTBOOKS:**

1. Engineering Thermodynamics / PK Nag / Mc Graw Hill
2. Fundamentals of Classical Thermodynamics by G. Van Wylan and R.E. Sonntag, John Wiley Pub
3. Thermodynamics – An Engineering Approach by Yunus A. Cengel and Michael A. Boles, TMH

**REFERENCE BOOKS:**

1. Engineering Thermodynamics by Jones and Dugan, PHI, 2007.
2. Thermodynamics by M. Achutan, PHI, 2<sup>nd</sup> Edition, 2013.
3. Thermodynamics and Heat Engines by R. Yadav, Central Book Depot, Allahabad.
4. Thermodynamics by S.C. Gupta, Pearson Publications.

**ME306PC: PRODUCTION TECHNOLOGY LABORATORY****B.Tech. II Year I Sem.**

L	T	P	C
0	0	2	1

**Pre-requisites:** Production Technology**Course Objectives:**

1. Know about the basic Physical and Chemical Properties of materials
2. Learn the basic operation of various manufacturing processes
3. Design and fabricate a simple product

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

1. Analyze the given problem and investigates the experimental setup.
2. Operate different types of welding machines
3. Perform operations on mechanical press.
4. get familiarity with the processing of Plastics.
5. Effectively communicate and explain the experimental analysis.

**A minimum of 12 Exercises need to be performed****I. Metal Casting Lab:**

1. To design and develop a functional pattern for a single casting based on the provided drawing.
2. To determine the strength and permeability of a sand sample relevant for sand casting applications.
3. To produce a casting using the sand-casting process, considering the design of the pattern, mold preparation, melting of metal, and pouring techniques.

**II. Welding Lab:**

1. (a) To produce a satisfactory lap joint using arc welding techniques.  
(b) To create a strong and visually appealing butt joint using arc welding.
2. To successfully perform spot welds on a designated material.
3. To demonstrate TIG welding by creating a clean and precise weld.
4. (a) To explore the capabilities of a water plasma device by cutting a variety of materials  
(b) To perform brazing on a designated joint using a water plasma device.

**III. Mechanical Press Working:**

1. To perform Blanking and Piercing operations and study the simple, compound, and progressive press tools.
2. To perform Deep drawing and extrusion operations.
3. To perform Bending and other operations.

**IV. Processing of Plastics**

1. To perform the Injection Moulding process.
2. To perform the Blow Moulding process.

**REFERENCE BOOK:**

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

**ME307PC: MATERIAL SCIENCE and MECHANICS OF SOLIDS LABORATORY****B.Tech. II Year I Sem.****L T P C**  
**0 0 2 1****Pre-Requisites:** Material Science and Metallurgy

**Course Objective:** The Objective is to teach the students the concepts of Metallurgy and Material Science in manufacturing processes, which convert raw materials into useful products. Students will be able to understand the 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.

**List of Experiments:**

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

**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 methods 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:

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

**List of Experiments:**

1. To determine the tensile properties of a material
2. To perform a Bending test on a Simple supported beam
3. To perform a Bending test on the Cantilever beam
4. To perform Torsion test
5. To perform Brinell hardness test/ Rockwell hardness test
6. To perform a Test on springs
7. To perform the Izod Impact test/ Charpy Impact test

**ME308PC: COMPUTER-AIDED MACHINE DRAWING****B.Tech. II Year I Sem.****L T P C**  
**0 0 2 1****Pre-requisites:** Engineering graphics

**Course objectives:** To familiarize with the standard conventions for different materials and machine parts in working drawings. To make part drawings including sectional views for various machine elements. To prepare assembly drawings given the details of part drawings.

**Course Outcomes:**

- Preparation of engineering and working drawings with dimensions and bill of material during design and development. Developing assembly drawings using part drawings of machine components.
- Conventional representation of materials, common machine elements, and parts such as screws, nuts, bolts, keys, gears, webs, and ribs.
- Types of sections – selection of section planes and drawing of sections and auxiliary sectional views. Parts are not usually sectioned.
- Methods of dimensioning, general rules for sizes and placement of dimensions for holes, centers, curved and tapered features.
- Title boxes, their size, location, and details - common abbreviations and their liberal usage
- Types of Drawings – working drawings for machine parts.

**Drawing of Machine Elements and simple parts**

Selection of Views, additional views for the following machine elements and parts with every drawing proportion.

1. Popular forms of Screw threads, bolts, nuts, stud bolts, tap bolts, and set screws.
2. Keys, cottered joints, and knuckle joints.
3. Rivetted joints
4. Shaft coupling, spigot, and socket pipe joint.
5. Journal, pivot and collar, and footstep bearings.

**Drawing of Machine Elements: Using Computer aided drafting in addition to manual drawing****Assembly Drawings:**

Drawings of assembled views for the part drawings of the following using conventions and easy drawing proportions.

1. Steam engine parts – stuffing box, crosshead, Eccentric.
2. Machine tool parts: Tailstock, Tool Post, Machine Vices.
3. Other machine parts - Screw jack, Connecting rod, Plumber block, Fuel Injector
4. Valves - Steam stop valve, spring loaded safety valve, feed check valve and air cock.

**Assembly Drawings: Using Computer aided drafting in addition to manual drawing**

**NOTE:** 1. First angle projection to be adopted.

1. All the drawing components/assemblies are to be drawn using any Computer aided drafting package

**TEXTBOOKS:**

1. Machine Drawing / N.D. Bhatt / Charotar
2. Machine Drawing with Auto CAD / Goutham Pohit, Goutam Ghosh / Pearson

**REFERENCE BOOKS:**

1. Machine Drawing by / Bhattacharyya / Oxford
2. Machine Drawing / Ajeet Singh / Mc Graw Hill

**Note:** - External examination is conducted in conventional mode and internal evaluation to be done by both conventional as well as using computer-aided drafting.

**\*MC309: CONSTITUTION OF INDIA****B.Tech. II Year I Sem.**

L	T	P	C
3	0	0	0

**Course Objectives:** Students will be able to:

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

**Course Outcomes:** Students will be able to:

- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
- Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution
- Discuss the passage of the Hindu Code Bill of 1956.

**Unit - 1** History of Making of the Indian Constitution- History of Drafting Committee.**Unit - 2** Philosophy of the Indian Constitution- Preamble Salient Features**Unit - 3** Contours of Constitutional Rights & Duties - Fundamental Rights

- Right to Equality
- Right to Freedom
- Right against Exploitation
- Right to Freedom of Religion
- Cultural and Educational Rights
- Right to Constitutional Remedies
- Directive Principles of State Policy
- Fundamental Duties.

**Unit - 4** Organs of Governance: Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions**Unit - 5** Local Administration: District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. Panchayat raj: Introduction, PRI: Zila Panchayat. Elected officials and their roles, CEO Zilla Panchayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed Officials, Importance of grass root democracy**Unit - 6** Election Commission: Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.**Suggested Reading:**

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar Framing of Indian Constitution, 1st Edition, 2015.
3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

**ME401PC: BASIC ELECTRICAL AND ELECTRONICS ENGINEERING****B.Tech. II Year II Sem.**

L	T	P	C
3	0	0	3

**Course Objectives:**

1. To introduce the concepts of electrical circuits and its components
2. To understand magnetic circuits, DC circuits, and AC single-phase & three phase circuits
3. To study and understand the different types of DC/AC machines and Transformers.
4. To impart the knowledge of various electrical installations.
5. To introduce the concept of power, power factor and its improvement.
6. To introduce the concepts of diodes & transistors, and
7. To impart the knowledge of various configurations, characteristics and applications.

**Course Outcomes:**

1. To analyze and solve electrical circuits using network laws and theorems.
2. To understand and analyze basic Electric and Magnetic circuits
3. To study the working principles of Electrical Machines
4. To introduce components of Low Voltage Electrical Installations
5. To identify and characterize diodes and various types of transistors.

**UNIT - I:**

**D.C. Circuits:** Electrical circuit elements (R, L, and C), voltage and current sources, KVL&KCL, analysis of simple circuits with dc excitation.

**A.C. Circuits:** Representation of sinusoidal waveforms, peak and rms values, phasor representation, real power, reactive power, apparent power, power factor, Analysis of single-phase ac circuits, Three- phase balanced circuits, voltage and current relations in star and delta connections.

**UNIT - II:**

**Electrical Installations:** Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, MCCB, Types of Wires and Cables, Earthing. Types of Batteries, Important Characteristics for Batteries. Elementary calculations for energy consumption, power factor improvement and battery backup.

**UNIT - III:**

**Electrical Machines:** Working principle of Single-phase transformer, equivalent circuit, losses in transformers, efficiency, Three-phase transformer connections. Construction and working principle of DC generators, EMF equation, working principle of DC motors, Torque equations and Speed control of DC motors, Construction and working principle of Three-phase Induction motor, Torques equations and Speed control of Three-phase induction motor. Construction and working principle of synchronous generators.

**UNIT - IV:**

**P-N Junction and Zener Diode:** Principle of Operation Diode equation, Volt-Ampere characteristics, Temperature dependence, Ideal versus practical, Static and dynamic resistances, Equivalent circuit, Zener diode characteristics and applications.

**Rectifiers and Filters:** P-N junction as a rectifier - Half Wave Rectifier, Ripple Factor - Full Wave Rectifier, Bridge Rectifier, Harmonic components in Rectifier Circuits, Filters – Inductor Filters, Capacitor Filters, L- section Filters,  $\pi$ - section Filters.

**UNIT - V:**

**Bipolar Junction Transistor (BJT):** Construction, Principle of Operation, Amplifying Action, Common Emitter, Common Base and Common Collector configurations, Comparison of CE, CB and CC configurations.

**Field Effect Transistor (FET):** Construction, Principle of Operation, Comparison of BJT and FET, Biasing FET.

**TEXTBOOKS:**

1. Basic Electrical and Electronics Engineering –M S Sukija TK Nagasarkar Oxford University
2. Basic Electrical and Electronics Engineering P Kothari. I J Nagarath, McGraw Hill Education

**REFERENCE BOOKS:**

1. Electronic Devices and Circuits – R. L. Boylestad and Louis Nashelsky, PEI/PHI, 9<sup>th</sup> Ed, 2006.
2. Millman's Electronic Devices and Circuits – J. Millman and C. C. Halkias, Satyabrata Jit, TMH, 2/e, 1998.
3. Engineering circuit analysis- by William Hayt and Jack E. Kemmerly, McGraw Hill Company, 6<sup>th</sup> edition.
4. Linear circuit analysis (time domain phasor and Laplace transform approaches) - 2<sup>nd</sup> edition by Raymond A. De Carlo and Pen-Min-Lin, Oxford University Press-2004.
5. Network Theory by N. C. Jagan& C. Lakshminarayana, B.S. Publications.
6. Network Theory by Sudhakar, Shyam Mohan Palli, TMH.
7. L. S. Bobrow, "Fundamentals of Electrical Engineering", Oxford University Press, 2011.
8. E. Hughes, "Electrical and Electronics Technology", Pearson, 2010.
9. V. D. Toro, "Electrical Engineering Fundamentals", Prentice Hall India, 1989.

**ME402PC: KINEMATICS OF MACHINERY****B.Tech. II Year II Sem.**

L	T	P	C
3	0	0	3

**Prerequisites:** Basic principles of Mechanics**Course Objectives:** The objectives of this course are

1. To introduce the concept of machines, mechanisms and related terminologies and the relative motion, velocity, and accelerations of the various elements in a mechanism.
2. To make the students familiar with the most commonly used mechanisms such as four-bar/slider crank/double slider crank mechanisms and their inversions.
3. To provide an overview of straight-line motion mechanisms, steering mechanisms, and Hooke's joint.
4. To familiarize higher pairs like cams and principles of cam design.
5. To understand the kinematic analysis of gears and gear trains.

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

1. Understand the various elements in the mechanism and the inversions of commonly used mechanisms such as four-bar, slider-crank, and double-slider-crank mechanisms.
2. Draw the velocity and acceleration polygons for a given configuration of a mechanism.
3. Understand the conditions for straight-line motion mechanisms, steering mechanisms, and the usage of Hooke's joint.
4. Draw displacement diagrams and cam profile diagrams for followers executing different types of motions and various configurations of followers.
5. Calculate the number of teeth and velocity ratio required for a given combination of gears.

**UNIT – I:**

**Mechanisms:** Elements or Links – Classification – Rigid Link, flexible and fluid link – Types of kinematics pairs – sliding, turning, rolling, screw and spherical pairs – lower and higher pairs – closed and open pairs – constrained motion – completely, partially or successfully and incompletely constrained.

**Mechanism and Machines** – Mobility of Mechanisms: Grubler's criterion, classification of machines – kinematic chain – inversion of mechanisms – inversions of quadric cycle chain, single and double slider crank chains, Mechanical Advantage.

**UNIT – II:**

**Kinematics:** Velocity and acceleration – Motion of link in the machine – Determination of Velocity and acceleration – Graphical method – Application of relative velocity method.

**Plane motion of body:** Instantaneous center of rotation – Kennedy's theorem – Graphical determination of instantaneous center, determination of the angular velocity of links by instantaneous center method. Klien's construction - determination of Coriolis component of acceleration.

**Analysis of Mechanisms:** Analysis of slider crank mechanism – Acceleration diagram for different mechanisms.

**UNIT – III:**

**Straight-line motion mechanisms:** Exact and approximate copied and generated types – Peaucellier - Hart - Scott Russel – Grasshopper – Watt -Tchebicheff's and Robert Mechanism - pantographs

**Steering gears:** Conditions for correct steering – Davis Steering gear, Ackerman's steering gear.

**Hooke's Joint:** Single and double Hooke's joint –velocity ratio – application – problems.

**UNIT – IV:**

**Cams:** Introduction to cam and followers –Types of followers and cams –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.

**UNIT – V:**

**Gears:** Introduction - Friction wheels and toothed gears – types – law of gearing, condition for constant velocity ratio for transmission of motion .

**Forms of teeth:** cycloidal and involutes profiles – phenomena of interferences – Methods of interference. Condition for minimum number of teeth to avoid interference – expressions for arc of contact and path of contact of Pinion and Gear and Pinion and Rack Arrangements– Introduction to Helical – Bevel and worm gearing

**Gear Trains:** Simple, Compound, Reverted and Epicyclic gear trains. Differential of an Automobile.

**TEXT BOOKS:**

1. S.S.Rathan, "Theory of Machines", McGrawHill, 5th Edition, 2019.
2. Thomas Bevan, "Theory of Machines", 3rd Edition, CBS Publishers and Distributors, 2005

**REFERENCE BOOKS:**

1. Sadhu Sigh, "Theory of Machines", Third Edition, Pearson Education, 2012.
2. Robert L. Norton, "Kinematics and Dynamics of Machinery", Tata McGraw-Hill, 2009.
3. Rao. J.S. and Dukupati. R.V. "Mechanisms and Machine Theory", Wiley-Eastern Ltd., New Delhi, 1992.
4. Uicker, J.J., Pennock G.R and Shigley, J.E., "Theory of Machines and Mechanisms", 4 th Edition, Oxford University Press, 2014.

**ME403PC: FLUID MECHANICS and HYDRAULIC MACHINES****B.Tech. II Year II Sem.**

L	T	P	C
3	0	0	3

**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 a given situation in power plants.
5. To estimate the performance parameters of a given Centrifugal and Reciprocating pump.
6. Able to demonstrate boundary layer concepts.

**UNIT – I:**

**Fluid statics:** Physical properties of fluids- specific gravity, viscosity, and surface tension - vapor 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:** Streamline, path line and streak lines and stream tube, classification of flows-steady and unsteady, uniform and non-uniform, laminar and turbulent, rotational and 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 streamline, momentum equation and its application on force on pipe bend.

**UNIT – III:**

**Boundary Layer Concepts:** Definition, thicknesses, characteristics along the thin plate, laminar and turbulent boundary layers (No derivation), separation of the 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.

**UNIT – IV:**

**Basics of turbomachinery:** Introduction to Turbomachinery, Hydrodynamic Forces on Vanes (inclined and curved), Velocity Diagrams, Work Done and Efficiency, and Flow Over Radial Vanes.

**Hydraulic Turbines:** Classification of turbines, Heads and efficiencies, impulse and reaction turbines, Pelton wheel, Franci's 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:** Introduction, Classification, Working Principle, Work Done and Head Developed, Losses and Efficiencies, Specific Speed, Performance Characteristic Curves, Net Positive Suction Head (NPSH).

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

**TEXTBOOKS:**

1. Fluid Mechanics and Hydraulic Machines by Dr. R. K. Bansal, Laxmi Publications, 2019.
2. Hydraulics, Fluid Mechanics and Hydraulic Machinery - MODI and SETH, 21<sup>st</sup> Edition, Standard Book House.
3. Fluid Mechanics and Hydraulic Machines by Er. R. K. Rajput, S. Chand, 2019.

**REFERENCE BOOKS:**

1. Fluid Mechanics and Fluid Power Engineering by D.S. Kumar, S.K. Kataria and Sons, 2018
2. Fluid Mechanics and Machinery by D. Rama Durgaiah, New Age International publishers
3. Hydraulic Machines by T.R. Banga and S.C. Sharma, 7<sup>th</sup> Edition, Khanna Publishers

**ME404PC: IC ENGINES and GAS TURBINES****B.Tech. II Year II Sem.**

L	T	P	C
3	0	0	3

**Pre-requisite:** Basic Thermodynamics**Course Objective:**

1. Explain the Components of IC Engines and systems.
2. Analyze the stages of combustion to improve the performance of IC engines with respect to fuel economy and control of emissions in global, environmental and social context.
3. Understand and evaluate the performance analysis of the major components and systems of IC engines and their applications.
4. Explore to the components and working principles of rotary, reciprocating, dynamic and axial compressors.
5. Understand the significance of gas turbines in real context in power generation.

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

1. Elaborate the working principles of IC Engine systems and its classification.
2. Explore the combustion stages of SI and CI engines, and factors influence for better combustion.
3. Evaluate the testing and performance parameters of IC engines.
4. Explain the function and working principles of rotary, reciprocating, dynamic axial compressors.
5. Understand the working principle of gas turbine and its classification with thermodynamic analysis.

**UNIT – I:**

**I.C. Engines:** Classification - Working principles of Four and Two stroke engine, SI and CI engines, Valve and Port Timing Diagrams, Air – Standard, air-fuel and actual cycles - Engine systems – Carburetor and Fuel Injection Systems for SI engines, Fuel injection systems for CI engines, Ignition, Cooling and Lubrication system, Fuel properties and Combustion Stoichiometry.

**UNIT – II:**

Normal Combustion and abnormal combustion in SI engines – Importance of flame speed and effect of engine variables – Abnormal combustion, pre-ignition and knocking in SI Engines – Fuel requirements and fuel rating, anti-knock additives – combustion chamber – requirements, types of SI engines.

Four stages of combustion in CI engines – Delay period and its importance – Effect of engine variables – Diesel Knock– Need for air movement, suction, compression and combustion induced turbulence in Diesel engine – open and divided combustion chambers and fuel injection– Diesel fuel requirements and fuel rating

**UNIT – III:**

**Testing and Performance:** Parameters of performance - measurement of cylinder pressure, fuel consumption, air intake, exhaust gas composition, Brake power – Determination of frictional losses and indicated power – Performance test – Heat balance sheet and chart

Classification of compressors – Fans, blowers and compressors – positive displacement and dynamic types – reciprocating and rotary types.

**Reciprocating Compressors:** Principle of operation, work required, Isothermal efficiency volumetric efficiency and effect of clearance volume, staged compression, under cooling, saving of work, minimum work condition for staged compression

**UNIT – IV:**

**Rotary Compressor (Positive displacement type):** Roots Blower, vane sealed compressor, mechanical details and principle of working – efficiency considerations.

**Dynamic Compressors:** Centrifugal compressors: Mechanical details and principle of operation – velocity and pressure variation. Energy transfer-impeller blade shape-losses, slip factor, power input factor, pressure coefficient and adiabatic coefficient – velocity diagrams – power.

**Axial Flow Compressors:** Mechanical details and principle of operation – velocity triangles and energy transfer per stage degree of reaction, work done factor - isentropic efficiency- pressure rise calculations – Polytropic efficiency.

**UNIT – V:**

**Gas Turbines:** Simple Gas Turbine Plant – Ideal Cycle – Closed Cycle and Open Cycle for Gas Turbines, Constant Pressure Cycle, Constant Volume Cycle, Efficiency – Work Ratio and Optimum Pressure Ratio for Simple Gas Turbine Cycle. Parameters of Performance, Actual Cycle.

**TEXT BOOKS:**

1. I.C. Engines, V. Ganesan, 4<sup>th</sup> Edition, Mc Graw Hill
2. Thermal Engineering, Mahesh M Rathore, Tata Mc Graw Hill, 2010

**REFERENCE BOOKS:**

1. Applied Thermodynamics for Engineering Technologists, Eastop and McConkey, Pearson
2. Fundamentals of Classical Thermodynamics, Vanwylen G.J., Sonntag R.E., Wiley Eastern
3. Internal Combustion Engines Fundamentals, John B. Heywood, McGraw Hill Ed.

**ME405PC: INSTRUMENTATION AND CONTROL SYSTEMS****B.Tech. II Year II Sem.****L T P C**  
**3 0 0 3****Prerequisite:** Mathematics-I, Thermodynamics, Basic of Electrical and Electronics Engineering.**Course Objectives:**

1. To impart the basic knowledge of the functional blocks of measurement systems.
2. To provide technical understanding of various Temperature and pressure measuring instruments.
3. To expose the students to know the working of various physical variable Level, Flow, Speed and Acceleration measuring instruments.
4. To understand the working of various physical and Electrical variables Stress, Humidity, Force, Torque and Power measuring instruments.
5. To understand the concept of control system and calculate transfer functions of mechanical and translational systems with different techniques.

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

1. Know the basic knowledge of the functional blocks of measurement systems.
2. Describe the working of various physical variable Temperature and pressure measuring instruments.
3. Explain the working of various physical variable Level, flow, Speed, and Acceleration measuring instruments.
4. Understand the working of various physical and Electrical variables Stress, Humidity, Force, Torque, and Power measuring instruments.
5. Understand the concept of control systems and calculate transfer functions of mechanical and translational systems with different techniques.

**UNIT – I:**

Introduction – Basic principles of measurement – Measurement systems, generalized configuration, and functional description of measuring instruments – examples. Static and Dynamic performance characteristics– sources of errors, Classification, and elimination of errors. Measurement of Displacement: Theory and construction of various transducers to measure displacement – Using LVDT, Piezoelectric, Inductive, capacitance, resistance, ionization, and Photo electric transducers.

**UNIT – II:**

**Measurement of Temperature:** Various Principles of measurement-Classification: Expansion Type: Bimetallic Strip- Liquid in glass Thermometer; Electrical Resistance Type: Thermistor, Thermocouple, RTD; Radiation Pyrometry: Optical Pyrometer; Changes in Chemical Phase: Fusible Indicators and Liquid crystals. Measurement of Pressure: Different principles used- Classification: Manometers, Deadweight pressure gauge Tester (Piston gauge), Bourdon pressure gauges, Bulk modulus pressure gauges, Bellows, Diaphragm gauges. Low-pressure measurement – Thermal conductivity gauges, ionization pressure gauges, McLeod pressure gauge.

**UNIT – III:**

**Measurement of Level:** Direct methods – Indirect methods – Capacitive, Radioactive, Ultrasonic, Magnetic, Cryogenic Fuel level indicators –Bubbler level indicators.

**Flow measurement:** Rotameter, magnetic, Ultrasonic, Turbine flowmeter, Hot–wire anemometer, Laser Doppler Anemometer (LDA).

**Measurement of Speed:** Mechanical Tachometers, Electrical tachometers, non-contact type Stroboscope; Measurement of Acceleration and Vibration: Different simple instruments – Principles of Seismic instruments – Vibrometer and accelerometer using this principle- Piezo electric accelerometer.

**UNIT – IV:**

**Stress-Strain measurements:** Various types of stress and strain measurements – Selection and installation of metallic strain gauges; electrical strain gauge – gauge factor – method of usage of resistance strain gauge for bending, compressive, and tensile strains – Temperature compensation techniques, Use of strain gauges for measuring torque, Strain gauge Rosettes.

**Measurement of Humidity:** Moisture content of gases, Sling Psychrometer, Absorption Psychrometer, Dew point meter. Measurement of Force, Torque, and Power- Elastic force meters, load cells, Torsion meters, and Dynamometers.

**UNIT – V:**

**Elements of Control Systems:** Introduction, Importance – Classification – Open and closed systems- Servomechanisms – Examples with block diagrams – Temperature, speed, and position control systems- Transfer functions- First and Second order mechanical systems

**TEXTBOOKS:**

1. Principles of Industrial Instrumentation and Control Systems/Chennakesava R alaavala, - Cengage Learning/1<sup>st</sup> Edition, 2009.
2. Basic Principles – Measurements (Instrumentation) and Control Systems /S. Bhaskar/ Anuradha Publications

**REFERENCE BOOKS:**

1. Measurement Systems: Applications and design, E. O. Doebelin, TMH, Tata Mcgraw Hill/6<sup>th</sup> Edition, 2017.
2. Instrumentation, Measurement and Analysis, B.C. Nakra and K.K. Choudhary, TMH, 4<sup>th</sup> Edition, 2016.
3. Experimental Methods for Engineers / Holman
4. Mechanical and Industrial Measurements / R. K. Jain/ Khanna Publishers.
5. Mechanical Measurements / Sirohi and Radhakrishna / New Age International, 3<sup>rd</sup> Edition, 2013.

**ME406PC: BASIC ELECTRICAL AND ELECTRONICS ENGINEERING LABORATORY****B.Tech. II Year II Sem.****L T P C**  
**0 0 2 1****Pre-requisites:** Basic Electrical and Electronics Engineering**Course Objectives:**

1. To introduce the concepts of electrical circuits and its components
2. To understand magnetic circuits, DC circuits and AC single phase & three phase circuits
3. To study and understand the different types of DC/AC machines and Transformers.
4. To impart the knowledge of various electrical installations.
5. To introduce the concept of power, power factor and its improvement.
6. To introduce the concepts of diodes & transistors, and
7. To impart the knowledge of various configurations, characteristics and applications.

**Course Outcomes:**

1. To analyze and solve electrical circuits using network laws and theorems.
2. To understand and analyze basic Electric and Magnetic circuits
3. To study the working principles of Electrical Machines
4. To introduce components of Low Voltage Electrical Installations
5. To identify and characterize diodes and various types of transistors.

**List of Experiments/ Demonstrations:****PART A: ELECTRICAL**

1. Verification of KVL and KCL
2. (i) Measurement of Voltage, Current and Real Power in primary and Secondary Circuits of a Single-Phase Transformer  
(ii) Verification of Relationship between Voltages and Currents (Star-Delta, Delta-Delta, Delta- star, Star-Star) in a Three Phase Transformer
3. Measurement of Active and Reactive Power in a balanced Three-phase circuit
4. Performance Characteristics of a Separately Excited DC Shunt Motor
5. Performance Characteristics of a Three-phase Induction Motor
6. No-Load Characteristics of a Three-phase Alternator

**PART B: ELECTRONICS**

1. Study and operation of  
(i) Multi-meters (ii) Function Generator (iii) Regulated Power Supplies (iv) CRO.
2. PN Junction diode characteristics
3. Zener diode characteristics and Zener as voltage Regulator
4. Input & Output characteristics of Transistor in CB / CE configuration
5. Full Wave Rectifier with & without filters
6. Input and Output characteristics of FET in CS configuration

**TEXT BOOKS:**

1. Basic Electrical and electronics Engineering –M S Sukija TK Nagasarkar Oxford University
2. Basic Electrical and electronics Engineering-D P Kothari. I J Nagarath, McGraw Hill Education

**REFERENCE BOOKS:**

1. Electronic Devices and Circuits – R. L. Boylestead and Louis Nashelsky, PEI/PHI, 9<sup>th</sup> Ed, 2006.
2. Millman's Electronic Devices and Circuits – J. Millman and C. C. Halkias, Satyabrata Jit, TMH, 2/e, 1998.

3. Engineering circuit analysis- by William Hayt and Jack E. Kemmerly, McGraw Hill Company, 6<sup>th</sup> edition.
4. Linear circuit analysis (time domain phasor and Laplace transform approaches) - 2<sup>nd</sup> edition by Raymond A. De Carlo and Pen-Min-Lin, Oxford University Press-2004.
5. Network Theory by N. C. Jagan& C. Lakshminarayana, B.S. Publications.
6. Network Theory by Sudhakar, Shyam Mohan Palli, TMH.
7. L. S. Bobrow, "Fundamentals of Electrical Engineering", Oxford University Press, 2011.
8. E. Hughes, "Electrical and Electronics Technology", Pearson, 2010.
9. V. D. Toro, "Electrical Engineering Fundamentals", Prentice Hall India, 1989

**ME407PC: FLUID MECHANICS and HYDRAULIC MACHINES LABORATORY****B.Tech. II Year II Sem.****L T P C**  
**0 0 2 1****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 equations.
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 a given situation in power plants.
5. To estimate the performance parameters of a given Centrifugal and Reciprocating pump.
6. Able to demonstrate boundary layer concepts

**List of Experiments:**

1. To determine the Impact of jets on Vanes.
2. To perform a test on Pelton Wheel.
3. To perform a test on Francis Turbine.
4. To perform a test on the Kaplan Turbine.
5. To perform a test on Single Stage Centrifugal Pump.
6. To perform a test on Multi Stage Centrifugal Pump.
7. To Performance Test on Reciprocating Pump.
8. To calibrate the Venturimeter.
9. To calibrate the Orifice meter.
10. To Determine the friction factor for a given pipeline.
11. To Determine the loss of head due to sudden contraction in a pipeline.
12. To Verification of Bernoulli's Theorems.

**ME408PC: INSTRUMENTATION AND CONTROL SYSTEMS LABORATORY****B.Tech. II Year II Sem.****L T P C**  
**0 0 2 1****Pre-requisites:** Basic principles of Instrumentation and control systems**Course Outcomes:** At the end of the course, the student will be able to

1. Characterize and calibrate measuring devices.
2. Identify and analyze errors in measurement.
3. Analyze measured data using regression analysis.
4. Calibration of Pressure Gauges, temperature, LVDT, capacitive transducer, and rotameter.

**List of Experiments:**

1. To calibrate the Pressure Gauges.
2. To calibrate the transducer for temperature measurement.
3. To Study and calibrate the LVDT transducer for displacement measurement.
4. To calibrate the strain gauge for temperature measurement.
5. To calibrate the thermocouple for temperature measurement.
6. To calibrate the capacitive transducer for angular displacement.
7. To Study and calibrate the photo and magnetic speed pickups for the measurement of speed.
8. To calibrate the resistance temperature detector for temperature measurement.
9. To Study and calibrate a rotameter for flow measurement.
10. To Study and use a Seismic pickup for the measurement of the vibration amplitude of an engine bed at various loads.
11. To Study and calibrate the McLeod gauge for low pressure.
12. To Measure and control the Pressure of a process using a SCADA system.
13. To Measure and control the level in a tank using a capacitive transducer with SCADA.
14. To Measure and control the temperature of a process using a resistance temperature detector with SCADA.

**\*MC410: GENDER SENSITIZATION LAB****B.Tech. II Year II Sem.**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>0</b>	<b>0</b>	<b>2</b>	<b>0</b>

**COURSE DESCRIPTION**

This course offers an introduction to Gender Studies, an interdisciplinary field that asks critical questions about the meanings of sex and gender in society. The primary goal of this course is to familiarize students with key issues, questions and debates in Gender Studies, both historical and contemporary. It draws on multiple disciplines – such as literature, history, economics, psychology, sociology, philosophy, political science, anthropology and media studies – to examine cultural assumptions about sex, gender, and sexuality.

This course integrates analysis of current events through student presentations, aiming to increase awareness of contemporary and historical experiences of women, and of the multiple ways that sex and gender interact with race, class, caste, nationality and other social identities. This course also seeks to build an understanding and initiate and strengthen programmes combating gender-based violence and discrimination. The course also features several exercises and reflective activities designed to examine the concepts of gender, gender-based violence, sexuality, and rights. It will further explore the impact of gender-based violence on education, health and development.

**Objectives of the Course**

- To develop students' sensibility with regard to issues of gender in contemporary India.
- To provide a critical perspective on the socialization of men and women.
- To introduce students to information about some key biological aspects of genders.
- To expose the students to debates on the politics and economics of work.
- To help students reflect critically on gender violence.
- To expose students to more egalitarian interactions between men and women.

**Learning Outcomes**

- Students will have developed a better understanding of important issues related to gender in contemporary India.
- Students will be sensitized to basic dimensions of the biological, sociological, psychological and legal aspects of gender. This will be achieved through discussion of materials derived from research, facts, everyday life, literature and film.
- Students will attain a finer grasp of how gender discrimination works in our society and how to counter it.
- Students will acquire insight into the gendered division of labor and its relation to politics and economics.
- Men and women students and professionals will be better equipped to work and live together as equals.
- Students will develop a sense of appreciation of women in all walks of life.
- Through providing accounts of studies and movements as well as the new laws that provide protection and relief to women, the textbook will empower students to understand and respond to gender violence.

**Unit-I: UNDERSTANDING GENDER**

Introduction: Definition of Gender-Basic Gender Concepts and Terminology-Exploring Attitudes towards Gender-Construction of Gender-Socialization: Making Women, Making Men  
- Preparing for Womanhood. Growing up Male. First lessons in Caste.

**Unit – II: GENDER ROLES AND RELATIONS**

Two or Many? -Struggles with Discrimination-Gender Roles and Relations-Types of Gender Roles-Gender Roles and Relationships Matrix-Missing Women-Sex Selection and Its Consequences-Declining Sex Ratio. Demographic Consequences-Gender Spectrum: Beyond the Binary

### **Unit – III: GENDER AND LABOUR**

Division and Valuation of Labour-Housework: The Invisible Labor- “My Mother doesn’t Work.” “Share the Load.”-Work: Its Politics and Economics -Fact and Fiction. Unrecognized and Unaccounted work.

-Gender Development Issues-Gender, Governance and Sustainable Development-Gender and Human Rights-Gender and Mainstreaming

### **Unit – IV: GENDER - BASED VIOLENCE**

The Concept of Violence- Types of Gender-based Violence-Gender-based Violence from a Human Rights Perspective-Sexual Harassment: Say No!-Sexual Harassment, not Eve-teasing-Coping with Everyday Harassment- Further Reading: “*Chupulu*”.

Domestic Violence: Speaking Out Is Home a Safe Place? -When Women Unite [Film]. Rebuilding Lives. Thinking about Sexual Violence Blaming the Victim-“I Fought for my Life....”

### **Unit – V: GENDER AND CULTURE**

Gender and Film-Gender and Electronic Media-Gender and Advertisement-Gender and Popular Literature- Gender Development Issues-Gender Issues-Gender Sensitive Language-Gender and Popular Literature - Just Relationships: Being Together as Equals Mary Kom and Onler. Love and Acid just do not Mix. Love Letters. Mothers and Fathers. Rosa Parks- The Brave Heart.

**Note:** Since it is Interdisciplinary Course, Resource Persons can be drawn from the fields of English Literature or Sociology or Political Science or any other qualified faculty who has expertise in this field from engineering departments.

- **Classes will consist of a combination of activities: dialogue-based lectures, discussions, collaborative learning activities, group work and in-class assignments. Apart from the above prescribed book, Teachers can make use of any authentic materials related to the topics given in the syllabus on “Gender”.**

- **ESSENTIAL READING:** The Textbook, “*Towards a World of Equals: A Bilingual Textbook on Gender*” written by A.Suneetha, Uma Bhrugubanda, DuggiralaVasanta, Rama Melkote, Vasudha Nagaraj, Asma Rasheed, Gogu Shyamala, Deepa Sreenivas and Susie Tharu published by Telugu Akademi, Telangana Government in 2015.

### **ASSESSMENT AND GRADING:**

- Discussion & Classroom Participation: 20%
- Project/Assignment: 30%
- End Term Exam: 50%

**ME501PC: DYNAMICS OF MACHINERY****B.Tech. III Year, I Sem.**

L	T	P	C
3	0	0	3

**Pre-requisite:** Kinematics of Machinery**Course Objectives:**

- To study the inertia forces, torques, and energy involved in different machine members
- To learn the theory involved in the analysis of clutches, brakes, dynamometers, governors, and flywheels
- To Understand the balancing of reciprocating and rotary parts
- To be Aware of situations like speed fluctuations, rotor imbalance, and machine vibrations in industries
- To Understand the importance of resonance and critical speed

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

- Analyze the effect of a gyroscope on ships, aeroplanes, and automobile
- Explain the inertia forces in working important machine elements like flywheels, connecting rods, etc.
- Understand the types of brakes and the roll of friction
- Understand the working of governors and estimate the unbalanced forces in a multi-cylinder reciprocating engine
- Estimate the longitudinal, transverse, and torsional vibrations to avoid resonance

**UNIT – I:****Precession:** Gyroscopes – effect of precession – motion on the stability of moving vehicles such as motorcycle – motorcar – aeroplanes and ships.**Static and Dynamic Force Analysis:** Static force analysis of planar mechanisms – Analytical Method – Dynamic Force Analysis – D'Alembert's principle, Dynamic Analysis of 4-link mechanism, Slider Crank Mechanism.**UNIT – II:****Turning Moment Diagram and Flywheels:** Engine Force Analysis – Piston Effort, Crank Effort, etc., Inertia Force in Reciprocating Engine – Graphical Method - Turning moment diagram – fluctuation of energy – flywheels and their design - Inertia of connecting rod- inertia force in reciprocating engines – crank effort and torque diagrams.-.**UNIT – III:****Friction:** pivots and collars – uniform pressure, uniform wear – friction circle and friction axis: lubricated surfaces – boundary friction – film lubrication. Clutches – Types – Single plate, multi-plate and cone clutches.**Brakes and Dynamometers:** Types of brakes: Simple block brake, band and block brake- internal expanding shoe brake-effect of braking of a vehicle. Dynamometers – absorption and transmission types. General description and methods of operation.**UNIT – IV:****Governors:** Types of governors - Watt, Porter, and Proell governors. Spring-loaded governors – Hartnell and Hartung with auxiliary springs. Sensitiveness, isochronism and hunting – stability – effort, and power of the governors.**Balancing:** Balancing of rotating masses- Primary, Secondary, and higher balancing of reciprocating masses. Analytical and graphical methods. Unbalanced forces and couples. Examination of “V” and multi-cylinder in-line and radial engines for primary and secondary balancing- locomotive balancing – Hammer blow – Swaying couple – variation of tractive effort.

**UNIT – V:**

**Vibrations:** Free Vibration of mass attached to vertical spring- Damped free vibrations– Transverse loads – vibrations of beams with concentrated and distributed loads. Dunkerly's method – Raleigh's method. Whirling of shafts – critical speed – torsional vibrations – one, two, and three rotor systems.

**TEXTBOOKS:**

1. Theory of Machines, S. S. Rattan, Mc Graw Hill, 2017
2. Theory of Machines /Sadhu Singh/ Pearson.

**REFERENCE BOOKS:**

1. Theory of Machines and Mechanisms, Joseph E. Shigley, Fifth Edition, Oxford University Press
2. Mechanism and Machine Theory, Rao, J.S and R.V. Duggipati, New Age
3. Bansal R.K, Brar J.S, Theory of Machines, Lakshmi Publications (P) Ltd, 2016 Edition

**ME502PC: DESIGN OF MACHINE ELEMENTS-I****B.Tech. III Year, I Sem.**

L	T	P	C
3	0	0	3

**Note:** Design Data books are not permitted in the Examinations. The design must not only satisfy strength criteria but also rigidity criteria.

**Pre-requisites:** Engineering mechanics, mechanics of solids, manufacturing processes, metallurgy and material science.

**Course Objectives:**

- To understand the general design procedures and principles in the design of machine elements.
- To study different materials of construction and their properties and factors determining the selection of materials for various applications.
- To determine stresses under different loading conditions.
- To learn the design procedure of different fasteners, joints, shafts and couplings.

**Course Outcomes:**

- The student acquires the knowledge about the principles of design, material selection, component behavior subjected to loads, and criteria of failure.
- Understands the concepts of principal stresses, stress concentration in machine members and fatigue loading.
- Design on the basis of strength and rigidity and analyze the stresses and strains induced in a machine element.

**UNIT – I:**

**Introduction:** General considerations in the design of Engineering Materials and their properties – selection –Manufacturing consideration in design. Tolerances and fits –BIS codes of steel.

**Design for Static Strength:** Simple stresses – Combined stresses – Torsional and Bending stresses – Impact stresses – Stress-strain relation – Various theories of failure – Factor of safety – Design for strength and rigidity – preferred numbers. The concept of stiffness in tension, bending, torsion and combined situations.

**UNIT – II:**

**Design for Fatigue Strength:** Stress concentration–Theoretical stress Concentration factor–Fatigue stress concentration factor- Notch Sensitivity – Design for fluctuating stresses – Endurance limit – Estimation of Endurance strength – Gerber’s curve– Goodman’s line– Soderberg’s line.

**UNIT – III:**

**Riveted, Welded and Bolted Joints:** Riveted joints- methods of failure of riveted joints- strength equations-efficiency of riveted joints-eccentrically loaded riveted joints.

Welded joints-Design of fillet welds-axial loads-circular fillet welds under bending, torsion. Welded joints under eccentric loading.

Bolted joints – Design of bolts with pre-stresses – Design of joints under eccentric loading – locking devices – bolts of uniform strength.

**UNIT – IV:**

**Keys, Cotters and Knuckle Joints:** Design of keys-stresses in keys-cottered joints-spigot and socket, sleeve and cotter, Gib and cotter joints-Knuckle joints.

**UNIT – V:**

**Shafts:** Design of solid and hollow shafts for strength and rigidity – Design of shafts for combined bending and axial loads – Shaft sizes – BIS code. - Gaskets and seals (stationary and rotary)

**Shaft Couplings:** Rigid couplings – Muff, Split muff and Flange couplings. Flexible couplings – Flange coupling (Modified).

**TEXT BOOKS:**

1. Design of Machine Elements, V B Bhandari, Fifth Edition, McGraw-Hill
2. Machine Design, Jindal, Pearson

**REFERENCE BOOKS:**

1. Design of Machine Elements, V. M. Faires, Macmillan.
2. Design of Machine Elements-I, Annaiah, M.H, New Age International Publishers

**ME503PC: METROLOGY and MACHINE TOOLS****B.Tech. III Year I Sem.**

L	T	P	C
3	0	0	3

**Course Objectives:**

- To impart the fundamental aspects of the metal cutting principles and their application in studying the behavior of various machining processes.
- To train in knowing the fundamental parts of various machine tools and their kinematic schemes.
- To improve problem solving skills by determining the machining time of various machining processes.
- To provide technical understanding of basic concepts of engineering metrology and its practice in the industry.
- To make the student to improve applications aspect in the measurements and control of a process in manufacturing.

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

- Explain the principles of metal cutting and working of lathe machine tools.
- Understand working of drilling, boring, shaping, slotting, planing machine tools and estimation of machining time.
- Describe the Principles of working and operations performed on milling and grinding machines.
- Explain the use of various measuring instruments, gauges and system of limits, fits and tolerances.
- Describe the process of measuring the surface roughness, screw thread parameters and principles of coordinate measuring machines.

**UNIT – I:**

**Metal cutting:** Introduction, elements of cutting process – Geometry of single point tool, Chip formation and types of chips, tool materials, tool life, tool wear, cutting fluids, Analysis of orthogonal cutting-Merchant's force diagram, Machinability.

Engine lathe – Principle of working, types of lathes, specifications, operations on lathe, Taper turning methods, Lathe attachments. Capstan and Turret lathe – Single spindle and multi-spindle automatic lathes – tool layouts.

**UNIT – II:**

**Drilling and Boring Machines** – Geometry of twist drill, Principles of working, specifications, types, operations performed, machining time calculations, Types of Boring machines and applications. Shaping, slotting and planing machines –Principles of working, specifications, types of operations performed, applications, quick return mechanisms, machining time calculations.

**UNIT – III:**

**Milling machines** – Principles of working – Types of milling machines – Geometry of milling cutters methods of indexing. **Grinding** – theory of grinding – classification of grinding machines. Types of abrasives, bonds. Selection of a grinding wheel. Lapping, honing and broaching machines, comparison and Constructional features, machining time calculations

**UNIT – IV:**

**Introduction to Metrology:** Need, Types, Terminology, Methods of measurements, Selection of measuring Instruments Linear Measurement: Line and end standard, slip gauges, micrometers, spirit level.

**Limits, fits and tolerances-** Types of Fits - Unilateral and bilateral tolerance system, hole and shaft basis system. Interchangeability and selective assembly.

**Limit Gauges:** Taylor's principle, Design of GO and NO-GO gauges.  
Measurement of angles using Bevel protractor and Sine bar. Measurement of flatness using straight edges, surface plates, optical flat and auto collimator.

**UNIT – V:**

**Surface Roughness Measurement:** Factors affecting the surface roughness, reasons for controlling the surface texture, elements of surface texture-Roughness, Waviness, evaluation of surface roughness-CLA, RMS, Rz Values. Methods of measurement of surface finish, Talysurf. Screw thread measurement, Gear measurement; Machine Tool Alignment Tests on lathe, milling and drilling machines. Coordinate Measuring Machines: Types and Applications of CMM.

**TEXT BOOKS:**

1. Machine Tool Practices/ Kibbe, John. Neely, T. White, Rolando O. Meyer/ Pearson
2. Engineering Metrology/ R.K. Jain/ Khanna Publishers.

**REFERENCE BOOKS:**

1. Gupta I.C., Engineering Metrology, Dhanpat Rai Publications (P) Ltd, 2021 Edition.
2. Principles of Machine Tools, Bhattacharyya A and Sen.G.C / New Central Book Agency.
3. Fundamentals of Dimensional Metrology / Connie Dotson / Thomson
4. Fundamentals of Metal Machining and Machine Tools / Geoffrey Boothroyd / McGraw Hill
5. Principles of Engineering Metrology/ Rega Rajendra/ Jaico Publishers.
6. Metrology and Measurement/ Bewoor and Kulkarni/ Tata Mc Graw Hill.

**SM504MS: BUSINESS ECONOMICS and FINANCIAL ANALYSIS****B.Tech. III Year, I Sem.**

L	T	P	C
3	0	0	3

**Course Objective:** To learn the basic Business types, impact of the Economy on Business and Firms specifically. To analyze the Business from the Financial Perspective.

**Course Outcome:** The students will understand the various Forms of Business and the impact of economic variables on the Business. The Demand, Supply, Production, Cost, Market Structure, Pricing aspects are learnt. The Students can study the firm's financial position by analysing the Financial Statements of a Company.

**UNIT – I: Introduction to Business and Economics**

**Business:** Structure of Business Firm, Theory of Firm, Types of Business Entities, Limited Liability Companies, Sources of Capital for a Company, Non-Conventional Sources of Finance.

**Economics:** Significance of Economics, Micro and Macro Economic Concepts, Concepts and Importance of National Income, Inflation, Money Supply in Inflation, Business Cycle, Features and Phases of Business Cycle. Nature and Scope of Business Economics, Role of Business Economist, Multidisciplinary nature of Business Economics.

**UNIT – II: Demand and Supply Analysis**

**Elasticity of Demand:** Elasticity, Types of Elasticity, Law of Demand, Measurement and Significance of Elasticity of Demand, Factors affecting Elasticity of Demand, Elasticity of Demand in decision making, Demand Forecasting: Characteristics of Good Demand Forecasting, Steps in Demand Forecasting, Methods of Demand Forecasting.

**Supply Analysis:** Determinants of Supply, Supply Function and Law of Supply.

**UNIT – III: Production, Cost, Market Structures and Pricing**

**Production Analysis:** Factors of Production, Production Function, Production Function with one variable input, two variable inputs, Returns to Scale, Different Types of Production Functions.

**Cost analysis:** Types of Costs, Short run and Long run Cost Functions.

**Market Structures:** Nature of Competition, Features of Perfect competition, Monopoly, Oligopoly, Monopolistic Competition.

**Pricing:** Types of Pricing, Product Life Cycle based Pricing, Break Even Analysis, Cost Volume Profit Analysis.

**UNIT – IV: Financial Accounting:** Accounting concepts and Conventions, Accounting Equation, Double-Entry system of Accounting, Rules for maintaining Books of Accounts, Journal, Posting to Ledger, Preparation of Trial Balance, Elements of Financial Statements, Preparation of Final Accounts.

**UNIT – V: Financial Analysis through Ratios:** Concept of Ratio Analysis, Liquidity Ratios, Turnover Ratios, Profitability Ratios, Proprietary Ratios, Solvency, Leverage Ratios (simple problems). Introduction to Fund Flow and Cash Flow Analysis (simple problems).

**TEXT BOOKS:**

1. D. D. Chaturvedi, S. L. Gupta, Business Economics - Theory and Applications, International Book House Pvt. Ltd. 2013.
2. Dhanesh K Khatri, Financial Accounting, Tata McGraw Hill, 2017.
3. Geethika Ghosh, Piyali Gosh, Purba Roy Choudhury, Managerial Economics, 2e, Tata McGraw Hill Education Pvt. Ltd. 2017

**REFERENCE BOOKS:**

1. Paresh Shah, Financial Accounting for Management 2e, Oxford University Press, 2019.
2. S. N. Maheshwari, Sunil K Maheshwari, Sharad K Maheshwari, Financial Accounting, 5e, Vikas Publications, 2013.

**ME506PC: CAD/CAM****B.Tech. III Year, I Sem.**

L	T	P	C
2	0	0	2

**Pre-requisites:** To learn the importance and use of computers in design and manufacture

**Course objectives:** To provide an overview of how computers are being used in design, development of manufacturing plans and manufacture. To understand the need for integration of CAD and CAM

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

- Understand geometric transformation techniques in CAD.
- Develop mathematical models to represent curves and surfaces.
- Model engineering components using solid modeling techniques.
- Develop programs for CNC to manufacture industrial components.
- Understand the application of computers in various aspects of Manufacturing viz., Design, Proper planning, Manufacturing cost, Layout and Material Handling system.

**UNIT – I:**

Fundamentals of CAD/ CAM, Application of computers for Design and Manufacturing, Benefits of CAD/ CAM - Computer peripherals for CAD/ CAM, Design workstation, Graphic terminal, CAD/ CAM software- definition of system software and application software, CAD/ CAM database and structure.

**Geometric Modeling:** Wire frame modeling, wire frame entities, Interpolation and approximation of curves, Concept of parametric and non-parametric representation of curves, Curve fitting techniques, definitions of cubic spline, Bezier, and B-spline.

**UNIT – II:**

**Surface modeling:** Algebraic and geometric form, Parametric space of surface, blending functions, parametrization of surface patch, Subdividing, Cylindrical surface, Ruled surface, Surface of revolution Spherical surface, Composite surface, Bezier surface. B-spline surface, Regenerative surface and pathological conditions.

**Solid Modelling:** Definition of cell composition and spatial occupancy enumeration, Sweep representation, Constructive solid geometry, Boundary representations.

**UNIT – III:**

**NC Control Production Systems:** Numerical control, Elements of NC system, NC part programming: Methods of NC part programming, manual part programming, Computer assisted part programming, Post Processor, Computerized part program, SPPL (A Simple Programming Language). CNC, DNC and Adaptive Control Systems.

**UNIT – IV:**

**Group Technology:** Part families, Parts classification and coding. Production flow analysis, Machine cell design.

**Computer aided process planning:** Difficulties in traditional process planning, Computer aided process planning: retrieval type and generative type, Machinability data systems.

**Computer aided manufacturing resource planning:** Material resource planning, inputs to MRP, MRP output records, Benefits of MRP, Enterprise resource planning, Capacity requirements planning

**UNIT – V:**

**Flexible manufacturing system:** F.M.S equipment, FMS layouts, Analysis methods for FMS benefits of FMS.

**Computer aided quality control:** Automated inspection- Off-line, On-line, contact, Non-contact; Coordinate measuring machines, Machine vision.

**Computer Integrated Manufacturing:** CIM system, Benefits of CIM

**TEXT BOOKS:**

1. CAD/CAM Concepts and Applications / Alavala / PHI
2. CAD/CAM Principles and Applications / P. N. Rao / Mc Graw Hill
3. CAD/CAM : Computer Aided Design and manufacturing , Groover M.P., Zimmers / Pearson

**REFERENCE BOOKS:**

1. CAD/CAM/CIM/ Radhakrishnan and Subramanyam / New Age

**ME507PC: THERMAL ENGINEERING LAB****B.Tech. III Year, I Sem.**

L	T	P	C
0	0	4	2

**Pre-Requisite:** Thermodynamics and Thermal Engineering - I**Objective:** To understand the working principles of IC Engines and compressors.**List of Experiments**

1. To understand the timing of valve or port openings and closings in a 4-stroke or 2-stroke engine cycle.
2. To measure and evaluate the performance characteristics of a 4-stroke spark-ignition (SI) engine.
3. To evaluate the performance of a 2-stroke SI engine.
4. To investigate the friction losses within an IC engine using three distinct tests (Morse, Retardation, and Motoring Tests)
5. To determine how the heat generated during engine combustion is distributed.
6. To find the engine speed at which the SI engine operates most economically (with the best BSFC).
7. To investigate the impact of the air-fuel ratio (A/F ratio) on a SI engine's performance and emissions.
8. To assess the performance characteristics of an engine with a variable compression ratio (VCR).
9. To evaluate the performance of a 4-stroke compression-ignition (CI) engine at a constant speed.
10. To measure and analyze the volumetric efficiency of an air compressor unit.
11. To provide students or trainees with hands-on experience in dismantling and reassembling an engine.
12. To gain knowledge about the principles of operation, design, and maintenance of boilers.

**Note:** Perform a minimum of any 10 out of the 12 Exercises.

**ME508PC: METROLOGY and MACHINE TOOLS LAB****B.Tech. III Year, I Sem.**

L	T	P	C
0	0	3	1.5

**Prerequisites:** Theoretical exposure to Metrology and machine tools.**Course Objectives:**

1. To impart practical exposure to the metrology equipment and Machine Tools
2. To conduct experiments and understand the working of the same.

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

- Identify parts of Lathe and perform different operations on Lathe
- Identify parts of drilling machine and perform operations on drilling machine
- Identify parts of Milling Shaping and Planning machine and perform operations on Milling, Shaping and Planning machine
- Identify various measuring instruments and use them appropriately.
- Measure surface finish of machined components.

**List of Experiments:**

1. To learn how to produce a workpiece with different diameters along its length (steps) using a lathe.
2. To practice machining a workpiece with a conical shape (taper) using the lathe's compound slide.
3. (a) To learn how to generate various thread profiles (internal or external) on a workpiece using a lathe and threading tools.  
(b) To create a textured pattern on a workpiece surface for improved grip using a knurling tool on a lathe.
4. To analyze the forces acting on the cutting tool during machining on a lathe.
5. To practice drilling and boring holes of various sizes and depths using drilling and boring machines.
6. To learn how to generate gear teeth on a workpiece using a milling machine and specialized gear cutting tools (gear cutters, hobs).
7. To develop skills in sharpening and shaping cutting tools using a cylindrical grinder (for round tools) or surface grinder (for flat tools).
8. To practice using basic measuring tools like vernier calipers and micrometers for accurate measurement of lengths, heights, and diameters.
9. To practice using gear teeth vernier calipers, a specialized tool designed to measure specific gear tooth dimensions like chordal addendum (tooth height above pitch circle) and chordal height (total tooth height).
10. Use of gear teeth vernier calipers for checking the chordal addendum and chordal height of the spur gear.
11. Angle and taper measurements by bevel protractor and sine bars.
12. Thread measurement by 2-wire and 3-wire methods.
13. Surface roughness measurement by Tally Surf.
14. Use of mechanical comparator

**Note:** Perform a minimum of any 10 out of the 14 Exercises.

**ME509PC: Kinematics and Dynamics Machinery Laboratory****B.Tech. III Year, I Sem.**

L	T	P	C
0	0	3	1.5

**Prerequisites:** Prerequisites for the graduate-level course are Kinematics, Dynamics, differential equations, motion simulation, displacement, velocity, acceleration, force, torque, power, Newton's motion laws, vibration, Gyroscopic Effect, Cams, and Bearings.

**Course Objectives:** The objective of the lab is to understand the kinematics and dynamics of mechanical elements such as linkages, gears, and cams and learn to design such elements to accomplish desired motions or tasks.

**Course Outcomes:** Upon successful completion of this lab, students should be able to:

- Understand types of motion
- Analyze forces and torques of components in linkages
- Understand static and dynamic balance
- Understand forward and inverse kinematics of open-loop mechanisms

**List of Experiments:** (A Minimum of 10 experiments are to be conducted)

1. To determine the state of balance of machines for primary and secondary forces
2. To determine the frequency of torsional vibration of a given rod
3. To Determine the effect of varying mass on the center of a sleeve in Porter and propel governor
4. To Find the motion of the follower if the given profile of the cam
5. The balance masses statically and dynamically for single rotating mass systems
6. Determine the critical speed of a given shaft for different n-conditions
7. For a simple pendulum determine time period and its natural frequency
8. For a compound pendulum determine time period and its natural frequency
9. Determine the effect of gyroscope for different motions
10. Determine time period, amplitude and frequency of undamped free longitudinal vibration of single-degree spring-mass systems.
11. Determine the pressure distribution of lubricating oil at various loads and speeds of a Journal bearing.
12. Determine time period, amplitude and frequency of damped free longitudinal vibration of single degree spring mass systems.

**Note:** Perform a minimum of any 10 out of the 12 Exercises.

**\*MC510: INTELLECTUAL PROPERTY RIGHTS****B.Tech. III Year, I Sem.**

L	T	P	C
3	0	0	0

**Course Objectives:**

- Significance of intellectual property and its protection
- Introduce various forms of intellectual property

**Course Outcomes:**

- Distinguish and Explain various forms of IPRs.
- Identify criteria to fit one's own intellectual work in particular form of IPRs.
- Apply statutory provisions to protect particular form of IPRs.
- Appraise new developments in IPR laws at national and international level

**UNIT – I**

**Introduction to Intellectual property:** Introduction, types of intellectual property, international organizations, agencies and treaties, importance of intellectual property rights.

**UNIT – II**

**Trade Marks:** Purpose and function of trademarks, acquisition of trade mark rights, protectable matter, selecting, and evaluating trade mark, trade mark registration processes.

**UNIT – III**

**Law of copyrights:** Fundamental of copyright law, originality of material, rights of reproduction, rights to perform the work publicly, copyright ownership issues, copyright registration, notice of copyright, International copyright law.

**Law of patents:** Foundation of patent law, patent searching process, ownership rights and transfer

**UNIT – IV**

**Trade Secrets:** Trade secret law, determination of trade secret status, liability for misappropriations of trade secrets, protection for submission, trade secret litigation.

Unfair competition: Misappropriation right of publicity, false advertising.

**UNIT – V**

New development of intellectual property: new developments in trade mark law; copyright law, patent law, intellectual property audits.

International overview on intellectual property, international – trade mark law, copyright law, international patent law, and international development in trade secrets law.

**TEXT BOOK:**

1. Intellectual property right, Deborah. E. Bouchoux, Cengage learning.

**REFERENCE BOOK:**

1. Intellectual property right – Unleashing the knowledge economy, prabuddha ganguli, Tata McGraw Hill Publishing company ltd.

**ME601PC: Design of Machine Elements-II****B.Tech. III Year, II Sem.**

L	T	P	C
3	0	0	3

**Note:** Design Data Book is permitted. Design of all components should include design for strength and rigidity apart from engineering performance requirements.

**Pre-requisites:** Study of engineering mechanics, design of machine members-I and theory of machines.

**Course objectives:**

- To gain knowledge about designing the commonly used important machine members such as bearings, engine parts, springs, belts, gears etc.
- To design the components using the data available in design data books.

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

- Understand the types of bearings, bearing material, bearing design using different empirical relations.
- Estimate the life of rolling element bearings and their selection for given service conditions.
- Design of engine components like piston, connecting rod
- Design of springs, pulleys and belts
- Design of gears

**UNIT – I:**

**Sliding contact bearings:** Types of Journal bearings – Lubrication – Bearing Modulus – Full and partial bearings – Clearance ratio – Heat dissipation of bearings, bearing materials – journal bearing design.

**UNIT – II:**

**Rolling contact bearings:** Ball and roller bearings – Static load – dynamic load – equivalent radial load – design and selection of ball and roller bearings.

**UNIT – III:**

**Engine Parts:** Connecting Rod: Thrust in connecting rod – stress due to whipping action on connecting rod ends –Pistons, Forces acting on piston – Construction, Design, and proportions of the piston.

**UNIT – IV:**

**Mechanical Springs:** Stresses and deflections of helical springs – Extension and compression springs – Design of springs for fatigue loading – natural frequency of helical springs – Energy storage capacity – helical torsion springs – Design of co-axial springs, Design of leaf springs.

**Belts and Pulleys:** Transmission of power by Belt and Rope Drives, Transmission efficiencies, Belts – Flat and V types – Ropes - pulleys for belt and rope drives.

**UNIT – V:**

**Gears:** Spur gears and Helical gears- Brief introduction involving important concepts – Design of gears using AGMA procedure involving Lewis and Buckingham equations. Check for wear.

**TEXTBOOKS:**

1. Design of Machine Elements / Spotts/ Pearson
2. Machine Design / Pandya and Shah, 21<sup>st</sup> Edition, 2022 / Charoathar

**REFERENCE BOOKS:**

1. Design of Machine Elements-II / Annaiah, Suresh kumar, chandrappa / New Age
2. Design of Machine Elements / Sharma and Purohit/PHI
3. Design Data Book/ P.V. Ramana Murthi and M. Vidyasagar/ B.S. Publications.
4. Design Data Handbook/ S. Md. Jalaludeen/ Anuradha Publishers.

**ME602PC: HEAT TRANSFER****B.Tech. III Year, II Sem.**

L	T	P	C
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**Note:** Heat Transfer Data Book is permitted.**Pre-requisite:** Thermodynamics**Course Objectives:** To provide knowledge about the application of conduction, convection, and radiation heat transfer concepts to different practical applications**Course Outcome:** At the end of this course, students will be able to

- Understand the basic modes of heat transfer
- Compute one-dimensional steady state heat transfer with and without heat generation
- Understand and analyze heat transfer through extended surfaces
- Understand one-dimensional transient conduction heat transfer
- Understand concepts of continuity, momentum, and energy equations
- Interpret and analyze forced and free convective heat transfer
- Understand the principles of boiling, condensation, and radiation heat transfer
- Design of heat exchangers using LMTD and NTU methods

**UNIT – I:****Conduction-I:** Modes and mechanisms of heat transfer – Basic laws of Fourier heat transfer –General discussion about heat transfer applications, Fourier law of equation – General heat conduction equation in Cartesian, Cylindrical, and Spherical coordinates –steady, unsteady, and periodic heat transfer.**One Dimensional Steady State Conduction Heat Transfer:** composite slabs, hollow cylinders, and spheres- Composite systems– overall heat transfer coefficient – Electrical analogy – Critical radius of insulation**UNIT – II: Conduction-II****Heat Transfer in Fins:** systems with heat sources or Heat Generation-Extended surface (fins) Heat Transfer – Long Fin, Fin with insulated tip and Short Fin, Application to error measurement of Temperature**One-Dimensional Transient Conduction Heat Transfer:** Systems with negligible internal resistance – Significance of Biot and Fourier Numbers –Infinite bodies- Chart solutions of transient conduction systems- Concept of Semi-infinite body.**UNIT – III: Convective-I****Free Convective:** Classification of systems based on causation of flow, condition of flow, configuration of flow and medium of flow – Dimensional analysis as a tool for experimental investigation – Buckingham pi Theorem and method, application for developing semi-empirical non-dimensional correlation for convection heat transfer – Significance of non-dimensional numbers – Concepts of Continuity, Momentum and Energy Equations – Integral Method as approximate method -Application of Von Karman Integral Momentum Equation for flat plate with different velocity profiles. Development of Hydrodynamic and thermal boundary layer along a vertical plate - Use empirical relations for Vertical plates and pipes.**UNIT – IV:****Forced convection:** External Flows, Concepts about hydrodynamic and thermal boundary layer and use of empirical correlations for convective heat transfer -Flat plates and Cylinders.**Boiling:** Pool boiling – Regimes – Calculations on Nucleate boiling, Critical Heat flux, and Film boiling.**Condensation:** Film-wise and drop-wise condensation –Nusselt's Theory of Condensation on a vertical plate - Film condensation on vertical and horizontal cylinders using empirical correlations.

**UNIT – V: Radiation**

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

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

**TEXTBOOKS:**

1. Fundamentals of Engineering Heat and Mass Transfer by, Domkundwar Arora, Danpati rai & co.
2. Heat Transfer, J.P. Holman, Tenth Edition, McGraw Hill

**REFERENCE BOOKS:**

1. Heat Transfer by a Practical Approach, Yunus Cengel, Boles, TMH
2. Heat transfer, A conceptual Approach, P. K. Sarma, Rama Krishna, New Age
3. Heat and mass Transfer, Dr. D. S. Kumar, S. K. Kataria and Sons
4. Essential Heat Transfer - Christopher A Long / Pearson.
5. Heat Transfer –Ghosh dastidar / Oxford.
6. Heat and Mass Transfer data book, by Domkundwar, Danpati rai & co.

**ME603PC: FINITE ELEMENT METHODS****B.Tech. III Year, II Sem.**

L	T	P	C
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**Pre-requisites:** Mechanics of Solids**Course Objectives:** The aim of the course is to provide the students.

- Basics of Finite Element Analysis.
- Use of available material models for structural materials, soils and interfaces/joints.
- Modeling of engineering systems and Soil–Soil-structure interaction (SSI).
- Importance of interfaces and joints on the behavior of engineering systems.
- Implementation of material model in finite element method and applications.

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

- Apply the finite element method to solve problems in solid mechanics, fluid mechanics and heat transfer
- Formulate and solve problems in one dimensional structure including trusses, beams and frames.
- Formulate FE characteristic equations for two dimensional elements and analyze plain stress, plain strain, axi-symmetric and plate bending problems.
- Use of ANSYS, ABAQUS, NASTRAN, etc.

**UNIT – I:**

**Introduction to Finite Element Methods:** General Procedure – Engineering Applications – Stress and Equations of Equilibrium, Strain – Displacement relations. Stress–strain relations: Finite Elements: 1- Dimensional, 2 – Dimensional, and 3-Dimensional Elements.

**One-Dimensional Problems:** Formulation of Stiffness Matrix for a Bar Element by the Principle of Minimum Potential Energy, Properties of Stiffness Matrix, Characteristics of Shape Functions, Quadratic shape functions. Problems on uniform and stepped bars for different loading conditions.

**UNIT – II:**

**Analysis of Trusses:** Derivation of Stiffness Matrix for Trusses, Stress and strain Calculations, Calculation of reaction forces and displacements.

**Analysis of Beams:** Derivation of Stiffness matrix for two noded, two degrees of freedom per node beam element, Load Vector, Deflection, Stresses, Shear force and Bending moment, Problems on uniform and stepped beams for different types of loads applied on beams.

**UNIT – III:**

**Finite element – formulation of 2D Problems:** Derivation of Element stiffness matrix for two-dimensional CST Element, Derivation of shape functions for CST Element, Elasticity Equations, constitutive matrix formulation, Formulation of Gradient matrix.

Finite element modeling of Axi-symmetric solids subjected to Axi-symmetric loading with a triangular element: two-dimensional Isoparametric Elements and Numerical integration.

**UNIT – IV:**

**Steady State Heat Transfer Analysis:** One Dimensional Finite Element analysis of fin and composite slabs. Two-dimensional steady state heat transfer problems: Derivation of Thermal Stiffness matrix for 2D heat transfer problems-CST, Derivation of thermal force vector for 2D heat transfer problems.

**UNIT – V:**

**Dynamic Analysis:** Formulation of finite element model, element - Mass matrices, evaluation of Eigen values and Eigen vectors for a stepped bar, truss, and beam.

Finite element – formulation to 3-D problems in stress analysis, convergence requirements, Mesh generation. techniques such as semi-automatic and fully Automatic use of software such as ANSYS, ABAQUS, and NASTRAN using Hexahedral and Tetrahedral Elements.

**TEXT BOOKS:**

1. Rao S.S., “The Finite Element Methods in Engineering”, pergamon Press, 1989.
2. “Finite Element Analysis” by S. Md. Jalaludeen/ Anuradha Publishers.

**REFERENCE BOOKS:**

1. Concepts of finite element method / V. K. Manicka Selvam, India Scitech Publications 2001
2. Finite Element Analysis: In Engineering Design. Author. S. Rajasekaran. Publisher. Wheeler, 1993.

3. Finite Element Methods: Basic Concepts and Applications/Alavala/PHI
4. Introduction to Finite Elements in Engineering, Chandrupatla, Ashok and Belegundu /Pearson
5. An Introduction to the Finite Element Method / J. N. Reddy/ Mc Graw Hill
6. Finite Element Analysis / SS Bhavikatti / New Age.
7. Finite Element Method/ Dixit/Cengage.

**ME611PE: UNCONVENTIONAL MACHINING PROCESSES (PROFESSIONAL ELECTIVE – I)****B.Tech. III Year, II Sem.**

L	T	P	C
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**Course Overview:** The objective of this course is to introduce the student to more advanced topics in the machining processes. To bring out the need for Unconventional Machining Processes which will overcome the difficulties associated with Traditional Machining.

**Course Objectives:**

- To differentiate conventional and Unconventional Machining Processes and Ultrasonic Machining.
- To understand the process capabilities of abrasive, water jet and electro-chemical machining processes.
- To understand the working principle and important features of electrical discharge machining process.
- To understand the process parameters, accuracy and surface finish of electron beam and laser beam machining Processes.
- To understand the working principle and metal removal rate of plasma arc machining and abrasive finishing process.

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

- Study the need for unconventional machining processes and explain ultrasonic machining process.
- Describe Abrasive jet, Water jet, and Abrasive water jet machining and electrochemical machining process.
- Describe working principle and process variables of EDM process.
- Explain the process capabilities and process parameters of Electron Beam machining and Laser Beam machining.
- Describe the working of Plasma Arc machining, chemical machining and Abrasive Finishing processes.

**UNIT – I:**

**Introduction** – Need for non-traditional machining methods-Classification of modern machining processes – considerations in process selection. Materials. Applications.

Ultrasonic machining – Elements of the process, mechanics of metal removal process, parameters, economic considerations, applications and limitations, recent development.

**UNIT – II:**

**Abrasive Jet Machining, Water Jet Machining and Abrasive Water Jet Machining:** Basic principles, equipment, process variable, and mechanics of metal removal, MRR, application and limitations.

**Electro – Chemical Processes:** Fundamentals of electro chemical machining, electrochemical grinding, electro chemical honing and deburring processes, metal removal rate in ECM, Tool design, Surface finish and accuracy, economic aspects of ECM – Simple problems for estimation of metal removal rate.

**UNIT – III:**

**Thermal Metal Removal Processes:** General Principle and applications of Electric Discharge Machining, Electric Discharge Grinding and electric discharge wire cutting processes – Power circuits for EDM, Mechanics of metal removal in EDM, Process parameters, selection of tool electrode and

dielectric fluids, methods surface finish and machining accuracy, characteristics of spark eroded surface and machine tool selection. Wire EDM, principle, applications.

**UNIT – IV:**

Generation and control of electron beam for machining, theory of electron beam machining, comparison of thermal and non-thermal processes –General Principle and application of laser beam machining – thermal features, cutting speed and accuracy of cut.

**UNIT – V:**

Application of plasma for machining, metal removing mechanism, process parameters, accuracy and surface finish and other applications of plasma in manufacturing industries. Chemical machining – principle - maskants - applications.

Magnetic abrasive finishing, Abrasive flow finishing, Electro stream drilling, shaped tube electrolyte machining.

**TEXT BOOKS:**

1. Advanced Machining Processes / VK Jain / Allied publishers
2. Modern Machining Processes - P. C. Pandey, H. S. Shan/ Mc Graw Hill

**REFERENCE BOOKS:**

1. Unconventional Manufacturing Processes/ Singh M.K/ New Age Publishers
2. Advanced Methods of Machining/ J.A. McGeough/ Springer International
3. Non-Traditional Manufacturing Processes/ Benedict G.F./ CRC Press

**ME612PE: PRODUCTION PLANNING and CONTROL (PROFESSIONAL ELECTIVE – I)****B.Tech. III Year, II Sem.**

L	T	P	C
3	0	0	3

**Pre-requisites:** Management Science and Productivity.

**Course Objectives:** Understand the importance of Production planning and control. Learning way of carrying out various functions so as to produce right product, right quantity at right time with minimum cost.

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

- Understand production systems and their characteristics.
- Evaluate MRP and JIT systems against traditional inventory control systems.
- Describe and apply methods of line balancing and routing techniques.
- Apply various types of scheduling techniques to production systems.
- Apply dispatching and follow up techniques to the production control and management system.

**UNIT – I:**

**Introduction:** Definition – Objectives of Production Planning and Control – Functions of production planning and control - Types of production systems - Organization of production planning and control department.

**Forecasting** – Definition- uses of forecast- factors affecting the forecast- types of forecasting- their uses - general principle of forecasting. Forecasting techniques- quantitative and qualitative techniques. Measures of forecasting errors.

**UNIT – II:**

**Inventory management** – Functions of inventories – relevant inventory costs – ABC analysis – VED analysis – Basic EOQ model- Inventory control systems –continuous review systems and periodic review systems, MRP I, MRP II, ERP, JIT Systems - Basic Treatment only.

**Aggregate planning** – Definition – aggregate-planning strategies – aggregate planning methods – transportation model.

**UNIT – III:**

**Line Balancing:** Terminology, Methods of Line Balancing, RPW method, Largest Candidate method and Heuristic method.

Routing– Definition – Routing procedure – Factors affecting routing procedure, Route Sheet.

**UNIT – IV:**

**Scheduling** –Definition – Scheduling Policies – types of scheduling methods – differences with loading – flow shop scheduling – job shop scheduling, line of balance (LOB) – objectives - steps involved.

**UNIT – V:**

**Dispatching:** Definition – activities of dispatcher – dispatching procedures – various forms used in dispatching.

**Follow up:** definition – types of follow up – expediting – definition – expediting procedures-Applications of computers in planning and control.

**TEXT BOOKS:**

1. Operations management/ Heizer/Pearson/13<sup>th</sup> Edition, 2019
2. Production and Operations Management / Ajay K Garg / Mc Graw Hill, 1<sup>st</sup> Edition, 2017

**REFERENCE BOOKS:**

1. Production Planning and Control- Textand cases/ SK Mukhopadhyaya /PHI, 2<sup>nd</sup> Edition, 2007.
2. Production Planning and Control- Jain and Jain – Khanna publications, 8<sup>th</sup> Edition, 1999.

**ME613PE: OPERATIONS RESEARCH (PROFESSIONAL ELECTIVE – I)****B.Tech. III Year, II Sem.**

L	T	P	C
3	0	0	3

**Course Objectives:** To Understand the importance of optimization model and solving it.**Course Outcome:** At the end of the course, the student will be able to

- Understand the problem, identify the variables and constants
- Formulate the optimization model and apply appropriate optimization technique

**UNIT – I:**

Development-definition-characteristics and phases-Types of models-Operations Research models-applications.

**Allocation:** Linear Programming Problem Formulation-Graphical solution- Simplex method-Artificial variable techniques: Two-phase method, Big-M method.**UNIT – II:****Transportation problem** - Formulation-Optimal solution, unbalanced transportation problem-Degeneracy.**Assignment problem-** Formulation-Optimal solution, - Variants of Assignment problem- Travelling salesman problem.**UNIT – III:****Sequencing-** Introduction-Flow-Shop sequencing- n jobs through two machines – n jobs through three machines- Job shop sequencing-two jobs through 'm' machines**Replacement:** Introduction- Replacement of items that deteriorate with time- when money value is not counted and counted- Replacement of items that fail completely- Group Replacement.**UNIT – IV:****Theory of Games:** Introduction- Terminology- Solution of games with saddle points and without saddle points. 2 x 2 games- dominance principle- m x 2 and 2 x n games- Graphical method.**Inventory:** Introduction- Single item, Deterministic models- purchase inventory models with one price break and multiple price breaks- Stochastic models \_ Demand may be discrete variable or continuous variable- single period model and no setup cost.**UNIT – V:****Waiting lines:** Introduction- Terminology- Single channel- Poisson arrivals and Exponential service times with infinite population.**Dynamic Programming:** Introduction- Terminology, Bellman's principle of optimality- Applications of Dynamic programming- shortest path problem- linear programming problem.**TEXT BOOK:**

1. Operations Research/M.V. Durga Prasad, K. Vijaya Kumar Reddy, J. Suresh Kumar/Cengage Learning.
2. Operations Research/NVS Raju/SMS Education/3<sup>rd</sup> Revised Edition
3. Operations Research Theory and Applications / J. K. Sharma sixth Edition, Trinity
4. Introduction to Operations Research/ Hillier and Lieberman/MGH

**REFERENCE BOOKS:**

1. Operations Research: An Introduction, Hamdy A.Taha/PHI
2. Operations Research /A. M. Natarajan, P. Balasubramaniam, A. Tamilarasi/Pearson Education.
3. Operations Research/ Wagner/ PHI Publications.

**ME614PE: MICROPROCESSORS IN AUTOMATION (PROFESSIONAL ELECTIVE – I)****B.Tech. III Year, II Sem.**

L	T	P	C
3	0	0	3

**UNIT - I: Basic Concepts of Digital Circuits**

Number Systems, Logic Gates, Combinational Circuits, Flip-flops, Sequential Logic Circuits: Counters, Shift Registers.

Basic components and computer architecture- CPU, Memory and Peripherals

**UNIT - II: Architecture of Microprocessor**

Introduction, Origin, Historical Developments, Introduction to 8085 Functional Block Diagram, Registers, ALU, Bus Systems, Timing and Control Signals, PIN diagram, Machine Cycles, Instruction Cycle and Timing States, Instruction Timing Diagrams, Addressing Modes. Concept of Interrupt, Need for Interrupts, Interrupt structure, Multiple Interrupt requests and their handling, Programmable interrupt controller

**UNIT - III: Assembly Language Programming**

Instruction Set, Simple programs in 8085 mainly on Addition, Subtraction, Multiplication, Rotation, Ascending and Descending of the given data

**UNIT - IV: Memory and I/O Device Interfacing**

Memory Interfacing - Memory structure and its requirements, Basic Concept in Memory Interfacing, Address Decoding, Interfacing Circuits, Address Decoding and Memory Addresses, Typical Examples on Memory interfacing: Interface (2k x 8) ROM, (8k x 8) EPROM, and (1k x 8) RAM with 8085.

IO Interfacing – Basic Interfacing Concepts-Peripheral I/O instructions, I/O Execution, Device Selection and data transfer, absolute vs. Partial Decoding, Input Interfacing, Interfacing I/Os using Decoders

**UNIT - V: Architecture of Microcontroller**

Introduction to Microcontrollers and how they differ from microprocessors, Block diagram of Microcontrollers, Architecture of 8051 microcontroller, Pin Diagram, Instruction set, simple 8051 programming, introduction to ARM microcontroller and its applications.

**TEXT BOOKS:**

1. Microprocessor Architecture, Programming, and Applications with the 8085, Ramesh Gaonkar, PENRAM International Publishers.
2. The 8051 Microcontroller and Embedded Systems: Using Assembly and C, Muhammad Ali Mazidi, Janice Gillispie Mazidi and Rolin D, Mckinlay, 2nd Edition, Pearson publication, 2007.

**REFERENCE BOOKS:**

1. Microprocessors and Interfacing: Programming and Hardware, Douglas V. Hall
2. Microcomputer Experimentation with the Intel SDK-85, Lance A. Leventhal, Prentice Hall
3. Introduction to Microprocessors, Aditya P Mathur, Tata McGraw-Hill, Europe; 3<sup>rd</sup> Edition, 1990.
4. Digital Electronics: An Introduction to Theory and Practice, William H. Gothmann, PHI Learning Private Limited.
5. Digital and microprocessor technology, Patrick J O'Connor, Prentice-Hall, 1983.
6. Digital and Microprocessor Engineering, S.J.Cahill, Willis Horwood Limited (John Wiley and Sons).
7. Digital Control Systems, Benjamin C. Kuo, Oxford University Press (2/e, Indian Edition, 2007).
8. Digital Computer Electronics: An Introduction to Microcomputers, Albert Pual Malvino, Tata McGraw-Hill Publishing Company Ltd.

**ME6110E: BASIC MECHANICAL ENGINEERING (OPEN ELECTIVE – I)****B.Tech. III Year, II Sem.**

L	T	P	C
3	0	0	3

**Course objectives:** To provide the essential basic knowledge of Mechanical Engineering to the students

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

- Understand different types of power generation, working of refrigerator
- Summarize different types of manufacturing processes and Power transmission systems
- Discuss about conventional and non-conventional sources of energy
- Identify automation of various manufacturing processes in engineering practice.
- Describe the basic concepts and applications of industrial robotics

**UNIT- I:**

Energy: Power Generation: External and internal combustion engines-Thermal Power Plants-Working Principle, layouts, element/component description, advantages, disadvantages, applications.

2-Stroke, 4-Stroke Engines and their Components.

Refrigeration: Mechanical Refrigeration and types – units of refrigeration – Air Refrigeration system, Vapour Compression Refrigeration System- Principle of operation.

**UNIT- II:**

Machine and Mechanisms-Degrees of Freedom, functions of Flywheel and Governors, Types of joints-Riveted, welded and bolted joints. Applications, Merits and Demerits.

Power Transmission Elements: Gears terminology of spur, helical and bevel gears, gear trains.

Belt drives (types). Chain drives.

**UNIT- III:**

Manufacturing Processes: Primary and secondary process. Casting: Types, equipment, applications. Metal forming processes-rolling, extrusion

Welding: Types – Equipment –Techniques employed – advantages / disadvantages – Gas cutting – Brazing and soldering.

**UNIT- IV:**

Machine Tools: Introduction to lathe, drilling machine, milling machine, grinding machine-Operations performed. CNC Machines- Basic elements, advantages. Limits, fits and tolerances, Surface finish of various manufacturing process.

**UNIT- V:** Non-conventional sources of energy-Solar, wind, tidal, biogas and nuclear- Principles.

Robotics – Joints, end effectors, applications. Introduction to 3D Printing.

**TEXT BOOKS:**

1. Sadhu Singh, Basic Mechanical Engineering, S. Chand and Co. Ltd, New Delhi, 2013
2. Pravin Kumar, Basic mechanical Engineering, 2018, Pearson

**REFERENCE BOOKS:**

1. Hajra Choudhary, S.K. and Hajra Choudhary, A. K., Elements of Workshop Technology Vols.I and II, Indian Book Distributing Company Calcutta, 2007.
2. Nag, P.K., Power Plant Engineering, Tata McGraw-Hill, New Delhi, 2008.
3. Rattan, S.S., Theory of Machines, Tata McGraw-Hill, New Delhi, 2010.

**ME612OE: RENEWABLE ENERGY SOURCES (OPEN ELECTIVE – I)****B.Tech. III Year, II Sem.**

L	T	P	C
3	0	0	3

**Course Objectives:**

- To provide an introduction to energy systems and renewable energy resources, with a scientific examination of the energy field and an emphasis on alternate energy sources and their technology and application.
- To explore society's present needs and future energy demands, examine conventional energy sources and systems, including fossil fuels and nuclear energy.
- To focus on alternate, renewable energy sources such as solar, biomass (conversions), wind power, geothermal, and hydro, Energy conservation methods.

**Course Outcomes:**

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

- Explain the main sources of energy including Solar energy and their primary applications in Global Context.
- Describe the challenges and problems associated with the use of solar energy sources and its Economic Evaluation
- Discuss significance of Wind energy systems and its components with basic working principles
- Elaborate the sources of energy from water by various means such as OTEC, Tidal energy etc.
- Narrate the importance and potential of geo thermal energy and MHD power generation

**UNIT- I:**

**Solar Radiation And Collecting Devices:** Solar Incident Flux, Extra-terrestrial Radiation, Clear Sky Irradiation, Solar Radiation Measurement, Monthly Average Radiation on Tilted Surfaces. Cover plates, Collector Plate Surfaces, Collector Performance, Collector Improvement, Effect of Incident Angle, Heat Transfer to Fluids, Heat Transfer Factors, Concentrating Collectors, Reflectors.

**UNIT- II:**

**Solar System Design And Economic Evaluation** Hot water heating, heating and hot water systems , pumps and fans, sizing pipe and duct work, fundamentals of economic analysis, systems optimization

**UNIT- III:**

**Wind Energy Systems:** Orientation systems and Regulating devices, Types of Wind Turbines, Operating Characteristics, Basics of Airfoil Theory, Wind energy for water pumping and generation of electricity, Installation operation and maintenance of small wind energy conversion systems.

**UNIT-IV:**

**Energy From Water:** OTEC–Principle of operation, Open and Closed OTEC cycles, Wave energy: Wave energy conversion machines and recent advances Tidal Energy: Single basin and double basin tidal systems Small-Mini-Micro hydro system: Concepts, Types of turbines, Hydrological analysis.

**UNIT- V:**

**Geothermal Energy:** Introduction, Classification of Geo-thermal areas, Applications of Geo-thermal energy for power generation, Economics of Geo-thermal energy. MHD POWER GENERATION: Principles of MHD Power Generation, Ideal MHD–Generator Performance, Practical MHD Generator: Faraday and Hall Configurations, MHD Technology.

**TEXT BOOKS:**

1. Non-Conventional sources of Energy by G. D. Rai, Kanna Publications.
2. Non-conventional Energy resources, BH Khan, McGraw-Hill

**REFERENCE BOOKS:**

1. Fundamentals of Renewable Energy Sources, G. N. Tiwari, Ghosal, Alpha Science
2. Solar Energy Fundamentals and Applications, H. P Garg, Prakash, TMH.
3. Solar Energy: Principles of thermal storage, S. P Sukhatme, TMH

**ME604PC: HEAT TRANSFER LAB****B.Tech. III Year, II Sem.**

L	T	P	C
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**Pre-requisite:** Thermodynamics**Course Objectives:** To enable the student to apply conduction, convection and radiation heat transfer concepts to practical applications**Course Outcome:** At the end of the lab sessions, the student will be able to

- Perform steady state conduction experiments to estimate thermal conductivity of different materials
- Perform transient heat conduction experiment
- Estimate heat transfer coefficients in forced convection, free convection, condensation and correlate with theoretical values
- Obtain variation of temperature along the length of the pin fin under forced and free convection
- Perform radiation experiments: Determine surface emissivity of a test plate and Stefan- Boltzmann's constant and compare with theoretical value

**Minimum ten experiments from the following:**

1. To determine the overall heat transfer coefficient of a composite wall (made of different materials).
2. To investigate the influence of insulation (lagging) on heat transfer through a pipe.
3. To measure the heat transfer rate between concentric spheres at different temperatures.
4. To determine the thermal conductivity of a specific metal rod.
5. To study the effect of pin fins (extended surfaces) on heat transfer from a solid object.
6. To observe and analyze the transient (time-varying) behavior of heat conduction in a solid object.
7. To investigate heat transfer through a fluid (liquid or gas) forced to flow over a surface.
8. To study heat transfer through a fluid (liquid or gas) due to natural buoyancy forces arising from temperature differences.
9. To determine the effectiveness of Parallel and counter-flow heat exchangers.
10. To measure the emissivity of a material.
11. To verify the Stefan-Boltzmann Law, which relates the radiant heat flux emitted by a blackbody (perfect emitter) to its absolute temperature.
12. To determine the critical heat flux (CHF) for a particular surface.
13. To explore the operating principles of a heat pipe, a passive heat transfer device that utilizes capillary action and phase change (evaporation and condensation) to efficiently transfer heat over long distances.
14. To observe and compare film wise and dropwise condensation phenomena.

**ME605PC: COMPUTER AIDED ENGINEERING LAB****B.Tech. III Year, II Sem.**

L	T	P	C
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**Course Objectives:**

- To be able to understand and handle design problems in a systematic manner.
- To be able to apply CAD in real life applications.
- To understand the basic principles of different types of analysis.

**Course Outcomes:**

- To understand the analysis of various aspects in design
- To have exposure to usage of software tools for design and manufacturing.
- To acquire the skills needed to analyze and simulate engineering systems.

**Note: conduct any TEN exercises from the list given below:**

1. To develop skills in creating technical drawings of machine components using orthographic (multiple views) and isometric (3D) projections.
2. To learn how to use CAD software to generate 3D models of components using various techniques.
3. To analyze the deflection (bending) and stresses in simple 2D and 3D trusses and beams under various loading conditions.
4. To perform more complex stress analysis using finite element analysis (FEA) software
5. To apply FEA or analytical methods to determine stresses in 3D structures (like brackets) and shell structures (like pressure vessels).
6. To learn how to estimate the natural frequencies (vibrational modes) and mode shapes (deformation patterns) of a 2D beam.
7. To use computational tools to perform steady-state heat transfer analysis of plane and axisymmetric components.
8. To develop process sheets that outline the necessary steps, tools, and machines required to manufacture a specific component.
9. To gain knowledge about common manufacturing defects and how to prevent them.
10. To Study the various post-processors used in NC Machines.
11. To learn how to use CAM software to generate NC code for machining complex free-form and sculptured surfaces
12. To practice transferring NC code generated by CAM software to actual NC lathes and mills for machining simple components.

**EN606HS: ADVANCED ENGLISH COMMUNICATION SKILLS LAB****B.Tech. III Year, II Sem.**

L	T	P	C
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**1. Introduction**

The introduction of the Advanced English Communication Skills Lab is considered essential at the B.Tech 3<sup>rd</sup> year level. At this stage, the students need to prepare themselves for their career which may require them to listen to, read, speak and write in English both for their professional and interpersonal communication in the globalised context.

The proposed course should be a laboratory course to enable students to use appropriate English and perform the following:

1. Gathering ideas and information to organise ideas relevantly and coherently.
2. Making oral presentations.
3. Writing formal letters.
4. Transferring information from non-verbal to verbal texts and vice-versa.
5. Writing project/research reports/technical reports.
6. Participating in group discussions.
7. Engaging in debates.
8. Facing interviews.
9. Taking part in social and professional communication.

**2. Objectives:**

This Lab focuses on using multi-media instruction for language development to meet the following targets:

- To improve the students' fluency in English, with a focus on vocabulary
- To enable them to listen to English spoken at normal conversational speed by educated English speakers
- To respond appropriately in different socio-cultural and professional contexts
- To communicate their ideas relevantly and coherently in writing
- To prepare the students for placements.

**3. Syllabus:**

The following course content to conduct the activities is prescribed for the Advanced English Communication Skills (AECS) Lab:

1. **Activities on Listening and Reading Comprehension:** Active Listening – Development of Listening Skills Through Audio clips - Benefits of Reading – Methods and Techniques of Reading – Basic Steps to Effective Reading – Common Obstacles – Discourse Markers or Linkers - Sub- skills of reading - Reading for facts, negative facts and Specific Details- Guessing Meanings from Context, Inferring Meaning - Critical Reading — Reading Comprehension – Exercises for Practice.
2. **Activities on Writing Skills:** Vocabulary for Competitive Examinations - Planning for Writing – Improving Writing Skills - Structure and presentation of different types of writing – Free Writing and Structured Writing - Letter Writing –Writing a Letter of Application –Resume vs. Curriculum Vitae – Writing a Résumé – Styles of Résumé - e-Correspondence – Emails – Blog Writing - (N)etiquette – Report Writing – Importance of Reports – Types and Formats of Reports– Technical Report Writing– Exercises for Practice.
3. **Activities on Presentation Skills** - Starting a conversation – responding appropriately and relevantly – using the right language and body language – Role Play in different situations including Seeking Clarification, Making a Request, Asking for and Refusing Permission, Participating in a Small Talk – Oral presentations (individual and group) through JAM sessions- PPTs – Importance of Presentation Skills – Planning, Preparing, Rehearsing and Making a Presentation – Dealing with Glossophobia or Stage Fear – Understanding Nuances of Delivery - Presentations through Posters/Projects/Reports – Checklist for Making a Presentation and Rubrics of Evaluation

4. **Activities on Group Discussion (GD):** Types of GD and GD as a part of a Selection Procedure - Dynamics of Group Discussion- Myths of GD - Intervention, Summarizing - Modulation of Voice, Body Language, Relevance, Fluency and Organization of Ideas – Do's and Don'ts - GD Strategies – Exercises for Practice.
5. **Interview Skills:** Concept and Process - Interview Preparation Techniques - Types of Interview Questions – Pre-interview Planning, Opening Strategies, Answering Strategies - Interview Through Tele-conference and Video-conference - Mock Interviews.

#### 4. Minimum Requirement:

The Advanced English Communication Skills (AECS) Laboratory shall have the following infrastructural facilities to accommodate at least 35 students in the lab:

- Spacious room with appropriate acoustics
- Round Tables with movable chairs
- Audio-visual aids
- LCD Projector
- Public Address system
- One PC with latest configuration for the teacher
- T. V, a digital stereo and Camcorder
- Headphones of High quality

**5. Suggested Software:** The software consisting of the prescribed topics elaborated above should be procured and used.

- **TOEFL and GRE** (KAPLAN, AARCO and BARRONS, USA, Cracking GRE by CLIFFS)
- **Oxford Advanced Learner's Dictionary**, 10<sup>th</sup> Edition
- **Cambridge Advanced Learner's Dictionary**
- **DELTA's key to the Next Generation TOEFL Test: Advanced Skill Practice.**
- **Lingua TOEFL CBT Insider**, by Dreamtech

#### 6. Books Recommended:

1. Rizvi, M. Ashraf (2018). *Effective Technical Communication*. (2<sup>nd</sup> ed.). McGraw Hill Education (India) Pvt. Ltd.
2. Suresh Kumar, E. (2015). *Engineering English*. Orient BlackSwan Pvt. Ltd.
3. Bailey, Stephen. (2018). *Academic Writing: A Handbook for International Students*. (5<sup>th</sup> Edition). Routledge.
4. Koneru, Aruna. (2016). *Professional Communication*. McGraw Hill Education (India) Pvt. Ltd.
5. Raman, Meenakshi and Sharma, Sangeeta. (2022). *Technical Communication, Principles and Practice*. (4<sup>TH</sup> Edition) Oxford University Press.
6. Anderson, Paul V. (2007). *Technical Communication*. Cengage Learning Pvt. Ltd. New Delhi.
7. McCarthy, Michael; O'Dell, Felicity and Redman, Stuart. (2017). *English Vocabulary in Use Series*. Cambridge University Press
8. Sen, Leela. (2009). *Communication Skills*. PHI Learning Pvt Ltd., New Delhi.
9. Elbow, Peter. (1998). *Writing with Power*. Oxford University Press.
10. Goleman, Daniel. (2013). *Emotional Intelligence: Why it can matter more than IQ*. Bloomsbury Publishing.

**\*MC609: ENVIRONMENTAL SCIENCE****B.Tech. III Year, II Sem.**

L	T	P	C
3	0	0	0

**Course Objectives:**

- Understanding the importance of ecological balance for sustainable development.
- Understanding the impacts of developmental activities and mitigation measures
- Understanding the environmental policies and regulations

**Course Outcomes:**

Based on this course, the Engineering graduate will understand /evaluate / develop technologies on the basis of ecological principles and environmental regulations which in turn helps in sustainable development

**UNIT – I:**

**Ecosystems:** Definition, Scope and Importance of ecosystem. Classification, structure, and function of an ecosystem, Food chains, food webs, and ecological pyramids. Flow of energy, Biogeochemical cycles, Bioaccumulation, Biomagnification, ecosystem value, services and carrying capacity, Field visits.

**UNIT – II:**

**Natural Resources: Classification of Resources:** Living and Non-Living resources, **water resources:** use and over utilization of surface and ground water, floods and droughts, Dams: benefits and problems. **Mineral resources:** use and exploitation, environmental effects of extracting and using mineral resources, **Land resources:** Forest resources, **Energy resources:** growing energy needs, renewable and non-renewable energy sources, use of alternate energy source, case studies.

**UNIT – III:**

**Biodiversity and Biotic Resources:** Introduction, Definition, genetic, species and ecosystem diversity. Value of biodiversity; consumptive use, productive use, social, ethical, aesthetic and optional values. India as a mega diversity nation, Hot spots of biodiversity. Field visit. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts; conservation of biodiversity: In-Situ and Ex-situ conservation. National Biodiversity act.

**UNIT – IV:**

**Environmental Pollution and Control Technologies: Environmental Pollution:** Classification of pollution, **Air Pollution:** Primary and secondary pollutants, Automobile and Industrial pollution, Ambient air quality standards. **Water pollution:** Sources and types of pollution, drinking water quality standards. **Soil Pollution:** Sources and types, Impacts of modern agriculture, degradation of soil. **Noise Pollution:** Sources and Health hazards, standards, **Solid waste:** Municipal Solid Waste management, composition and characteristics of e-Waste and its management. **Pollution control technologies:** Wastewater Treatment methods: Primary, secondary and Tertiary.

Overview of air pollution control technologies, Concepts of bioremediation. **Global Environmental Problems and Global Efforts:** Climate change and impacts on human environment. Ozone depletion and Ozone depleting substances (ODS). Deforestation and desertification. International conventions / Protocols: Earth summit, Kyoto protocol, and Montréal Protocol.

**UNIT – V:**

**Environmental Policy, Legislation and EIA:** Environmental Protection act, Legal aspects Air Act-1981, Water Act, Forest Act, Wild life Act, Municipal solid waste management and handling rules, biomedical waste management and handling rules, hazardous waste management and handling rules. EIA: EIA structure, methods of baseline data acquisition. Overview on Impacts of air, water, biological and Socio-

economical aspects. Strategies for risk assessment, Concepts of Environmental Management Plan (EMP). **Towards Sustainable Future:** Concept of Sustainable Development, Population and its explosion, Crazy Consumerism, Environmental Education, Urban Sprawl, Human health, Environmental Ethics, Concept of Green Building, Ecological Foot Print, Life Cycle assessment (LCA), Low carbon life style.

**TEXT BOOKS:**

1. Textbook of Environmental Studies for Undergraduate Courses by Erach Bharucha for University Grants Commission.
2. Environmental Studies by R. Rajagopalan, Oxford University Press.

**REFERENCE BOOKS:**

1. Environmental Science: towards a sustainable future by Richard T. Wright. 2008 PHL Learning Private Ltd. New Delhi.
2. Environmental Engineering and science by Gilbert M. Masters and Wendell P. Ela. 2008 PHI Learning Pvt. Ltd.
3. Environmental Science by Daniel B. Botkin and Edward A. Keller, Wiley INDIA edition.
4. Environmental Studies by Anubha Kaushik, 4<sup>th</sup> Edition, New age international publishers.
5. Text book of Environmental Science and Technology - Dr. M. Anji Reddy 2007, BS Publications.

**ME701PC: INDUSTRIAL MANAGEMENT****B.Tech. IV Year, I Sem.**

L	T	P	C
2	0	0	2

**Prerequisites:** None**Course objectives:**

- Understand the philosophies of management gurus
- Understand the various types of organization structures and their features, and Their advantages and disadvantages.
- Learning various Industrial Engineering Practices like Operations Management techniques, work study, statistical quality control techniques, Job evaluation techniques and network analysis techniques.

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

- apply principles of management
- design the organization structure
- apply techniques for plant location, design plant layout and value analysis
- carry out work study to find the best method for doing the work and establish standard time for a given method
- apply various quality control techniques and sampling plans
- do job evaluation and network analysis.

**UNIT – I:**

**Introduction to Management:** Entrepreneurship and organization – Nature and Importance of Management, Functions of Management, Taylor’s Scientific Management Theory, Fayol’s Principles of Management, Maslow’s Theory of Human Needs, Douglas McGregor’s Theory X and Theory Y, Herzberg’s Two-Factor Theory of Motivation, Systems Approach to Management, Leadership Styles, Social responsibilities of Management

**UNIT – II:**

**Designing Organizational Structures:** Departmentalization and Decentralization, Types of Organization structures – Line organization, Line and staff organization, functional organization, Committee organization, matrix organization, Virtual Organization, Cellular Organization, team structure, boundary less organization, inverted pyramid structure, lean and flat organization structure and their merits, demerits and suitability.

**UNIT – III:**

**Operations Management:** Objectives- product design process- Process selection-Types of production system (Job, batch and Mass Production), Plant location-factors- Urban-Rural sites comparison-Types of Plant Layouts- Design of product layout- Line balancing (RPW method) Value analysis-Definition- types of values- Objectives- Phases of value analysis- Fast diagram

**UNIT - IV:**

**Work Study:** Introduction — definition — objectives — steps in work study — Method study — definition, objectives — steps of method study. Work Measurement — purpose — types of study — stop watch methods — steps — key rating — allowances — standard time calculations — work sampling.

**Statistical Quality Control:** variables-attributes, Shewart control charts for variables- chart, R chart, – Attributes- Defective-Defect- Charts for attributes-p-chart -c chart (simple Problems), Acceptance Sampling- Single sampling- Double sampling plans-OC curves.

**UNIT – V:**

**Job Evaluation:** Methods of job evaluation — simple routing objective systems — classification method factor comparison method, point method, benefits of job evaluation and limitations. **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. (simple problems)

**TEXT BOOKS:**

1. Industrial Engineering and Management/O.P. Khanna/Khanna Publishers.
2. Industrial Engineering and Management Science/T.R. Banga and S.C. Sarma/Khanna Publishers.

**REFERENCE BOOKS:**

1. Motion and Time Study by Ralph M Barnes! John Willey and Sons Work Study by ILO.
2. Human factors in Engineering and Design/Ernest J McCormick /TMH.
3. Production and Operation Management /Paneer Selvam/PHI.
4. Industrial Engineering Management/NVS Raju/Cengage Learning.
5. Industrial Engineering Hand Book/Maynard.
6. Industrial Engineering Management I Ravi Shankar/Galgotia.

**ME702PC: REFRIGERATION and AIR CONDITIONING****B.Tech. IV Year, I Sem.**

L	T	P	C
3	0	0	3

**Prerequisites:** Thermodynamics**Course Objectives:**

- Apply the principles of thermodynamics to analyze different types of refrigeration and HAV
- To understand the functionality of the major components of the refrigeration and HAV
- To apply the knowledge in effective refrigeration and HAV systems for better performances in real context
- Discuss the heating procedure by Air conditioning process
- Explain the requirement of ventilation devices/processes

**Course Outcomes:**

- Differentiate between different types of refrigeration systems with respect to application as well as conventional and unconventional refrigeration systems.
- Analyse thermodynamically low temperature refrigeration and Vapour absorption refrigeration for evaluation of performance parameters.
- Apply the air refrigeration principles for different types of Air craft refrigeration systems
- Elaborate the principles of psychometrics to design the air conditioning heating /cooling loads for industrial applications.
- explain the requirement of ventilation air, various sources of infiltration air, ventilation and infiltration as a part of cooling load

**UNIT– I:**

**Vapour Compression Refrigeration:** Performance of Complete vapor compression system. Actual Vs Ideal cycle - Effect of operating parameters on COP.

**Components of Vapor Compression System:** The condensing unit – Evaporators – Expansion valve – Refrigerants – Properties – ODP and GWP - Load balancing of vapor compression Unit.

**Compound Compression:** Flash inter-cooling – flash chamber – Multi-evaporator and Multistage systems.

**UNIT– II:**

**Production of Low Temperature:** Liquefaction system, Liquefaction of gases, Hydrogen and Helium, Cascade System – Applications– Dry ice system.

**Vapor absorption system** – Simple and modified aqua – ammonia system – Representation on Enthalpy –Concentration diagram. Lithium – Bromide system Three fluid system – HCOP.

**UNIT– III:**

**Air Refrigeration:** Applications – Air Craft Refrigeration -Simple, Bootstrap, Regenerative, and Reduced ambient systems – Problems based on different systems.

**Steam Jet refrigeration system:** Representation on T-s and h-s diagrams – limitations and applications.

**Unconventional Refrigeration system** – Thermo-electric – Vortex tube and Pulse tube – working principles.

**UNIT– IV:**

**Air Conditioning:** Psychometric properties and processes – Construction of Psychometric chart. Requirements of Comfort Air –conditioning – Thermodynamics of the human body – Effective temperature and Comfort chart – Parameters influencing the Effective Temperature.

**Heating Load Calculations:** Summer/ Winter heating load calculation-heat losses through structure-heat losses due to infiltration. Effects of solar radiation and internal heat sources on heating loads. Air Heating System: Classification - gravity warm heating system, forced warm air heating system balancing a warm air heating system, warm air furnaces, air cleaners, humidifiers and De-humidifiers

**UNIT– V:**

**Air Conditioning Systems:** All Fresh air, Re-circulated air with and without bypass, with reheat systems – Calculation of Bypass Factor, ADP, RSHF, ESHF, and GSHF for different systems.

**Ventilation:** Ventilation and Infiltration: Requirement of ventilation air, various sources of infiltration air, ventilation and infiltration as a part of cooling load. Fans and Blowers: Types, performance characteristics, series and parallel arrangement, selection procedure. Equipment and Controls: Chillers, Condensing units, Cooling coils, bypass factors, humidifiers, dehumidifiers

**TEXT BOOKS:**

1. Refrigeration and Air Conditioning by C.P. Arora, TMH.
2. Refrigeration and Air Conditioning by Arora and Domkundwar, Dhanpat Rai.
3. Refrigeration and Air Conditioning by Manohar Prasad

**REFERENCE BOOKS:**

1. Basic Refrigeration and Air Conditioning by P.N. Ananthanarayanan, McGraw Hill.
2. Refrigeration and Air Conditioning by Stoecker, Mc Graw Hill.
3. Refrigeration and Air Conditioning by Dr. S.S. Thipse, Jaico.
4. Refrigeration and Air Conditioning by Jordanand Preister, Prentice Hall.
5. Refrigeration and Air Conditioning by Dossat, Mc Graw Hill.

**ME721PE: ADDITIVE MANUFACTURING (PROFESSIONAL ELECTIVE – II)****B.Tech. IV Year, I Sem.**

L	T	P	C
3	0	0	3

**Pre-requisites:** Manufacturing Processes, Engineering Materials**Course Objectives:**

- To understand the fundamental concepts of Additive Manufacturing (i.e. Rapid Prototyping) and 3-D printing, its advantages and limitations.
- To classify various types of Additive Manufacturing Processes and know their working principle, advantages, limitations etc.
- To have a holistic view of various applications of these technologies in relevant fields such as mechanical, Bio-medical, Aerospace, electronics etc.

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

- Explain and summarize the principles and key characteristics of additive manufacturing technologies and commonly used 3D printing and additive manufacturing systems.
- Describe various liquid based Rapid Prototyping systems.
- Understand and apply different powder based Rapid Prototype systems.
- Describe various CAD issues for 3D printing and rapid prototyping and related operations for STL model manipulation.
- Understand and apply Rapid prototyping in various applications like forensic science, anthropology and medicine etc.

**UNIT – I:**

**Introduction:** Prototyping fundamentals, Historical development, Fundamentals of Rapid Prototyping, Advantages and Limitations of Rapid Prototyping, commonly used Terms, Classification of RP process, Rapid Prototyping Process Chain: Fundamental Automated Processes.

**UNIT – II:**

**Liquid-based Rapid Prototyping Systems:** Stereo lithography Apparatus (SLA): Models and specifications, Process, working principle, photopolymers, photo polymerization, Layering technology, laser and laser scanning, Applications, Advantages and Disadvantages, Case studies. Solid ground curing (SGC): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Solid-based Rapid Prototyping Systems: Laminated Object Manufacturing (LOM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Fused Deposition Modeling (FDM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies.

**UNIT – III:**

**Powder Based Rapid Prototyping Systems:** Selective laser sintering (SLS): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Three-dimensional Printing (3DP): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Rapid Tooling: Introduction to Rapid Tooling (RT), Conventional Tooling Vs RT, Need for RT. Rapid Tooling Classification; Indirect Rapid Tooling Methods: Spray Metal Deposition, RTV Epoxy Tools, Ceramic tools, Investment Casting, Spin Casting, Die casting, Sand Casting, 3D Keltool process. Direct Rapid Tooling: Direct AIM, LOM Tools, DTM Rapid Tool Process, EOS Direct Tool Process and Direct Metal Tooling using 3DP

**UNIT – IV:**

Rapid Prototyping Data Formats: STL Format, STL File Problems, Consequence of Building Valid and Invalid Tessellated Models, STL file Repairs: Generic Solution, Other Translators, Newly Proposed Formats. Rapid Prototyping Software's: Features of various RP softwares like Magics, Mimics, Solid View, View Expert, 3 D View, Velocity 2, Rhino, STL View 3 Data Expert and 3 D doctor.

**UNIT – V:**

RP Applications: Application - Material Relationship, Application in Design, Application in Engineering, Analysis and Planning, Aerospace Industry, Automotive Industry, Jewelry Industry, Coin Industry, GIS application, Arts and Architecture. RP Medical and Bioengineering Applications: Planning and simulation of complex surgery, Customized Implants and Prosthesis, Design and Production of Medical Devices, Forensic Science and Anthropology, Visualization of Biomolecules.

**TEXTBOOKS:**

1. Rapid prototyping; Principles and Applications /Chua C.K., Leong K.F. and LIM C.S/World Scientific Publications/3<sup>rd</sup> Edition, 2010
2. Rapid Manufacturing /D.T. Pham and S.S. Dimov/Springer/1<sup>st</sup> Edition, 2012

**REFERENCE BOOKS:**

1. Terry Wohlers, Wohlers Report 2000, Wohlers Associates.
2. Rapid Prototyping and Manufacturing /Paul F. Jacobs/ASME/ 1<sup>st</sup> Edition, 1993.

**ME722PE: AUTOMATION IN MANUFACTURING (PROFESSIONAL ELECTIVE – II)****B.Tech. IV Year, I Sem.**

L	T	P	C
3	0	0	3

**Course Objectives:**

- To understand types of Automation and production system technologies in modern manufacturing.
- To understand importance of automated flow lines in manufacturing a product.
- To understand the Assembly system and Line Balancing in Manufacturing System.
- To understand Automated Material handling equipments and Automated Storage Systems.
- To understand industrial control and automatic inspection techniques.

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

- Describe the importance of Automation implementation in Manufacturing.
- Analyze the various Automated flow lines.
- Perform Line balancing of assembly system.
- Describe automated Material Handling and automated storage
- Explain Industrial Process controls and automatic inspection.

**UNIT – I:**

**Introduction:** Types and strategies of automation, pneumatic and hydraulic components circuits, Automation in machine tools. Mechanical feeding and tool changing and machine tool control transfer the automaton.

**UNIT – II:**

**Automated flow lines:** Methods or work part transport transfer Mechanical buffer storage control function, design and fabrication consideration.

**Analysis of Automated flow lines:** General terminology and analysis of transfer lines without and with buffer storage, partial automation, implementation of automated flow lines.

**UNIT – III:**

**Assembly system and line balancing:** Assembly process and systems assembly line, line balancing methods, ways of improving line balance, flexible assembly lines.

**UNIT –IV:**

**Automated material handling:** Types of equipment, functions, analysis and design of material handling systems conveyor systems, automated guided vehicle systems.

Automated storage systems, Automated storage and retrieval systems; work in process storage, interfacing handling and storage with manufacturing.

**UNIT –V:**

**Fundamentals of Industrial controls:** Review of control theory, logic controls, sensors and actuators, Data communication and LAN in Manufacturing.

Business process Re-engineering: Introduction to BPE logistics, ERP, Software configuration of BPE.

**TEXT BOOKS:**

1. Automation, Production Systems and Computer Integrated Manufacturing: M.P. Groover. /Pearson Education/4<sup>th</sup> Edition, 2016.
2. Computer Control of Manufacturing Systems/ Yoram koren/ Mc Graw Hill/ 1<sup>st</sup> Edition, 1983.

**REFERENCE BOOKS:**

1. Computer Aided Manufacturing/Tien-Chien Chang, Richard A. Wyskand Hsu-Pin Wang/Pearson/ 3<sup>rd</sup> Edition, 2005.
2. Automation /W. Buekinsham/PHI Publications/ 1<sup>st</sup> Edition, 2011.

**ME723PE: ARTIFICIAL INTELLIGENCE IN MECHANICAL ENGINEERING  
(PROFESSIONAL ELECTIVE – II)**

**B.Tech. IV Year, I Sem.**

L	T	P	C
3	0	0	3

**UNIT - I: Introduction to Artificial Intelligence**

Definition, History, Present state of Artificial Intelligence (AI), Phases of AI, Approaches to AI - Hard or Strong AI, Soft or Weak AI, Applied AI, Cognitive AI, and Applications domains focused on mechanical engineering,

**UNIT - II: Problem Solving Methods**

Problem solving methods-1. Uninformed search includes Depth First Search (DFS), Breadth First Search (BFS), Uniform Cost Search (UCS), Depth Limited Search, Iterative Deepening Depth First Search (IDDFS) and bidirectional search. 2. Informed Search (heuristic search) includes greedy best first search, A\* search, memory bounded heuristic search, learning to search better, Simple problems

**UNIT - III: Neural Networks**

Introduction to Perceptron and Neural Networks, Activation and Loss functions, Single Neuron of Human and Human Brain Modelling, ANN architecture-Input layer, Hidden layer and output layer, Types of Neural Networks- Single layer feed-forward network, Multilayer feed-forward network, Multi-Layer Perceptron (MLP), Recurrent networks or feedback ANN, Characteristics of Neural Networks, Simple problems on Back Propagation Algorithms to minimize the error

**UNIT - IV: Machine Learning**

Unsupervised learning- Definition, basic concepts, applications, K-means Clustering, hierarchical Clustering, Dimension Reduction-PCA, Simple Examples

Supervised Learning - Definition, basic concepts, applications, Linear Regression, Multiple Variable Linear Regression, Logistic Regression, Naive Bayes Classifiers, k-NN Classification, Support Vector Machine, Simple Examples.

Reinforcement Learning (RL) - Framework, Component of RL Framework, Types of RL Systems. Q-learning, Examples of RL Systems, Simple Examples

**UNIT - V: Ensemble Learning Techniques**

Introduction on ensemble methods, Decision Trees, Bagging, Random Forests, Boostin, Simple Examples

**TEXT BOOK:**

1. Artificial Intelligence: A Modern Approach, Stuart Russell and Peter Norvig, Prentice-Hall, Third Edition (2009).

**REFERENCE BOOKS:**

1. Artificial Intelligence, Ela Kumar, Wiley, 2021
2. Artificial Intelligence: Concepts and Applications, Lavika Goel, Kindle Edition, Wiley, 2021.
3. Nature-Inspired Optimization in Advanced Manufacturing Processes and Systems, Edited by Ganesh M. Kakandikar and Dinesh G. Thakur, CRC press, First edition, 2021.

**ME724PE: MECHATRONICS (PROFESSIONAL ELECTIVE – II)****B.Tech. IV Year, I Sem.**

L	T	P	C
3	0	0	3

**UNIT - I:**

**Introduction:** Overview, History of mechatronics, Scope and significance of Mechatronics systems, elements of Mechatronic systems, Needs and benefits of Mechatronics in manufacturing.

**Sensors:** Classification of sensors basic working principles, displacement sensor – linear and rotary potentiometers, LVDT and RVDT, incremental and absolute encoders, Proximity and range sensors – Eddy current sensor, ultrasonic sensor, laser interferometer transducer, hall Effect sensor, inductive Proximity switch, Light sensors – Photodiodes, Phototransistors, Flow Sensors – ultrasonic Sensor, Laser Doppler Anemometer, Tactile Sensors – PVDF tactile sensor, micro-switch and reed switch, Piezoelectric sensors, Vision Sensor.

**UNIT - II:**

**Actuators: Electrical Actuators:** Solenoids, relays, diodes, thyristors, triacs, BJT, FET, DC motor, Servo Motor, BLDC Motor, AC Motor, Stepper Motor, Hydraulic and pneumatic devices – Power supplies, valves, Cylinder sequencing, Design of hydraulic and pneumatic circuits. Piezo Electric Actuators, Shape memory alloys.

**UNIT - III:**

**Basic System models and Analysis:** Modeling of one and two degrees of freedom Mechanical, Electrical, fluid and thermal systems, block diagram representations of these systems. Dynamic Responses of System: Transfer function, modeling dynamic systems, first order systems, second order systems.

**UNIT - IV:**

**Digital Electronics:** Number systems, BCD codes and arithmetic, Gray codes, self-complimenting codes, Error detection and correction principles. Boolean functions using Karnaugh Map, Design of combinational circuits, design of arithmetic circuits, Design of code converters, encoders and decoders.

**Signal Conditioning:** Operational amplifiers, inverting amplifier, differential amplifier, Protection, comparator, filters, multiplexer, Pulse width modulation counters, decoders. Data acquisition – Quantizing theory, Analog to digital conversion, digital to analog conversion.

**Controllers:** Classification of Control systems, Feedback, Closed loop and open loop systems **PLC**

**UNIT - V:**

**Programming:** PLC Principles of operation, PLC sizes, PLC hardware components, I/O section Analog I/O section, Analog I/O modules, digital I/O modules, CPU processor memory, module programming, Ladder Programming, ladder diagrams, Timers, Internal relays and counters, data handling, analogue input and output. Application on real time industrial automation systems.

**Advanced Applications in Mechatronics:** Sensors for condition monitoring, mechatronic control in automated manufacturing, Artificial intelligence in Mechatronics, micro sensors in mechatronics, Application of Washing machine as mechatronic device.

**TEXT BOOKS:**

1. W. Boton, "Mechatronics", 5th edition, Adison Wesley Longman Ltd, 2010.
2. Mechatronics system design by Devdas Shetty and Richard A. Kolk, P.W.S. Publishing company, 2001.
3. Alciatore David G and Histan Michael B, "Introduction to Mechatronics and Measurement systems", 4th edition, Tata McGraw Hill, 2006

**ME731PE: POWER PLANT ENGINEERING (PROFESSIONAL ELECTIVE – III)****B.Tech. IV Year, I Sem.**

L	T	P	C
3	0	0	3

**Pre-Requisites:** None**Course Objectives:** The goal of this course is to be aware of the design of conventional and alternative power-generation plants. The learning objectives include

- Analysis and preliminary design of the major systems of conventional fossil-fuel steam-cycle power plants.
- A working knowledge of the basic design principles of nuclear, gas turbine, combined cycle, hydro, wind, geothermal, solar, and alternate power plants.
- Awareness of the economic, environmental, and regulatory issues related to power generation.

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

- Understand the concept of Rankine cycle.
- Understand working of boilers including water tube, fire tube and high-pressure boilers and determine efficiencies.
- Analyze the flow of steam through nozzles.
- Evaluate the performance of condensers and steam turbines.
- Evaluate the performance of gas turbines.

**UNIT – I:**

Introduction to the Sources of Energy – Resources and Development of Power in India.

**Steam Power Plant:** Plant Layout, Working of different Circuits, Fuel and handling equipments, types of coals, coal handling, choice of handling equipment, coal storage, Ash handling systems.**Combustion Process:** Properties of coal – overfeed and underfeed fuel beds, traveling grate stokers, spreader stokers, retort stokers, pulverized fuel burning system and its components, combustion needs and draught system, cyclone furnace, design and construction, Dust collectors, cooling towers and heat rejection. Corrosion and feed water treatment.**UNIT – II:****Internal Combustion Engine Plant:** Diesel Power Plant: Introduction – IC Engines, types, construction– Plant layout with auxiliaries – fuel supply system, air starting equipment, lubrication and cooling system – super charging.**Gas Turbine Plant:** Introduction – classification - construction – Layout with auxiliaries – Principles of working of closed and open cycle gas turbines. Combined Cycle Power Plants and comparison.**UNIT – III:****Hydro Electric Power Plant:** Water power – Hydrological cycle / flow measurement – drainage area characteristics – Hydrographs – storage and Pondage – classification of dams and spill ways.**Hydro Projects and Plant:** Classification – Typical layouts – plant auxiliaries – plant operation pumped storage plants.**UNIT – IV:****Nuclear Power Station:** Nuclear fuel – breeding and fertile materials – Nuclear reactor – reactor operation. **Types of Reactors:** Pressurized water reactor, Boiling water reactor, sodium-graphite reactor, fast Breeder Reactor, Homogeneous Reactor, Gas cooled Reactor, Radiation hazards and shielding – radioactive waste disposal.

**UNIT – V:**

**Power Plant Economics and Environmental Considerations:** Capital cost, investment of fixed charges, operating costs, general arrangement of power distribution, Load curves, load duration curve. Definitions of connected load, Maximum demand, demand factor, average load, load factor, diversity factor – related exercises. Effluents from power plants and Impact on environment – pollutants and pollution standards – Methods of Pollution control.

**TEXT BOOKS:**

1. Power Plant Engineering/ P. K. Nag / Mc Graw Hill
2. Power Plant Engineering / Hegde / Pearson.

**REFERENCES BOOKS:**

1. Power Plant Engineering / Gupta / PHI
2. Power Plant Engineering / A K Raja / New age

**ME732PE: AUTOMOBILE ENGINEERING (PROFESSIONAL ELECTIVE – III)****B.Tech. IV Year, I Sem.**

L	T	P	C
3	0	0	3

**Course Objectives:** The Objective of this course is to provide the student to

- Elaborate the Systems of Automobile, Components of Engine, fuel and Lubrication system and its requirements
- Explain the significance and features of Cooling, Ignition and Electrical Systems
- Illustrate the working of transmission system and Suspension systems and its components
- Elaborate the function of each accessory of steering and braking system and their role for effective performance of automobile
- Discuss the particulates of combustion in CI and SI engines, reasons for formation of particulates and methods adopted to control the pollution

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

- Illustrate the function of each and every system of an automobiles including fuel system and injection approaches
- Explain the Cooling, ignition and electrical system of the Automobile
- Describe each component of transmission system of an automobile viz clutch, gear box, propeller shaft and differential and suspension system and the effect of the same on tyre performance and other components of an automobile
- Analyze the geometry of the steering mechanism and braking system
- Demonstrate about emission standards, emission control techniques and electrical systems. Student can identify thrust areas for carrying their dissertation in future.

**UNIT – I:****Introduction:** Layout of automobile – introduction chassis and body components. Types of Automobile engines. – Power unit – Introduction to engine lubrication – engine servicing**Fuel System:** S.I. Engine: Fuel supply systems, Mechanical and electrical fuel pump – filters – carburetor – types – air filters – petrol injection. Introduction to MPFI and GDI Systems.**C.I. Engines:** Requirements of diesel injection systems, types of injection systems, DI Systems IDI systems. Fuel pump, nozzle, spray formation, injection timing, testing of fuel pumps. Introduction to CRDI and TDI Systems.**UNIT – II:****Cooling System:** Cooling Requirements, Air Cooling, Liquid Cooling, Thermo, water and Forced Circulation System – Radiators – Types – Cooling Fan - water pump, thermostat, evaporative cooling – pressure sealed cooling – antifreeze solutions.**Ignition System:** Function of an ignition system, battery ignition system, constructional features of storage, battery, auto transformer, contact breaker points, condenser, and spark plug – Magneto coil ignition system, electronic ignition system using contact breaker, electronic ignition using contact triggers – spark advance and retard mechanism.**Electrical System:** Charging circuit, generator, current – voltage regulator – starting system, bendix drive mechanism solenoid switch, lighting systems, Horn, wiper, fuel gauge – oil pressure gauge, engine temperature indicator etc.**UNIT – III:****Transmission System:** Clutches, principle, types, cone clutch, single plate clutch, multi plate clutch, magnetic and centrifugal clutches, fluid fly wheel – gear boxes, types, sliding mesh, constant mesh, synchro mesh gear boxes, epicyclic gear box, over drive torque converter. Propeller shaft – Hotch – Kiss drive, Torque tube drive, universal joint, differential rear axles – types – wheels and tyres.

**Suspension System:** Objects of suspension systems – rigid axle suspension system, torsion bar, shock absorber, independent suspension system.

**UNIT – IV:**

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

**Steering System:** Steering geometry – camber, castor, king pin rake, combined angle toein, center point steering. Types of steering mechanism – Ackerman steering mechanism, Davis steering mechanism, steering gears – types, steering linkages.

**UNIT – V:**

Emissions from Automobiles – Pollution standards National and international – Pollution Control – Techniques – Multipoint fuel injection for SI Engines. Common rail diesel injection Energy alternatives – Solar, Photo-voltaic, hydrogen, Biomass, alcohols, LPG, CNG, liquid Fuels, and gaseous fuels, Hydrogen as a fuel for IC Engines. - Their merits and demerits. Standard Vehicle maintenance practice.

**TEXT BOOKS:**

1. Automobile Engineering / William H Crouse
2. A Text Book Automobile Engineering–Manzoor, Nawazish Mehdi and Yosuf Ali, Frontline Publications.

**REFERENCE BOOKS:**

1. A Text Book of Automobile Engineering by R K Rajput. Laxmi Publications.
2. Automotive Mechanics / Heitner
3. Automotive Engineering / Newton Steeds and Garrett
4. Automotive Engines / Srinivasan.
5. A Text Book of Automobile Engineering By Khalil U Siddiqui New Age International

**ME733PE: NON-CONVENTIONAL ENERGY SOURCES (PROFESSIONAL ELECTIVE – III)****B.Tech. IV Year, I Sem.**

L	T	P	C
3	0	0	3

**Course Objectives:** The Objective of this course is to

- Introduce the need of the non-convective energy sources.
- Differentiate various solar collectors
- Identify the energy resources utilization systems
- Recognize the source and potential of wind energy and understand the classifications of wind mills.
- Summarize the principles of bio-conversion, ocean energy and geo thermal energy.

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

- Choose the appropriate renewable energy as an alternate for conventional power in any application.
- Understand principles of various solar collectors and use them in different applications
- Inculcate the knowledge on usage of alternate energy sources in I.C Engines
- Know various energy conversion techniques
- Analyze large scale demand of heat energy for meeting day to day domestic, institutional and industrial requirements can be met by utilizing solar thermal systems, biogas, PV cells, wind energy, Geothermal, MHD etc.

**UNIT-I:**

Principles of Solar Radiation, Role and potential of new and renewable source, the solar energy option, Environmental impact of solar power - Physics of the sun, the solar constant, extra-terrestrial and terrestrial solar radiation, Solar radiation on tilted surface, Instruments for measuring solar radiation and sun shine, solar radiation data.

**UNIT-II:**

Solar Energy Collection Flat plate and concentrating collectors, classification of concentrating collectors, orientation and thermal analysis, advanced collectors. Solar Energy Storage and Applications: Different methods, sensible, latent heat and stratified storage, solar ponds. Solar applications - solar heating/ cooling techniques, solar distillation and drying, Photovoltaic energy conversion.

**UNIT-III:**

Wind Energy Sources and potentials, horizontal and vertical axis windmills, performance characteristics. Bio-Mass: Principles of Bio-Conversion, Anaerobic /aerobic digestion, types of Bio-gas digesters, gas yield, combustion characteristics of bio-gas, utilization for cooking, I.C. Engine operation, and economic aspects.

**UNIT-IV:** Geothermal Energy Resources, types of wells, methods of harnessing the energy, potential in India. OTEC: Principles, utilization, setting of OTEC plants, thermodynamic cycles. Tidal and Wave Energy: Potential and conversion techniques, mini-hydel power plants, their economics.

**UNIT-V:**

Direct Energy Conversion Need for DEC, Carnot cycle, limitations, Principles of DEC. Thermo-electric generators, Seebeck, Peltier and Joule Thompson effects, figure of merit, materials, applications, MHD generators, principles, dissociation and ionization, hall effect, magnetic flux, MHD accelerator, MHD engine, power generation systems, electron gas dynamic conversion, economic aspects. Fuel cells, principle, faraday's laws, thermodynamic aspects, selection of fuels and operating conditions.

**TEXT BOOKS:**

1. Renewable Energy Sources/Twidell and Weir /Taylor and Francis / 2nd Special Indian Edition.
2. Non- conventional Energy Sources / G.D. Rai / Dhanpat Rai and Sons.

**REFERENCE BOOKS:**

1. Energy Resources Utilization and Technologies/Anjaneyulu and Francis/BS Publications/2012.
2. Principles of Solar Energy / Frank Krieth and John F Kreider / Hemisphere Publications.
3. Non-Conventional Energy / Ashok V Desai / Wiley Eastern.
4. Non-Conventional Energy Systems / K Mittal / Wheeler.
5. Renewable Energy Technologies /Ramesh and Kumar /Narosa.
6. Renewable Energy Resources /Tiwari and Ghosal /Narosa.

**ME734PE: SOLAR ENERGY TECHNOLOGY (PROFESSIONAL ELECTIVE – III)****B.Tech. IV Year, I Sem.**

L	T	P	C
3	0	0	3

**Course Objectives**

- Focus on solar energy utilization
- Explain the concepts of solar water heating and its layout
- Concepts of thermal energy storage
- Discuss the energy conversion technologies
- Concentrate the economic aspects of Solar Energy

**Course Outcomes**

- Explain the solar energy potential and construction details of collector with performance analysis
- Analyse the concepts of solar water heating technologies and its parameters
- Narrate the methods of solar energy storage and its working
- Infer the direct energy conversion and conversion efficiencies calculations
- Discuss the Principles of Economic Analysis and optimization with respect solar energy

**UNIT- I:**

**Introduction** – Solar energy option, specialty and potential – Sun – Earth – Solar radiation, beam and diffuse – measurement – estimation of average solar radiation on horizontal and tilted surfaces – problems – applications. Capturing solar radiation – physical principles of collection – types – liquid flat plate collectors – construction details – performance analysis – concentrating collection – flat plate collectors with plane reflectors – cylindrical parabolic collectors – Orientation and tracking – Performance Analysis.

**UNIT- II:**

**Design of Solar Water Heating System and Layout:** Power generation – solar central receiver system – Heliostats and Receiver – Heat transport system – solar distributed receiver system – Power cycles, working fluids and prime movers, concentration ratio.

**UNIT- III:**

**Thermal Energy Storage:** Introduction – Need for – Methods of sensible heat storage using solids and liquids – Packed bed storage – Latent heat storage – working principle – construction – application and limitations. Other solar devices – stills, air heaters, dryers, Solar Ponds and Solar Refrigeration, active and passive heating systems.

**UNIT- IV:**

**Direct Energy Conversion:** solid-state principles – semiconductors – solar cells – performance – modular construction – applications. conversion efficiencies calculations.

**UNIT- V:**

**Economics:** Principles of Economic Analysis – Discounted cash flow – Solar system – life cycle costs – cost benefit analysis and optimization – cost-based analysis of water heating and photo voltaic applications.

**TEXT BOOKS:**

1. Principles of solar engineering/ Kreith and Kerider/Taylor and Francis/2<sup>nd</sup> Edition.
2. Solar energy thermal processes/ Duffie and Beckman/John Wiley and Sons

**REFERENCE BOOKS:**

1. Solar energy: Principles of Thermal Collection and Storage/ Sukhatme/TMH/2nd edition
2. Solar energy/ Garg/TMH 5. Solar energy/ Magal/Mc Graw Hill
3. Solar Thermal Engineering Systems / Tiwari and Suneja/Narosa
4. Power plant Technology/ El Wakil/TMH.

**ME741PE: RE-ENGINEERING (PROFESSIONAL ELECTIVE – IV)****B.Tech. IV Year, I Sem.**

L	T	P	C
3	0	0	3

**Course objective:** The objective is to understand the terminologies related to forward engineering and reverse engineering and to identify the process of designing, manufacturing, assembling, and maintaining products and systems.

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

- Familiarize with the process of reverse engineering and its applications.
- Understand the methodologies and techniques for Reverse Engineering.
- Learn various data collection techniques and the data processing chain.
- Select a proper system to generate geometric representations of physical objects.
- Integrate Reverse Engineering and Rapid Prototyping.

**UNIT - I**

**Introduction to Reverse Engineering:** Reverse Engineering –The Generic Process  
Reverse Engineering in Automotive, Aerospace, Medical sectors: Legal Aspects of Reverse Engineering: Copyright Law, Reverse Engineering, Recent Case Law, Barriers to Adopting Reverse Engineering. A discussion on a few benchmarks case studies

**UNIT - II**

**Methodologies and Techniques for Reverse Engineering:** The Potential for Automation with 3-D Laser Scanners, What Is Not Reverse Engineering, What is Computer-aided (Forward) Engineering, What Is Computer-aided Reverse Engineering, Computer Vision and Reverse Engineering, Structured-light Range Imaging, Scanner Pipeline

**UNIT - III**

**Reverse Engineering–Hardware and Software:** Contact Methods Noncontact Methods, Destructive Method. Reverse Engineering Software Classification, Fundamental Reverse Engineering Operations, Reverse Engineering Phases

**UNIT - IV**

**Selecting a Reverse Engineering System:** The Selection Process, Some Additional Complexities, Point Capture Devices, Triangulation Approaches, “Time-of-flight” or Ranging Systems, Structured-light and Stereoscopic Imaging Systems, issues with Light-based Approaches, Tracking Systems, Internal Measurement Systems, X-ray Tomography, Destructive Systems, Some Comments on Accuracy, Positioning the Probe, Post processing the Captured Data, Handling Data Points, Curve and Surface Creation, Inspection Applications, Manufacturing Approaches.

**UNIT - V:**

**Integration between Reverse Engineering and Rapid Prototyping:** Modeling Cloud Data in Reverse Engineering, Data Processing for Rapid Prototyping, Integration of RE and RP for Layer-based Model Generation, Adaptive Slicing Approach for Cloud Data Modeling, Planar Polygon Curve Construction for a Layer, Determination of Adaptive Layer Thickness.

**TEXT BOOK:**

1. Reverse Engineering: An Industrial Perspective by Vinesh Raja and Kiran J. Fernandes, Springer-Verlag London Limited 2008

**REFERENCE BOOKS:**

1. K. Otto and K. Wood, Product Design: Techniques in Reverse Engineering and New Product Development, Prentice Hall, 2001.
2. Anupam Saxena, Birendra Sahay, Computer Aided Engineering Design, Springer, 2005.
3. Ali K. Kamrani and Emad Abouel Nasr, Engineering Design and Rapid Prototyping, Springer, 2010.

**ME742PE: COMPUTATIONAL FLUID DYNAMICS (PROFESSIONAL ELECTIVE – IV)****B.Tech. IV Year, I Sem.**

L	T	P	C
3	0	0	3

**Pre-requisite:** Heat Transfer and Fluid Mechanics**Course Objective:** To apply the principles of Heat Transfer and Fluid Mechanics to formulate governing equations for physical problems and to solve those using different numerical techniques**Course Outcomes:** At the end of the course, the student should be able to:

- Differentiate between different types of Partial Differential Equations and to know and understand appropriate numerical techniques.
- Solve the simple heat transfer and fluid flow problems using different numerical techniques, viz., FDM.
- Understand and to appreciate the need for validation of numerical solution.

**UNIT - I:**

Basic Aspects of the Governing Equations – Physical Boundary Conditions – Methods of solutions of Physical Problems – Need for Computational Fluid Dynamics – Different numerical/CFD techniques – FDM, FEM, FVM etc., - Main working principle - CFD as a research and design tool – Applications in various branches of Engineering

Mathematical behavior of Partial Differential Equations (Governing Equations): Classification of linear/quasi linear PDE – Examples - Physical Processes: Wave Equations and Equations of Heat Transfer and Fluid Flow – Mathematical Behavior - General characteristics – Its significance in understanding the physical and numerical aspects of the PDE – One way and Two Way variables – Well posed problems – Initial and Boundary Conditions

Solution of Simultaneous Algebraic Equations: Direct Method – Gauss Elimination – LU Decomposition – Pivoting – Treatment of Banded Matrices – Thomas Algorithm  
Iterative Method: Gauss Seidel and Jordan Methods - Stability Criterion

**UNIT - II:**

Finite Difference Method: Basic aspects of Discretization – Finite Difference formulae for first order and second order terms – Solution of physical problems with Elliptic type of Governing Equations for different boundary conditions - Numerical treatment of 1D and 2D problems in heat conduction, beams etc., - Solutions –Treatment of Curvilinear coordinates – Singularities – Finite Difference Discretization – Solution of 1D heat conduction problems in Heat conduction in curve linear coordinates

**UNIT - III:**

FDM: Solution of physical problems with Parabolic type of Governing Equations – Initial Condition – Explicit, implicit and semi implicit methods – Types of errors – Stability and Consistency – Von Neumann Stability criterion– Solution of simple physical problems in 1D and 2D – Transient Heat conduction problems- ADI scheme - Simple Hyperbolic type PDE - First order and Second order wave equations – Discretization using Explicit method - Stability criterion – Courant Number – CFL Condition - Its significance - Treatment of simple problems

**UNIT - IV:**

Finite Difference Solution of Unsteady Inviscid Flows: Lax – Wendroff Technique – Disadvantages – Maccormack's Technique

Fluid Flow Equations – Finite Difference Solutions of 2D Viscous Incompressible flow problems – Vorticity and Stream Function Formulation – Finite Difference treatment of Lid Driven Cavity Problem

-

Application to Cylindrical Coordinates with example of flow over infinitely long cylinder and sphere – Obtaining Elliptic Equations

**UNIT - V:**

Finite Difference Applications in Fluid flow problems: Fundamentals of fluid Flow modeling using Burger's Equation – Discretization using FTCS method with respect to Upwind Scheme and Transport Property – Upwind Scheme and Artificial Viscosity

Solutions of Navier Stokes Equations for Incompressible Fluid Flows: Staggered Grid – Marker and Cell (MAC) Formulation – Numerical Stability Considerations – Pressure correction method - SIMPLE Algorithm

**TEXT BOOKS:**

1. Computational Fluid Dynamics: The basics with applications/ John D Anderson/McGraw Hill Publications
2. Numerical Heat Transfer and Fluid Flow/ S.V. Patankar/ Mc Graw Hill

**REFERENCE BOOKS:**

1. Computational Fluid Flow and Heat Transfer / K Muralidharan and T Sudarajan/ Narosa Publishers.
2. Computational Methods for Fluid Dynamics / Firziger and Peric/ Springer

**ME743PE: TURBO MACHINERY (PROFESSIONAL ELECTIVE – IV)****B.Tech. IV Year, I Sem.**

L	T	P	C
3	0	0	3

**Pre-requisites:** Thermal Engineering, Heat Transfer**Course Objectives:**

- To provide the knowledge of basic principles, governing equations and applications of turbo machinery.
- To explain construction and working principle and evaluate the performance characteristics of Turbo Machines

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

- Apply thermodynamics and kinematics principles to turbo machines
- Understand mechanisms behind working of Turbines, compressors.
- Understand the thermodynamic and flow analysis for turbines and compressors
- Analyze the performance of turbo machines.

**UNIT – I:**

**Introduction to Turbomachinery:** Classification of turbo-machines, second law of thermodynamics applied to turbine and compressors work, nozzle, diffuser work, fluid equation, continuity, Euler's, Bernoulli's, equation and its applications, expansion and compression process, reheat factor, preheat factor

**UNIT – II:**

**Fundamental Concepts of Axial and Radial Machines:** Euler's equation of energy transfer, vane congruent flow, influence of relative circulation, thickness of vanes, number of vanes on velocity triangles, slip factor, Stodola, Stanitz and Balje's slip factor, suction pressure and net positive suction head, phenomena of cavitation in pumps, concept of specific speed, shape number, axial, radial and mixed flow machines, similarity laws.

**UNIT – III:**

**Gas Dynamics:** Fundamental thermodynamic concepts, isentropic conditions, mach numbers, and area, Velocity relations, Dynamic Pressure, Normal shock relation for perfect gas. Supersonic flow, oblique shock waves. Normal shock recoveries, detached shocks, Aerofoil theory.

**Centrifugal compressor:** Types, Velocity triangles and efficiencies, Blade passage design, Diffuser and pressure recovery. Slip factor, Stanitz and Stodolas formula's, Effect of inlet mach numbers, Pre whirl, Performance

**UNIT – IV:**

**Axial Flow Compressors:** Flow Analysis, Work, and velocity triangles, Efficiencies, Thermodynamic analysis. Stage pressure rise, Degree of reaction, Stage Loading, General design, Effect of velocity, Incidence, Performance

**Cascade Analysis:** Geometrical and terminology. Blade force, Efficiencies, Losses, Free end force, Vortex Blades.

**UNIT – V:**

**Axial Flow Gas Turbines:** Work done. Velocity triangle and efficiencies, Thermodynamic flow analysis, Degree of reaction, Zweifel's relation, Design cascade analysis, Soderberg, Hawthorne, Ainley, Correlations, Secondary flow, Free vortex blade, Blade angles for variable degree of reaction. Actuator

disc, Theory, Stress in blades, Blade assembling, Material and cooling of blades, Performances, Matching of compressors and turbines, off design performance.

**TEXT BOOKS:**

1. Principles of Turbo Machines/DG Shepherd / Macmillan
2. Turbines, Pumps, Compressors/Yahya/ Mc Graw Hill

**REFERENCE BOOKS:**

1. A Treatise on Turbo machines / G. Gopal Krishnan *and* D. Prithviraj/ SciTech
2. Gas Turbine Theory/ Saravanamuttoo/ Pearson.
3. Turbo Machines/ A Valan Arasu/ Vikas Publishing House Pvt. Ltd.

**ME744PE: FLUID POWER SYSTEM (PROFESSIONAL ELECTIVE – IV)****B.Tech. IV Year, I Sem.**

L	T	P	C
3	0	0	3

**Pre-requisites:** Fluid Mechanics and Hydraulics Machinery**Course outcomes:** At the end of the course, student will be able to:

- Understand the basic types of pumps and motors
- Analyse different types of valves
- Design and analysis of hydraulic circuits
- Visualize how a hydraulic/pneumatic circuit works to accomplish the function.
- Design an appropriate hydraulic or pneumatic circuit or combination circuit like electro- hydraulics, electro-pneumatics for a given application.

**UNIT- I:**

Introduction to oil hydraulics and pneumatics, their structure, advantages and limitations. ISO symbols, energy losses in hydraulic systems. Applications, Basic types and constructions of Hydraulic pumps and motors. Pump and motor analysis. Performance curves and parameters.

**UNIT- II:**

Hydraulic actuators, types and constructional details, lever systems, control elements – direction, pressure and flow control valves. Valve configurations, General valve analysis, valve lap, flow forces and lateral forces on spool valves. Series and parallel pressure compensation flow control valves. Flapper valve Analysis and Design.

**UNIT- III:**

Proportional control valves and servo valves. Nonlinearities in control systems (backlash, hysteresis, dead band and friction nonlinearities). Design and analysis of typical hydraulic circuits. Regenerative circuits, high low circuits, Synchronization circuits, and accumulator sizing.

**UNIT- IV:**

Intensifier circuits Meter-in, Meter-out and Bleed-off circuits; Fail Safe and Counter balancing circuits, accessories used in fluid power system, Filtration systems and maintenance of system. Components of pneumatic systems; Direction, flow and pressure control valves in pneumatic systems. Development of single and multiple actuator circuits. Valves for logic functions; Time delay valve; Exhaust and supply air throttling;

**UNIT- V:**

Examples of typical circuits using Displacement – Time and Travel-Step diagrams. Will-dependent control, Travel-dependent control and Time dependent control, combined control, Program Control, Electropneumatic control and air-hydraulic control, Ladder diagrams. Applications in Assembly, Feeding, Metal working, materials handling and plastics working.

**TEXT BOOKS:**

1. Fluid Power Control systems/ Pippenger, J.J., and R. M. Koff/ New York: McGraw Hill.
2. Fluid Power Systems: modeling, simulation and microcomputer control"/ John Watton/ Prentice Hall International.

**REFERENCE BOOKS:**

1. Fundamentals of Fluid Power Control. / John Watton/ 1<sup>st</sup> Ed. Cambridge University Press, 2009.
2. Fluid Power with applications"/ Anthony Esposito / Pearson Education.

**ME7210E: QUANTITATIVE ANALYSIS FOR BUSINESS DECISIONS  
(OPEN ELECTIVE – II)**

**B.Tech. IV Year, I Sem.**

L	T	P	C
3	0	0	3

**Course Objectives:**

- To impart knowledge of basic tools of Operations research in solving the management problems using mathematical approaches for decision-making.
- To teach the methods of solving Linear Programming Problems.
- To impart knowledge on assignment model and transportation problems.
- To impart knowledge on the significance of decision trees and Network analysis.
- To highlight the importance of Queuing Theory.

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

- Understand the origin and application of operations research.
- Learn about the Formulation of Linear Programming Problem for different areas.
- appreciate the significance of variations of assignment problem, methods for finding Initial feasible solution.
- Learn the aspects of Decision Theory and Network Analysis
- Gain insights of the theoretical principles and practical applications of different queuing models.

**UNIT – I: Introduction to Operations Research:** Nature and Scope of Operations Research: Origins of OR, Applications of OR in different Managerial Areas, Problem Solving and Decision-making, Quantitative and Qualitative Analysis. Defining a Model, Types of Models, Process for Developing an Operations Research Model, Practices, Opportunities and Shortcomings of using an OR Model.

**UNIT – II: Linear Programming Method:** Structure of LPP, Assumptions of LPP, Application Areas of LPP, Guidelines for Formulation of LPP, Formulation of LPP for Different Areas, Solving of LPP by Graphical Method: Extreme Point Method, Simplex Method, Converting Primal LPP to Dual LPP, Limitations of LPP.

**UNIT – III: Assignment Model:** Algorithm for Solving Assignment Model, Hungarians Method for Solving Assignment Problem, Variations of Assignment Problem: Multiple Optimal Solutions, Maximization Case in Assignment Problem, Unbalanced Assignment Problem, Travelling Salesman Problem, Simplex Method for Solving Assignment Problem.

**Transportation Problem:** Mathematical Model of Transportation Problem, Methods for Finding Initial Feasible Solution: Northwest Corner Method, Least Cost Method, Vogels Approximation Method, Test of Optimality by Modi Method, Unbalanced Supply and Demand, Degeneracy and its Resolution.

**UNIT – IV: Decision Theory:** Introduction, Ingredients of Decision Problems. Decision-making under Uncertainty, Cost of Uncertainty Under Risk, Under Perfect Information, Decision Tree, Construction of Decision Tree.  
Network Analysis: Network Diagram, PERT, CPM, Critical Path Determination, Project Completion Time, Project Crashing.

**UNIT – V: Queuing Theory:** Queuing Structure and Basic Component of a Queuing Model, Distributions in Queuing Model, Different Queuing Models with FCFS, Queue Discipline, Single and Multiple Service Station with Finite and Infinite Population. Game Theory, Saddle Point, Value of the Game.

**TEXT BOOKS:**

1. Mik Wisniewski, Dr Farhad Shafti, Quantitative Analysis for Decision Makers, Pearson, 7e, 2019.
2. Miguel Ángel Canela, Inés Alegre, Alberto Ibarra, Quantitative Methods for Management: A Practical Approach, Springer International Publishing, 1e, 2019.

**REFERENCE BOOKS:**

1. James E. Sallis, Geir Gripsrud, Ulf Henning Olsson, Ragnhild Silkoset, Research Methods and Data Analysis for Business Decisions: A Primer Using SPSS, Springer International Publishing, 1e, 2021.
2. R. Pannerselvam, Operations Research, Prentice Hall International, 3e, 2015.
3. N.V.S. Raju, Operations Research: Theory and Practice, CRC Press, 2020.
4. R. Pannerselvam, Operations Research, Prentice Hall International, 3e, 2015
5. J.K. Sharma, Operations Research: Theory and applications, MacMillian, 5e, 2013.

**ME7220E: INDUSTRIAL ENGINEERING and MANAGEMENT (OPEN ELECTIVE – II)****B.Tech. IV Year, I Sem.**

L	T	P	C
3	0	0	3

**Prerequisites:** None**Course objectives:** The main objectives of this course are the following to Learn:

- Philosophies of various management gurus and characteristics of various organization structures
- Various Industrial Engineering practices
- Human resource management practices
- Network analysis through PERT and CPM techniques

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

- Practice the management theories proposed by Taylor, Fayol etc
- Consider various factors and identify plant location for given industry.
- Determine EOQ, classify items and implement P-system and Q-system
- Conduct work study (method study+ Work measurement: a) Time study and Work sampling))
- Practice HRM principles
- Analyze the networks by using PERT and CPM

**UNIT - I:**

**Management and Organization** – Functions of Management - Contributions of Taylor, Fayol, Douglas Mc-Gregor, Mayo Hertzberg and Maslow. – Systems Approach to Management - Organizational Structures: Basic concepts related to Organization - Departmentation and Decentralization, Types of mechanistic and organic structures of organization and their merits, demerits and suitability.

**UNIT- II:**

**Operations Management-I:** Plant location, definition, factors affecting the plant location, comparison of rural and urban sites-methods for selection of plant- Matrix approach. Types of plant layout – various data analyzing forms-travel chart - Work study: Method study and Work measurement. Inventory – functions, types, Determination of Economic Order Quantity (EOQ), ABC and VED analysis. Inventory Control Systems-Continuous review system-periodical review system. Stores Management and Stores Records. Purchase management, duties of purchase of manager, JIT System.

**UNIT - III:**

**Operations Management-II:** Inspection and quality control, types of inspections - Statistical Quality Control-techniques- Charts for variables and attributes. Acceptance sampling plan- single sampling and double sampling plans-OC curves. Introduction to TQM-Quality Circles, ISO 9000 series procedures. Functions of Marketing, Marketing vs Selling, Marketing mix, Product Life Cycle.

**UNIT - IV:**

**Human Resources Management (HRM):** Concepts of HRM, HRD and Personnel Management and Industrial Relations (PMIR), HRM vs PMIR, Basic functions of HR Manager: Manpower planning, Recruitment, Selection, Training and Development, Placement, Wage and Salary Administration, Promotion, Transfer, Separation, Performance Appraisal, Grievance Handling and Welfare Administration, Job Evaluation and Merit Rating – Capability Maturity Model (CMM) Levels – Performance Management System.

**UNIT- V:**

**PERT/CPM:** Project management, network modelling-probabilistic model, various types of activity time's estimation-programme evaluation review techniques- Critical Path-probability of completing the project, Critical Path Method (CPM) - Project crashing. Simple problems.

**TEXT BOOKS:**

1. Aryasri, Management Science, McGraw hill, 2012
2. Kumar, Rao and Chhalill: Introduction to Management Science, Cengage 2012.

**REFERENCE BOOKS:**

1. Stoner, Freeman, Gilbert, Management, Pearson Education, New Delhi, 2012.
2. Amrine, Manufacturing Organization and Management, Pearson, 2012.
3. Chase, Jacobs, Aquilano, Operations Management, McGraw Hill, 2012.
4. Panner Selvam, Production and Operations Management, PHI, 2012.
5. Nadha Muni Reddy and Vijaya Kumar Reddy, Reliability Engineering and Quality Engineering, Galgotia, 2012.
6. Ralph M Barnes, Motion and Time Studies, John Wiley and Sons, 2012.
7. L. S. Srinath, PERT / CPM, Affiliate East-West Press, New Delhi, 2012.
8. Gary Dessler, Human Resource Management, Pearson Education Asia, 2012.
9. Phillip Kotler, Marketing Management, Pearson, 2012.
10. S. K. Basu, K. C. Sahu, B. Rajiv: Industrial Organization and Management, PHI, 2012.
11. Dipak Kumar Bhattacharyya: Industrial Management, Vikas publishing house 2013.

**ME851PE: INDUSTRIAL ROBOTICS (PROFESSIONAL ELECTIVE – V)****B.Tech. IV Year, II Sem.**

L	T	P	C
3	0	0	3

**Pre-requisites:** Basic principles of Kinematics and mechanics

**Course Objectives:** The goal of the course is to familiarize the students with the concepts and techniques in robotic engineering, manipulator kinematics, dynamics and control, chose, and incorporate robotic technology in engineering systems.

- Make the students acquainted with the theoretical aspects of Robotics
- Enable the students to acquire practical experience in the field of Robotics through design projects and case studies.
- Make the students to understand the importance of robots in various fields of engineering.
- Expose the students to various robots and their operational details.

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

- understand the basic components of robots.
- Differentiate types of robots and robot grippers.
- Model forward and inverse kinematics of robot manipulators.
- Analyze forces in links and joints of a robot.
- Programme a robot to perform tasks in industrial applications.
- Design intelligent robots using sensors.

**UNIT – I:**

**Introduction:** Automation and Robotics – An over view of Robotics – present and future applications.

**Components of the Industrial Robotics:** common types of arms. Components, Architecture, number of degrees of freedom – Requirements and challenges of end effectors, Design of end effectors, Precision of Movement: Resolution, Accuracy and Repeatability, Speed of Response and Load Carrying Capacity.

**UNIT – II:**

**Motion Analysis:** Basic Rotation Matrices, Equivalent Axis and Angle, Euler Angles, Composite Rotation Matrices. Homogeneous transformations as applicable to rotation and translation – problems.

**Manipulator Kinematics**-H notation-H method of Assignment of frames-H Transformation Matrix, joint coordinates and world coordinates, Forward and inverse kinematics – problems on Industrial Robotic Manipulators.

**UNIT – III:**

Differential transformation of manipulators, Jacobians – problems. Dynamics: Lagrange – Euler and Newton – Euler formations – Problems.

Trajectory planning and avoidance of obstacles, path planning, Slew motion, joint interpolated motion – straight line motion.

**UNIT – IV:**

**Robot actuators and Feedback components:** Actuators: Pneumatic, Hydraulic actuators, electric and stepper motors, comparison of Actuators, Feedback components: position sensors – potentiometers, resolvers, encoders – Velocity sensors, Tactile and Range sensors, Force and Torque sensors – End Effectors and Tools

**UNIT V:**

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

Programming Methods – Languages: Lead Through Programming, Textual Robotic Languages such as APT, MCL.

**TEXT BOOKS:**

1. Industrial Robotics / Groover M P /Mc Graw Hill
2. Introduction to Industrial Robotics / Ramachandran Nagarajan / Pearson

**REFERENCE BOOKS:**

1. Robot Dynamics and Controls / Spony and Vidyasagar / John Wiley
2. Robot Analysis and control / Asada, Slotine / Wiley Inter-Science.
3. Robotics – Fu et al / TMH Publications.

**ME852PE: MECHANICAL VIBRATIONS (PROFESSIONAL ELECTIVE – V)****B.Tech. IV Year, II Sem.**

L	T	P	C
3	0	0	3

**Pre-requisites:** Engineering Mechanics.**Course objectives:** To Understand various types of vibrations.**Course Outcomes:** At the end of the course, the student will be able to,

- Understand the causes and effects of vibration in mechanical systems.
- Develop schematic models for physical systems and formulate governing equations of motion
- Understand the role of damping, stiffness and inertia in mechanical systems
- Analyze rotating and reciprocating systems and compute critical speeds.
- Analyze and design machine supporting structures, vibration isolators and absorbers.

**UNIT – I:**

**Single degree of Freedom systems - I:** Undamped and damped free vibrations; forced vibrations coulomb damping; Response to excitation; rotating unbalance and support excitation; vibration isolation and transmissibility.

**UNIT – II:**

**Single degree of Freedom systems - II:** Response to Non-Periodic Excitations: unit impulse, unit step and unit Ramp functions; response to arbitrary excitations, The Convolution Integral; shock spectrum; System response by the Laplace Transformation method.

**UNIT – III:**

**Two-degree freedom systems:** Principal modes- undamped and damped free and forced vibrations; undamped vibration absorbers;

**Multi degree freedom systems:** Matrix formulation, stiffness and flexibility influence coefficients; Eigen value problem; normal modes and their properties; Free and forced vibration by Modal analysis; Method of matrix inversion; Torsional vibrations of multi- rotor systems and geared systems; Discrete- Time systems.

**UNIT – IV:**

**Continuous system:** Free vibration of strings – longitudinal oscillations of bars- traverse vibrations of beams- Torsional vibrations of shafts.

**Critical speeds of shafts:** Critical speeds without and with damping, secondary critical speed.

**Numerical Methods:** Rayleigh's stodola's, Matrix iteration, Rayleigh- Ritz Method and Holzer's methods.

Vibration measuring instruments: Vibrometers, velocity meters and accelerometers

**UNIT – V:**

**Sound level and subjective response to sound:** Subjective response to sound, frequency dependent human response to sound, sound-pressure dependent human response, the decibel scale, relationship among sound power, sound intensity and sound pressure level, relationship between sound power level and sound intensity, relationship between sound intensity level and sound pressure level, sound measuring instruments.

**TEXT BOOKS:**

1. Elements of Vibration Analysis / Meirovitch/ Mc Graw Hill
2. Principles of Vibration / Benson H. Tongue/Oxford

**REFERENCE BOOKS:**

1. Mechanical Vibrations / SS Rao / Pearson
2. Mechanical Vibration /Rao V. Dukkipati, J Srinivas/ PHI.
3. Mechanical Vibrations/ G.K. Grover/ Nemchand and Brothers.

**ME853PE: COMPOSITE MATERIALS (PROFESSIONAL ELECTIVE – V)****B.Tech. IV Year, II Sem.**

L	T	P	C
3	0	0	3

**Course objectives:**

- Develop understanding of the structure of ceramic materials on multiple length scales.
- Develop knowledge of point defect generation in ceramic materials, and their impact on transport properties.
- To describe key processing techniques for producing metal, ceramic-, and polymer-matrix composites.
- To demonstrate the relationship among synthesis, processing, and properties in composite materials.

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

- Understand the crystal structures of a wide range of ceramic materials and glasses.
- explain how common fibers are produced and how the properties of the fibers are related to the internal structure.
- select matrices for composite materials in different applications.
- describe key processing methods for fabricating composites.

**UNIT – I:**

Introduction: Definition, Classification of Composite materials based on structure, based on matrix, Advantages of composites, Applications of composites, Functional requirements of reinforcement and matrix.

**UNIT – II:**

Types of reinforcements and their properties: Fibers: Carbon, Boron, Glass, Aramid, Al<sub>2</sub>O<sub>3</sub>, SiC, Nature and manufacture of glass, carbon and aramid fibres, Comparison of fibres. Role of interfaces: Wettability and Bonding, The interface in Composites, Interactions and Types of bonding at the Interface, Tests for measuring Interfacial strength.

**UNIT – III:**

Fabrication of Polymeric Matrix Composites, Structure and properties of Polymeric Matrix Composites, Interface in Polymeric Matrix Composites, Applications; Fabrication of Ceramic Matrix Composites, Properties of Ceramic Matrix Composites, Interface in Ceramic Matrix Composites, Toughness of Ceramic Matrix Composites Applications of Ceramic Matrix Composites.

**UNIT – IV:**

Fabrication of Metal Matrix Composites: Solid state fabrication, Liquid state fabrication and In-situ fabrication techniques; Interface in Metal Matrix Composites: Mechanical bonding, Chemical bonding and Interfaces in In-situ Composites; Discontinuously reinforced Metal Matrix Composites, Properties and Applications. Fabrication of Carbon fiber composites, properties, interface and applications.

**UNIT – V:**

Micromechanics of Composites: Density, Mechanical Properties: Prediction of Elastic constants, Micro mechanical approach, Halpin-Tsai equations, Transverse stresses; Thermal properties: Hydrothermal stresses and Mechanics of Load transfer from matrix to fiber.

**TEXTS BOOKS:**

1. Composite Materials – Science and Engineering, K.K. Chawla, Springer-Verlag, New York, 1987.
2. An Introduction to Composite Materials, Hull, Cambridge, 2nd Edt. 1997.

**REFERENCE BOOKS:**

1. Composites, Engineered Materials Handbook, Vol. 1, ASM International, Ohio, 1988.
2. Structure and Properties of Composites, Materials Science and Technology, Vol. 13, VCH, Weinheim, Germany, 1993.
3. Composite Materials: Engineering and Science, F.L. Matthews and R.D. Rawlings, Chapman and Hall, London, 1994.

**ME854PE: ENERGY CONSERVATION AND MANAGEMENT (PROFESSIONAL ELECTIVE – V)****B.Tech. IV Year, II Sem.**

L	T	P	C
3	0	0	3

**Course Objectives:**

- To understand the principles of energy conservation
- To understand thermal insulation and refractors.
- To know waste heat recovery systems.
- To gain knowledge about engineering economics.
- To impart knowledge Energy management programs.

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

- Understand the basic concept of energy conservation and its role in energy management.
- Focus on thermal Insulation and refractors, classification and applications.
- Discuss the energy conservation opportunities in the energy intensive industries by waste heat recovery system.
- Analyze the quantum of electrical energy that can be saved by the use of energy efficient lighting systems and energy audit parameters.
- Understand concept of Project management and energy management Programs

**UNIT-I:**

**Energy Conservation:** Rules for efficient energy conservation – technologies for energy conservation – outline of waste heat and material reclamation, load management, alternate energy sources, and energy storage.

**UNIT-II:**

**Thermal Insulation and Refractors:** Heat loss through un-insulated surfaces, effects of insulation on current carrying wires – economic thickness of insulation – critical radius of insulation – properties of thermal insulators – classification of insulation materials – classification of refractors – properties of refractors – criteria for good refractory material – applications of insulating and refractory materials.

**UNIT-III:**

**Waste Heat Recovery Systems:** Guideline to identify waste heat – feasibility study of waste heat – shell and tube heat exchanger – thermal wheel – heat pipe heat exchanger – heat pump – waste heat boilers – incinerators.

Heat Recovery Systems and Heat Exchanger Networks: Liquid to liquid heat exchangers – gas to liquid heat recovery systems, regenerators, recuperators, rotating regenerators – miscellaneous heat recovery methods – selection of materials for heat exchangers – combined radiation and convective heat exchanger, U tube heat exchanger, tube heat exchanger, fluidized bed heat exchanger – economizer.

**UNIT-IV:**

**Engineering Economics:** Managerial objectives, steps in planning – efficiency of organization- capital budgeting – classification of costs – interest – types – nominal and effective interest rates – discrete and continuous compounding – discounting - time value of money – cash flow diagrams – present worth factor, capital recovery factor, equal annual payments – equivalent between cash flows.

**ENERGY AUDITING:** A definition – objectives – level of responsibility – control of energy – uses of energy – check lists – energy conservation schemes – energy index – cost index – pie charts – sankey diagrams – load profiles – types of energy audits – questionnaire – energy audit of industries – general energy audit – detailed energy audit – energy saving potential.

**UNIT-V:**

**Project Management**

Method of investment appraisal – rate of return method, pay back method, net present value method (NPV) – adoption of the methods in energy conservation campaign – types of projects — propose of project management – classification – role and qualities of project manager – types of budgets - budget committee – budgeting.

Energy Management Programs: Necessary steps of energy management programme – concepts of energy management – general principles of energy management – energy management in manufacturing and process industries – qualities and functions of energy managers – duties of energy manager - language of energy manager – checklist for top management.

**TEXT BOOKS:**

1. Waste heat recovery systems -D.A. Reay/Pergmon Press.
2. Energy Management -W.R. Murphy and G. Mickay, Butterworths

**REFERENCE BOOKS:**

1. Energy Conservation -P.W.O' Callaghan, Pergamon Press 1981.
2. Engineering Heat Audits -C.P. Gupta and Rajendra Prakash, Nechand and Bros.
3. Hand book of energy audits -Albert Thumann, The F.Airmont Press Inc., Atlanta Georgia, 1979.
4. Energy Management Principles -Craig B. Smithm, Pergarmon Press.

**ME861PE: INDUSTRY 4.0 (PROFESSIONAL ELECTIVE – VI)****B.Tech. IV Year, II Sem.**

L	T	P	C
3	0	0	3

**Course Objectives:** The objectives of this course are

- To understand the basics of Industry 4.0
- To understand the Business model and impact of IIoT
- To understand the concepts of virtual reality, lean manufacturing
- To gain knowledge of various sensors and actuators.
- To understand various data transmission technologies.

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

- Explain Smart Business Perspective, Cyber security, Impacts of Industry 4.0.
- Understand the basics of the Industrial Internet of Things.
- Understand various key technologies.
- Implement various sensors and actuators.
- Understand different industrial transmission technologies and IIOT applications in real life

**UNIT – I:**

**Industry 4.0 Basics:** Industrial revolution: Phases, Evolution of Industry4.0, Environmental impacts of industrial revolution, Applications, Design requirements, Drivers of Industry4.0, Sustainability Assessment of industries, Smart Business Perspective, Cyber security, Impacts of Industry 4.0.

**UNIT – II:**

**Industrial Internet of Things- Basics:** IIoT and Industry 4.0, IIC, Industrial Internet Systems, Design of industrial internet systems, Impact of industrial internet, Benefits of industrial internet, Industrial sensing, Industrial Processes, Features of IIoT for industrial processes, Industrial plant–The future architecture, Digital Enterprise

**Business Models and Reference Architecture of IIoT:** Definition of a business model, Business models of IIoT, Industrial Internet Reference Architecture

**UNIT –III:**

**Key Technologies:** Off-site Technologies, Cloud Computing, Fog Computing

**Key Technologies:** On-site Technologies, Augmented Reality, Virtual Reality, Smart factories, Lean manufacturing system, Big Data and Advanced Analytics

**UNIT –IV:**

**Sensors:** Various sensor types and their underlying working principles, Characteristics of Sensors – Resolution, calibration, accuracy and others, Sensor Categories – Thermal, Mechanical, Electrical, Optical and Acoustic sensors.

**Actuators:** Thermal, Hydraulic, Pneumatic, Electro mechanical Actuator

**UNIT – V:**

**Industrial Data Transmission and Acquisition:** Architecture of various data transmission technologies like Foundation Fieldbus, Profibus, Highway Addressable Remote Transducer (HART), Interbus, Bitbus, Digital STROM, Controller Area Network, and other recent and upcoming Technologies. Distributed Control System, SCADA and PLC System.

**IIOT Applications:** IoT Applications on Industrial automation, Factories and Assembly line, Plant Security and Safety, Transportation, Agriculture, Healthcare, Home Automation, Oil, Chemical and Pharmaceutical Industry and others.

**TEXT BOOKS:**

1. Introduction to Industrial Internet of Things and Industry 4.0 by Sudip Misra, Chandana Roy, Anandarup Mukherjee, CRC Press
2. Vijay Madiseti, Arshdeep Bahga, Internet of Things, "A Hands-on Approach", University Press.

**REFERENCE BOOKS:**

1. Dr. SRN Reddy, Rachit Thukral and Manasi Mishra, "Introduction to Internet of Things: A practical Approach", ETI Labs
2. Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press
3. Adrian McEwen, "Designing the Internet of Things", Wiley.
4. Raj Kamal, "Internet of Things: Architecture and Design", McGraw Hill.
5. Cuno Pfister, "Getting Started with the Internet of Things", O Reilly Media

**ME862PE: FUZZY LOGIC AND ANN (PROFESSIONAL ELECTIVE – VI)****B.Tech. IV Year, II Sem.**

L	T	P	C
3	0	0	3

**Prerequisite:** Operations research, Optimisation Techniques, Control Systems

**Course Objectives:** The goal of this course is to give a good basic understanding of Neural Networks and Fuzzy Logic. This course is mainly intended for engineers who desire to learn more about these \*\*techniques

**Course outcomes:** After completion of this course, the student will be able to

- Understand the concepts of neural networks and fuzzy logics
- Understand the topology of multi-layer perceptron, recurrent neural networks and Fuzzification and Defuzzification.
- Understand the basic structure and operation of Fuzzy logic control systems

**UNIT-I:**

**Evolution of neural networks;** Artificial Neural Network: Basic model, Classification, Feed forward and Recurrent topologies, Activation functions; Learning algorithms: Supervised, Un-supervised and Reinforcement; Fundamentals of connectionist modeling: McCulloch – Pits model, Perceptron, Adaline, Madaline.

**UNIT-II:**

**Topology of Multilayer perceptron,** Back propagation learning algorithm, limitations of Multilayer perceptron. Radial Basis Function networks: Topology, learning algorithm; Kohonen's self-organising network: Topology, learning algorithm; Bidirectional associative memory Topology, learning algorithm, Applications.

**UNIT-III:**

**Recurrent neural networks:** Basic concepts, Dynamics, Architecture and training algorithms, Applications; Hopfield network: Topology, learning algorithm, Applications; Industrial and commercial applications of Neural networks: Semiconductor manufacturing processes, Communication, Process monitoring and optimal control, Robotics, Decision fusion and pattern recognition.

**UNIT-IV:**

**Classical and fuzzy sets:** Introduction, Operations and Properties, Fuzzy Relations: Cardinality, Operations and Properties, Equivalence and tolerance relation, Value assignment: cosine amplitude and max-min method; Fuzzification: Membership value assignment- Inference, rank ordering, angular fuzzy sets. Defuzzification methods, Fuzzy measures, Fuzzy integrals, Fuzziness and fuzzy resolution; possibility theory and Fuzzy arithmetic; composition and inference; Considerations of fuzzy decision-making.

**UNIT-V:**

**Basic structure and operation of Fuzzy logic control systems;** Design methodology and stability analysis of fuzzy control systems; Applications of Fuzzy controllers. Applications of fuzzy theory.

**TEXT BOOKS:**

1. Neural Networks in Computer Intelligence by Limin Fu, McGraw Hill, 2003.
2. Soft Computing and Intelligent Systems Design, Theory, Tools and Applications by Fakhreddine O. Karray and Clarence De Silva., Pearson Education, India, 2009.

**REFERENCE BOOKS:**

1. Fuzzy Logic with Engineering Applications by Timothy J. Ross, McGraw Hill, 1995.
2. Artificial Neural Networks by B. Yegnanarayana, PHI, India, 2006.

**ME863PE: ELECTRIC AND HYBRID VEHICLES (PROFESSIONAL ELECTIVE – VI)****B.Tech. IV Year, II Sem.**

L	T	P	C
3	0	0	3

**Course Objectives:**

- Explain the history of Electric vehicles and development
- Discuss the Social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies
- Explore to basic concept of electric traction, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives etc.
- Analyse the Fuel Cell based energy storage and Super Capacitor based energy storage etc.
- Explore to types of Driving Cycles, Range modelling for Battery Electric Vehicle, Hybrid (ICE and others) etc.

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

- Choose the appropriate source of energy for the hybrid electric vehicle based on driving cycle.
- Analyze the power and energy need of the various hybrid electric vehicle and Measure and Estimate the energy consumption of the Hybrid Vehicles
- Evaluate energy efficiency of the vehicle for its drive trains
- Elaborate the types of storage systems such as battery based, fuel cell based etc.
- Explain the types of Driving Cycles, Fuel Cell EV, Solar Powered Vehicles

**UNIT- I:**

**Introduction To Electric Vehicle:** History of Electric Vehicles, Development towards 21st Century, Types of Electric Vehicles in use today – Battery Electric Vehicle, Hybrid (ICE and others), Fuel Cell EV, Solar Powered Vehicles. Motion and Dynamic Equations of the Electric Vehicles: various forces acting on the Vehicle in static and dynamic conditions.

**UNIT- II:**

**Introduction To Hybrid and Electric Vehicles:** Social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid Drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis

**UNIT- III:**

**Electric Drive Trains:** Basic concept of electric traction, introduction to various electric drivetrain topologies, power flow control in electric drive-train topologies, fuel efficiency analysis. Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency

**UNIT- IV:**

**Types of Storage Systems:** Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices. Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Calculation for the rating.

**UNIT- V:**

**Modelling of Hybrid Electric Vehicle Range:** Driving Cycles, Types of Driving Cycles, Range modelling for Battery Electric Vehicle, Hybrid (ICE and others), Fuel Cell EV, Solar Powered Vehicles. Case study of 2-wheeler, 3-wheeler and 4-wheeler vehicles.

**TEXT BOOKS**

1. James Larminie, J. Lowry, "Electric Vehicle Technology Explained", John Wiley and Sons Ltd. 2003.
2. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design", CRC Press, 2004.

**REFERENCE BOOKS**

1. S. Onori, L. Serrao and G. Rizzoni, "Hybrid Electric Vehicles: Energy Management Strategies", Springer, 2016.
2. Iqbal Hussein, "Electric and Hybrid Vehicles: Design Fundamentals", CRC Press, 2010.

**ME864PE: TOTAL QUALITY MANAGEMENT (PROFESSIONAL ELECTIVE – VI)****B.Tech. IV Year, II Sem.**

L	T	P	C
3	0	0	3

**Course Objectives:**

- Develop an understanding of the necessary information and skills needed to manage, control and improve quality practices in the organizations through TQM philosophy.
- To understand customer and supplier relationships and Bench marketing.
- Apply TQM in traditional organizations.
- Analysis of quality in cost and management.
- To understand various ISO around the world.

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

- Understand the concept of TQM and various control charts
- To analyze the relationship between customer and supplier
- Implement TQM in an organization
- To evaluate the cost of quality
- Understand the third-party audit and documentation of various ISO audits

**UNIT – I:**

Introduction: The concept of TQM, Quality and Business performance, attitude and involvement of top management, communication, culture and management systems. Management of Process Quality: Definition of quality, Quality Control, a brief history, Product Inspection vs, Process Control, Statistical Quality Control, Control Charts and Acceptance Sampling.

**UNIT – II:**

Customer Focus and Satisfaction: Process Vs. Customer, internal customer conflict, quality focus, Customer Satisfaction, role of Marketing and Sales, Buyer – Supplier relationships. Bench Marketing: Evolution of Bench Marketing, meaning of Bench marketing, benefits of bench marketing, the bench marketing process, pitfalls of bench marketing.

**UNIT – III:**

Organizing for TQM: The systems approach, organizing for quality implementation, making the transition from a traditional to a TQM organizing, Quality Circles. Productivity, Quality and Reengineering: The leverage of Productivity and Quality, Management systems Vs. Technology, Measuring Productivity, Improving Productivity Re-engineering.

**UNIT – IV:**

The Cost of Quality: Definition of the Cost of Quality, Quality Costs, Measuring Quality Costs, use of Quality Cost Information, Accounting Systems and Quality Management.

**UNIT – V:**

ISO9000: Universal Standards of Quality: ISO around the world, The ISO9000 ANSI/ASQCQ-90. Series Standards, benefits of ISO9000 certification, the third-party audit, Documentation ISO9000 and services, the cost of certification implementing the system.

**TEXT BOOKS:**

1. Total Quality Management: Text, cases and Readings, Third Edition - Joel E. Ross.
2. Beyond TQM - Robert L. Flood.

**REFERENCE BOOKS:**

1. Statistical Quality Control – Eugene Grant, Richard McGraw-Hill, 2017.
2. Total Quality Management, Besterfield D. H., Pearson Education Asia – 2015-4<sup>th</sup> Edition
3. The Management and Control of Quality, Evans J. R, and Lindsay W. M., Southwestern (Thomson Learning), Fifth Edition.

**ME831OE: ENTREPRENEURSHIP DEVELOPMENT (OPEN ELECTIVE – III)****B.Tech. IV Year, II Sem.**

L	T	P	C
3	0	0	3

**Course objectives:** The study of this subject provides an understanding of the scope of an entrepreneur, key areas of development, financial assistance by the institutions, methods of taxation and tax benefits, etc.

**Course Outcomes:** Upon completion of the course, students will be able to

- Identify the factors affecting entrepreneurial growth
- Understand various programs supporting entrepreneurship
- Write preliminary project report
- Estimate the finances for the project
- Appraise and avail support rendered by the Government and other Appropriate Agencies

**UNIT I**

**Entrepreneurship** Entrepreneur – Types of Entrepreneurs – Difference between Entrepreneur and Intrapreneur Entrepreneurship in Economic Growth, Factors Affecting Entrepreneurial Growth.

**UNIT II**

**Motivation** Major Motives Influencing an Entrepreneur – Achievement Motivation Training, Self Rating, Business Game, Thematic Apperception Test – Stress Management, Entrepreneurship Development Programs – Need, Objectives.

**UNIT III**

**Business** Small Enterprises – Definition, Classification – Characteristics, Ownership Structures – Project Formulation – Steps involved in setting up a Business – Identifying, selecting a Good Business opportunity, Market Survey and Research, Techno Economic Feasibility Assessment – Preparation of Preliminary Project Reports – Project Appraisal – Sources of Information – Classification of Needs and Agencies.

**UNIT IV**

**Financing and Accounting:** Need – Sources of Finance, Term Loans, Capital Structure, Financial Institution, Management of working Capital, Costing, Break Even Analysis, Network Analysis Techniques of PERT / CPM – Taxation – Income Tax, Excise Duty – Sales Tax.

**UNIT V**

**Support to Entrepreneurs** Sickness in small Business – Concept, Magnitude, Causes and Consequences, Corrective Measures – Government Policy for Small Scale Enterprises – Growth Strategies in small industry – Expansion, Diversification, Joint Venture, Merger and Sub Contracting

**TEXT BOOKS:**

1. S.S. Khanka, "Entrepreneurial Development" S. Chand and Co. Ltd., 2020.
2. Kuratko and Hodgetts, "Entrepreneurship – Theory, process and practice", Thomson learning 6th edition.

**REFERENCE BOOKS:**

1. Hisrich R D, Peters M P, Dean Shepherd, "Entrepreneurship" 12th Edition McGraw-Hill.
2. Mathew J Manimala, "Entrepreneurship theory at cross roads: paradigms and praxis" Dream tech, 2nd edition 2006.
3. Rabindra N. Kanungo, "Entrepreneurship and innovation: Models for Development", Sage Publications, 1998.
4. EDII "Faulty and External Experts – A Hand Book for New Entrepreneurs Publishers: Entrepreneurship Development", Institute of India.

**ME832OE: ELEMENTS OF ELECTRIC AND HYBRID VEHICLES (OPEN ELECTIVE – III)****B.Tech. IV Year, II Sem.**

L	T	P	C
3	0	0	3

**Course Objectives**

- Explain the history of Electric vehicles and development
- Discuss the Social and environmental importance of hybrid and electric vehicles, t h e impact of modern drive-trains on energy supplies
- Explore to basic concept of electric traction, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, etc.
- Analyse the Fuel Cell-based energy storage and super-capacitor-based energy storage etc.
- Explore to types of Driving Cycles, Range modelling for Battery Electric Vehicle, Hybrid (ICE and others), etc.

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

- Choose the appropriate source of energy for the hybrid electric vehicle based on the driving cycle.
- Analyze the power and energy needs of the various hybrid electric vehicles and Measure and Estimate the energy consumption of the Hybrid Vehicles
- Evaluate the energy efficiency of the vehicle for its drive trains
- Elaborate the types of storage systems such as battery-based, fuel cell-based, etc.
- Explain the types of Driving Cycles, Fuel Cell EVs, Solar Powered Vehicles

**UNIT- I:**

**Introduction to Electric Vehicle:** History of Electric Vehicles, Development towards 21st Century, Types of Electric Vehicles in use today – Battery Electric Vehicle, Hybrid (ICE and others), Fuel Cell EV, Solar Powered Vehicles. Motion and Dynamic Equations of the Electric Vehicles: various forces acting on the Vehicle in static and dynamic conditions.

**UNIT- II:**

**Introduction to Hybrid and Electric Vehicles:** Social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid Drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis

**UNIT- III:**

**Introduction to Electric Drive Trains:** Basic concept of electric traction, introduction to various electric drive train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis. Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency

**UNIT- IV:**

**Types of Storage Systems:** Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices. Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Calculation for the rating.

**UNIT- V:**

**Modeling of Hybrid Electric Vehicle Range:** Driving Cycles, Types of Driving Cycles, Range modeling for Battery Electric Vehicle, Hybrid (ICE and others), Fuel Cell EV, Solar Powered Vehicles. Case study of 2-wheeler, 3-wheeler and 4-wheeler vehicles.

**TEXTBOOKS**

1. James Larminie, J. Lowry, "Electric Vehicle Technology Explained", John Wiley and Sons Ltd. 2003.
2. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design", CRC Press, 2004.

**REFERENCE BOOKS**

1. S. Onori, L. Serrao and G. Rizzoni, "Hybrid Electric Vehicles: Energy Management Strategies", Springer, 2016.
2. Iqbal Hussein, "Electric and Hybrid Vehicles: Design Fundamentals", CRC Press, 2010