# B Tech Mechanical Engineering (ME) Curriculum - 2019 Intake Onward

## Programme Core Curriculum

## Semester 1

| Course code | L-T-P-C | Course Name |
|---|---|---|
| ME 100 | 1-0-0-1 | Introduction to Profession |

*Total Credits 23*

*Refer to Institute Core Course List for semester-1 for the remaining courses in semester-1.*

## Semester 2

| Course code | L-T-P-C | Course Name |
|---|---|---|
| ME 110 | 2-1-0-3 | Statics and Dynamics |

*Total Credits 21*

*Refer to Institute Core Course List for semester-2 for the remaining courses in semester-2.*

## Semester 3

| Course code | L-T-P-C | Course Name |
|---|---|---|
| ME 200 | 2-1-0-3 | Thermodynamics |
| ME 201 | 2-1-2-4 | Fluid Mechanics |
| ME 210 | 3-1-0-4 | Mechanics of Materials |
| ME 211 | 0-0-3-2 | Solid Mechanics Lab |
| | 3-0-0-3 | Open Elective |
| MTH 3142 | 3-1-0-2 | Differential Equations II |

*Total Credits 18*

## Semester 4

| Course code | L-T-P-C | Course Name |
|---|---|---|
| ME 212 | 1-0-3-2 | Machine drawing lab |
| ME 220 | 2-1-0-3 | Manufacturing Processes I |
| ME 221 | 1-0-3-2 | Mechanical Measurements & Metrology |
| ME 222 | 3-0-0-3 | Engineering Metallurgy |
| | 3-0-0-3 | Open Elective |
| | 3-0-0-3 | Open Elective |
| MTH 213 | 3-1-0-4 | Numerical Analysis |

*Total Credits 20*

## Semester 5

| Course code | L-T-P-C | Course Name |
|---|---|---|
| ME 300 | 2-1-3-4 | Applied Thermodynamics |
| ME 310 | 2-1-2-4 | Kinematics and Dynamics of Machines |
| ME 320 | 2-1-0-3 | Manufacturing Processes II |
| ME 321 | 0-0-3-2 | Manufacturing Processes Lab |
| | 3-0-0-3 | Open Elective |
| | 3-0-0-3 | Open Elective |

*Total Credits 19*

## Semester 6

| Course code | L-T-P-C | Course Name |
|---|---|---|
| ME 301 | 2-1-2-4 | Heat Transfer |
| ME 311 | 2-1-2-4 | Machine Design |
| ME 322 | 2-1-0-3 | Industrial Engineering and Operations research |

| Course code | L-T-P-C | Course Name |
|---|---|---|
| ME 323 | 0-0-3-2 | Digital Manufacturing Lab |
| | 3-0-0-3 | Program Elective |
| | 3-0-0-3 | Open Elective |

*Total Credits 19*

## Semester 7

| Course code | L-T-P-C | Course Name |
|---|---|---|
| ME 430 | 12-0-0-12 | Internship |
| | | OR |
| ME 431 | 6-0-0-6 | BTP I |
| | 3-0-0-3 | Program Elective |
| | 3-0-0-3 | Program Elective |

*Total Credits 12*

## Semester 8

| Course code | L-T-P-C | Course Name |
|---|---|---|
| | 3-0-0-3 | Program Elective |
| | 3-0-0-3 | Program Elective |
| | 3-0-0-3 | Program Elective/BTP II |
| | 3-0-0-3 | Open Elective |

*Total Credits 12*

**Program Total Credits 144**

- Track 1: A student doing industrial internship will have to earn 12 credits through program electives.
- Track 2: A student who is not doing 6 months' industrial internship will have to earn 6 BTP credits and program electives equivalent to 18 credits of which 3 credits can be for BTP-II.
- A student has to earn a minimum of 12 credits from the courses offered by HSS department and a minimum of 12 credits through open electives.

ME - Mechanical Engineering Core Course
MTH - Core Course in Mathematics
HSS - Humanities and Social Sciences

## Course numbering

ME XYZ denotes a course offered in the year X of undergraduate studies, of category Y. The number Z linearly orders courses with the same X and Y components.

| Course categories | Code |
|---|---|
| Thermofluids | 0 |
| Solid Mechanics & Design | 1 |
| Manufacturing | 2 |
| Internship/Projects | 3 |

## Course Description

**ME 100 Introduction to Profession 1-0-0-1**

*Objective*: This course is intended as a bird's-eye view of the various aspects of Mechanical Engineering.

*Contents*:

- Introduction to Thermofluids Engineering, Solid Mechanics & Design, Manufacturing Technology.
- A brief introduction to written communication and technical writing.

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**ME 110 Statics and Dynamics 2-1-0-3**

*Objective*: This course is aimed at introducing fundamental concepts of mechanics, both statics and dynamics. The learning objectives include solving equilibrium problems using Newton's laws and energy methods, basics of dynamics and vibrations.

*Contents*:

- Concept of force and moment, Equivalent force systems, Equilibrium of rigid bodies, Free body diagram, Friction, Static analysis of trusses, Statically determinate and indeterminate systems, Virtual Work, Principle of potential energy.
- Dynamics of system of particles, Kinematics of rigid bodies, General plane motion, Coriolis acceleration, Kinetics of rigid bodies.
- Vibration of single degree of freedom (SDOF) systems - undamped free vibration, free vibration with viscous and Coulomb damping, Harmonically excited vibration of SDOF systems, Transmissibility.

*Reference Textbooks:*

1. Engineering Mechanics - Statics, J. L. Meriam, L. G. Kraige and J. N. Bolton, Wiley.
2. Engineering Mechanics - Dynamics, J. L. Meriam, L. G. Kraige and J. N. Bolton, Wiley.
3. Vector mechanics for Engineers: Statics and Dynamics (SI Edition), F. P. Beer, R. Johnston Jr., D. F. Mazure, P. J. Cornwell, and S. Sanghi, McGraw Hill Education.
4. Engineering Mechanics: Statics and Dynamics, I. H. Shames, G. K. Mohana Rao, Pearson.

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**ME 200 Thermodynamics 2-1-0-3**

*Objective:*

1. Understand the concepts like system, control volume, laws of thermodynamics and thermodynamic properties and their units .
2. Know how to apply various laws and concepts of thermodynamics on engineering systems and processes with special emphasis on thermomechanical systems.
3. Know how to use thermodynamic property charts, thermodynamic relations along with laws of thermodynamics for analysis and calculation of thermal efficiency, power generation rate and other important parameters for different types of thermomechanical systems such as engines, refrigerators, turbines, pumps, compressor etc .

*Contents:*

- Thermodynamic System, Control Volume, Macroscopic Versus Microscopic Point of View, Properties, State, Processes and Cycles, Units.
- Equality of Temperature and Zeroth Law of Thermodynamics, Temperature Scales. Work, Heat and their comparison. Vapor-Liquid-Solid-Phase Equilibrium in a Pure Substance, Independent Properties of a Pure Substance, Tables of Thermodynamic Properties, The P–V–T Behavior of Low- and Moderate-Density Gases, The Compressibility Factor, Equations of State.
- The First Law and 2nd law of Thermodynamics for a Control Mass and control volume. Definition and calculation of Different Specific Heats, Internal Energy change, Enthalpy, Entropy of pure materials, ideal gas etc. The Steady-State Process, The Transient Process.
- Rate equation and conservation equations for mass, energy and entropy.Heat Engines and Refrigerators. Concept of Reversible and Irreversible Processes, Entropy Generation, Carnot Cycle and its efficiency. The Thermodynamic Temperature Scale, The Ideal-Gas Temperature Scale.
- Principle of the Increase of Entropy, Available Energy, Reversible Work, and Irreversibility, Availability and Second-Law Efficiency, Exergy Balance Equation Thermodynamic Property Relationship: Important mathematical and property Relationships, Maxwell's equations,Volume expansivity, isothermal and isentropic compressibility, Joule Thompson coefficient.

*Suggested Textbook:*

1. Fundamentals of Thermodynamics. 7th Edition (2009). Claus Borgnakke and Richard E. Sonntag. John Wiley & Sons, Inc.

*Reference Textbooks:*

1. Fundamentals of Engineering Thermodynamics . 8th Edition (2014). Michael K. Moran, Howard N. Shapiro , Daisie D. Bottner, Margaret B. Bailey. John Wiley & Sons, Inc.
2. Thermodynamics an Engineering Approach. 8th Edition (2015). Yunus A. Cengel, Michael A. Boles. McGraw-Hill Education.

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**ME 201 Fluid Mechanics 2-1-2-4**

*Objective:* This course is aimed at introducing fundamental aspects of mechanics of fluids. The learning objectives include physical properties of fluids, fluid statics, control volume analyses, Navier-Stokes equations and boundary layer theory

*Contents:*

- Introductory concepts: Definition of fluid, Newton's law of viscosity, continuum hypothesis, properties of fluids, non-Newtonian fluids
- Fluid statics: Pascals law, hydrostatic pressure distribution, manometer, hydrostatic force on a submerged plane & curved surfaces, buoyancy, stability of submerged & floating bodies
- Kinematics: Lagrangian& Eulerian description, steady and uniform flows, acceleration, streamline, pathline and streakline, motion and deformation of a fluid particle, vorticity
- Governing equations in integral form: Reynolds transport theorem, conservation of mass, momentum and energy, Bernouli's theorem
- Governing equations in differential form: derivation of continuity equation and its alternative form, stream function, conservation of momentum (Cauchy equation), constitutive law for Newtonian fluids, Navier-Stokes equations, exact solutions to specific problems
- Dimensional analysis: principle of dimensional homogeneity, Buckingham Pi theorem, method of repeating variables, non-dimensional numbers, physical similarity, incomplete similarity
- Flow through pipes: laminar & turbulent flows, Reynolds dye experiment, entrance & fully developed region, Hagen-Poiseuille flow, transition, Darcy friction factor, Moody diagram, Colebrook and Harrland approximations, minor losses, flow measurement techniques
- Boundary layers: D'Alemberts paradox, idea of boundary layer, BL thickness, BL equations, Blasius solution, momentum integral technique, flow separation, lift & drag acting on immersed solid bodies

*Reference Textbooks:*

1. RW Fox, PJ Pritchard, AT McDonald, Introduction to fluid mechanics, John Wiley & Sons.
2. YA Cengel, JM Cimbala, Fluid mechanics, McGraw Hill Publishers.
3. FM White, Fluid mechanics, McGraw Hill Publishers.
4. SK Som, G Biswas, S Chakraborty, Introduction to fluid mechanics and fluid machines, McGraw Hill publishers.

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**ME 210 Mechanics of Materials 3-1-0-4**

*Objective:* Understanding different types of stresses and strains, Calculation of stresses and strains and design for different cases of loads, Identifying maximum stress/strain under axial, bending and twisting loads, Calculation of deflection/rotation under bending/twisting, Calculation of stress and buckling load in columns, Applying energy methods to engineering structures.

*Contents:*

- Fundamentals of mechanics of deformable solids; Concepts of stress and strain and their Relationships; Axial forces, Simple (direct) shear, Combined stresses, thin cylinders and spheres, Mohr's circle diagram for stress and strain; Torsion of circular cross-section shafts.
- Beam bending – normal and shear stresses, Euler-Bernoulli Model, deflections; Statically indeterminate problems in bending.
- Buckling of columns.

- Energy methods – Castigliano's theorem and its applications, Potential energy methods and applications.
- Experimental methods of stress analysis – strain gages, strain rosettes and photoelasticity.

*Reference Textbooks:*


1. S.H. Crandall, N.C. Dahl and S.J. Lardner, An introduction to Mechanics of solids, Tata McGraw Hill Third Edition 2012;
2. E.P. Popov, Engineering Mechanics of Solids, Prentice Hall of India, 2nd edition, 2012;
3. M. Salvadori and R. Heller, Structure in Architecture, Prentice Hall Inc, 1963;
4. S.P. Timoshenko and D.H. Young, Elements of Strength of Materials, 5th ed, Affiliated East West Press, 1976;
5. J.P. Den Hartog, Strength of Materials, Dover, 1949;
6. J.M. Gere and S.P. Timoshenko, Mechanics of Materials, CBS Publishers, 1986;
7. S.P. Timoshenko; History of Strength of Materials, Dover, 1983;
8. Sadd, Elasticity; Theory, Applications, and Numerics, 1st ed., Elsevier India, 2006;
9. Gere and Goodno, Mechanics of Materials, 7th ed., Cengage Learning India, 2012.


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**ME 211 Solid Mechanics Lab 0-0-3-2**

*Objective:* The objective of this Laboratory course is to give hands on experience of different experiments related to the Mechanics of Materials. The students are expected to learn the basic principles of experimentation. Through the selected experiments, the students will learn standard measurement process, data analysis, experiments for measurements of mechanical properties, material characterization etc.

*Contents:*

- Introduction to experimental methodology - Goal of experiments, Data analysis, Preparing Laboratory reports
- Large deflection of cantilever beam
- Experimental validation of reciprocal and superposition theorem
- Torsion of a circular shaft
- Brinell hardness test
- Rotating beam bending fatigue
- Charpy impact test
- Uniaxial tensile test
- Compression testing of materials
- Nanoindentation experiments
- Microscopy techniques
- Strain Measurement by optical (non-contact) methods

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**MTH 3142 Differential Equations II 3-1-0-2**

*Contents:*

- Sturm-Liouville problems, Power series solution, Second-order PDEs, and their classification.
- Laplace, Heat and Wave equations- Fourier series, Method of separation of variables

*Reference Textbooks:*

- Walter A. Strauss, Partial Differential Equations: An Introduction.
- Mark A. Pinsky, Partial Differential Equations and Boundary value Problems with Applications.
- Sandro Salsa. Partial Differential Equations in Action: From Modelling to Theory, 2015.
- Lawrence C. Evans Partial Differential Equations , 2nd edition, 2010.

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**ME 212 Machine Drawing 1-0-3-2**

*Objective:* To visualize the mechanical component and convert it into a drawing, to understand conventional symbols and mechanical details as per the standards, to assemble and disassemble the mechanical components.

*Contents:*

- Introduction: Introduction to machine drawing, Conventional representation of machine components, Materials, Springsand gears, Indication of surface texture
- Review of AutoCAD
- Threaded Fasteners and Joints: Screw thread nomenclature, Types of threads, nut, bolt and washer, Locking arrangements of nuts, Foundation bolts
- Keys, Cotters and Pin Joints: Keys, Cotter joints, Socket and spigot joint, Sleeve and cotter joints Jib and cotter joint, Knuckle joint
- Riveted Joints: Introduction, Classification, Caulking and fullering for rivets
- Welded Joints: Types of welded joints, Welding symbols
- Pipe Joints and Fittings
- Power Transmission Units: Shaft couplings, Shaft bearings
- Limits, Fits and Tolerances: Terms related to dimensional tolerances, Types of tolerances, Systems of dimensional tolerances and fits, Calculation of fundamental deviations and tolerances, Types of fits, Geometrical tolerances
- Assembly Drawings with Sectioning and Bill of Materials
- Valves: Blow-off cock, Steam stop valve, Rams bottom safety valve, Non-return valve etc.
- Bearings: Plummer block, Pedestal bearing, Footstep bearing etc.
- Miscellaneous Parts: Lathe tool post, Lathe and milling machine tail stock, Screw Jack, Drill Jig, Crane hook, Connecting rod etc.

*Lab Component:*

- Preparation of assembly and part drawings in 2D and 3D as per prevailing standards

*Reference Textbooks:*

1. N. Siddheshwar, P. Kannaiah, V. V. S. Sastry; Machine Drawing; Tata-McGraw Hill.
2. K. C. John; A text book of Machine Drawing; PHI Learning Pvt. Ltd., New Delhi.
3. N. D. Junnarkar; Machine Drawing; Pearson Education.
4. N. D. Bhat; Machine Drawing; Charotar Publishing Company.
5. P. S. Gill; Machine Drawing; S. K.Kataria& Sons, New Delhi.
6. K. L. Narayana; P. Kannaiah, K. Venkata Reddy; Machine Drawing; New Age International Publishers.
7. K. R. Gopalkrishna; Machine Drawing; Subhash Publications.
8. BIS (Board of Indian Standards) SP 46.

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**ME 220 Manufacturing Process I 3-0-0-3**

*Objective:* Introduction to various fundamental manufacturing processes and basic analysis of manufacturing processes such as casting, forming, welding and powder metallurgy.

*Contents:*

- Casting processes: dispensable and permanent mould processes; analysis of melting, pouring and solidification phenomena; design of pattern, core, feeder and gating system; casting defects and inspection.
- Joining processes: fusion and solid-state welding; brazing and soldering; weld joint design, cooling rate, and joint properties; welding defects and inspection.
- Bulk and Sheet Forming processes: rolling, forging, extrusion and drawing; sheet metal working; forming limit diagram; loads, friction and lubrication; forming defects and inspection.
- Powder processing: Powder manufacture, characterization, compaction and sintering; metal injection moulding; hot and cold isostatic pressing.
- Polymers and Composites: Thermoplastics, thermosets, elastomers and composites; related processes; injection mould design; moulding defects and inspection.
- Advanced processes: Free form fabrication (rapid prototyping), and net shape manufacturing processes.

*Suggested Textbooks/Reference Textbooks:*


1. Ghosh A. and Mallick A. K., Manufacturing Science, Affiliated East West Press, 2001.
2. Rao P. N., Manufacturing Technology- Foundry, Forming and Welding, Tata McGraw Hill, 1987.
3. Schey J., Introduction to Manufacturing Processes, Tata McGraw Hill, 2000.
4. DeGarmo E. P., Black J. T. and Kohser R. A., Materials and Processes in Manufacturing, Prentice Hall India, 1997.
5. Pye R. G. W., Injection Mold Design, Longman Scientific & Technical, Essex, 1989.


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**ME 221 Mechanical Measurements and Metrology 1-0-3-2**

*Objective:* The course is designed as an exposition to important measurement techniques in mechanical engineering and to provide a solid understanding of the theory behind the measurements and errors involved in the measurements.

*Contents:*

- Introduction: Generalized measurement system, Zero, first and second order measurement systems, static and dynamic calibration, random errors, uncertainty analysis and error propagation.
- Basic measurement techniques in thermal, mechanical, and fluid systems.
- Introduction to various mechanical measurement devices, their static and dynamic characteristics, calibration experiments.
- Measurement of temperature, pressure, force, strain and motion.
- Sampling and data acquisition: Sampling concepts, data acquisition systems and components, signal conditioning, amplifiers, filters.
- Measurement of lengths and angles (Hand and Precision Instruments).
- Limits and Fits.
- Geometric Tolerances for form, position and location.
- Design of special purpose inspection gages/comparators.

- Inspection of complex shapes like screw threads, worms and gears.
- Surface finish and its measurement.
- Introduction to Modern Techniques of inspection based on the above topics.

*Reference Textbooks:*


1. R. K. Jain, 'Engineering Metrology', Khanna Publishers, 1999.
2. J. F. W. Gayler and C.R. Shotbolt, 'Metrology for Engineers' Cassel London, 1964.
3. K. J. Hume, 'Engineering Metrology' MC Donald London, 1963.
4. G. G. Thomas, 'Engineering Metrology', Butterworth's, 1974.
5. S. P. Venkateshan, 'Mechanical Measurements', Ane Books, 2015.


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**ME 222 Engineering Metallurgy 3-0-0-3**

*Objective:* The course objectives are to provide a broad based coverage of science and engineering of materials of construction particularly metallic materials. Fundamental concepts of Metal Physics are first discussed in depth for metals and common alloys. These are then extended to more complex alloy systems and other materials such as ceramics, polymer, etc…Behaviour of materials during their processing and applications is examined in relation to microstructure, their composition, resistance to environments, etc.

*Contents:*

- Atomic and crystal structures, interatomic bonding, crystallography, environment Elements from the periodic table, which form part of the engineering materials, are identified.
- The basic parameters of the microstructure of the materials interatomic bonding, crystallography, allotropy, lattice defects and flaws in materials, grains and interfaces, imperfections, texture, microstructure, grains and grain surfaces, texture.
- Mechanical behavior including stress strain relationship, plasticity, strength, toughness, formability, etc.
- Measurements of strength, toughness, resistance to fracture and fatigue damage, creep, etc.
- Corrosion resistance and measures to control corrosion susceptibility of materials.
- Failures of materials in service, mechanisms and option of failure prevention.
- Major alloy systems, phase transformations, equilibrium diagrams and thermal/thermo mechanical processing, strengthening mechanisms.
- Optimization of microstructures in relation to desired properties,
- Design and processing of alloys, Selection of industrial alloys for applications.
- Material specifications and test standards. Application of databases and and property charts for materials selection.
- Case studies in materials design, selection and applications

*Reference Textbooks:*


1. Materials Science and Engineering: An Introduction, Sixth Edition by William D. Callister, Jr.
2. Phase Transformations in Metals and Alloys: Amazon.in: David A. Porter, Kenneth E. Easterling


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**MTH 213 Numerical Analysis 3-1-0-4**

*Contents:*

- System of linear equations: matrix norms, Gaussian Elimination, LU decomposition, QR decomposition, Gauss Jacobi and Gauss Seidel methods with convergence analysis, condition number, Gershgorin theorem for locating eigenvalues, power method to approximate the eigenvalues.
- Nonlinear equations/systems: Bisection method, Regula Falsi, Secant method, Newton's method, fixed point iteration and order of convergence.
- Interpolation/Approximation: Polynomial interpolation, Hermite interpolation, spline interpolation, error analysis.
- Numerical Integration: Trapezoidal and Simpsons rules, Gaussian quadrature formulae and error analysis.
- Numerical Differentiation: Forward, backward and central difference approximations, single and multistep methods for initial value problems. Numerical solutions to PDE using finite difference method.

*Suggested References:*

- S. D. Conte and Carl de Boor, Elementary Numerical Analysis- An Algorithmic Approach.
- K. E. Atkinson, Introduction to Numerical Analysis.
- Steven C. Chapra, Applied Numerical Methods with MATLAB for Engineers and Scientists.
- D. Kincaid and W. Cheney, Numerical Analysis: Mathematics of Scientific Computing. (2002).
- Richard L. Burden and J. Douglas Faires, Numerical Analysis, (2010).

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**ME 300 Applied Thermodynamics 2-1-3-4**

*Objective:* This course is a bridge between the basic thermodynamics course and various advanced courses on steam turbines, gas turbines, refrigeration, air-conditioning, IC engines, turbo machinery, and so on. The course focuses on the practical significance, working principles, general layout, and analytical characterization of these devices.

*Contents:*

- Combustion and Thermochemistry: Introduction to combustion; review of basic thermodynamic concepts; mixtures of ideal gasses and evaluating properties of mixtures; Clausius-Clapeyron equation; stoichiometry; standardized enthalpy and enthalpy of formation; using property tables; applications of first law of thermodynamics - enthalpy of reaction, enthalpy of combustion, heating values, and adiabatic flame temperature
- Gas power cycles-Internal combustion (IC) engines: Basic IC engine terminology & concepts; Ideal air standard cycle assumptions; 1st law and 2nd law analysis of idealized Otto, Diesel, and duel cycle; comparison of various cycles and effects of variable specific heat on cycle performance; Engine classification and operation (4-stroke, 2-stroke, multi-cylinder, rotary, Wankel); Indicator diagrams and real cycle analysis; performance testing of engines; future of IC engines
- Gas power cycles-Jet engines: Introduction to gas turbines and their applications; description, 1st law and 2nd law analysis of idealized Brayton cycle, regenerative Brayton cycle, inter-cooled Brayton cycle, Ericson cycle, and Stirling cycle; principles of jet propulsion
- Vapor power cycles: basics of vapor power cycle; vapor Carnot cycle; using steam tables; 1st law and 2nd law analysis of idealized Rankine cycle, Rankine cycle with super-heating, Rankine cycle with re-

heating, Rankine cycle with regeneration, binary cycle, combined cycle, and co-generation; brief review of boilers, steam generators, steam engines, steam turbines

- Refrigeration and Heat Pump Systems: Introduction and definitions; Carnot refrigeration cycle; vapor compression cycle analysis and applications; refrigerants, their characteristics, selection, and properties; analysis of vapor absorption system; thermoelectric cooling; analysis of Carnot heat pump and vapor compression heat pump; gas refrigeration system or inverse Brayton cycle; Analysis of ideal and actual inverse Brayton cycle
- Air conditioning and psychrometry: analysing systems and processes involving mixtures of ideal gasses: compression, expansion, mixing, heating, cooling; psychrometric principles: moist air, it's characteristics, and processes; psychrometers and psychrometric charts; analysis of various air conditioning processes; cooling towers
- Compressible fluid flow: Momentum equation for steady 1-D flow; velocity of sound and Mach number; stagnation state properties; One-Dimensional Steady Flow in Nozzles and Diffusers; Flow with Constant specific Heats

*Reference Textbooks:*


1. M.J.Moran and H.N.Shapiro, 'Fundamentals of Engineering Thermodynamics', Fourth Edition, Wiley, New York, 2000.
2. R.W.Hay wood, 'Analysis of Engineering Cycles', Fourth Edition, Pergamon Press, Oxford, 1991.
3. M. L . Mathur and F. S. Mehta, 'Steam and Other Tables (with Mollier Chart)', Revised Edition, Jain Brothers, New Delhi, 2008 (or later).


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**ME 310 Kinematics and Dynamics of Machines 2-1-2-4**

*Objective:* The objective of this course is to understand the scientific principles behind the development and working of various kinds of mechanisms and machines, which are used for transferring and transforming motion and power.

*Contents:*

- Introduction to Mechanisms – planar and spatial mechanisms, kinematic pairs, kinematic diagrams, kinematic inversion, four-link planar mechanism, mobility, number synthesis. Displacement, velocity and acceleration analysis of planar mechanisms, Instantaneous center of velocity, Aronhold-Kennedy theorem.
- Dimensional synthesis – path generation and function generation.
- Cam-follower mechanism.
- Gears – fundamental law of gearing, spur gears, gear trains.
- Dynamic force analysis of planar linkages. Balancing of rotating masses.
- Gyroscopic action in machines – precision of a symmetrical rotor.

*Reference Text books:*


1. Theory of Mechanisms and Machines, Amitabha Ghosh and Asok Kumar Mallik, East-West Press Private Limited.
2. Theory of Machines and Mechanisms, John J. Uicker, Gordon R. Pennock, Joseph E. Shigley, Oxford University Press.
3. Kinematics, Dynamics and Design of Machinery, Kenneth J. Waldron, Gary L. Kinzel, Wiley.
4. The Theory of Machines, Thomas Bevan, Pearson Education India/CBS Publishers.


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**ME 320 Manufacturing Processes II 2-1-0-3**

- Objective:*

- To understand the fundamentals of metal removal processes.
- To study the cutting tool technology.
- To study various machining processes and understand different operations on manufacturing machines.
- To understand the economics involved in machining.
- To study unconventional machining processes and numerically controlled machines.

*Contents:*

- Fundamentals of machining – Mechanics of cutting, Cutting forces and power, Temperatures in cutting
- Cutting tool technology– Tool life, Tool materials, Tool geometry, Cutting fluids
- Economics of machining – Machinability, Surface finish, Selection of cutting conditions, Cutting speeds optimization
- Machining processes and machine tools – Turning, Drilling, Milling, Related processes – Boring, Reaming, Planing, Shaping, Broaching, Gear manufacturing
- Abrasive machining – Grinding and other finishing processes
- Advanced machining processes – Mechanical energy processes, Electrochemical machining, Thermal energy processes, Chemical machining
- Numerical control – NC, CNC, DNC, Adaptive control, NC part programming
- Introduction to rapid prototyping

*Reference Textbooks:*


1. M. P. Groover; Principles of Modern Manufacturing; John Wiley & Sons Singapore Pte. Ltd.; 5th Edition; 2013.
2. S. Kalpakjian, S. R. Schmid; Manufacturing Engineering and Technology; Pearson India Education Services Pvt. Ltd.; 7th Edition; 2018.
3. P. N. Rao; manufacturing Technology – Metal Cutting & Machine Tools; Tata McGraw-Hill Publishing Company Limited; 2000.
4. A. Ghosh, A. K. Malik; Manufacturing Science; East-West Press Pvt. Ltd.; 2010.
5. B. L. Juneja, G. S. Sekhon, N. Seth; Fundamentals of Metal Cutting and Machine Tools; New Age International Publishers; 2009.


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**ME 321 Manufacturing Processes Lab 0-0-3-2**

*Objective:*

- To expose the students to a variety of manufacturing processes including their typical use and capabilities.
- To provide a practical understanding of various manufacturing processes.

*Contents:*

- Lathe and Milling Operations

- Chip Formation on Lathe Machine
- Gear Cutting on Milling Machine
- Measurement of turning and milling forces
- EDM Machine
- Programming and Simulation on CNC Lathe Trainer
- Programming and Simulation on CNC Mill Trainer
- Solid Modelling using Solid-Works and 3-D Printing of a part/component

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**ME 301 Heat transfer 2-1-2-4**

*Objective:* The objective of this course is to introduce with fundamental concepts of heat transfer which is relevant to all subfields of mechanical engineering. The course covers three modes of heat transfer – conduction, convection and radiation.

*Contents:*

- Conduction: 1-D conduction, fins, 1-D transient conduction, 2-D conduction.
- Convection: Introduction, Review of fluid mechanics
- Forced convection: single phase forced convection, governing equations, flow through a tube, boundary layer over a flat plate, flow across a cylinder, correlations
- Natural convection: single phase natural convection, vertical flat plate, horizontal cylinders, horizontal plates, correlations
- Radiation: Basic laws, properties of surfaces, heat transfer between bodies, view factors.
- Heat Exchanger: Introduction, classifications of heat transfer, overall heat transfer coefficient, fouling factor, temperature distributions in various types of heat exchangers using LMTD method, the effectiveness-NTU method
- Condensation: Dropwise and film condensation, film condensation on a vertical plate, condensations on horizontal tubes
- Boiling: Types of boiling, pool boiling curve, correlations in saturated pool boiling.

*Suggested Textbooks:*

1. Fundamentals of Heat and Mass Transfer, Frank P. Incrorpera, David P. Dewitt, Theodore L. Bergman, Adrienne S. Lavine, 7th edition , John Wiley & Sons.

*Reference Textbooks:*

1. A textbook on heat transfer, S. P. Sukhatme, 4th edition, Universities Press.
2. Heat transfer, J. P. Holman, 8th edition, McGraw hill.

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**ME 311 Machine Design 2-1-2-4**

*Objective:*
To understand the fundamental principles of mechanical design
To apply those fundamental principles for designing machine components
Learning the procedure for design of machine components

*Contents:*

- Fundamentals – Review of strength of materials.
- Theories of failure - failure under static loads, failure under dynamic loads (fatigure), Prestress due to yielding
- Machine components - Springs, spur gears, threaded fasteners and power screws, cultches and brakes, roller-element bearings, lubrication and sliding bearings, welding, shafts and associated parts, and micro/nanoscale machine elements

*Suggested Textbooks:*

1. Fundamentals of machine component design, Robert C. Juvinall, Kurt M. Marshek, John Wiley & Sons

*Reference Textbooks:*

1. Mechanical engineering design, Joseph E. Shigley, Charles R. Mischke, Tata McGraw Hill
2. Design of machine elements, V B Bhandari, McGraw Hill Education

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**ME 322 Industrial Engineering & Operations Research 2-1-0-3**

*Objective:*

- To understand the concept of productivity and the techniques of improving the existing system.
- To study methods of establishing work standard.
- To study various methods for effective management of production operations.
- To analyse real life decision making situations and develop the art of converting these situations into mathematical models.
- To understand the working principles of techniques to solve linear programming problems.

*Contents:*

- Introduction to Industrial Engineering
- Productivity, Work Study, Method Study, Principles of Motion Economy, Ergonomics, Work Measurement
- Forecasting Techniques
- Plant Location and Plant Layout
- Sequencing and Scheduling
- Inventory Management
- Project Management, CPM and PERT Analysis
- Introduction to Concepts of Operations Research and Optimization
- Linear Programming, Problems formulation, Graphical Method, Simplex Method, its Extensions and Variants, Sensitivity Analysis
- Concepts and Applications of Primal-Dual Problems, Duality Theory
- Transportation and Assignment Models

*Reference Textbooks:*

1. R. M. Barnes; Motion and Time Study Design and Measurement of Work; John Wiley & Sons; 7th Edition, 2013.
2. M. K. Groover; Work Systems — The Methods, Measurement & Management of Work; Pearson India Education Services Pvt. Ltd.; 1st Edition; 2017.
3. K. George; Introduction to Work Study by ILO; Universal Book Corporation, Bombay; 2011.

4. W. J. Stevenson; Operation Management; McGraw Hill Education (India) Pvt. Ltd.; 12th Edition; 2018.
5. R. Panneerselvam; Operations and Production Management; PHI Learning Pvt. Ltd.; 3rd Edition; 2019.
6. F. S. Hillier, G. J. Lieberman, B. Nag, P. Basu; Introduction to Operations Research; McGraw Hill Education (India) Pvt. Ltd.; 10th Edition; 2017.
7. H. A. Taha; Operations Research — An Introduction; Dorling Kindersley (India) Pvt. Ltd.; 8thEdition; 2008.
8. H. S. Kasana, K. D. Kumar; Introductory Operations Research — Theory and Applications; Springer International Edition; 2011.
9. S. R. Yadav, A. K. Malik; Operations Research; Oxford University Press; 2014.
10. A.Ravindran, D.T. Philips and J.J. Solberg; Operations Research; Principles and Practice, John Wiley & Sons; 2005.

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**ME 323 Digital manufacturing Lab 0-0-3-2**

Objective: Offering fundamental understanding of digital manufacturing techniques . Imparting training on Hands on practical skills of digital manufacturing.

*Contents:*

- Introduction to digital manufacturing
- 3 D Scanning, 3D CAD Modelling, Design process and role of CAD, Types and applications of design models, Three dimensional modelling
- Solid modelling - Parametric modeling, Assembly modeling, CNC Programming: CNC Lathe, CNC Milling
- 3 D printing of objects: introduction to fused deposition technique, introduction to additive manufacturing

*Suggested Textbooks/Reference Textbooks:*

1. Mikell P. Groover, Automation, Production Systems, and Computer-Integrated Manufacturing, 4th Edition, Pearson , 2015.
2. Ibrahim Zeid and Sivasubramanian R, “CAD/CAM - Theory and Practice”, Tata McGraw Hill Education, 2011.
3. Peter Smid, CNC Programming Handbook, Industrial Press, 24-Jan-2008

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