III Semester

MEE2001: ENGINEERING ECONOMICS [3 0 0 3]

Course Outcomes: On completion of this course student shall be able to –

1. Describe various economic decision-making concepts and types of estimates.
2. Assess the financial viability of engineering projects.
3. Discuss budget and budgetary control concepts.
4. Analyse for replacement analysis and break-even analysis.
5. Estimate the projects for economic feasibility by risk analysis to enhance entrepreneurship skills.

Concept and Value Analysis, Economic Decision Making, Types of Estimates, Accounting and Control, Elements of Cost, Prime Cost, Overheads, Types of Cost, Process Cost & Cost of Production, Break Even Analysis, Inventory Control & Management, EOQ, Financial Analysis, Simple payback, Return on Investment, NPV (Net Present Value), IRR (Internal rate of Return), Life Cycle Cost Method, Sensitivity Analysis, Project Financing Options. Budget and Budgetary Control, Concept of Budgeting, Type of Budgets. Risk - Risk vs Return, System Concept and Value Analysis, System Analysis & System Engineering, Value Analysis. Replacement Analysis, Depreciation, Network Analysis, Network Techniques, PERT (Programme evaluation and review technique), CPM (Critical Path Method).

Reference Books:

1. R. Panneerselvam, *Engineering Economics*, Prentice Hall of India, Latest Edition.
2. Riggs, D.D. Bedworth and S.U. Randhawa, *Engineering Economics*, McGraw Hill Education, Latest Edition.
3. P.L. Mehta, Managerial Economics, Sultan Chand & Sons, Latest Edition.
4. E.L. Grant, W.G. Ireson and R.S. Leavenworth, *Principles of Engineering Economic Analysis*, John Wiley, Latest Edition.
5. G, J. Tuesen, W.J. Fabrycky and H.G. Tuesen, *Engineering Economy*, Prentice Hall of India, Latest Edition.

MEE2101: MATERIAL SCIENCE & METALLURGY [4 0 0 4]

Course Outcomes: On completion of this course student shall be able to –

1. Elucidate the concept of crystal structure.
2. Compare microstructure of different engineering materials.
3. Select materials for different engineering application.
4. Identify suitable heat treatment process for attainment of desirable property in metals to enhance employability.
5. Describe applications of advanced materials.

Classifications, application and properties of engineering materials, Crystal structure, Crystal directions and planes, Miller indices, Polymorphism or Allotropy, Diffusion processes. Crystallization, Imperfections in Crystals: Point, line and surface defects. Plastic deformation of metals and alloys, Role of dislocation; slip and twinning, grain growth. Solidification of metals and alloys, Phase Diagrams-Phase and Lever Rules, Iron- Carbon equilibrium diagram, Time-Temperature-Transformation Diagram, Heat treatment processes, Powder metallurgy, Corrosion of Metal and Alloys, Mechanical properties of metals, Microstructural characterization Non-destructive testing of materials. Polymeric materials, Structure and

properties of ceramics, Composites Materials, Biocomposites, Nanocomposites, Smart materials, Biomaterials, Nanomaterials.

Reference Books:

1. Callister William D & R. Balasubramaniam, *Materials Science and Engineering*, Wiley Student Edition.
2. Lawrence H. van Vlack, *Elements of Material Science and Engineering*, Pearson Education.
3. K. I. Parashivamurthy, *Materials Science and Metallurgy*, Pearson Education.
4. W.F.Smith, J. Hashmi and R. Prakash, *Materials Science and Engineering*, Tata McGraw Hill, New Delhi.
5. G.E.Dieter ,*Mechanical Metallurgy*, SI Metric Edition McGraw Hill, London.

MEE2102: THERMAL ENGINEERING [3 1 0 4]

Course Outcomes: On completion of this course student shall be able to –

1. Apply different laws and basic concept of thermodynamics in engineering applications.
2. Compute the performance parameters of power and refrigeration cycles.
3. Recognise the application of air compressors and steam turbines.
4. Compare the performance of thermal systems for enhancement of employability opportunities.
5. Estimate availability of close and open systems.

Heat & Work, Thermodynamic Properties, Properties of steam, Laws of Thermodynamics: Applications to Non flow and flow processes, Carnot principle, Absolute thermodynamic temperature scale, Clausius Inequality, Entropy, Principle of increase-in-Entropy, Entropy generation; Availability: Concept of Available Energy, Availability of closed & open systems, Irreversibility; Gas Power cycles: Air standard cycle- Otto, Diesel, Dual, Brayton Cycle, Vapour Power: Rankine Cycle. Reverse Carnot Cycle, Vapour Compression Refrigeration Cycle, Air compressor: working and performance parameters, Steam turbines: impulse and reaction turbine, turbine efficiencies.

Reference Books:

1. P.K. Nag, *Engineering Thermodynamics*, (6e), McGraw Hill, Latest edition.
2. Y.A. Cengel and M A Boles, *Thermodynamics: An Engineering Approach*, (8e), McGraw Hill, Latest Edition.
3. C. Borgnakke and R E. Sonntag *Fundamentals of Thermodynamics*, SI Version, Wiley India Edition.
4. T. J Kotas, *The Exergy Method of Thermal Plant Analysis*, Paragon Publishing, 2012.

MEE2103: STRENGTH OF MATERIALS [2 1 2 4]

Course Outcomes: On completion of this course student shall be able to –

1. Describe concepts of stresses and strains in solids and structures under different types of loadings.
2. Apply concept of stress strain transformation in 2D and 3D structures for enhancing employability.
3. Analyse determinate and indeterminate structures under axial and torsional loading.
4. Compute shear force and bending moment for beams subjected to transverse loading.
5. Explain theory of failure for different class of Materials.

Concept of Stress, Strain Stress-strain diagram, Stress and strain at a point: stress and strain tensors, different state of stresses and strains: stress and strain transformations, Principal stresses, and strains.

Mohr's circle concept. Deformations in axial loaded members. Bending of beams: shear force and bending moment diagrams, pure bending, normal and shear stresses in beams, deflection in beams. Torsion of circular members, Columns: Euler's theory, Buckling load for different end conditions, Rankine-Gordon's formula for columns, Theories of failures. Experiments on Izod and Charpy Impact testing, Rockwell, Vicker's Brinell, Hardness Testing. Torsion, Tensile, Compression, Bending, Shear Testing.

Reference Books:

1. F.P. Beer, R.J. Johnson, J. Dewole and D. Mazurek, *Mechanics of Materials*, (7e), McGraw Hill, 2015.
2. S.B. Timoshenko, J.M. Gere J.M, *Mechanics of Materials*, (2e), CBS Publishers, 2006.
3. B.C. Punamia, A.K Jain, *Mechanics of Materials*, Laxmi Publications, 2006.
4. R.C. Hibbeler, *Mechanics of Material*, Pearson Education, Low Price Edition, 2007

MEE2130: THERMAL ENGINEERING LAB-I [0 0 2 1]

Course Outcomes: On completion of this course student shall be able to –

1. Estimate the calorific values of different fuels.
2. Analyse the performance parameters of CI and SI engines.
3. Evaluate the performance characteristics of an IC engine using alternative fuels to enhance employability opportunity.
4. Investigate the performance parameters of compressor.

Fire and flash point tests; calorific value of fuels, Measurement of dryness Fraction by separating calorimeter. Performance test and Heat balance analysis of 4 stroke 4-cylinder Diesel engine with Electrical dynamometer; Evaluating friction power by Morse test rig and Williams line method, Four Stroke Four Cylinder Petrol Engine Test Rig With Electrical Dynamometer; Performance test and heat balance analysis of four stroke single cylinder CI engines test rig with DC generator; Performance test and heat balance analysis of four stroke single cylinder CI engines test rig for alternate fuels, performance assessment of compressor.

References Books:

1. P.K. Nag, *Engineering Thermodynamics*, (6e), McGraw Hill, Latest edition.
2. Y.A. Cengel, M A Boles, *Thermodynamics: An Engineering Approach*, (8e), McGraw Hill, Latest Edition.

MEE2131: COMPUTER AIDED DRAWING LAB [0 0 2 1]

Course Outcomes: On completion of this course student shall be able to –

1. Draw the orthographic views of an object in CAD & production of engineering drawings.
2. Modelling two-dimensional sketches, visualization in CAD environment.
3. Interpret different views of 3D model and create its CAD model and enhance the employability in product development.
4. Modelling various types of machine parts to enhance the employability in product development.

Introduction to design process and drawings of CAD Software. Review of sectioning, drawing standards, dimensioning, and notes. Fasteners – screws, bolts, and nuts. Assembly drawings with sectioning and bill of materials. Assembly of screw jack, and piston. Detailed part drawings from assembly drawings. Production drawings - limits, fits and tolerances, dimensional and geometric tolerances.

Reference Books:

1. K.L. Narayana, *Machine Drawing*, (2e), Wiley Eastern, 2009.
2. C. Jensen, J. Helsel and D. Short, *Engineering Drawing and Design*, (7e), McGraw-Hill Science, 2007.

MEE2170: PROJECT BASED LEARNING-1 [0 0 2 1]

Course Outcomes: On completion of this course student shall be able to -

1. Conduct literature review to identify research gaps in the field of interest.
2. Design the project for entrepreneurship skill enhancement.
3. Recognize the viability of the project.
4. Present the project to the evaluators.

Introduction to project-based learning, Selection of a project topic and defining project scope, Research methodology and literature review, Project planning and time management, Data collection and analysis, Presentation and communication skills.

Flexi Core 1:
MEE2120: OPTIMIZATION TECHNIQUES [4 0 0 4]

Course Outcomes: On completion of this course student shall be able to –

1. Develop an optimization model of real systems to cultivate entrepreneurial skills.
2. Solve optimization model using linear / Integer/ Goal/ Dynamic programming techniques.
3. Analyse Transportation and Assignment Models.
4. Evaluate queuing problems in single and multiple-channel situations.
5. Apply multi-criteria decision-making approaches to manufacturing systems.

Introduction to optimization; Linear Programming: graphical method, Simplex method, Degeneracy, Duality, Post Optimal and Sensitivity Analysis. Allocation problems: Transportation & Assignment model, Waiting Line Models: States in queue, Single server model (M/M/l), Multiple server model (M/M/S), Single server model with finite capacity; Game Theory: Rectangular, two persons Zero-sum games, Maximin and Minimax Principles, Saddle point, Dominance, Graphical and Algebraic methods, Integer Programming: cutting plane method, branch and bound method; Goal Programming, Dynamic Programming and Simulation, Decision Making: Single criterion, multi-criteria decision making, group decision making.

Reference Books:

1. Taha, Hamdy, *Operations Research*, 7th edition, (USA: Macmillan Publishing Company, Latest Ed.
2. Tzeng, G-H., Huang, J-J. *Multiple Attribute Decision Making: Methods and Applications*, Chapman and Hall/CRC, 2011.
3. A. Ravindran, D. T. Phillips, J. J Solberg, *Operations research: principles and practice*, Wiley New York 2007.

IV Semester

MEE2201: FLUID MECHANICS [2 1 2 4]

Course Outcomes: On completion of this course student shall be able to –

1. Describe the properties and classification of fluid and depict the effect of these properties on fluid in motion and at rest.
2. Establish understanding about fluid pressure and flow rate measuring devices.
3. Analyse the stability of floating and submerged bodies and distinguish between various types of flows.
4. Modify different operating parameters to enhance the performance of hydraulic machines.
5. Recognize different applications of fluid mechanics and fluid flow through different cross-sections.

Properties of Fluids, Newtonian and Non-Newtonian Fluids. Fluid Statics: Pressure and its measurement: Pascal's law, Hydrostatic law: Forces on plane and curved surfaces, Buoyancy, equilibrium of submerged and floating bodies, metacentric height. Fluid Kinematics: Lagrangian and Eulerian description of fluid flow, Types of Fluid flow, Streamline, path line and streak lines, Continuity equation, Fluids subjected to Velocity and acceleration, Stream function, Velocity Potential function Fluid Dynamics: Euler's and Bernoulli's equation, Pipe flow: Darcy Weisbeck equation, Friction factor. Dimensional Analysis: Basic and derived quantities, Similitude and dimensional analysis, Boundary layer concept: Boundary layer separation. Viscous flow, Hagen Poiseuille's equation, Introduction to hydraulic machines. Experiments on Flow measuring devices, Impact of jet on Vanes, Characteristic and performance testing of various types of turbines and pumps, Reynold's Apparatus, Friction in pipe: Ship model apparatus-Metacentric Height measurement.

Reference Books:

1. Frank, White, *Fluid Mechanics*, (7e), Tata McGraw Hills Pub.,2011
2. Modi, Seth, *Fluid Mechanics*, (5e), Standard Book House Pub., 2002.
3. Y A. Cengel, J. M. Cimbala, *Fluid Mechanics*, (3e), 2014.
4. A. K. Jain, *Fluid Mechanics Including Hydraulic Machines*, (12e), Khanna Publication, 2016
5. R. K. Bansal, *Fluid Mechanics and Hydraulic Machines*, (9e), Laxmi Publications, 2015

MEE2202: PRODUCTION TECHNOLOGY [4 0 0 4]

Course outcomes: On completion of this course student shall be able to –

1. Calculate parameters of metal casting, welding, plastic moulding and forming processes to enhance employability.
2. Compute cutting forces and machining time in machining operations on conventional machine tools.
3. Select non-traditional manufacturing process for specific applications.
4. Identify suitable clamping and measuring method for given machining process.
5. Describe 3D printing techniques on the basis of applications.

Casting techniques, Welding techniques, Sheet metal forming operations, Metal forming techniques. Plastic part manufacturing techniques. Working principle and operations on Lathe, Shaper, Planer, Milling, Drilling and Grinding machines, Indexing methods. Theory of metal cutting, Machinability parameters, Cutting force calculations, Merchant's analysis, Taylor's equation, Tool life and wear. Tool

life calculation. Non-traditional manufacturing process - Equipment, Process parameters, principle, Advantages, Limitations. Principle and analysis of locating and clamping methods, Types of Jigs and Fixtures. Measurement methods, Definition of standard terms, Limits, fits & tolerances, Gauges & comparators, Introduction to 3D printing.

Reference Books:

1.P.N. Rao, *Manufacturing Technology*, Tata McGraw-Hill Publishing Company Limited, 2006.
2. Serope Kalpakejian, Steven Schmid R, *Manufacturing Engineering and Technology*, Pearson Education, 2005.
3. V K. Jain, *Advanced Machining Processes*, 1st ed., Allied Publishers Pvt. Ltd., 2013.
4. Beckwith Thomas., *Mechanical Measurements*, Pearson Education, 2003.
5. Sawhney, *Mechanical Measurement & Instrumentation*, Dhanpat Rai and Co, 2002.
6. Thomas., *Mechanical Measurements*, Pearson Education, 2003.

MEE2230: NUMERICAL METHODS & COMPUTATIONAL LAB [0 0 2 1]

Course Outcomes: On completion of this course student shall be able to –

1. Explain the Applications of computational tools in Engineering Problem Solving.
2. Write codes for generating 2D and 3D plots.
3. Develop algorithms using loops and conditional statements.
4. Utilize computational techniques for numerical analysis.
5. Construct & solve mathematical models for different physical problems to enhance employability.

Introduction, Working with Command, Script, and Figure Windows, 2-D Plots, and 3-D Plots, Programming with MATLAB, Flow Control, Writing Functions, Loops and Conditional Statements, Functions, Symbolic Calculations in MATLAB, Polynomial Functions, Numerical Method Problems Through MATLAB, Solving Linear Algebraic Equations, Runga-Kutta Method, Simpson's Rule for Integration, Optimizations, etc, Applications of MATLAB in Physical Problems, Evaluating the Velocity of a jumper with Free Fall Jump, Modelling of Flow Through Pipe, Evaluating Stress in a Bar Under Axial Load.

Reference Books:

1. MATLAB User Manual
2. C.C. Steven, *Applied Numerical Methods*, McGraw-Hill, 2008.

MEE2231: PRODUCTION TECHNOLOGY LAB [0 0 2 1]

Course Outcomes: On completion of this course student shall be able to -

1. Apply machining operations on conventional and non-conventional machines.
2. Use measurement techniques in manufacturing and assembly operation to enhance employability.
3. Analyze gear parameters and profile.
4. Demonstrate 3D printer.

Experiments on conventional and non-conventional machines, Experiments on measuring instruments and gauges, Screw thread measurement using tool maker's microscope, Use of comparators; Gear testing (Parkinson's and Gear roller tester), Angle measurement - Sine bar, surface roughness measurement, measurement using interferometer; Demonstration of 3D Printer Machine.

Reference Books:

1. S.K. Chaudhury, S.K. Hajara, *Elements of Workshop Technology Vol.1*, (14e), Media Promoters & Publishers Pvt. Ltd., 2010.
2. B.S. Raghuvanshi, *A course in Workshop Technology Vol.2*, Dhanpat Rai & Sons, 2015.
3. A.K. Bewoor, V. Kulkarni, *Metrology & Measurement*, McGraw Hill Publication, 2012.
4. N.V. Raghavendra, L. Krishnamurty, *Engineering Metrology & Measurements*, Oxford Publications, 2013.

MEE2270: PROJECT BASED LEARNING 2 [0 0 2 1]

Course Outcomes: On completion of this course student shall be able to –

1. Conduct literature review to identify research gaps in the field of interest.
2. Design their own projects for entrepreneurship skill enhancement.
3. Assess viability of the project
4. Present the project to the evaluators.

Introduction to project-based learning, Selection of a project topic and defining project scope, Research methodology and literature review, Project planning and time management, Data collection and analysis, Presentation, and communication skills.

Flexi Core-2

MEE2220: THEORY OF MACHINES [4 0 0 4]

Course Outcomes: On completion of this course student shall be able to –

1. Describe the concepts of linkage and their relative motion.
2. Identify suitable mechanism using velocity and acceleration analysis.
3. Compute the static and dynamic force.
4. Analyze the functioning of flywheel and governor for skill enhancement.
5. Explain the principle of gyroscope and balancing.

Mechanism and Machine: Constrained motion, rigid and resistant bodies, link, kinematic pair and degrees of freedom. Kinematic chain: Linkage mechanism and structure, mobility and range of movement – Kutzbach and Grubler's criterion, number synthesis, Grashof's criterion, Four bar chain and slider crank chain and its inversions. Displacement, velocity and acceleration analysis of plane mechanisms, Gears and Gear Trains. Static force analysis; inertia forces, dynamic force analysis, dynamically equivalent system, turning moment diagram, flywheels; working principle of governors, centrifugal governors, characteristics of governors, controlling force curve. Principle of gyroscopic couple, stability of plane, ships and vehicles. Balancing for rotating and reciprocating machines, balancing of inline engines.

Reference Books:

1. Rattan, "*Theory of machines*" Tata McGraw Hill, 4th Edition, 2014.
2. Ghosh, Mallik, "*Theory of Mechanisms and Machines*" East West Press, 3rd Edition, 2006.
3. Hamilton H. Mabie and Charles, "*Mechanisms and dynamics of machinery*" John Wiley and sons, Latest Ed.
4. J.E.Shigley and Jr.Uicker, "*Theory of Machines and Mechanisms*" Oxford University press, 4th Edition, 2011.
5. R L Norton, "*Kinematics and Dynamics of Machinery*" Tata McGraw-Hill Education, 1st Edition in SI unit, 2009.

Program Electives

MEE2240: PRODUCT DESIGN AND DEVELOPMENT [3 0 0 3]

Course Outcomes: On completion of this course student shall be able to –

1. Analyze various stages of product design and development processes.
2. Apply the methodologies for product design, development, and management.
3. Employ systematic methods in product development management to meet customer requirements to cultivate entrepreneurial skills.
4. Understand product lifecycle management (PLM) and implement various PLM strategies.
5. Identify Intellectual Property Rights type for specific applications.

New product development, characteristics, challenges, economics, value, concurrent and reverse engineering. Product development process: planning, concept development, system-level design, detailed design, testing and refinement, production ramp-up. Identifying Voice of Customer: Product opportunity identification, Perceptual mapping, Kano model, Quality function deployment, benchmarking, product specifications, conjoint analysis, Failure mode and effects analysis. concept selection, testing and prototyping, Product Architecture: Integral and modular design, Robust design, Industrial design, Design for manufacturing, Design for X, Product Lifecycle Management, Intellectual Property Rights: Patents, copyrights, trademarks, geographical indicators.

References Books:

1. Ulrich., Eppinger, and Yang, *Product Design and Development*, Tata McGraw Hill 7e, 2020.
2. Chitale, A. K. and Gupta, R. C., *Product Design and Manufacturing*, PHI 7e, 2013.
3. Jamnia., A., *Introduction to Product Design and Development for Engineers*, CRC Press, 2018

MEE2241: INDUSTRIAL ENGINEERING [3 0 0 3]

Course Outcomes: On completion of this course student will be able to -

1. Apply techniques of method study and work measurement.
2. Develop plant layout for new manufacturing facilities.
3. Use quality tools in defect reduction in manufacturing processes.
4. Prepare master production schedule for manufacturing of components to enhance employability.
5. Explain methods of value analysis.

Industrial Engineering, Method study, Principle of motion economy, Techniques of method study, Work measurement, time study, Productivity, Various methods of measurement, Factors effecting productivity, Strategies for improving productivity, Ergonomics. Facility planning, plant layout and material handling. Quality Management: Costs of quality, Statistical quality Control (SQC), Variables & Attributes, X, R, P & C - charts, Acceptance sampling, OC - curve, Concept of AOQL, Sampling plan. Simple & Weighted moving average methods, Aggregate planning, Master production schedule (MPS), Sequencing – Johnson algorithm. Role of 5S's, Introduction to value engineering and analysis.

References Books:

1. Schroeder, *Operations Management*, McGraw Hill ISE, Latest Ed.
2. Monks, *Operation Management*, McGraw Hill ISE, Latest Ed.
3. Martinich, *Production and Operations Management*, John Wiley SE, Latest Ed.
4. Turner, Mize, Chase, *Industrial and Systems Engineering* -, Prentice Hall Pub, Latest Ed.

MEE2242: SOLAR ENERGY TECHNOLOGY [3 0 0 3]

Course Outcomes: On completion of this course student shall be able to –

1. Describe the technologies used to harness solar thermal energy.
2. Develop the basic concepts and system components related to solar thermal energy.
3. Capable of assessing the business and policies regarding solar thermal power projects to cultivate entrepreneurial skills.
4. Evaluate the challenges and problems associated with solar thermal energy applications.
5. Analyse technical concepts, economics, and regulatory issues associated with solar thermal energy development and control.

Solar Radiation, measuring instruments, solar geometry, Flat plate Collector, solar concentrating collector, solar water heater, solar cooker, solar desalination, solar food drying, active & passive solar house heating and cooling, solar green houses, solar refrigeration and air conditioning, solar thermal energy storage, solar furnaces, solar thermo-mechanical power, solar photovoltaic, other methods of solar energy utilization, economic analysis.

Reference Books:

1. Soteris A. Kalogirou, *Solar Energy Engineering Processes and Systems*, (Latest Edition), Elsevier.
2. S.P. Sukhatme, *Solar Energy Principle of Thermal Collection and Storage*, (Latest Edition), Tata McGraw Hill.
3. J. A. Duffie, W. A. Beckman, *Solar Engineering of Thermal Process*, (Latest Edition), John Wiley & Sons.
4. H.P. Garg, J. Prakash, *Solar Energy: Fundamentals and Applications*, (Latest Edition), McGraw-Hill.