CURRICULUM & SYLLABI

Minor In MECHANICAL ENGINEERING

Effective from AY: 2024-25



NATIONAL INSTITUTE OF TECHNOLOGY WARANGAL

WARANGAL, TELANGANA

Credit Structure

Code	Course Title	L-T-P	Credits
ME1M01	Fluid Mechanics and Applied Thermodynamics	3-0-0	3
ME1M02	Kinematics and Dynamics of Machinery	3-0-0	3
ME1M03	Manufacturing Processes	3-0-0	3
ME1M04	Engineering Design	3-0-0	3
ME1M05	Industrial Engineering	3-0-0	3
		Total	**15**

SYLLABI

Minor: Mechanical Engineering

ME1M01 **3-0-0 (3)**

Fluid Mechanics and Applied Thermodynamics

Pre-Requisites: **None**

Course Outcomes:

CO-1	Evaluate the hydrostatic forces acting over a plane solid surface of any orientation
CO-2	Apply the conservation equations to fluid flow problems and also estimate the losses in pipe flows
CO-3	Evaluate the heat transfer rate for one-dimensional regular geometries
CO-4	Understand the laws of thermodynamics to analyze thermal power plants and refrigerators
CO-5	Apply the principles of heat transfer and analyze thermal equipment

Syllabus:

Fluid properties: Density, specific weight, specific gravity, Viscosity, Vapor Pressure, Surface tension

Fluid statistics: Pressure, hydrostatic pressure force on a curved surface, buoyancy, floatation and stability

Kinematics of Fluids: Lagrangean and Eulerian description, Velocity potential, Streamfunction and Vorticity.

General theory of Stress and Rate of Strain: Stress-strain relations.

Fundamental Conservation Equations: Integral and differential forms.

Viscous flows in pipes: Laminar and turbulent flows, Pipe flow losses: major losses, minor losses, Flow over Immersed bodies: Boundary layer, Lift and drag

Dimensional Analysis: Flow over a bluff body – Lift and Drag, Dimensional analysis and similitude.

Thermodynamics: Thermodynamic System, State, Properties, Zeroth law of Thermodynamics, Work & Heat, First law – cyclic process, Limitations of First law, heat engine, Heat pump/Refrigerator, Second law, Carnot cycle, Entropy, T-s and P- V diagrams, Rankine cycle, thermal power plant and its components

Heat Transfer: Basic modes of heat transfer: Conduction, Convection and radiation, General Heat Conduction Equation, Forced and free convection; Internal and external flows, Fundamental principles of radiation heat transfer, Heat Exchangers,

Refrigeration and Air Conditioning: Carnot Refrigeration Cycle, Vapor compression Refrigeration cycle and its components, Desirable properties of Refrigerants, Psychrometry and psychrometric processes.

Learning Resources:

Text Books:

1. Fox, R. W., McDonald, A. T., & Pritchard, P. J. Hoboken, N.J, Introduction to fluid mechanics, Wiley 2008.
2. P.K.Nag, Engineering Thermodynamics, McGraw Hill Education, 2017, 6th Edition..
3. Arora, R.C., Refrigeration & Air conditioning, PHI, 2010

4. Yunus A. Çengel, Michael A. Boles, and Mehmet Kanoğlu,Thermodynamics-An Engineering Approach, McGraw-Hill Education, 2019, 9th Edition.

Reference Books:

1. Munson, B. R., Young, D. F., & Okiishi, T. H Hoboken, NJ, Fundamentals of fluid mechanics, J. Wiley & Sons, 2006.
2. Holman, J. P., Heat Transfer, Tata McGraw Hill, New Delhi.
3. M. Necati Ozisik, Heat Transfer - A Basic Approach, McGraw Hill, New York.

Other Suggested Readings:

1. Fluid Mechanics, NPTEL course by S.K. Som, IIT Kharagpur (Link:https://nptel.ac.in/courses/112/105/112105171/#)
2. Heat and mass transfer NPTEL Web Course (https://nptel.ac.in/courses/112/108/112108149/#)

ME1M02 **3-0-0 (3)**

Kinematics and Dynamics of Machinery

Pre-Requisites: **None**

Course Outcomes:

CO-1	Understand the principles of Four bar mechanism and planar mechanisms
CO-2	Understand the Velocity and Acceleration Analysis
CO-3	Characterize and design flywheels
CO-4	Design centrifugal governors
CO-5	Understand the principles of mechanical vibrations

Syllabus:

Basics of Mechanisms: Definitions of Mechanism and Machine and distinguishing these two. Plane and space mechanisms with examples. Four bar mechanism and slider crank mechanism with practical examples; deriving the latter from the former. Kinematic pairs with examples. Kinematic chains with examples. Kinematic inversions of single and double slider crank mechanisms. Degrees of freedom of mechanisms. Grashof and non-Grashof mechanisms. Quick return mechanisms and time ratio. Geneva and eccentric mechanisms, Cam and follower mechanism and applications.

Velocity and Acceleration Analysis: Concept of instantaneous center, Kennedy's theorem. Velocity analysis. Concept of relative velocity method. Examples on simple mechanism.
Acceleration analysis: Klein's construction, slider crank linkage, Coriolis acceleration component, Crank and slotted lever.

Spur Gears: Kinematics of gears, law of gearing, involute teeth, terminology such as addendum, dedendum, addendum circle, dedendum circle, pitch circle, base circle, pitch point, pressure line, pressure angle, clearance, rack and pinion, different types of pitches, path of contact.

Gear Trains: Kinematics of gear trains, simple gear trains and velocity ratio. Planetary gear trains and analysis; simple problems only. Differential gear of automobiles.

Flywheels: Working principle, Force analysis of single slider crank chain. Turning moment diagrams. Maximum fluctuation of energy and its determination. Coefficient of fluctuation of speed. Rim type versus solid type flywheel.

Gyroscope: Principle of gyroscope, Roll, Pitch and Yaw motions, Gyroscopic effect in a two- wheeler, car, ship and airplane.

Balancing of Rotors: Balancing and its types, Rotor balancing, Single plane and two plane balancing. Unbalanced forces and couples. Static and dynamic balancing, Balancing of rotors by analytical method and graphical method. Balancing of reciprocating machines- primary and secondary and higher order unbalanced forces.

Mechanical Vibrations: Free and forced vibrations of spring mass system with and without

damper. Natural frequency, Degree of freedom, Resonance. Energy method and Rayleigh's method. Vibration of undamped system under harmonic excitation, Effect of frequency of excitation on the

amplitude of vibrations. Magnification Factor, Phase difference between excitation and motion. Rotating unbalance, whirling of shaft, critical speed and its practical importance in the design of shafts. Vibration isolation and some practical cases.

Learning Resources:

Text Books:

1. Amitabha Ghosh and Ashok Kumar Mallik, Theory of Mechanisms and Machines, East West Press Pvt. Ltd., New Delhi, 2017, 3rd edition.
2. S.S.Rattan, Theory of Machines, McGraw-Hill Publications, New Delhi, 2011, 3rd edition.
3. Shigley J. E. and John Joseph Uicker, Theory of Machines and Mechanisms, McGraw- Hill international edition 2003, 2nd edition.
4. Robert Norton, Design of Machinery: An Introduction to the Synthesis and Analysis of Mechanisms and Machines, McGraw-Hill, 2003, 5th edition.

ME1M03 **3-0-0 (3)**

Manufacturing Processes

Pre-Requisites: **None**

Course Outcomes:

CO-1	Design patterns and cores for metal casting process
CO-2	Design near net shaped components from metal and ceramic powders
CO-3	Develop joints using solid state and fusion joining, brazing and soldering techniques
CO-4	Develop process-maps for metal forming processes using plasticity principles
CO-5	Understand the classification of AM processes

Syllabus:

Introduction to Manufacturing, History of Manufacturing, Net and near-net shape manufacturing and their evolution

Primary Processes:

Casting: Introduction, Types of different Casting Methods, Solidification of Alloys and its mechanism, Gating System Design and Estimation of Solidification time, Riser Design and Riser Placement, Process Variations, Defects and Remedies. Problems on casting

Powder Metallurgy: (Metals and Ceramics) Techniques of near net shape manufacturing, techniques of powder manufacturing, powder compaction methods, introduction to sintering, Sintering phenomenon, post sintering operations. Problems on sintering

Welding: Physics of Welding - Types of welding - Fusion and Solid-state welding processes- Solidification Phenomenon in Welding – Microstructural Evolution – Different Zones of Weld Region and their Microstructural Evolution - Brazing and Soldering, Defects and Remedies - Problems on welding

Deformation Processes:

Metal Forming: Introduction, Types of Forming Methods - Bulk and Sheet, Mechanism of plastic deformation, State of Stress and boundary conditions in Upsetting/forging, Rolling, Wire and tube drawing, Extrusion and Deep Drawing, Defects, Load estimation for one plane strain and one axi-symmetric bulk deformation processes. Problems on forming

Subtractive Processes:

Machine Tools: Introduction: Generatrix and Directrix, Elements of M/C Tools, M/C Tool drives, Classification of Machine Tools.

Lathe: Types, Parts, Feed Mechanisms, Specifications of lathe, Lathe Operations, Accessories and Attachments, Machining time estimation.

Shaper and Planer: Types, Specifications, Crank and slotted link mechanism, Stroke length and position adjustments, Automatic feed mechanisms, Shaper Vs Planer, Machining time estimation

Drilling: Operations, Types, Mechanisms, Nomenclature of a drill, Machining time estimation. Milling: Types, Up Milling Vs Down Milling, Types of milling cutters, Operations, Machining time estimation, Methods of indexing, dividing head

Grinding: Specification and selection of grinding wheels, Truing, Dressing, Classification of Grinding wheels.

Additive Processes: Introduction to AM and its need, categorization of AM process, steps in AM process, Additive processes for non-metal, metal based additive manufacturing process, development of functionally graded material, applications of AM using case studies.

Learning Resources:

Text Books:

1. Amitabha Ghosh and Mallick A. K, Manufacturing Science, Affiliated East-West Press Pvt. Ltd. 2010
2. P N Rao,Manufacturing Technology Vol1 – Foundry, Forming and Welding, 2018, 5th Edition
3. P N Rao, Manufacturing Technology Vol2 – Metal Cutting and Machine Tools, 2018, 4th Edition

Reference Books:

1. Serope Kalpakjian, Steven R. Schmid, Manufacturing Engineering and Technology (SI Edition), Pearson, 2014, 7th Edition
2. J. T. Black, Ronald A. Kohser, DeGarmo's Materials and Processes in Manufacturing, 2019, 13th Edition

Other Suggested Readings:

1. https://www.mooc-list.com/tags/manufacturing

ME1M04 **3-0-0 (3)**

Engineering Design

Pre-Requisites: **None**

Course Outcomes:

CO-1	Determine the resistance and deformation in machine members subjected to axial, flexural and torsional loads
CO-2	Design the machine elements under static loading conditions
CO-3	Make use of the concept of finite element method for solving machine design problems
CO-4	Solve problems in 1-D and 2-D structural systems involving bars, trusses, beams and frames
CO-5	Compare the design of machine elements using numerical and analytical techniques

Syllabus:

Resistance and Deformation: Concept of Resistance and deformation - Determinate and Indeterminate problems in Tension and Compression - Thermal Stresses - pure shear - Young's modulus of elasticity, Poisson's ratio, Modulus of rigidity and Bulk modulus - Relation between elastic constants - Stress-strain diagrams for brittle and ductile materials - working stress - Strain energy in tension and compression - Impact loading.

Shear Force and Bending Moment: Types of supports - Types of beams - Types of loads - articulated beams - Shear Force and Bending Moment diagrams.

Theory of Simple Bending: Assumptions - Bending stresses in beams - Efficiency of various cross sections - Composite beams.

Shear Stress Distribution: Flexural shear stress distribution in different cross sections of beams.

Deflection of Beams: Slope and deflection of beams - Double Integration method- Macaulay's method - strain energy method.

Torsion of Circular cross sections: Theory of pure torsion - transmission of Power in Solid and Hollow circular shafts - Combined bending and torsion.

Historical Perspective of FEM and applicability to mechanical engineering design problems

Finite Element Analysis for One Dimensional Structural problems: Structural problems with one dimensional geometry. Bar element: formulation of stiffness matrix, consistent and lumped load vectors, Formulation for Truss elements.

Beams and Frames: Review of bending of beams, higher order continuity (C^0 and C^1 Continuity), interpolation for beam elements and formulation of FE characteristics, Plane and space frames and examples problems involving hand calculations. Algorithmic approach for developing computer codes involving 1-D & 2D elements.

Verify the FE analysis with the analytical methods for design of simple machine elements like Shaft, Beam, Springs, Frames, Structural members etc.

Learning Resources:

Text Books:

1. Timoshenko and Gere, Mechanics of Materials, CBS Publishers, 2011, 2nd Edition.
2. E.P.Popov,Engineering Mechanics of Solids, Pearson, 2015, 2nd Edition.
3. S. B. Junarkar, Mechanics of Structures, Charotar Publishers, 2012.
4. Singiresu S.Rao, Finite element Method in Engineering, 5ed, Elsevier, 2012.
5. Reddy, J.N., Finite Element Method in Engineering, Tata McGraw Hill, 2017.

Reference Books:

1. Pytel & Singer, Strength of Materials, Harper & Row Publishers, 2018, 4th Edition.
2. L.S Srinath, Advanced Mechanics of Solids, McGraw Hill Education, 2017, 3rd Edition.
3. Beer and Johnston, Mechanics of Materials, McGraw Hill India Pvt. Ltd., 2020, 8th Edition (SI Units).
4. Zeincowicz, The Finite Element Method 4 Vol set, 4th Edition, Elsevier 2007.

ME1M05 **3-0-0 (3)**

Industrial Engineering

Pre-Requisites: **None**

Course Outcomes:

CO-1	Understand the role of production systems to support a given competitive strategy
CO-2	Understand the role of productivity in streamlining a production system.
CO-3	Apply the inventory management tools in managing inventory.
CO-4	Apply quality engineering tools in designing products and process controls.
CO-5	Apply PERT and CPM in the management of projects.

Syllabus:

Production Systems: Evolution of production systems, Classification and characterization, Competitive strategies, Production and Inventory control strategies, Process management, Facility Design.

Productivity and Work study: Productivity and its role in the economy, Techniques for improving productivity, Method study, Principles of motion economy, Stopwatch time study, Work sampling, Predetermined Time Standards.

Quality Management: Dimensions of quality, Process control charts, Acceptance sampling, Quality function deployment, Taguchi's Quality Engineering, Introduction to TQM.

Inventory Management: Purpose of inventories, Inventory costs, ABC classification, Economic Order Quantity (EOQ), P and Q systems of inventory control.

Project Management: Project activities, Network diagrams, CPM, PERT, Project Feasibility studies.

Learning Resources:

Text Books:

1. Chase, Operations and Supply Chain Management, Tata McGraw Hill, 2024, 17th Edition.
2. Krajewski L.J. and Ritzmen L.P, Operations Management: Strategy and Analysis, Pearson Education, 2021, 11th Edition.
3. Mahadevan. B, Operations Management: Theory and Practice, Pearson Education, 2015, 3rd Ed.

Reference Books:

1. Hopp W. J. and Spearman M. L., Factory Physics: Foundations of Manufacturing Management, McGraw Hill International Edition, 2008, 3rd Edition.