Teaching Scheme: B. Tech. (Mechanical Engineering) II Year

SEMESTER - III

Sr. No.	Subject	Code	Scheme	Exam Scheme				Total	Credit
				Theory		Tuto.	Pract.		
				Hrs.	Marks	Marks	Marks		
1.	Mathematics - III	MA219	3 – 1 – 0	3	100	25	-	125	04
2.	Engineering Thermodynamics	ME201	4 – 1 – 0	3	100	25	-	125	05
3.	Theory of Machines	ME203	3 – 1 – 2	3	100	25	50	175	05
4.	Metallurgy	ME205	3 – 0 – 2	3	100	-	50	150	04
5.	Measurement and Instrumentation	ME207	3 – 1 – 2	3	100	25	50	175	05
		Total	16 – 4 – 6	15	500	100	150	750	23

Engineering Mathematics-III

MA219

L	T	P	Credit
3	1	0	04

1. Course Outcomes (COs):

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

CO1	Understand the concept of convergence and divergence of infinite series
CO2	Expand the periodic functions in the form of Fourier series along with different cases
CO3	Obtain Fourier integral from Fourier series and understand the concept of integral transforms with their applications
CO4	Apply the methods to obtain the solution of certain partial differential equations
CO5	Analyse various Engineering applications for ODE's and its solution using Runge-Kutta family methods
CO6	Solve the engineering problems using the numerical methods such as finite difference method

2. Syllabus

- **INFINITE SERIES** **(06 Hours)**
  Introduction, positive term series, comparison test, Cauchy's root test, D'Alembert's test, Raabe's test, logarithmic test, integral test, Gauss's test, series with arbitrary terms, rearrangement of terms.

- **FOURIER SERIES** **(06 Hours)**
  Definition, Fourier series with arbitrary period, in particular periodic function with period 2π. Fourier series of even and odd function, Half range Fourier series.

- **FOURIER INTEGRAL AND FOURIER TRANSFORMS** **(07 Hours)**
  Fourier integral theorem, Fourier sine and cosine integral complex form of integral, Inversion formula for Fourier transforms, Fourier transforms of the derivative of a function.

- **PARTIAL DIFFERENTIAL EQUATION** **(08 Hours)**
  Second order PDE of mathematical physics (heat, wave and Laplace equation, one dimensional with standard boundary conditions, solution by separation of variable method using Fourier series, solution by separation of variables & transformation techniques.

- **SOLUTION OF ORDINARY DIFFERENITAL EQUATIONS** **(07 Hours)**
  Introduction to initial and boundary value problem, Euler's method, Runge-Kutta method, Taylor's series method, Predictor-Corrector method. Shooting method for boundary value problems and Eigen value problem.

- **FINITE DIFFERENCE METHOD** **(08 Hours)**
  Introduction to finite difference method. Approximation to derivatives and boundary conditions of different kinds. Finite difference method to boundary value problems. Explicit and implicit Finite difference method for parabolic PDEs in one dimension with different boundary conditions. Approximation to ∇^2, Five-point formula for Laplace and Poisson equation.

(Total Lecture Hours: 42)

3. Books Recommended:

1. E. Kreyszig, Advanced Engineering Mathematics, 10th Edition, John Wiley, 2011.
2. C. R. Wylie, Advanced Engineering Mathematics, 6th Edition, McGraw Hill Education, 2003.
3. P. V. O'Neil, Advanced Engineering Mathematics, 7th Edition, Cengage, 2012.
4. M. D. Greenberg, Advanced Engineering Mathematics, 2nd Edition, Pearson Education, 2002.
5. B. V. Ramana, Higher Engineering Mathematics, 1st Edition, McGraw-Hill, New Delhi, 2010.

Further Reading:

1. S.S. Chapra and R.P. Canale, Numerical Methods for Engineers, 7th Edition, McGraw Hill International Edition, 2015.
2. K.S. Rao, Numerical Methods for Scientists and Engineers, 3rd Edition, Prentice-Hall India, 2007.

Engineering Thermodynamics

ME201

L	T	P	Credit
4	1	0	05

1. Course Outcomes (COs):

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

CO1	Relate the thermodynamic laws to engineering systems and processes.
CO2	Describe the second law of thermodynamics in analyzing performance of heat pump and refrigerator
CO3	Apply the entropy concepts to various thermal systems
CO4	Evaluate the various thermal systems based on exergy concepts and thermodynamic relations
CO5	Solve thermodynamics problems of pure substance and ideal gas and gas mixture
CO6	Classify various steam generators

2. Syllabus

- **INTRODUCTION** **(02 Hours)**

- **SECOND LAW OF THERMODYNAMICS** **(07 Hours)**
  Statements of second law of thermodynamics. - The Carnot cycle & Carnot's theorem, Corollary of Carnot's theorem, Efficiency of reversible engine, Causes of irreversibility, C.O.P. of heat pump & refrigerator.

- **ENTROPY** **(08 Hours)**
  Inequality of Clausius theorem, Entropy as a property, Change in entropy in reversible and irreversible processes, Principle of increase of entropy, Entropy change of an ideal gas in various thermodynamics processes, Second law of thermodynamics for steady flow process & its application

- **AVAILABILITY AND IRREVERSIBILITY** **(10 Hours)**
  Basic concepts, Available and unavailable energy for a cycle, Different form of Exergy, Exergy balance for closed system and open system, Decrease of Exergy principle, Difference between first law & second law efficiency, Second law efficiency for steady flow devices.

- **THERMODYNAMIC RELATIONS & EQUILIBRIUM** **(08 Hours)**
  The Maxwell relations, Clausis–Clapeyron equation, Joule –Thomson coefficient, Relationships involving specific heats, enthalpy, entropy.

- **PROPERTIES OF PURE SUBSTANCE** **(08 Hours)**
  Definition of pure substance, Phases of a pure substance, P-V-T behavior of a pure substance, Critical & triple point of a pure substance, Mollier diagram, steam table & dryness fraction of steam, Measurement of dryness fraction of steam.

- **PROPERTIES OF GAS AND GAS MIXTURE** **(05 Hours)**
  Equation of state for ideal gas, Change in entropy, internal energy, enthalpy of gas in various thermodynamics processes, Dalton's law of partial pressure & properties of gas mixture.

- **STEAM GENERATIORS** **(08 Hours)**
  Types of steam generators like natural circulation and forced circulation. Heat recovery steam generators (HRSG) with LP and HP evaporators, economizers, super heaters and air preheaters. High pressure boilers such as La Mont, Loeffler, Benson, Schmidt, Velox Boiler. Performance of boilers.

(Total Lecture Hours: 56)

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3. Books Recommended:

1. W. Van, R.E. Sonnetag and C. Borgnakke, Fundamental of Classical Thermodynamics, John Wiley & sons, 2005.
2. P K Nag, Engineering Thermodynamics, McGraw Hill Education Private Limited, 2013.
3. Y.A. Cengel and M.A. Boles, Thermodynamics, Tata McGraw Hill, 2004.
4. C.P. Kothandaraman, P.R. Khajuria and S. Domkundrar, A Course in Thermal Engineering, Dhanpat Rai & Sons,2004.
5. P.L. Ballaney, Thermal Engineering, Khanna Publishers, 2000.

Theory of Machines

ME203

L	T	P	Credit
3	1	2	05

1. Course Outcomes (COs):

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

CO1	Understand the various concepts related to machines and mechanisms
CO2	Apply the kinematic analyses in existing real life mechanisms
CO3	Analyze the kinematic requirements and shape of the cam and follower mechanism
CO4	Evaluate gears and gear trains for specific applications
CO5	Design of Belt, Rope and Chain Drives
CO6	Develop steering gear and straight line motion mechanism

2. Syllabus

- **MACHINES AND MECHANISMS** **(06 Hours)**
  Introduction, Mechanism and machine, Rigid and resistant body, Link, Kinematic pair, Types of motion, Degrees of freedom (mobility), Classification of kinematic pairs, Kinematic chain, Linkage, Mechanisms, Kinematic inversion, Inversions of slider crank chain, Double slider-crank chain

- **VELOCITY ANALYSIS** **(08 Hours)**
  Trace the loci of points in simple mechanisms, Absolute and relative motions, Vectors, Addition and subtraction of vectors, Motion of a link, Angular velocity, Rotation of a rigid body, Translation and rotation of a rigid body, Velocity analysis of mechanisms by relative velocity method (graphical), Instantaneous centre, Kennedy's Theorem, Locating I- centres, Velocity analysis by instantaneous centers, Centrode.

- **ACCELERATION ANALYSIS** **(09 Hours)**
  Definition of acceleration, Angular acceleration, A general case of acceleration, Radial and transverse components of acceleration, The Coriolis component of acceleration, Acceleration analysis of mechanisms, Acceleration diagrams, Coriolis Acceleration component, Kinematic analysis of mechanisms with computer assisted software: Modeling and assembly of the linkages, joints and constraints, motion animation of the mechanism, Kinematic analysis of the existing or real life mechanism.

- **BELTS, ROPES AND CHAINS** **(06 Hours)**
  Introduction, Belt and rope drives, Open and crossed belt drives, Velocity ratio, Slip, Materials for belt and ropes, Law of belting, Length of belt, Ratio of friction tensions, Power transmitted, Centrifugal effect on belts, Maximum power transmitted by a belt, Initial tension, Creep, Chains, Cha in length, Angular speed ratio, Classification of chains

- **GEARS AND GEAR TRAINS** **(07 Hours)**
  Introduction, Classification of gears, Gear terminology, Law of gearing, Velocity of sliding, Forms of teeth, Cycloidal profile teeth, Involute profile Teeth, Comparison of cycloidal and involute tooth forms, Birth of contact, Arc of contact, number of pairs of teeth in contact, Interference in involute gears, Minimum number of teeth, Interference between rack and pinion, Undercutting, Introduction to helical, Spiral, Worm, Worm gear and bevel gears. Types of gear trains. Kinematic analysis of gear

trains, Differential of an automobile.

- **CAMS** **(06 Hours)**
  Introduction, Types of cams, Types of followers, Cam terminology, Displacement diagrams, Motions of the follower, Graphical construction of cam profile.

(Total Lecture Hours: 42)

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3. Practicals:

1. To study and demonstrate various types of mechanisms and their inversions.
2. To draw velocity diagram of a mechanisms using instantaneous centre method.
3. To draw velocity and acceleration diagrams for mechanisms.
4. To draw velocity and acceleration diagram of a mechanism involving Coriolis component of acceleration.
5. Kinematic analysis of existing or real life mechanisms with computer assisted software – I
6. Kinematic analysis of existing or real life mechanisms with computer assisted software – II
7. To study and demonstrate various types of cams and followers.
8. To draw the layout of cam profile for a reciprocating radial knife edge follower to provide constant velocity to the follower
9. To draw the layout of cam profile for an offset reciprocating roller follower to provide constant acceleration and retardation motion to the follower
10. To draw the layout cam profile for a flat faced reciprocating follower to provide SHM motion to the follower
11. To draw the layout of cam profile for an oscillating follower to provide cycloidal motion to the follower

4. Books Recommended:

1. S. S. Rattan, Theory of machines. Tata McGraw-Hill Education, 2014.
2. J. J. Uicker, G. R. Pennock and J.E. Shigley, Theory of Machines and Mechanisms, 3rd Edition, Oxford University Press, 2011.
3. J.S., Rao and R.V. Dukkipati, Mechanism and Machine Theory, New edge international publishers, 2007.
4. A. Ghosh, and A.K. Mallik, Theory of mechanisms and machines, Affiliated East-West Press Private Limited, 2002.
5. A. G. Ambekar, Mechanism and Machine Theory, Prentice Hall of India Private Limited, 2007.

Metallurgy

ME205

L	T	P	Credit
3	0	2	04

1. Course Outcomes (COs):

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

CO1	Describe the importance of metallurgical industries and explain the basic principles of metallography and extraction of metallic elements.
CO2	Understand the microstructure of ferrous and non-ferrous alloys with their properties and applications.
CO3	Analyze solidification and strengthening mechanisms of metals to control the structure of engineering products
CO4	Interpret the elastic and plastic deformation of metallic materials.
CO5	Explain the phase-equilibria in binary alloys and heat treatment techniques of ferrous and nonferrous alloys.
CO6	Choose the non-destructive testing technique based on the advantages and limitations.

2. Syllabus:

- **INTRODUCTION AND SCOPE** **(04 Hours)**
  Various fields of metallurgical engineering, Status of metallurgical industry in India, Sources of metals, Basic outline of the principles of production of iron and steel, copper, aluminum. Basic concepts of metallography.

- **STRUCTURE-PROPERTY CORRELATIONSHIP IN METALS** **(06 Hours)**
  Ferrous: Allotropic forms of iron, Wrought iron, Cast irons - Grey, White, Malleable and Spheroidal Graphite, Steel - Plain carbon steel, Alloying of steels, Stainless steels, Tool steels, Maraging steels. Non-ferrous: Copper & Copper alloys - Brass, Bronze, Cupro-Nickel; Aluminum and Aluminum alloys, Titanium alloys, Nickel based super alloys.

- **SOLIDIFICATION OF METALS** **(04 Hours)**
  Solidification of pure metals, Nucleation, Growth, Applications of controlled nucleation & controlled growth.

- **DEFORMATION OF METALS** **(06 Hours)**
  Elastic & plastic deformation of metals, Strengthening mechanisms, Importance of grain size, directional properties, Recovery, Recrystallization and grain growth

- **EQUILIBRIUM PHASE DIAGRAMS** **(08 Hours)**
  Objectives & classification, Basic terms - system, phases & structural constituent, Phase systems – Isomorphous, Eutectic. Eutectoid, Peritectic. Interpretation of phase diagrams - Lever rule, Gibb's phase rule, Equilibrium phase diagram of Fe-Fe_3C system, Equilibrium phase diagrams of non-ferrous alloys.

- **HEAT TREATMENT** **(08 Hours)**
  Purpose, Definition and classification of heat-treatment processes for steels, Heat treatments for bulk materials - Annealing, Normalizing, Hardening, Tempering, Isothermal cooling transformation diagram (ICT/TTT) and Continuous cooling transformation (CCT) diagrams for steels, Various surface hardening heat-treatment of steels; Heat-treatment of Al alloys - Solution treatment, Solution quenching & Precipitation hardening.

- **NON-DESTRUCTIVE TESTING TECHNIQUES** **(06 Hours)**
  Importance, principle, procedure, equipment, advantages & limitations of various non-destructive techniques - visual inspection, radiography, ultrasonic testing, magnetic particle inspection, liquid penetrant inspection, eddy current testing

(Total Lecture Hours: 42)

3. Practicals:

1. To study construction and working of metallurgical microscope.
2. To preparation specimen for microscopic observation
3. To study structure, properties and applications of ferrous alloys.
4. To study Fe-Fe_3C equilibrium phase diagram and its applications.
5. To Study structure, properties and applications of non-ferrous alloys.
6. To study T-T-T & C-C-T diagram of steels.
7. To estimate effect of severity of quenching media in hardening heat-treatment of steels.
8. To determine hardenability of steel using Jominy end quench test.

4. Books Recommended:

1. R. Balasubramanian, Callister's Materials Science and Engineering, John Wiley & Sons, 2014.
2. D. R. Askland, P. P. Fulay, W. J. Wright, The Science and Engineering of Materials, Cengage Learning, 2015.
3. S. H. Avner, Introduction to Physical Metallurgy, McGraw-Hill, 2017.
4. O. P. Khanna, A Text book of Materials Science And Metallurgy, Dhanpat Rai Publications.
5. W. Smith, J. Hashemi, R. Prakash, Materials Science & Engineering, McGraw Hill, 2014.

Measurements and Instrumentation

ME207

L	T	P	Credit
3	1	2	04

1. Course Outcomes (COs):

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

CO1	Draw block diagram of different measurement instruments.
CO2	Describe basic concepts of mechanical measurement, errors in measurements and uncertainty.
CO3	Identify the type of measurement instruments and their relevant specification for a particular process or parameter measurement.
CO4	Choose the appropriate instrument to measure the temperature, pressure and flow
CO5	Measure the force, torque, strain, displacement, velocity and acceleration in a measurement system
CO6	Characterize the behavior of a control system in terms of different performance parameters.

2. Syllabus

- **BASIC CONCEPTS & IMPORTANCE OF MEASUREMENTS: (07 hours)**
  Aim of measurement, Methods of measurement, Generalized measurement systems, Instruments & its classifications, Performance characteristics of instruments, Statistic & dynamic characteristics, Analysis of experimental data, Regression analysis, Correlation, Estimation of uncertainty and presentation of data, Design of experiments, Errors in measurements.

- **TEMPERATURE MEASUREMENTS: (06 Hours)**
  Temperature scales, Ideal gas, Temperature measuring devices, Thermometer, Bi- metallic strip, Electrical resistance thermometer, Thermistors and thermocouples, Laws of thermocouples and their applications, Construction and calibration of thermocouples, Radiation pyrometers, total radiation pyrometers

- **PRESSURE MEASUREMENT: (07 hours)**
  Definition of pressure, Units, Types of pressure measurement devices, Manometers, Dead weight tester, Bourdon tube pressure gauge, Diaphragms and bellows, Low pressure measurement, McLeod gauge, Pirani thermal conductivity gauge, Knudsen gauge, Ionization gauge, Piezo electric transducer, Selection of pressure measuring devices for specific applications, Calibration of pressure measuring devices.

- **FLOW MEASUREMENTS**: **(07 hours)**
  Types of flow measuring devices, Constructional features, Obstruction meters like orifice, Venturi nozzle and their calibration, Flow measurement by drag effects (rotameter), Pitot tube, Hot wire anemometers, Magnetic flow Meters, Flow visualization Techniques, Shadowgraph, Interferometer, Laser Doppler, Ultra sonic flow meter.

- **MEASUREMENT OF FORCE, TORQUE AND STRAIN: (6 hours)**
  Load cells, Cantilever beams, Proving rings, Differential transformers. Measurement of torque: Torque measurement on rotating shaft, Prony brake and eddy current dynamometer. Measurement of strain:

Mechanical strain gauges, Electrical strain gauges, Strain gauge: materials, gauge factors, Theory of strain gauges and method of measurement, Rosettes, Bridge arrangement, Temperature compensation.

- **DISPLACEMENT, VELOCITY, SPEED AND ACCELERATION MEASUREMENTS:** **(5 hours)**

  Working principal of resistive potentiometer, Linear variable differential transducers, Electromagnetic transducers, Mechanical, electrical and photoelectric Tachometers, Piezoelectric accelerometer, Seismic accelerometer.

- **CONTROL SYSTEMS:** **(04 hours)**

  Basic concepts of control systems, Classifications of control system, Close loop control systems, Open loop control system, Automatic control systems, Servo mechanism, Regulator, Representation through model, Analogous system, Block diagram, Mathematical block diagram, Signal flow graph, Time response of control systems stability, Frequency response, Industrial controllers pneumatic and hydraulic control systems, Micro controller

(Total Lecture Hours: 42)

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3. Practicals:

1. To calibrate the thermocouples.
2. To demonstrate temperature by using RTD & thermistor
3. To determine the fluid flow velocity through orifice meter, Venturimeter,
4. To determine the fluid flow velocity through rotameter and magnetic flow meter.
5. To demonstrate temperature of force by using strain gauge.
6. To demonstrate temperature pressure measurement through dead weight tester.
7. To demonstrate temperature measurements of speed of machine elements.
8. To demonstrate temperature measurement of temperature by using optical pyrometer.

4. Books Recommended:

1. O. E. Doeblin and D. N. Manik, Measurements System, 7th Edition, McGraw Hill, 2019
2. Richard S. Figiliola,Theory and Design for Mechanical Measurements; 6thEdition, Wiley India, 2015
3. D. S. Kumar, Mechanical Measurement and control,5th edition, Metropolitan Book Co. (P) Ltd., 2015.
4. A. K. Sawhney and Puneet Sawhney, A Course in Mechanical Measurements and Instrumentation and Control, Dhanpat Rai & Co., 2017
5. R. K. Rajput, Mechanical Measurements and Instrumentation, Kataria and sons, 2013

Teaching Scheme: B. Tech. (Mechanical Engineering) II Year

SEMESTER - IV

Sr. No.	Subject	Code	Scheme	Exam Scheme				Total	Credit
				Theory		Tuto.	Pract.		
				Hrs.	Marks	Marks	Marks		
1.	Fluid Mechanics	ME202	3 – 1 – 2	3	100	25	50	175	05
2.	Heat Transfer	ME204	3 – 1 – 2	3	100	25	50	175	05
3.	Machine Design and Drawing	ME206	4 – 0 – 4	3	100	-	100	200	06
4.	Dynamics of Machines	ME208	3 – 1 – 2	3	100	25	50	175	05
5.	Industrial Engineering	ME212	3 – 0 – 0	3	100	-	-	100	03
		Total	16 – 3 – 10	15	500	75	250	825	24

Fluid Mechanics

ME202

L	T	P	Credit
3	1	2	05

1. Course Outcomes (COs):

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

CO1	Understand the concept of performance evaluation of Prototypes using dimensionless numbers.
CO2	Analyse mass balance in a flow system using continuity equations in Cartesian and cylindrical coordinates.
CO3	Compute local Velocity and Acceleration in the complex fluid flow domain.
CO4	Use Bernoulli's equation for the solution of fluid dynamic problems.
CO5	Evaluate fluid flow properties for laminar and turbulent flow through pipes and channels
CO6	Apply Navier Stokes equations to analyse fluid flow systems

2. Syllabus

- **FLUID KINEMATICS** **(12 Hours)**
  Velocity Field, Steady and unsteady Flows, One, Two and Three Dimensional Flows, Uniform and non-uniform flows, Steam Lines and Stream Tubes, Path Lines and Streak Lines, Euler and Lagrangian Methods, Substantial Derivative and Acceleration, Translation, Rotation and Deformations, Vorticity, Rotational and Irrotational flows, Circulation, Velocity Potential function, Equation of Continuity in differential form for Cartesian and cylindrical coordinate system, Equation of Stream Line, Discharge in Terms of Steam Function, Stream Function and Velocity Potential function, Laplace Equation in terms of Stream Function and Velocity Potential function, Boundary Conditions, Flow Nets, Differential and Integral Approach Applied to Conservation of Mass, Momentum and Energy Principles..

- **FLUID DYNAMICS** **(10 Hours)**
  Newton's Laws of Motion, Reynold's Transport Theorem, Euler's Equation, Bernoulli's Equation, Flow Through Confined Passages, Navier-Stokes Equation, Exact solution of Navier-Stokes Equation for simple flows. Vortex flow, Free vortex flow and forced vortex flow.

- **DIMENSIONAL ANALYSIS** **(04 Hours)**
  Dimensions, Dimensional Homogeneity, Buckingham-π Theorem, Dimensional Grouping, Non - Dimensional Numbers, Geometrical, Kinematics and Dynamic Similarity.

- **LAMINAR AND TURBULENT FLOWS** **(06 Hours)**
  Concepts of Laminar and Turbulent Flows, Laminar Flow Through Round Pipes, Laminar Flow between Parallel Plates for Moving and Stationary plates, Measurement of Viscosity. Concept of Eddy Viscosity, Prandtl's Mixing Length Theory, Viscous Sub layer, Smooth and Rough Pipes, Nickuradse Experiment, Moody's Chart.

- **PIPE SYSTEMS** **(05 Hours)**
  Major and Minor losses in pipes, Losses in Fittings, Power Transmission Through Pipes, Pipes connected in Series and Parallel, Branched Pipes, Total Energy line and Hydraulic Gradient Lines. Water distribution system.

- **BOUNDARY LAYER THEORY** **(05 Hours)**

  Concept of Boundary Layer, Boundary Layer over Flat Plates and Tubes, Boundary Layer Parameters, Boundary Layer Thickness, Momentum Thickness, Displacement Thickness, Von - Karman Momentum Integral Equation, Boundary Layer Separation and Control, Concept of Drag, Streamlined and Bluff Bodies.

(Total Lecture Hours: 42)

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3. Practicals:

1. Flow of an Incompressible Fluid through an Orifice meter and its calibration for measurement of discharge.
2. Flow of an Incompressible Fluid through a Nozzle meter and its calibration it for measurement of discharge.
3. Flow of an Incompressible Fluid through a Venturi Meter and its Calibration for measurement of discharge.
4. Flow of an Incompressible Fluid through a Centrifugal Head Meter and its Calibration for measurement of discharge.
5. Forced Vortex flow of water in the vessel.
6. Variation of friction factor with Reynolds number for Laminar flow through circular pipe
7. Variation of friction factor with Reynolds number for Turbulent flow through circular pipe
8. Determination of the velocity distribution in circular pipe.
9. Study of types of Pipes, Pipe symbols, Pipe Fittings and Valves.

4. Books Recommended:

1. F. M. White, Fluids Mechanics, McGraw -Hill Inc., 2015.
2. V. L. Streeter, E. B. Wylie, Fluid Mechanics, McGraw -Hill Book Co. Inc., 2001.
3. A. K. Mohanty, Fluid Mechanics, Prentice -Hall India Private Ltd., 2004.
4. J. F. Douglas, J. M. Gasiorek, J. A. Swaffield, Fluid Mechanics, Pearson Education Pvt. Ltd., 2001.
5. S. K. Som, G. Biswas, Introduction to Fluid Mechanics and Fluid Machines, Tata McGraw Hill Co. Pvt. Ltd., 2017.

Heat Transfer

ME204

L	T	P	Credit
3	1	2	05

1. Course Outcomes (COs):

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

CO1	Apply appropriate mode of heat transfer while analysing complex engineering problems.
CO2	Compute steady state and transient heat conduction problems in slab, cylindrical and spherical systems.
CO3	Explore various Nusselt number correlations for forced and free convection systems.
CO4	Calculate surface to surface radiative heat transfer in engineering systems.
CO5	Design the heat transfer equipment
CO6	Investigate the performance of heat exchanger using LMTD and NTU-effectiveness methods.

2. Syllabus

- **INTRODUCTION** **(01 Hours)**
  Modes of heat transfer, conduction, convection and radiation.

- **CONDUCTION** **(14 Hours)**
  Fourier's law. General three-dimensional heat conduction equation in Cartesian, cylindrical and spherical co -ordinates. One-dimensional steady conduction through plane wall, cylinder and sphere. Contact Resistance. Critical radius of insulation. Heat source systems in plane wall and cylinder. Heat conduction through extended surface. Effectiveness and fin efficiency. Derivation of governing differential equation (GDE) for pin fin. Solution GDE of pin fin subjected to different boundary conditions. Heat flow rate from finned system. One-dimensional unsteady state heat conduction. Lumped heat capacity analysis. Analysis of system with considerable temperature gradient. Heisler and Grober charts.

- **CONVECTION** **(14 Hours)**
  Forced Convection: Governing differential equation, Dimensionless number and their physical significance, Internal forced convection, External forced convection, Flow over tube banks, Reynolds analogy and Colburn analogy. Free convection: Governing differential equation, Dimensionless number and their physical significance, Empirical relations for plate and cylinder and their use. Combined natural and forced convection. Fundamentals of boiling & condensation heat transfer.

- **RADIATION** **(07 Hours)**
  Thermal radiation, Monochromatic and total emissive power. Basic laws of radiation. Radiation shape factors, Black and grey surfaces, Heat transfer in presence of re-radiating surfaces.

- **HEAT EXCHANGERS** **(06 Hours)**
  Basic types of heat exchangers, Fouling factors, LMTD, Effectiveness – NTU methods of design.

(Total Lecture Hours: 42)

3. Practicals:

1. To calibrate copper constantan of thermocouple.
2. To plot temperature distribution and analyse heat transfer through composite wall.
3. To determine thermal conductivity of insulating powder.
4. To find and compare heat transfer coefficient in natural convection
5. To assess emissivity of circular surface
6. To determine and compare heat transfer coefficient in internal forced convection phenomena.
7. To compute Stefan Boltzmann constant value
8. To determine pin-fin efficiency in natural and forced convection.
9. To calculate the overall heat transfer coefficient in shell and tube heat exchanger.

4. Books Recommended:

1. S. P. Sukhatme, Heat Transfer, Universities Press, 20012.
2. J. P. Holman, Heat Transfer, McGraw Hill, 2017.
3. Y. A. Cengel, A. J.Ghajar, Heat and Mass Transfer, McGraw Hill, 2017.
4. N. V. Suryanarayana, Engineering Heat Transfer, Penram International Publishing, 2015.
5. R. C. Sachdeva, Fundamentals of Heat and Mass Transfer, New Age International Publications, 2012.

Machine Design and Drawing

ME206

L	T	P	Credit
4	0	4	06

1. Course Outcomes (COs):

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

CO1	Describe the basic principles of machine design and drawing considerations.
CO2	Understand the stress and strain and the theories of failure to machine element.
CO3	Estimate the life of machine components subjected to fatigue load
CO4	Analyse the machine elements for transmitting torque, bending moment and axial loads.
CO5	Design the various type of joints, fasteners, shafts and shaft components.
CO6	Evaluate the design of various types of mechanical springs.

2. Syllabus

- **THEORIES OF STRESS AND STRAIN** **(10 Hours)**
  Concept of stress and strain and their relationships, equilibrium equations, strain displacement relation, simple beams, bending moments, shear forces and stresses in beams. torsion, energy methods.

- **COMBINE LOADING AND THEORIES OF FAILURE** **(10 Hours)**
  Combined stresses, Mohr's circle diagram for stress and strain rosettes. theories of failure, stresses in thin and thick cylinders.

- **DESIGN CONSIDERATIONS** **(05 Hours)**
  Introduction to design procedure, design requirements and material selection, review of force analysis concepts, factor of safety concepts, concept and mitigation of stress concentration.

- **DYNAMIC LOADING** **(05 Hours)**
  Cyclic loading, endurance limit, fatigue and thermal stresses, creep.

- **DESIGN OF MECHANICAL ELEMENTS**
  Screws, Fasteners, and Design of Joints **(12 Hours)**
  Threaded fasteners and power screws, design of welded, riveted and bolted joints, knuckle and cotter joints.
  Shafts and Shaft Components **(07 Hours)**
  Design of keys, splines, shafts and shaft couplings.
  Mechanical Springs **(07 Hours)**
  Stresses in helical springs, curvature effect, deflection of helical springs, spring materials, helical compression spring design for static service, fatigue loading, extension and leaf springs.

(Total Lecture Hours: 56)

3. Practicals:

Machine Drawing Practice

1. DETACHABLE FASTENERS: Specifications of screw threads and threaded fasteners, foundation bolts; shaft couplings, knuckle and cotter joints.
2. PERMANENT FASTENINGS: Rivets and riveted joints, types of welds and welded joints, and representation of welds on drawings.
3. ASSEMBLY DRAWINGS: Review of sheet preparation: boundary lines, zones, title block, revision panel, parts list, numbering of components and associated detail drawings; assembly drawing practices, exposure to CAD software.
4. COMPONENTS DRAWING: Use of tolerances, tolerance dimensioning, general tolerances; Surface quality symbols: Terminology and representation on drawings, correlation of tolerances and surface quality with manufacturing techniques, detail drawing practices: I.C. Engine parts, boiler mounting accessories.

4. Books Recommended:

1. S. P. Timoshenko and D. H. Young, Elements of Strength of Materials, 5th Edition, East-West Press Pvt. Ltd., 2009.
2. R. G. Budynas and K. Nisbett, Shigley's Mechanical Engineering Design,11th Edition, McGraw Hill, 2020.
3. V. B. Bhandari, Design of Machine Elements, 4th Edition, Tata McGraw Hill, 2016.
4. R. L. Norton, Machine Design, 5th Edition, Pearson Education India Ltd., 2014.
5. N. D. Bhatt and V. M. Panchal, Machine Drawing, 48th Edition, Charotar Publishing House, 2013.

Dynamics of Machines

ME208

L	T	P	Credit
3	1	2	05

1. Course Outcomes (COs):

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

CO1	Understand the conditions of the static equilibrium and free body diagrams and analyse different types of governors
CO2	Utilize the knowledge of static and dynamic force analysis in existing mechanisms
CO3	Analyze the effect of balancing for rotating unbalanced masses
CO4	Analyze the effect of balancing for reciprocating unbalanced masses
CO5	Predict the stability, power and controlling force of a governor
CO6	Demonstrate the stability of automobile, naval ship and other related devices considering gyroscopic effect

2. Syllabus

- **INTRODUCTION** **(09 Hours)**
  Forces, couples, conditions of static equilibrium, free body diagrams, analysis of mechanisms, spur gears, worm gears.

- **STATIC AND DYNAMIC FORCE ANALYSIS** **(11 Hours)**
  Inertia forces, analysis of a floating link, rotation, method of virtual work. Dynamic analysis of Four-link mechanism, combined static and inertia force analysis of different mechanisms, Turning moment diagrams, fluctuation of speed and energy, flywheels, Inertia force analysis of simple mechanisms.

- **BALANCING** **(09 Hours)**
  Introduction, static balancing, dynamic balancing of several masses in different planes. Balancing of inline engines, V-engines, radial engines, balancing machines.

- **GOVERNORS** **(08 Hours)**
  Introduction, types of governors, sensitiveness of a governor, hunting, isochronisms, stability, effort and power of a governor, controlling force.

- **GYROSCOPE** **(05 Hours)**
  Angular velocity, angular acceleration, gyroscopic couple, gyroscopic effect on naval ships, stability of an automobile, stability of a two-wheel vehicle.

(Total Lecture Hours: 42)

3. Practicals:

1. To determine mass moment of inertia of connecting rod by compound pendulum mentioned.
2. To determine mass moment of inertia of connecting rod by bifilar method.
3. To determine mass moment of inertia of connecting rod by trifilar method.

4. To balance multi-rotor system by experimental and validation with analytical and graphical method.
5. To prepare the performance characteristic curves on Porter governor.
6. To prepare the performance characteristic curves on Proell governor.
7. To prepare the performance characteristic curves on Watt governor.
8. To find the gyroscopic couple acting on rotating disc.

4. Books Recommended:

1. S. S. Rattan, Theory of Machines, McGraw Hill Education (India) Private Limited, 2009.
2. J.E. Shigley, J. J. Uicker and G. R. Pennock, Theory of Machines and Mechanisms, 3rd Edition, Oxford University Press, 2005.
3. R. S. Khurmi and J. K. Gupta, Theory of Machines, S. Chand and Company Ltd., 2003.
4. J.S. Rao, and R.V. Dukkipati, Mechanism and Machine Theory, New Age International (P) Ltd., 2006
5. A. Ghosh and A. K. Malick, Theory of Mechanisms and Machines, 3rd Edition, East West Press Pvt. Ltd., 2000.

Industrial Engineering

ME212

L	T	P	Credit
3	0	0	03

1. Course Outcomes (COs)

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

CO1	Identify the factors influencing productivity in industrial engineering.
CO2	Classify the tools of method study and time study for creating the improved process and timing for doing a job.
CO3	Examine the factors affecting the plant layout and location decisions.
CO4	Explain qualitative and quantitative techniques for solving the problems of forecasting.
CO5	Compare deterministic and probabilistic inventory control models for evaluating the inventory level.
CO6	Develop an understanding of functions of production planning, control and human resources.

2. Syllabus

- **INDUSTRIAL ENGINEERING AND PRODUCTIVITY** **(04 Hours)**
  Introduction, history, Objectives, Organization structure, scope, Productivity, Factors influencing productivity, Productivity measurement, Causes of low productivity and techniques of their elimination, Introduction to advance industrial engineering techniques.
- **WORK STUDY AND ERGONOMICS** **(10 Hours)**
  History, Scope, Objectives, Overview, Method study objectives and procedure, Micro motion study, Method study tools, Time study procedure, Performance rating, Allowances, Predetermined Motion Time Systems (PMTS), Work sampling, Ergonomics, Work science, Design factors, Effect of environment, Man-Machine System, Workload and Fatigues.
- **PLANT LOCATION AND LAYOUT** **(07 Hours)**
  Factors affecting location decisions, Methods of evaluating location alternative, Layout types, Work cells, Repetitive and product oriented layout, Computerized layout design procedure
- **FORECASTING** **(06 Hours)**
  Steps, Qualitative and quantitative approaches, Monitoring and controlling forecast, Forecasting in service sector
- **INVENTORY CONTROL** **(07 Hours)**
  Managing inventory, Inventory models for independent demand, Probabilistic models and safety stock, Single period model, Fixed period model
- **PRODUCTION PLANNING AND CONTROL (PPC)** **(04 Hours)**
  Production systems, Job, Batch, Mass and Continuous production system, Objectives of PPC, Functions of PPC

- **HUMAN RESOURCE MANAGEMENT** **(04 Hours)**

  Functions of Human Resource Manager, Training and development, Job evaluation and merit rating, Wage and wage incentives, Grievance handling, Discipline and welfare

(Total Lecture Hours: 42)

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3. Books Recommended:

1. J. Heizer, B. Render, C. Munson, and A. Sachan, Operations Management, 12th Edition, Pearson Education, 2017.
2. E. S. Buffa and R. K. Sarin, Modern Production/ Operations Management, 8th Edition, John Wiley & Sons, 2007.
3. S. Eilon, Elements of Production Planning and Control, 3rd Edition, Universal Publishing Corporation, 2015.
4. N.V. S. Raju, Industrial Engineering and Management, 1st Edition, Cengage Learning, 2013.
5. M. Mahajan, Industrial Engineering and Production Management, 1st Edition, Dhanpat Rai & Co. (P) Limited, 2015.