Scheme for Teaching & Examination

B. Tech. - II (Mechanical) Third Semester											
Sr. No.	Course	Code	Teaching Scheme			Exam Scheme				Total	Credits
						Theory		Tuto.	Pract.		
			L	T	P	Hrs.	Marks	Marks	Marks		
1	Theory of Machines	ME 201	3	1	2	2	100	25	50	175	5
2	Machine Drawing	ME 203	1	1	2	2	50	25	50	125	3
3	Manufacturing Technology	ME 205	3	1	2	2	100	25	50	175	5
4	Measurement Systems (IS 1)	ME 207	4	0	2	2	100	-	50	150	5
5	Solid Mechanics (IS 2)	AM 205	3	0	2	2	100	-	50	150	4
	TOTAL		14	3	10		450	75	250	775	22
Total Theory Hrs. per week (27) Total Credits =22 Total Marks =775											

B. Tech. - II (Mechanical) Fourth Semester											
Sr. No.	Course	Code	Teaching Scheme			Exam Scheme				Total	Credits
						Theory		Tuto	Pract.		
			L	T	P	Hrs.	Marks	Marks	Marks		
1	Materials Science & Metallurgy	ME 202	3	1	2	2	100	25	50	175	5
2	Engg. Mathematics - III (IS 3)	MH 210	4	1	0	2	100	25	-	125	5
3	Mechatronics (IS 4)	ME 204	3	1	0	2	100	25	-	125	4
4	Thermodynamics	ME 206	3	1	2	2	100	25	50	175	5
5	Fluid Mechanics	ME 208	3	1	2	2	100	25	50	175	5
	TOTAL		16	5	6		500	125	150	775	24
Total Theory Hrs. per week (27) Total Credits =24 Total Marks = 775											

B. Tech. (Mechanical), Semester – 3	L	T	P	C
ME 201: THEORY OF MACHINES	**3**	**1**	**2**	**5**

Course Outcomes (COs):

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

- **MECHANISMS AND MACHINES (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)**
  Vectors, Displacement of a rigid body, Relative displacement, Definition of velocity, Angular velocity, Rotation of a rigid body, Translation and rotation of a rigid body, Relative velocity method (graphical and analytical), Instantaneous axes of motion, Properties of instantaneous centers, Aronhold- Kennedy theorem of three centers, Velocity analysis by instantaneous centers, Line-of-centers method, Link to link method, Velocity analysis by components, Velocity images, Velocity diagrams.

- **ACCELERATION ANALYSIS (10 Hours)**
  Definition of acceleration, Angular acceleration, General case of acceleration, Radial and transverse components of acceleration, Coriolis component of acceleration, Examples of acceleration analysis, Acceleration diagrams, Computer-aided kinematic analysis of mechanisms.

- **BELTS, ROPES & 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, Chain length, Angular speed ratio, Classification of chains.

- **GEARS & GEAR TRAINS (10 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.

- **CAMS (05 Hours)**
  Introduction, Types of cams, Types of followers, Cam terminology, Displacement diagrams, Motions of the follower, Graphical construction of cam profile.

(Total Lecture Hours: 45)

PRACTICALS:

1. To study and demonstration of various types of mechanisms & their inversions.
2. To draw velocity diagram using instantaneous centre method.
3. To draw velocity and acceleration diagram for a simple mechanism.
4. To draw velocity & acceleration diagram of a mechanism involving coriolis component acceleration.
5. To study and demonstration of various types of cams & followers.

6. To draw the layout of cam profile for a reciprocating radial knife edge follower.
7. To draw the layout of cam profile for an offset reciprocating roller follower.
8. To draw the layout cam profile for a flat faced reciprocating follower
9. To draw the layout of cam profile for an oscillating follower.
10. To study of various types of gears and gear trains.

BOOKS RECOMMENDED:

1. Shigley, J.E. and Uicker, J.J. and Pennock, G. R., "Theory of Machines and Mechanisms", 3rd Edition, Oxford University Press, 2005.
2. Bevan T., "Theory of Machines: a text book for engineering students", 3rd Edition Pearson Education Limited, 2012.
3. Rao, J.S., and Dukkipati, R.V., "Mechanism and Machine Theory", 2nd Edition, New Age International (P) Ltd., New Delhi, 2006.
4. Rattan, S.S.: "Theory of Machines", 2nd Edition, Tata McGraw-Hill, Publishing Co. Ltd., New Delhi, 2006.
5. Ghosh, A, and Malick, A. K. "Theory of Mechanisms and Machines" 3rd Edition, East West Press Pvt. Ltd., 2000.

B. Tech. (Mechanical), Semester – 3	L	T	P	C
ME 203: MACHINE DRAWING	**1**	**1**	**2**	**3**

Course Outcomes (COs):

CO1	Understand the machining symbols and surface textures
CO2	Explain the orthographic drawings of screw threads, screw fastenings
CO3	Draw the assembly drawings of riveted joints, welded joints and cotter joints
CO4	Recognize the welding symbols and draw the different types of keys
CO5	Illustrate the shaft coupling, shaft bearing, bracket, pulley, pipe joints through drawings
CO6	Assemble the various steam engine parts through drawing and understand the production drawing, drafting packages

- Machining symbols & surface textures. **(01 Hours)**
- Screw threads and screw fastenings. **(02 Hours)**
- Riveted joints, pin joints, keys and cotter joints. **(01 Hours)**
- Welding symbols and welded joints. **(01 Hours)**
- Shaft couplings. **(02 Hours)**
- Shaft bearings, brackets and hangers. **(02 Hours)**
- Pulleys. **(01 Hours)**
- Pipe joints, piping drawing. **(01 Hours)**
- Engine parts: stuffing box, cross head, connecting rod, cranks, eccentric, etc. **(02 Hours)**
- Pattern making drawing, production drawing & construction drawing of chimney, funnels & pressure vessels. **(02 Hours)**
- Exposure to drafting packages

(Total Lecture Hours: 15)

TUTORIALS:

- Each student will submit a set of drawing sheets and sketch book based on the above syllabus.
- Interpretation of industrial drawings & machining symbols
- Free hand sketches

BOOKS RECOMMENDED:

1. N.D. Bhatt, “Machine Drawing”, Charotar publishing house,2000.
2. N. Siddheswar, “Machine Drawing”, Tata McGraw Hill,2001.
3. R.K. Dhawan, “A Text Book of Engineering Drawing”, 3rd Edition, S. Chand & Company Ltd. 2006.
4. Pocket Welding Guide, 31st Edition, Hobart Institute of Welding Technology, 2013
5. BI Standards – 696 – 1972.

B. Tech. (Mechanical), Semester – 3	L	T	P	C
ME 205: MANUFACTURING TECHNOLOGY	3	1	2	5

Course Outcomes (COs):

CO1	Explain basics of sand casting process and working of various casting tools.
CO2	Select special casting processes for manufacturing of specialized products.
CO3	Analyze the principle, procedure and tooling for bulk deformation processes.
CO4	Illustrate various sheet metal working operations.
CO5	Compare the importance and working of various arc welding processes.
CO6	Identify the importance of advanced arc welding and solid state welding processes in manufacturing.

- **INTRODUCTION TO MANUFACTURING TECHNOLOGY** **(02 Hours)**
  Primary manufacturing processes - Secondary manufacturing processes.
- **CASTING** **(10 Hours)**
  Introduction, Casting terms:
  Patterns- Allowances - Types of patterns- Moulding materials- Properties and testing cores, Type, Chaplets, CO_2 moulding , Gating & riser system, Sprue, Ingates, Gating, Ration, Trapping of slag, Cleaning of casting, Product design, Special casting processes, Shell moulding, Die casting investment, Precision casting, Permanent moulding, Centrifugal casting, Low pressure die casting, Continuous casting process, Cosworth process, Squeeze casting, Semisolid meal working process, Rapid solidification process, Cupola, Cokeless cupola.
- **METAL WORKING** **(10 Hours)**
  True stress, True strain, Hot working, Hot working temperatures, Cold working, Rolling, Principles of rolling, Forging, Principle of forging, Extrusion, Principle of extrusion, Hot & cold extrusion, Wire drawing, Principle of wire drawing, Tube drawing, Sheet metal working, Definitions of various operations like shearing, Blanking, Piercing, Trimming, Shaving, Hammers and presses.
- **GAS WELDING** **(08 Hours)**
  Principles of gas welding, Types of gases used, Types of flames, Welding techniques, Edge preparation, Equipment used, Torch, Regulators, Welding filler rods, Gas cutting, Principles of gas cutting, Position of torch, Soldering, Brazing, Adhesive bonding.
- **ELECTRIC ARC WELDING** **(08 Hours)**
  Principles of electric arc welding, A.C. / D.C. welding, Edge preparation, Equipment used, A.C./ D.C. Machines, Welding electrodes, Designation and selection, Manual metal arc welding, Carbon arc welding, Inert gas shielded arc welding, TIG & MIG, Submerged arc welding, Atomic hydrogen arc welding, Plasma arc welding, Stud arc welding, Arc cutting.
- **RESISTANCE WELDING** **(07 Hours)**
  Principles of resistance welding, Heat balance, Electrodes, Spot welding, Seam welding, Projection welding, Upset welding, Flash welding, Fusion welding processes: thermit welding, electro-slag welding, Electron beam and laser beam welding.

(Total Lecture Hours: 45)

PRACTICALS:

1. Pattern making practice – 1
2. Patten making practice – 2
3. Butt type welding joint
4. Lap type welding joint
5. Soldering practice
6. Tin smity practice

7. Molding practice
8. To find grain finess number for given sand
9. To find clay content from mould sand
10. To find water content from mould sand
11. To find permeability numbers for given sample of mould material
12. Pouring practice for permanent mould.

BOOKS RECOMMENDED:

1. P.N. Rao, “Manufacturing Technology”, TMH Edition. 2004
2. Heine and Roshenthal, “Principles of Metal Casting”, TMH Edition. 2000
3. R. L. Little, “Welding Technology”, Tata McGraw Hill, 2005
4. J. A. Schey, “Introduction to Manufacturing Processes”, McGraw Hill, 2002
5. S. Kalpakjian and S. R. Schmid, “Manufacturing Engineering. and Technology”, Pearson Education Asia, 2002.

B. Tech. (Mechanical), Semester – 3	L	T	P	C
ME 207: MEASUREMENT SYSTEMS	**4**	**0**	**2**	**5**

Course Outcomes (COs):

CO1	Learn all the different measurement methods for measurement of flow, temperature, pressure, force, speed, voltage, ampere, power etc.
CO2	Understand the concept of error analysis, causes and uncertainty analysis
CO3	Articulate modern methods and latest instrument for various kinds of measurements
CO4	Evaluate basics of electrical measuring instrumentation and power system
CO5	Determine efficiency of transformer, Induction Motor and DC motor
CO6	Analyse the characteristic of various DC machines

- **BASIC CONCEPTS (03 Hours)**
  Terminology, Calibration, Standards and units, Generalized block diagrams of measuring systems, Input output configuration of measuring systems, Standard deviation and variance.

- **PRESSURE MEASUREMENT (06 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.

- **TEMPERATURE MEASUREMENT (07 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.

- **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 anemometer, Ultra sonic flow meter.

- **MISCELLANEOUS MEASUREMENTS (07 Hours)**
  Basic methods of force measurements, Torque measurement on rotating shaft, Prony brake and eddy current dynamometers, Stress and strain measurements, Types of strain gauges, Electric resistance strain gauges, Wheatstone bridge, Gauge factor of strain gauge, Rosettes, Speedometer and stroboscope, Ballast circuit, Vibration measurement using accelerometer.

- **INTRODUCTION TO MEASURING INSTRUMENTS (09 Hours)**
  Ammeter, Voltmeter, Wattmeter, Energy meter, Potential transformer and current transformer, Frequency meter and megger.

- **EFFICIENCY OF TRANSFORMER AND RELATED MEASUREMENT (06 Hours)**
  Measurement of losses of transformer by open circuit and short circuit tests, Determination of voltage regulation, Efficiency and parameter calculation using the result of above tests for single-phase & three-phase transformers, Polarity test and determination of three phase connection of transformer.

- **EFFICIENCY OF INDUCTION MOTOR AND RELATED MEASUREMENT (05 Hours)**
  Measurement of losses of three phase induction motor by No load and blocked rotor tests, Efficiency, Torque and parameter calculation to find characteristic of motor.

- **EFFICIENCY OF DC MOTOR AND RELATED MEASUREMENT (04 Hours)**
  Measurement of speed, Power determination of torque of DC motor, Efficiency calculation from no load test & load test.

- **DETERMINATION OF VOLTAGE REGULATION & EFFICIENCY IN POWER SYSTEM (06 Hours)**
  Measurement of power, Energy, Power factor, Determination of cost of generation and supply, Comparison of AC & DC supply system & related measurements to determine voltage relationships, Voltage regulation & determination of losses & determination of efficiency from there of.

(Total Lecture Hours: 60)

PRACTICALS:

1. Calibration of thermocouple.
2. Calibration of bourdon tube type pressure gauge.
3. Calibration of eccentric orifice meter.
4. Calibration of rotameter.
5. To find out velocity distribution.
6. Hysteresis curve for bourdon tube type pressure gauge.
7. No load and blocked rotor test on induction motor.
8. Polarity test on single phase transformer.
9. Load test on induction motor.
10. Speed control of DC motor.
11. Measurement of electrical energy.
12. Exposure to oscilloscopes
13. Exposure to data acquisition systems

BOOKS RECOMMENDED:

1. Nakra, B.C. and Chaudhry, K.K., “Instrumentation, Measurements and Analysis”, McGraw Hill Education India Private Limited, 2016.
2. Beckwith, T. G. and W.L. Buck: “Mechanical Measurements”, 2nd Edition, Addison Wesely Publishing Company, Reading, Mass, 2000
3. A. K. Sawhney “A course in Electrical measurement & Instrumentation”, Dhanpat Rai & Co., Seventh Edition, 2007
4. V.K.Mehta, “Principles of Power System”, S. Chand & Co., 2003
5. V. N. Mittle, “Basic Electrical Engineering”, Tata McGraw Hill, Second Edition, 2006

B. Tech. (Mechanical), Semester - III

L	T	P	C
3	0	2	4

AM 205 : SOLID MECHANICS

Course Outcomes (COs):

CO1	Understand the concepts of stress and strain in mechanics of solids and structures and material properties
CO2	Apply the knowledge of mechanical/elastic/thermal properties of materials and constitutive relationships to solve elementary level determinate and indeterminate problems
CO3	Analyze the response of structural elements subjected to axial force, bending, shear and torsion or in combination and graphically represent the distribution.
CO4	Evaluate strain energy and principal stresses-strains for subsequent applications of failure theories.
CO5	Design the columns, springs, thin cylinders and spherical shells.
CO6	Interpret laboratory data relating to behavior of structures and the materials they are made of, and undertake associated laboratory work individually and in teams.

- **STRESSES AND STRAINS (05 Hours)**
  Concept of stresses and strains – Types of stresses – Hook's Law – Lateral strain – Poisson's ratio – Elongation due to own weight – Tapering sections – Varying cross sections – Composite sections – Relation between Modulus of Elasticity, Modulus of Rigidity and Bulk Modulus – Thermal Stresses – Eccentric load – Limit of eccentricity – Core /Kernel of the section.

- **SHEAR FORCE DIAGRAM AND BENDING MOMENT DIAGRAM (05 Hours)**
  Types of beams – Types of supports – Types of loads – Shear force – Bending moment – Sign conventions – Overhanging beams – Point of contra-flexure – Varying loads – Relation between SF and BM.

- **STRESSES IN BEAMS (05Hours)**
  Theory of simple bending – Moment of resistance – Beam of uniform strength – Flitched beams – Shear stress concept – Derivation of shear stress – Shear stress variation in rectangular, circular, T-section and I – section

- **SPRINGS (05 Hours)**
  Types of springs – Close coiled helical spring subjected to axial load and twist – Leaf springs – Semi elliptical and Quarter elliptical leaf springs

- **PRINCIPAL STRESSES (03 Hours)**
  Principal plane – Principal stress – Tangential and normal stress – Derivation of major and minor principal stresses for different cases – Mohr's circle graphical method

- **THEORIES OF FAILURE (03 Hours)**

- **THIN CYLINDERS (03 Hours)**
  Stresses in cylinders – Thin cylinders and thin spheres – Volumetric strain – Wire wound thin cylinders

- **WELDED JOINTS (02 Hours)**

- **TORSION (05 Hours)**
  Basic theory of torsion – Solid shaft – Hollow shaft – Power transmitted by shaft – Composite shafts

- **COLUMN AND STRUTS (05 Hours)**
  Euler's theory for columns – Different end conditions – Rankine's formula – Limitations of Euler's theory

- **STRAIN ENERGY (04 Hours)**
  Strain energy – Resilience – Strain energy due to tension and compression - Strain energy due to freely falling load

(Total Lecture Hours: 45)

PRACTICALS:

1. Tension Test on MS and CI specimens
2. Torsion Test on MS Specimen
3. Charpy Impact Test
4. Transverse Test on Wooden beam
5. Spring Test
6. Compression test on CI Columns
7. Shear Strength Test
8. Hardness Test

BOOKS RECOMMENDED:

1. Timoshenko S & Young D H “Elements of Strength of Materials”, Tata Mc Graw Hill, New Delhi,2006
2. Ryder G H, “Strength of Material”, English Language Book Society, New Delhi,2006
3. Bhavikatti S S “Strength of Materials”, Vikas Publication House, New Delhi,2007
4. Egar P. Popov & Toader A . Balan “Engineering Mechanics of Solids” 2nd Edition, Pretice Hall of India Pvt Ltd, New Delhi,2002
5. Beer F. P. & Johnston S J, “Strength of Materials” Tata Mc Graw Hill Publication, New Delhi,2004

B. Tech. (Mechanical) Semester – 4	L	T	P	C
ME 202: MATERIALS SCIENCE & METALLURGY	**3**	**1**	**2**	**5**

Course Outcomes (COs):

CO1	Understand the properties of different materials such as ferrous, Non-ferrous metals and Non-metals.
CO2	Differentiate the phases present in steels and C.I. at different temperatures and for different compositions.
CO3	Predict the composition, properties and applications of different alloy steels.
CO4	Analyse the effect of different heat treatments on steels.
CO5	Express about the production of powder metallurgical components.
CO6	Anticipate the optimum utilization of materials to satisfy the ever increasing demand of the society for modern life.

- **INTRODUCTION TO THE SUBJECT AND ITS APPLICATION IN ENGINEERING FIELD (02 Hours)**
- **SCIENCE OF METALS (06 Hours)**
  Crystal structure, Types of crystal systems, Crystal lattice, Lattice parameters, Metallic structures, Miller indices, Atomic radius & atomic packing factors for various cubic systems, Crystalline materials, Amorphous materials, Crystal imperfections, Bragg's law of X-ray diffraction.
- **MECHANICAL BEHAVIOR OF METALS (07 Hours)**
  Properties of metals, Deformation of metals, Mechanisms of deformation, Deformation in polycrystalline materials, Mechanical testing of materials (destructive & non-destructive testing methods).
- **IRON MAKING (04 Hours)**
  Definition & classification of metallurgy, Extractive metallurgy classification & composition of pig iron, Manufacturing of pig iron, Principle, Construction & operation of blast furnace.
- **STEEL MAKING (04 Hours)**
  Methods of steel making: Crucible process, Bessemer converter: principle, Construction & operational details, Open hearth furnace: principle, Construction & operational details, Oxygen steel making: Basic oxygen or L.D. process, & Kaldo process. Electric furnace for steel making: arc & induction furnace, Merits & demerits of the various processes.
- **CLASSIFICATION OF MATERIALS AND METALS (04 Hours)**
  Semiconductor, Magnetic materials, Dielectric materials, Superconductor, Nanomaterials, Biomaterials, Engineering alloy steels, Cast irons, Non-ferrous metals & alloys, Basic concept of metallography.
- **PHASE DIAGRAM (04 Hours)**
  Objectives & classification, System, Phases & structural constituent of phase diagram, Coring & dendritic segregation, Gibb's, solid phase rule, Eutectic, Peritectic & eutectoid system, Equilibrium diagrams for non-ferrous alloys, Lever rule.
- **SOLIDIFICATION OF METALS (04 Hours)**
  Concept of solidification of metals, Solidification of pure metals, Nucleation, Growth, Growth of the new phase, Solidification of alloys, Progressive, Directional solidification & control of solidification to obtain sound castings.
- **HEAT TREATMENT PROCESSES (06 Hours)**
  Definition, Purpose & classification of heat treatment processes for various types of special steels, Introduction & applications of various case hardening & surface hardening treatments, TTT & CCT curves.

- **POWDER METALLURGY** **(02 Hours)**
  Concept, Processes, Characteristics of metal powders, Production of metal powders, Blending & mixing, Compacting, Pre-sintering & sintering secondary operations.

- **POLYMERS, CERAMICS & COMPOSITES** **(02 Hours)**
  Definition, Classification & characteristics of polymers, Types of polymerization, Polymer processing, Elastomers, Properties of ceramic materials, Cermets, Composite materials, Fiber reinforced plastic (FRP).

(Total Lecture Hours: 45)

PRACTICALS:

1. To discuss in detail various application of iron-carbon equilibrium diagram.
2. To study of a metallurgical microscope.
3. To prepare the specimen for microscopic observation.
4. To study of microstructure of wrought iron cast iron & plastic steel.
5. To study of the microstructure of non ferrous metals and alloys.
6. Heat treatment for various ferrous & nonferrous metals & alloys.
7. To determine the hardenability by Jominy end quench test.
8. To determine machine defects by dye-penetrant & magnetic flow detection NDT technique
9. To determine flows by ultrasonic technique.

BOOKS RECOMMENDED:

1. Vlack, L.H.V., “Elements of Material Science & Engineering”, 6th Ed., Pearson Education India, 2002.
2. Guy Albert G., “Elements of Physical Metallurgy”, Addison- Wesley Publication, USA, 1974.
3. Higgins R. A., “Engineering Metallurgy”, Viva books Pvt. Ltd., 2004.
4. Raghvan V., “Material Science & Engg.”, Prentice Hall of India, New Delhi. 2003
5. Rajan T. V., Sharma C.P., “Heat Treatment Principles & Techniques”, Prentice Hall of India, New Delhi, 2004.

B. Tech. (Mechanical) Semester – 4	L	T	P	C
MH 210: ENGG. MATHEMATICS – III	**4**	**1**	**0**	**5**

Course Outcomes (COs):

CO1	Estimate the area, volume and mass using the integral evaluation techniques.
CO2	Explain vector calculus and Fourier series for different cases.
CO3	Describe 1-D heat equation, 1-D wave equation and 2-D heat equation (Laplace equation).
CO4	Demonstrate the solution of 1-D heat equation, 1-D wave equation and 2-D heat equation (Laplace equation) using analytical approach.
CO5	Analyze various Engineering applications for ODE's and its solution using Runge-Kutta family methods
CO6	Solve steady/unsteady PDE's using Taylor series based Finite difference Methods.

- **CALCULUS, MULTIPLE INTELRALS (08 Hours)**
  Reorientation of concepts of integrals, Double and triple integrals evaluation techniques, Change of order of Integration, Change of variable, Application of double and triple integrals for evaluation of area, volume and mass.

- **BASIC CONCEPTS OF VECTOR CALCULUS (08 Hours)**
  Line integrals, Scalar and vector point function, Differential operator, Gradient, Directional derivative, Physical meaning of gradient, Divergence, Curl and Laplacian with their properties, Surface integral, Volume integral, Green's, Gauss and Stoke's theorem & application.

- **FOURIER SERIES (06 Hours)**

  Definition, Fourier series with arbitrary period, particular periodic function with period 2π, Fourier series of even and odd function, Half range, Fourier series.

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

- **INTRODUCTION TO ENGINEERING ANALYSIS (06 Hours)**
  Types of problems encountered in Mechanical Engineering, Classification of problems based on methods of solution.

- **SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS (12 Hours)**
  Euler's method, Runge-Kutta method, Boundary value and Eigen value problems, Application to mechanical engineering problems, Taylor's series and Predictor-Corrector method.

- **FINITE DIFFERENCE METHOD (12 Hours)**
  Methods to derive finite difference equations, Elliptic and parabolic equations, Boundary conditions, Explicit and Implicit method, Application to mechanical engineering problems

(Total Lecture Hours: 60)

BOOKS RECOMMENDED:

1. E. Kreyszing, "Advanced Engineering Mathematics", John Wiley, 10th Edition, 2010.
2. Peter O' Neel, "Advance Engineering & Mathematics", Thompson (Singapore) Indian Edition, 2002
3. Michael D. Greenber, "Advance Engineering Mathematics", Pearson (Singapore) Indian Edition, 2007
4. S.S. Chapra & R.P. Canale, "Numerical Methods for Engineers", McGraw Hill International edition, 2002
5. K. S. Rao, "Numerical Methods for Scientists and Engineers", Prentice-Hall India, 2nd Edition, 2004
6. N. K. Raju & K. U. Muthu, "Numerical Methods for Engineering Problems", Macmillan India Ltd., 2nd Edition, 2005

B. Tech. (Mechanical), Semester – 4	L	T	P	C
ME 204: MECHATRONICS	**3**	**1**	**0**	**4**

Course Outcomes (COs):

CO1	Explain the basic elements of mechatronics system.
CO2	Report the functioning of sensors, transducers and actuators.
CO3	Analyze the electronic elements such as, digital circuits, AD converters, etc.
CO4	Articulate the basics of PLC programming.
CO5	Develop a mechatronic system using the gained knowledge
CO6	Apply the programming logic to electronic system design

- **INTRODUCTION TO MECHATRONICS & SUBJECT OVERVIEW (01 Hour)**

- **MECHATRONIC SYSTEM ELEMENTS (04 Hours)**
  Measurement system, Control system, Microprocessor based controllers & its applications, Other applications with mechatronic approach, Building blocks of mechatronic system.

- **SENSORS & TRANSDUCERS (09 Hours)**
  Classification, Performance terminologies, Displacement, Position & proximity sensors, Photo detectors, Optical encoders, Pneumatic sensor, Hall effect sensor, Velocity & motion sensors: Incremental encoder, Tachogenerator, Piezo electric sensors, Tactile sensors, Flow & temperature sensors: Ultrasonic sensors, Light sensors, Selection of sensors, Interference & noise in measurement.

- **ACTUATION SYSTEMS (16 Hours)**
  - Pneumatic & hydraulic actuation systems:
    System configuration, Control System & its elements, Linear actuators, Rotary actuators.
  - Mechanical actuation:
    System types & its configuration, Fixed ratio type, Invariant motion profile type, variator etc.
  - Electrical actuation system types & configurations, Mechanical switches, Solid state switches, Solenoids.

- **DIGITAL CIRCUITS (05 Hours)**
  Boolean algebra combinational circuits. (adders, subtractors, encoders, decoders, multiplexers, de–multiplexers, memory units: RAM, ROM, EPROM etc.), Sequential circuits.

- **ANALOG SIGNAL PROCESSING (05 Hours)**
  Amplifiers, Operational amplifiers, Ideal model for operational amplification, Inverting amplifier, Non-inverting amplifier, Summer, Difference amplifier, Instrumentation amplifier, Integrator, Differentiator, Sample & hold circuit, Comparator, The real operational amplification ADC & DAC, Timers, Signal Modulation.

- **ELECTRONIC SYSTEM DESIGN (05 Hours)**
  Introduction to MPU & MCU, Assembly programming, Interfacing, Introduction to PLC & basics of PLC programming, Basics of filters, Types of filters, Basics of LPS & SMPS, Clipper & clamper circuits. Effect of damping on Band width & resolution.

(Total Lecture Hours: 45)

BOOKS RECOMMENDED:

1. Necsulescu D., “Mechatronics”, Pearson Education (Singapore), 2002.
2. Shetty D., Kolk R. A., “Mechatronic System Design”, PWS Publicity Boston, 2002.
3. HMT Ltd., “Mechatronics”, Tata McGraw Hill Publication, 2002
4. W. Bolton, “Mechatronics”, Pearson Education (India) 2003
5. Morris Mano, “Digital Logic & Computer Design”, Prentice Hall, 2001.

B. Tech. (Mechanical), Semester – 4	L	T	P	C
MED 206: THERMODYNAMICS	**3**	**1**	**2**	**5**

Course Outcomes (COs):

CO1	Relate the thermodynamics laws to engineering systems and process.
CO2	Solve thermodynamics problem using Mollier diagram, steam and gas table/charts
CO3	Evaluate the properties of gas and gas mixtures
CO4	Apply the second law of thermodynamics and entropy concepts in analyzing performance of heat pump and refrigerator
CO5	Explain the method of improving performance of a system by reducing irreversibility
CO6	Measure the various properties of fuels and lubricants

- **BASIC CONCEPTS & DEFINITIONS** **(06 Hours)**
  Classical thermodynamics & statistical thermodynamics, Thermodynamic: system, properties, states, processes, cycle & equilibrium, Zeroth law of thermodynamics & its applications.

- **WORK AND HEAT** **(04 Hours)**
  Definition of work & heat and their evaluation for various thermodynamics processes, Comparison of heat & work.

- **PROPERTIES OF PURE SUBSTANCE** **(05 Hours)**
  Definition of pure substance, Phases of a pure substance, P-V-T behaviour 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** **(04 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.

- **FIRST LAW OF THERMODYNAMICS** **(07 Hours)**
  First law of thermodynamics for a cycle & for a process, First law of thermodynamics for a non flow and flow process, Application of 1st law of thermodynamics to boilers, Engines, turbines, Components etc.

- **SECOND LAW OF THERMODYNAMICS** **(06 Hours)**
  Statements of second law of thermodynamics - 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** **(07 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.

- **FUELS AND LUBRICANTS** **(06 Hours)**
  Definition & classification of fuels, Its composition & calorific value, Proximate and ultimate analysis of fuel, Types & properties of lubricants. Flash point, fire point, Viscosity, Vap. pressure, Cloud point, pour point etc.

(Total Lecture Hours: 45)

PRACTICALS:

1. To determine flash point and fire point of a given sample of oil.
2. To determine penetration number of grease by grease – penetrometer.

3. To determine viscosity of an oil by Redwood viscometer.
4. To determine calorific value of gaseous fuel by Junker's calorimeter.
5. To determine carbon residue by Conradson apparatus.
6. To determine vapour pressure of a fuel by Reid's vapour pressure apparatus.
7. To determination calorific value of solid fuels by Bomb Calorimeter
8. To carry out Proximate Analysis of a given fuel by proximate analyzer

BOOKS RECOMMENDED:

1. Wylen, V., Sonntag, R.E., and Borgnakke, C., "Fundamentals of Classical thermodynamics" 6th ed. John Wiley & Sons, New York 2003.
2. Cengel, Y.A., and Boles, M.A., "Thermodynamics" 4th Ed., Tata Mc Graw Hill, New Delhi, 2004
3. Rogers, G., and Mayhew, Y., "Engineering Thermodynamics" 4th Ed., Addison Wesley, 2004.
4. Simonson, J., "Thermodynamics" 4th Ed., Mc Milan 1997.
5. Sarkar. S., "Fuels and Lubricants", 2nd Edition, Tata McGraw Hill, New Delhi
6. Nag, P.K., "Engineering Thermodynamics" 6th Edition, McGraw Hill Education, 2017.

B. Tech. (Mechanical) Semester – 4	L	T	P	C
ME 208: FLUID MECHANICS	**3**	**1**	**2**	**5**

Course Outcomes (COs):

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

- **FLUID PROPERTIES: (04 Hours)**
  Ideal Fluid, Continuum, Properties of Fluid, Classification of Fluids.

- **FLUID STATICS: (06 Hours)**
  Pressure at a Point, Forces on Areas - Horizontal, Inclined and Vertical, Centre of Pressure, Forces on Curved Surfaces, Buoyant Forces, Stability of Floating and Submerged Bodies, Relative Equilibrium under Linear Acceleration and Constant Rotation.

- **DIMENSIONAL ANALYSIS: (02 Hours)**
  Dimensions, Dimensional Homogeneity, Buckingham-π Theorem, Dimensional Grouping, Non-Dimensional Numbers, Geometrical, Kinematics and Dynamic Similarity.

- **FLUID KINEMATICS: (10 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: (08 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.

- **LAMINAR AND TURBULENT FLOWS: (05 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.

- **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: 45)

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. Determination of metacentric height of a floating body
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.

BOOKS RECOMENDED:

1. White F. M., “Fluids Mechanics”, McGraw-Hill Inc., 7th Ed., New York, 2010.
2. Streeter V. L., Wylie E. B., “Fluid Mechanics”, McGraw-Hill Book Co. Inc., Singapore, 2001.
3. Mohanty A.K., “Fluid Mechanics”, Prentice-Hall India Private Ltd., 2nd Ed., New Delhi, 2000.
4. Douglas J.F, Gasiorek J.M, Swaffield J.A, Fluid Mechanics, Pearson Education (Singapore) Pvt. Ltd., New Delhi, 4th Ed., 2001.
5. Som S K, Biswas G., Introduction to Fluid Mechanics and Fluid Machines, Tata McGraw Hill Co. Pvt. Ltd., New Delhi, 2002.