SYLLABUS OF
UNDERGRADUATE DEGREE COURSE

Mechanical Engineering

Effective for the students admitted in year 2021-22 and onwards.

B.Tech. : Mechanical Engineering
2nd Year - III Semester

f THEORY										
SN	Category	Course Code	Course Title	Hours			Marks			Credit
				L	T	P	IA	ETE	Total	
1	DC	3ME4-01	Engineering Thermodynamics	3	1	0	30	70	**100**	**4**
2		3ME4-02	Materials Engineering and Technology	2	0	0	30	70	**100**	**2**
3		3ME4-03	Manufacturing Processes	3	0	0	30	70	**100**	**3**
4		3ME4-04	Mechanics of Solids	3	1	0	30	70	**100**	**4**
5		3ME4-05	Renewable Energy Systems	3	0	0	30	70	**100**	**3**
6	UC	3ME2-01	Engineering Mechanics	3	0	0	30	70	**100**	**3**
			Sub Total	**17**	**2**	**0**	**180**	**420**	**600**	**19**
PRACTICAL & SESSIONAL										
7	DC	3ME4-20	Machine Drawing Practice	0	0	3	60	40	**100**	**1.5**
8		3ME4-21	Production Practice Lab	0	0	3	60	40	**100**	**1.5**
9		3ME4-22	Materials Testing Lab	0	0	2	60	40	**100**	**1**
10	UI	3ME7-30	Professional Training	0	0	2*	60	40	**100**	**1**
11	CCA	3ME8-00	SODECA/NCC/NSS/ ANANDAM/IPR	-	-	-	-	100	**100**	**1**
			Sub- Total	**0**	**0**	**10**	**240**	**260**	**500**	**6**
			TOTAL OF III SEMESTER	**17**	**2**	**10**	**420**	**680**	**1100**	**25**

L = Lecture, **T** = Tutorial, **P** = Practical, **IA**=Internal Assessment, **ETE**=End Term Exam, **Cr**=Credits

***for calculation of contact hours**

B.Tech. : Mechanical Engineering
2nd Year - IV Semester

THEORY											
SN	Category	Course Code	Course Title	Hours			Marks			Credit
				L	T	P	IA	ETE	Total	
1	DC	4ME4-01	Theory of Machines-I	3	1	0	30	70	**100**	**4**
2		4ME4-02	Fluid Mechanics	3	1	0	30	70	**100**	**4**
3		4ME4-03	Internal Combustion Engines and Gas Turbines	3	0	0	30	70	**100**	**3**
4		4ME4-04	Industrial Engineering	3	0	0	30	70	**100**	**3**
5		4ME4-05	Manufacturing Technology-I	3	0	0	30	70	**100**	**3**
6	UC	4ME2-01	Advanced Engineering Mathematics	3	0	0	30	70	**100**	**3**
			Sub Total	**18**	**2**	**0**	**180**	**420**	**600**	**20**
PRACTICAL & SESSIONAL										
7	DC	4ME4-20	Theory of Machines Lab-I	0	0	2	60	40	**100**	**1**
8		4ME4-21	Fluid Mechanics Lab	0	0	2	60	40	**100**	**1**
9		4ME4-22	MATLAB Programming	0	0	2	60	40	**100**	**1**
10		4ME4-23	Production Engineering Lab	0	0	2	60	40	**100**	**1**
11	CCA	4ME8-00	SODECA/NCC/NSS/ ANANDAM/IPR	-	-	-	-	100	**100**	**1**
			Sub- Total	**0**	**0**	**8**	**240**	**260**	**500**	**5**
			TOTAL OF IV SEMESTER	**18**	**2**	**8**	**420**	**680**	**1100**	**25**

L = Lecture, **T** = Tutorial, **P** = Practical, **IA**=Internal Assessment, **ETE**=End Term Exam, **Cr**=Credits

***for calculation of contact hours**

3ME4-01: Engineering Thermodynamics

(Common for ME and MX)

Credit: 4Max **Marks: 100(IA: 30, ETE: 70)**

3L+1T+0P **End Term Exam: 3 Hours**

Course Objectives

To disseminate the basic concepts of thermodynamics and the working devices operating on the principles of thermodynamics.

Course Outcomes

Student will be able to

1. CO1: Students will be able to understand the basic concepts/laws of thermodynamic substances, processes and systems as a whole.
2. CO-2: Students will be able to establish the relation between thermodynamic properties and to identify the models to estimate the thermodynamic properties of working substances in closed system and open system.
3. CO-3: Students will be able to evaluate thermodynamic performances of different power cycles and other thermal systems.

S. No	Contents	Hours
1	**Basic Concepts and definitions of Thermodynamics**: System, Surroundings, Property, Energy, Thermodynamic Equilibrium, Process, work and modes of work. **Zeroth and First Law of Thermodynamics**: Zeroth of Thermodynamics, Temperature scale, First law of thermodynamics, First law analysis of some elementary processes. Steady and unsteady flow energy equations.	3
2	**Second Law of Thermodynamics**: Heat engine, Heat pump and refrigerator, Second law of thermodynamics, Equivalence of the Kelvin Plank and Clausius statements. Reversible and Irreversible Processes, Carnot engine, Efficiency of a Carnot engine, Carnot principle, thermodynamic temperature scale, Clausis Inequality. **Entropy**: Entropy, Calculation of Entropy change, Principle of entropy increase. Temperature-Entropy diagram, Second law analysis of a control volume. **Availability:** Available energy, Loss in available energy, Availability Function, Irreversibility.	9
3	**Thermodynamic Properties of Fluids:** Pure substance, Concept of Phase, Graphical representation of p-v-T data, Properties of steam. Steam tables, Mollier chart. **Ideal Gas and Real Gas**: Ideal gas, Real gas, Internal energy, enthalpy and specific heats of an ideal gas, equations of state, Dalton's law of partial pressures, Gibbs Dalton law, Thermodynamic properties of gas mixtures.	12
4	**Thermodynamic Relations**: Thermodynamic variables, Independent and dependent variables, Maxwell's thermodynamic relations, Thermodynamic relations involving entropy, Thermodynamic relations involving enthalpy and internal energy, Joule-Thomson coefficient, Clapeyron equation. **Power Cycles:** Otto cycle, Diesel cycle, Dual cycle, Brayton cycle and Ericsson cycle.	9

5	**Vapour power cycle:** Rankine cycle, effect of operating conditions on its efficiency, properties of ideal working fluid in vapour power cycle Reheat cycle, regenerative cycle, bleeding extraction cycle, feed water heating co-generation cycle.	8

TEXT BOOKS

1. Nag.P.K., "Engineering Thermodynamics", 6th Edition, Tata McGraw Hill (2017), New Delhi
2. Van G.J. Wylen and Sonntag R.E., Fundamental of Thermodynamics, John Wiley & Sons, 2003

REFERENCE BOOKS

1. Cengel Y.A., Boles M.A, Thermodynamics-An Engineering Approach, McGraw Hill, 2011
2. Rao Y.V.C., An Introduction to Thermodynamics, Wiley Eastern Ltd., 1993.
3. Rogers, Gorden., Engineering Thermodynamics, Pearson Education
4. Jones J.B.&.Dugan R.E, Engineering Thermodynamics, Prentice Hall of India.
5. Moran M.J and H.N. Shapiro, Fundamentals of Engineering Thermodynamics, John Wiley and Sons

3ME4-02: Materials Engineering and Technology

(Common for ME and MX)

Credit: 2Max **Marks: 100(IA: 30, ETE: 70)**

2L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. Core competence in materials, i.e. fundamental understanding of material behavior, or conceived, designed, and realized useful products and technology platforms within realistic engineering constraints.
2. Choose their careers as practicing materials engineer in all fields of materials industries
3. Understanding of the subject to present a wealth of real world engineering examples to give students a feel of how material science is useful in engineering practices.
4. To apply knowledge of materials solutions to enhance or radically improve existing and future technology.

Course Outcomes

Upon successful completion of the course the students will be able to;

1. **CO1:** Distinguish the various casting methods for product making with their merits and demerits.
2. **CO2:** Distinguish the various materials joining process and associated defects with possible cause and cure.
3. **CO3:** Discuss various metals forming process with its application.
4. **CO4:** Understanding of powder metallurgy.
5. **CO5:** Apply the manufacturing process suitable for making products.

S. No.	Contents	Hours
1	**Introduction:** Introduce Material Science & Engineering and provide basis for different materials categories and classification. **Crystallography:** Bonding in solids: Ionic, amorphous and crystalline, single crystal and polycrystalline material, polymorphism, lattice, unit cell, Bravais lattice, types of crystals, Linear and Planer densities, crystal defects and their effect on properties (Point, Line ,Surface and Volume defects), strengthening mechanism, Elastic & plastic modes of deformation, Bauschinger's effect, slip & twinning, strain hardening, cold/hot working, recovery, re-crystallization and grain growth.	7
2	**Solidification:** Mechanism of solidification, Homogenous and Heterogeneous nucleation, crystal growth, cast metal structures. Phase Diagram I: Solid solutions, Hume Rothary rule, substitutional and interstitial solid solutions, intermediate phases, Gibbs phase rule. **Phase Diagram:** Construction of equilibrium diagrams involving complete and partial solubility, lever rule. Iron carbon equilibrium diagram description of phases, solidification of steels and cast irons, invariant reactions.	5
3	**Heat treatment:** TTT curves, continuous cooling curves, annealing and its types. Normalizing, hardening, tempering, martempering, austempering, hardenability, Jominey end quench test, surface hardening methods like carburizing, cyaniding, nitriding, flame hardening and induction hardening. Application of above processes to machine components and mechanical equipment's such as gears, shaft bearings, turbine blades, crank shafts, pistons etc.	7

4	**Mechanical properties and testing of materials:** Tensile, compression and torsion tests; Young's modulus, relations between true and engineering stress-strain curves, generalized Hooke's law, yielding and yield strength, ductility, resilience, toughness and elastic recovery; Hardness: Rockwell, Brinell and Vickers and their relation to strength. Impact Test (Charpy and Izod specimens, Fatigue Test (Fatigue testing apparatus, S-N Curve for ferrous and non-ferrous, Fatigue fracture (transgranular fracture), endurance and fatigue limits, Methods of improving fatigue life.	5
5	**Non-metallic materials:** Polymers-types of polymer, commodity and engineering polymers, properties and applications of PE, PP, PS, PVC, 4 PMMA, PET, PC, PA, ABS, PI, PAI, PPO,PPS, PEEK, PTFE Polymers. Urea and Phenol formaldehydes. **Ferrous and non-ferrous metals**: Effect of alloying additions on steel (Mn, Si, Cr, Mo, V, Ti & W), stainless and tool steels, HSLA steel.	5
6	**Classification** of steels and cast iron constitution and properties. BIS standards. **Engineering Ceramics**: Properties and applications of Al_2O_3, SiC, Si_3N_4, PSZ etc. Mechanical/Electrical behaviour and processing of Ceramics. **Fiber and particulate reinforced composites:** types, production techniques, structure, Processing and applications. **Introduction to nano materials:** Nano structured materials, nano clusters & nano crystals, smart materials.	5

TEXT BOOKS

1. William D. Callister Jr, Materials Science and Engineering, John Wiley & Sons., 2001.
2. V. Raghavan, Materials Science and Engineering, Prentice Hall, India, 2007.
3. B. K. Agrawal, Introduction to Engineering Materials, Tata McGraw-Hill, 1988.

REFERENCE BOOKS

1. Narula, Narula and Gupta, Material Science, New Age Publishers, India, 1988.
2. H. VanVlack, Elements of Materials Science and Engineering, , Addison- Wesley Edn., 1998
3. K. Bhargava, C.P. Sharma. Mechanical Behavior & Testing of Materials, P H I Learning Private Ltd., 2011
4. S.H.,Avner, Introduction to Physical Metallurgy, 2nd Edition, Tata McGraw-Hill, 1997
5. G. E. Dieter, Mechanical Metallurgy, McGraw Hill Book Company, London, 1988.

3ME4-03: Manufacturing Processes

(Common for AR, ME and MX)

Credit: 3Max **Marks: 100(IA: 30, ETE: 70)**

3L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To teach the manufacturing processes which convert raw materials into useful products adapted to human needs.
2. To expose the students to a variety of manufacturing processes including their typical use and capabilities.
3. To teach the important effects that manufacturing processes may have on the material properties of the processed part with a focus on the most common processes.
4. To provide a technical understanding of common processes to aid in appropriate process selection for the material and required tolerances.
5. The students will enable to seek employment in engineering upon graduation and provide a firm foundation for manufacturing technologies.

Course Outcomes

Upon successful completion of the course the students will be able to;

1. **CO1:** Upon graduation, students would have acquired and developed the necessary background and skills for successful careers .
2. **CO2:** After completing the program, the student should be well prepared for management positions in industry or continued education toward a graduate degree.
3. **CO3:** The student will be having the capability of selecting suitable manufacturing processes to manufacture the products optimally.
4. **CO4:** The student will be able to identify/control the appropriate process parameters, and possible defects of manufacturing processes so as to remove them.
5. **CO5:** Acquire abilities and capabilities in the areas of advanced manufacturing methods, quality assurance and shop floor management.

S. No.	Contents	Hours
1	General classification and introduction to manufacturing processes **Introduction to Foundry:** Steps involved in casting, advantages, limitations and applications of casting process, pattern types, allowances for pattern, pattern materials, color coding and storing of patterns moulding. **Moulding**: methods and processes-materials, equipment, moulding sand ingredients, essential requirements, sand preparation and control, properties, testing; grain fineness; moisture content, clay content and permeability test. cores and core making, Design considerations in casting, gating and riser - directional solidification in castings, metallurgical aspects of casting	8
2	**Casting Processes**: Sand castings, pressure die casting, permanent mould casting, centrifugal casting, precision investment casting, shell moulding, CO_2 moulding, continuous casting-squeeze casting, defects in castings, causes, effects and remedy.	6

3	**Metal Joining Processes**: Types of welding: gas welding, arc welding, shielded metal arc welding, GTAW, GMAW, SAW, ESW, Resistance welding (spot, seam, projection, percussion, flash types), thermit welding, flame cutting - use of Oxyacetylene, modern cutting processes, arc cutting. Heat input, effect of welding parameters preheating, and post heating temperature. Selection of electrodes, flux etc. Soldering, brazing and braze welding and their application.	6
4	**Special Welding Processes** : Principles and process details of Forge welding; Friction welding; laser beam welding, electron beam welding, diffusion welding; ultrasonic welding. explosive welding, welding defects; types, causes, effects and remedy.	6
5	**Metal Forming Processes**: Classification; hot working and cold working, principle, advantages, disadvantages and applications. Forging: classification, drop forging and press forging methods and use; Forging dies; types, materials. Rolling: characteristics and applications of hot rolling and cold rolling; Extrusion: work materials and products; Press tool works; Basic principles, system, operations and applications. Drawing: wire drawing, tube drawing and deep drawing. Shearing; parting, notching, trimming, nibbling, blanking and piercing.	8
6	**Powder Metallurgy**: properties of powder processed materials, powder manufacturing, mechanical pulverization, sintering, electrolytic process, chemical reduction, atomization, properties of metal powders, compacting of powders sintering, advantages and applications of powder metallurgy.	6

TEXT BOOKS

1. P.N. Rao, Manufacturing Technology, Vol. I, Tata McGraw Hill, NewDelhi, 2014
2. Amitabha Ghosh and Mallik, “Manufacturing Science”, East West Press Pvt. Ltd.
3. R. K Jain, A Text Book of Production Technology, Khanna Publishers, NewDelhi. 1999.
4. R. K. Rajput, A Text Book of Manufacturing Technology, Laxmi Publications, India, 2007.

REFERENCE BOOKS

1. S. Kalpakjian, Manufacturing Engineering and Technology, Pearson Education, Singapore
2. S. K. Hajra Choudhry, Elements of Workshop Technology, Vol I, Media Promoters & Publishers Pvt.,Ltd.
3. De Garmo, Materials and Processes in Manufacturing, Prentice Hall of India, New Delhi.

3ME4-04: Mechanics of Solids

(Common for AR, ME and MX)

Credit: 4Max **Marks: 100(IA: 30, ETE: 70)**

3L+1T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To understand the basic concepts of the stresses and strains for different materials and strength of structural elements.
2. To know the development of internal forces and resistance mechanism for one dimensional and two dimensional structural elements.
3. To analyse and understand different internal forces and stresses induced due to representative loads on structural elements.
4. To analyse and understand principal stresses due to the combination of two dimensional stresses on an element and failure mechanisms in materials.
5. To evaluate the behavior of torsional members, columns and struts.

Course Outcomes

Student will be able to

1. To evaluate the strength of various structural elements internal forces such as compression, tension, shear, bending and torsion.
2. To suggest suitable material from among the available in the field of manufacturing.
3. To evaluate the behavior and strength of structural elements under the action of compound stresses and thus understand failure concepts.
4. To understand the basic concept of analysis and design of members subjected to torsion.
5. To understand the basic concept of analysis and design of structural elements such as columns and struts.

S. No	Contents	Hours
1	**Introduction:** Concept of stress, Mechanical properties of materials, stress-strain diagrams (tension- structural steel, aluminum and compression-copper, cast iron) internal forces (stress resultants), Normal stress and strain, Linear elasticity, Hooke's law, and Poisson's ratio with limitations, Shear stress and strain, Hooke's law in shear, stress circle	3
2	**Uniaxial loaded members:** Changes in lengths of axially loaded members- prismatic bars, cables; Changes in lengths under non-uniform conditions-bars with intermediate axial loads, bars consisting of prismatic segments, bars with continuously varying loads or dimensions; Stresses in Statically Indeterminate Structures, Thermal effects; pre-strains of bolts and turnbuckles; Axial stresses on inclined sections, maximum normal and shear stresses, Strain energy - elastic and inelastic strain energy, strain-energy density, impact loading, suddenly applied load, repeated loading and fatigue, Saint-venant's principle, nonlinear stress-strain curves	7
3	**Analysis of Stress and Strain:**	5

	Plane stress- stresses on inclined sections, transformation equations for plane stress; Principal stresses and maximum shear stresses; Mohr's circle for plane stress; Hooke's law for plane stress and volume change; Relation between various elastic constants, Tri-axial stress - maximum shear stresses, Hooke's law for tri-axial stress, unit volume change and volumetric strain Members subjected to combined loadings, concept of theory of failure.	
4	Stresses and strains in the walls of thin spherical pressure vessels and cylindrical pressure vessels;	2
5	**Shear Forces and Bending Moments:** Types of beams, loads, and reactions, types of loads, shear forces and bending moments, relationships between loads, shear forces, and bending moments – for distributed, concentrated and couple loading; Shear-force and bending moment diagrams for - concentrated load, uniform load, several concentrated loads, combination of loads, couple loading	6
6	**Stresses in Beams:** Pure bending and non-uniform bending, Theory of flexure for initially straight beams, distribution of bending stresses across the beam cross-section, curvature of a beam, longitudinal strains in beams, normal stresses in beams, moment-curvature relationship, flexure formula and limitations; Strain Energy due to bending Shear stresses in beams of rectangular cross section, circular cross section, beams with flanges - shear formula; distribution of shear stresses, maximum and minimum shear stresses and limitations; built-up beams	4
7	**Deflections of Beams:** Differential equations of the deflection curve; Deflections by integration of the bending-moment equation; deflections by integration of the shear-force and load equations; method of superposition; moment-area method; Castigliano's theorem	6
8	**Torsion:** Torsional deformations of a circular bar- shear stress and strains outside and within the bar and in circular tubes; angle of twist; limitations of the torsion formula; Non-uniform torsion for constant torque, stepped and composting shafts; transmission of power by circular shafts; Stresses and strains in pure shear- stresses on inclined planes, strains in pure shear; Transmission of power by circular shafts; statically indeterminate torsional members; strain energy in torsion and pure shear; Thin-walled tubes- shear stresses and shear flow, torsion formula for thin-walled tubes;	5
9	**Columns:** Buckling and Stability- Critical Load, Equilibrium, Effective Lengths of Columns; Euler buckling theory - Columns with pinned ends, column fixed at the base and free at the top, column with both ends fixed against rotation, column fixed at the base and pinned at the top	3

	Columns with eccentric axial loads, the Secant formula for columns Introduction to Inelastic Buckling - Tangent-Modulus Theory, Reduced-Modulus Theory, Shanley Theory	

TEXT BOOKS

1. Gere, J.M. and Goodno, B.J., "Strength of Materials", Indian Edition (4th reprint), Cengage Learning India Private Ltd.
2. S.S. Rattan " Strength of Materials" McGraw Hill Education (India) Pvt. Ltd., 2nd Edition (Sixth reprint 2013)
3. Mechanics of Materials Paperback by B.C. Punmia , Ashok Kumar Jain , Arun Kumar Jain, Laxmi PublicatioN

REFERENCE BOOKS

1. Beer, F.P., Johuston, Jr., E.R., Dewolf, J.T. and Mazureu, D.E., "Mechanics of Materials", Fifth Edition, McGraw Hill
2. Hibbeler, R.C., "Mechanics of Materials", Sixth Edition, Pearson
3. Crandall, S.H., Dahl, N.C. and Lardner, T.J., "An Introduction to the Mechanics of Solids", 2nd Edition, McGraw Hill.

3ME4-05: Renewable Energy Systems

Credit: 3Max **Marks: 100(IA: 30, ETE: 70)**

3L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To help students gain essential knowledge on the importance of various renewable energy sources
2. To familiarize the students with principles of energy conversion for various renewable energy sources
3. To do practical experiments for energy resource performance under different operating conditions
4. To understand the method for assessment of various input energy resources for meeting the specific requirements.
5. To know the limitations in renewable energy conversion techniques

Course Outcomes

Student will be able to

1. Explain the current energy scenario and requirement of migration to renewable energy sources
2. Demonstrate the knowledge of various solar thermal energy applications
3. Design solar PV systems under stand-alone mode and analyze the performance of solar cells
4. Design a bio-gas digester
5. Analyze the performance of wind mills
6. Assess the power potential of a given site and choose adequate hydro turbine
7. Explain various methods for harvesting the ocean energy

S. No	Contents	Hours
1	**Introduction:** World energy situation, conventional and non-conventional energy sources, Indian energy scene.	4
2	**Solar Energy:** Solar radiation, solar radiation geometry, solar radiation on tilted surface. Solar energy collector. Flat- plate collector, concentrating collector - parabolidal and heliostat. Solar pond. Basic solar power plant. Solar cell, solar cell array, basic photo-voltaic power generating system.	8
3	**Wind Energy:** Basic principle of wind energy conversion, efficiency of conversion, site selection. Electric power generation-basic components, horizontal axis and vertical axis wind turbines, towers, generators, control and monitoring components. Basic electric generation schemes- constant speed constant frequency, variable speed constant frequency and variable speed variable frequency schemes. Applications of wind energy.	6
4	**Geothermal Energy:** Geothermal fields, estimates of geothermal power. Basic geothermal steam power plant, binary fluid geothermal power plant and geothermal preheat hybrid power plant. Advantages and disadvantages of geothermal energy. Applications of geothermal energy. Geothermal energy in India.	4
5	**Tidal Energy:** Introduction to tidal power. Components of tidal power plants, double basin arrangement. Power generation. Advantages and limitations of tidal power generation. Prospects of tidal energy in India.	4

6	**Biomass Energy:** Introduction, biomass categories, bio-fuels. Introduction to biomass conversion technologies. Biogas generation, basic biogas plants-fixed dome type, floating gasholder type, Deen Bandhu biogas plant, Pragati design biogas plant. Utilization of bio gas. Energy plantation. Pyrolysis scheme.	4

TEXT BOOKS

1. Non-Conventional Energy Sources by G.D. Rai, Khanna Publication, 4e
2. Non-Conventional Energy Resources, B. H. Khan, McGraw Hill Education Publisher, 2017.

REFERENCE BOOKS

1. A. N. Mathur: Non-Conventional Resources of Energy. Laxmi Publications; First edition
2. Boyle, Godfrey ed. (2012). Renewable Energy: Power for a Sustainable Future (3rd ed.). Oxford: Oxford University Press
3. Renewable Energy: Physics, Engineering, Environmental Impacts, Economics and Planning by Bent Sørensen, Elsevier. 3e.

3ME2-01: Engineering Mechanics

(Common for AR, ME and MX)

Credit: 3Max **Marks: 100(IA: 30, ETE: 70)**

3L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To enable students to apply fundamental laws and basic concepts of rigid body mechanics to solve problems of bodies under rest or in motion.
2. To enable the students to apply conditions of static equilibrium to analyse physical systems.
3. To compute the properties of areas and bodies.

Course Outcomes

Student will be able to

1. Compute the resultant of system of forces in plane and space acting on bodies.
2. Predict the support-reactions and the internal forces of the members of various trusses and frames.
3. Analyse equilibrium problems with friction.
4. Apply transfer theorems to determine properties of various sections.
5. Analyse equilibrium of connected bodies virtual work method.
6. Predict motion parameters of bodies under rectilinear, curvilinear and general plane motion.

S. No	Contents	Hours
1	**Introduction to Engineering Mechanics 8 Introduction to Engineering Mechanics:** Composition and resolution of forces, parallelogram law, principle of transmissibility, types of force systems - concurrent and concurrent coplanar forces, resultant of coplanar force systems couple, moment of a force Varignon's theorem, concept of free body diagrams, concept of equilibrium of coplanar force and non-coplanar systems.	5
2	**Analysis of Structures and Friction:** Introduction to plane trusses, analysis of plane trusses by method of joints and method of sections. Friction: Laws of friction, types of friction, equilibrium of force systems involving frictional forces, wedge friction. Free body diagrams involving frictional forces.	8
3	**Properties of Surfaces and Moment of Inertia:** Properties of Surfaces and Volumes: Centroid and center of gravity, derivation of centroids from first moment of area, centroids of composite sections, center of gravity of common volumes - cylinder, cone, sphere, theorem of Pappus-guldinus. Moment of Inertia: Area moment of inertia of plane and composite shapes, parallel axis theorem, perpendicular axis theorem, polar moment of inertia, mass moment of inertia of common volumes - thin plates, thin rod, cylinder, cone, sphere, rectangular prism, radius of gyration, Principle of virtual work.	8
4	**Kinematics:** Equations of motion for rigid bodies, constant and variable acceleration, rectilinear and curvilinear motion, motion under gravity -projectile motion, use of rectangular coordinates, tangential and normal coordinates, radius of curvature, rotation of a rigid body about a fixed axis, introduction to plane motion.	8
5	**Kinetics and Ideal Systems:** Kinetics: Principles of dynamics - Newton's Laws of motion, D'Alembert's principle in rectilinear translation, principle of work and energy.	8

	Ideal Systems: Principle of conservation of energy, concept of power, conservation of linear and angular momentum, principle of momentum and impulse, impact - types of impact. Basic principles: Equivalent force system, Equations of equilibrium, Free body diagram; Reaction, Static indeterminacy.	

TEXT BOOKS

1. Beer F.P and Johnson E.R., "Vector Mechanics for Engineers- Statics and Dynamics",9th Edition, Tata McGraw-Hill Publishing Company
2. Meriam J.L., Kraige L.G, et al., "Engineering Mechanics Statics and Dynamics", 9th Edition, (An Indian Adaptation), Wiley India

REFERENCE BOOKS

1. Hibbeler R. C and Gupta A., Engineering Mechanics,", 12th Edition, 2012, Pearson Education
2. Shames I.H and Rao G.K.M., "Engineering Mechanics Statics and Dynamics", 4th Edition, Pearson

3ME4-20: Machine Drawing Practice

(Common for AR, ME and MX)

Credit: 1.5Max **Marks: 100(IA: 60, ETE: 40)**

0L+0T+3P

Course Objectives

1. To acquire the knowledge of CAD software and its features.
2. To familiarize the students with Indian Standards on drawing practices.
3. To impart knowledge of thread forms, fasteners, keys, joints and couplings.
4. To make the students understand and interpret drawings of machine components leading to preparation of assembly drawings manually and using CAD packages.
5. To acquire the knowledge of limits, tolerance and fits and indicate them on machine drawings

Course Outcomes

1. Identify the national and international standards pertaining to machine drawing.
2. Understand the importance of the linking functional and visualization aspects in the preparation of the part drawings.
3. Apply limits and tolerances to assemblies and choose appropriate fits for given assemblies.
4. Interpret the Machining and surface finish symbols on the component drawings.
5. Preparation of the part or assembly drawings as per the conventions.

S. No	Contents	Hours
1	**Part – A (Theory and Sketch-book)** Review of graphic interface of the software. Review of basic sketching commands and navigational commands. Starting a new drawing sheet. Sheet sizes. Naming a drawing, Drawing units, grid and snap. Conversion of pictorial views into orthographic projections of simple machine parts (with section planes indicated on the part). Thread Forms: Thread terminology, sectional views of threads. ISO Metric (Internal & External), BSW (Internal & External) square and Acme. Sellers thread, American Standard thread. Fasteners: Hexagonal headed bolt and nut with washer (assembly), square headed bolt and nut with washer (assembly) simple assembly using stud bolts with nut and lock nut. Flanged nut, slotted nut, taper and split pin for locking, counter sunk head screw, grub screw, Allen screw. Keys: Parallel key, Taper key, Feather key, Gib-head key and Woodruff key. Joints: Cotter joint (socket and spigot), knuckle joint (pin joint) for two rods. Couplings: Split Muff coupling, Protected type flanged coupling, pin (bush) type flexible coupling, and universal coupling (Hooks' Joint). Limits, Fits and Tolerances: Introduction, Fundamental tolerances, Deviations, Methods of placing limit dimensions, machining symbols, types of fits with symbols and applications, geometrical tolerances on drawings. Standards followed in industry.	Simultaneous to section 2

2	**Part – B (Use any CAD software)** A. Plummer block (Pedestal Bearing) B. Lever Safety Valve C. I.C. Engine connecting rod D. Screw jack (Bottle type) E. Tailstock of lathe F. Machine vice G. Tool head of shaper	36

3ME4-21: Production Practice Lab

(Common for AR, ME and MX)

Credit: 1.5Max **Marks: 100(IA: 60, ETE: 40)**

0L+0T+3P

Course Objectives

1. The course provides students with fundamental knowledge and principles in material removal processes.
2. In this course, the students apply the fundamentals and principles of metal cutting to practical applications through multiple labs using lathes, milling machines, grinding machines and other machining processed.
3. To demonstrate the fundamentals of machining processes and machine tools.
4. Demonstration of Casting and welding techniques in detail.

Course Outcomes

Upon successful completion of the course the students will be able to;

1. **CO1:** Study of various parts of lathe machine and its construction. Understanding of various lathe operations i.e. turning, taper turning, chamfering and knurling, thread cutting.
2. **CO2:** Study shaper machine, its mechanism and calculate quick return ratio, and milling machine.
3. **CO3:** Understanding of various Foundry shop operations. i.e. prepare mould, perform moisture test and clay content test, Strength Test, hardness test and to perform permeability test.
4. **CO4:** Understanding of Welding shop and practice on spot welding.

S. No	Contents	Hours
1	**Turning Shop** 1. To study lathe machine construction, attachments, lathe tools cutting speed, feed and depth of cut. 2. To cut multi-start Square/Metric threads on lathe machine. 3. To perform taper turning using compound rest. 4. Boring using a boring bar in a centre lathe and cut BSW/Metric internal threads on lathe machine.	
2	**Machine shop** 1. To study the milling machine, milling cutters, indexing heads and indexing methods and to prepare a gear on milling machine. 2. To machine a hexagonal /octagonal nut using indexing head on milling machine. 3. To study of single point cutting tool geometry and to grind the tool as per given tool geometry. 4. To study shaper machine, its mechanism and calculate quick return ratio and to prepare a job on shaper from given mild steel rod.	
3	**Demonstration and study** 1. Demonstration for job by eccentric turning on lathe machine. 2. Study of capstan lathe and its tooling and prepare a tool layout & job as per given drawing.	

	3. Grinding of milling cutters and drills. 4. Study of grinding wheel and their materials.	
4	**Foundry Shop** 1. To prepare mould of a given pattern requiring core and to cast it in aluminium. 2. To perform moisture test and clay content test. 3. To perform permeability test 4. A.F.S. Sieve analysis test. 5. Strength Test (compressive, Tensile, Shear Transverse etc. in green and dry conditions) and Hardness Test (Mould and Core).	
5	**Welding Shop** 1. Hands-on practice on spot welding.	

3ME4-22: Materials Testing Lab

(Common for AR, ME and MX)

Credit: 1Max **Marks: 100(IA: 60, ETE: 40)**

0L+0T+2P

Course Objectives

1. Students may apply knowledge of mathematics and engineering in calculating the mechanical properties of structural materials.
2. Ability to work on multi-disciplinary teams in the area of materials testing.
3. Ability to use the techniques, skills and modern engineering tools necessary for engineering and used in engineering design.
4. Understanding of professional and ethical responsibility in the areas of material testing.
5. Ability to communicate effectively the mechanical properties of materials.

Course Outcomes

Upon successful completion of the course the students will be able to;

1. **CO1:** The students will understand the different types of crystal structures.
2. **CO2:** The students will be able to identify and select the suitable materials for different application.
3. **CO3:** The students will be able to find out the mechanical properties of various materials.
4. **CO4:** The students will be able to prepare and evaluate the microstructures of different material specimens.
5. **CO5:** The students will be able to understand heat treatment techniques, and their effect on behavior of material.

S. No	Contents	Hours
	Material Science Lab Experiments:	
1	Study of various crystals structures through models BCC, FCC, HCP, tetrahedral and octahedral voids.	
2	Specimen preparation for micro structural examination cutting, grinding, polishing, etching.	
3	Comparative study of microstructures of different given specimens (mild steel, gray C.I., brass, cooper etc.)	
4	Heat treatment experiments such as annealing, normalizing, quenching, case hardening and comparison of hardness before and after.	
5	Study of Microstructure and hardness of steel at different rates of cooling.	
	Material Testing Lab Experiments: (At least 5 of the following)	
1	To perform Tensile/Compressive/Shear/torsion test on a given material and to determine its various mechanical properties under tensile/compression/Shear/torsional loading	
2	To determine Rockwell/ Vickers/Brinell hardness of a given material	
3	Impact testing on impact testing machine like Charpy, Izod or both.	
4	Torsion testing of a rod on torsion testing machine.	

5	Spring index testing on spring testing machine.	
6	Deflection of beam experiment, comparison of actual measurement of deflection with dial gauge to the calculated one, and or evaluation of young's modulus of beam.	
7	Study of non-destructive testing methods like magnetic flaw detector, ultrasonic flaw detector, and eddy current testing machine, dye penetrate tests.	
8	Fatigue testing on fatigue testing machine	
9	Creep testing on creep testing machine.	

4ME4-01: Theory of Machines - I

Credit: 4Max **Marks: 100(IA: 30, ETE: 70)**

3L+1T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To impart knowledge on various types of Mechanisms and visualize their applications in practical life
2. To impart knowledge of cams, followers, flywheels and governors
3. To familiarize about concept of friction, brakes and dynamometers

Course Outcomes

Student will be able to -

1. ***CO1:*** Students will be able to understand various mechanisms, their velocity and acceleration analysis and kinematic analysis of machines
2. ***CO2:*** Students will be able to understand inertia force analysis of piston and connecting rod, draw turning moment diagram of a flywheel
3. ***CO3:*** Students will be able to understand various cams, followers and draw their displacement, velocity and acceleration curves
4. ***CO4:*** Students will be able to understand various laws of friction and their occurrence in various mechanical components
5. ***CO5:*** Students will be familiar with various types of brakes, dynamometers and governors

S. No	Contents	Hours
1	***Mechanisms and Machines:*** Kinematic pair, Kinematic chain, Four-bar chain, single slider-crank chain, double slider-crank chain and their inversions.	5
2	***Velocity and acceleration analysis:*** for four link mechanism, slider-crank mechanism, crank and slotted-lever mechanism, Instantaneous centre, algebraic methods, Klein's construction, Coriolis component	6
3	***Inertia force analysis:*** Velocity and acceleration of slider crank and four bar mechanism, inertia force, piston thrust and forces on connecting rod, turning moment diagram, flywheel	8
4	***Cams:*** Type of cams, displacement, velocity and acceleration curves for different cam followers, Cams with specified contours.	6
5	***Friction:*** Laws of static, dynamic and rolling friction, dry and viscous friction, inclined plane and screw jack, pivots and collars, friction clutches, rolling friction, film lubrication.	5
6	***Brakes and Dynamometers:*** Band, block and band & block brakes, effect of braking action, Dynamometers: absorption and transmission type dynamometers, prony, rope and hydraulic dynamometers.	6
7	***Governors:*** Types of Governors, Watt, Porter, Proell, Hartnell and spring-controlled governors, sensitivity and stability of governors, Isochronism and hunting, governor effort and power.	6

TEXT BOOKS

1. S. S. Rattan, "Theory of Machines", Tata McGraw Hill, 5th Edition 2019
2. Joseph Edward Shigley and John Jospeh Uicker JR, Theory of Machines and Mechanisms SI Edition, Oxford University Press, 2014

REFERENCE BOOKS

1. R L Norton, Kinematics and Dynamics of Machinery, McGraw-Hill Education, 2017
2. Thomas Bevan, "Theory of Machines", Pearson, 3rd Edition 2009

4ME4-02: Fluid Mechanics

(Common for AR, ME and MX)

Credit: 4Max **Marks: 100(IA: 30, ETE: 70)**

3L+1T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To apply hydrostatic law, principle of mass and momentum in fluid flows, concepts in Euler's and Bernoulli equations.
2. To provide fundamental knowledge of fluids, its properties and behaviour under various conditions of internal and external flows.
3. To determine the losses in a flow system, flow through pipes, boundary layer concepts.

Course Outcomes

Student will be able to -

1. Analyse various hydraulic systems by applying the fundamental laws of fluid statics.
2. Solve the fluid flow governing equations by taking suitable constraints and assumptions
3. Evaluate major and minor losses in pipes
4. Analyse the practical significance of open channel flows
5. Perform dimensional analysis on any real life problems
6. Interpret the boundary layer aspects of laminar and turbulent flows
7. Experimentally determine the fluid properties and flow parameters using various experimental setups

S. No	Contents	Hours
1	**Basic Definitions and Fluid Properties:** Definition of Fluid. Incompressible and compressible fluids. Fluid as a continuum, Mass, density, specific weight, relative density, specific volume. Bulk modulus, velocity of sound Ideal fluid, viscosity. Newtonian and Non-Newtonian fluid, Kinematic viscosity, Effect of temperature and pressure on viscosity, surface tension capillarity, vapour pressure and cavitation. **Fluid Statics:** General differential equation, Hydrostatics Manometry, Fluid forces on submerged surfaces. Curved surfaces, Isothermal atmosphere, polytropic atmosphere. Buoyancy and floatation.	6
2	**Kinematics and Conservation of Mass:** Flow classifications. Fluid velocity and acceleration, streamlines and the stream function. Pathlines and streak lines. Deformation of a fluid element, vorticity and circulation. Irrotational and Rotational flow. Flownet, Laplace equation Conservation of mass and the continuity equation for three dimensions. **Fluid Momentum:** The momentum theorem. Applications of the momentum theorem. Equation of motion, Euler's equation of motion. Integration of Euler's equation of motion--Bernoulli's equation. Applications of Bernoulli's equation. Equation of motion for viscous fluid, Navier Stoke's equation	7
3	**Flow Through Pipes:** Reynold's experiment. Darcy's Weisback equation. Loss of head due to sudden enlargements, contraction, entrance, exit obstruction, bend, pipe fittings. Total and Hydraulic gradient lines, Flow through pipe line, Pipes in series, parallel, Transmission of power through pipes. Orifice discharging, free Jet, vena contracta, co-efficient of contraction, velocity and discharge,	8

	Orifices and mouthpieces, Nozzles and weirs.	
4	**Laminar Flow:** Simple Solution of Navier Stokes equations. Hagen-Poiseuille flow, Plane Poiseuille flow and coutte flow. **Turbulent Flow:** Variation of friction factor with Reynold's number, The Prandtl Mixing length hypothesis applied to pipe flow, velocity distribution in smooth pipes, rough pipes. The Universal pipe friction laws. **The Boundary Layer:** Description of the boundary layer, Boundary layer thickness, boundary layer separation and control. The Prandtl boundary layer equation. Solution for laminar boundary layer. The momentum equation for the boundary layer. The flat plate in uniform free stream with no pressures gradients: Approximate momentum analysis - Laminar boundary layer. Turbulent boundary layer, Viscous sublayer, combined laminar and turbulent boundary layers.	9
5	**Dimensional Analysis:** Buckingham's theorem, Model Similitude. Force ratio, Reynolds, Froude's, Mach, Weber and Euler numbers and their applications. Undistorted model, distorted model. Film Lubrications: Tower's experiment. Reynold's theory and interpretation. High speed journal loaded and unloaded. Sommerfeld diagram. Hydrostatic Lubrication. Flow around a Body: Drag, Skin friction drag, Pressure drag. Combined skin friction and pressure drag (Profile drag), Wave drag. lift induced drag, Flow past sphere and cylinder.	9

TEXT BOOKS

1. Yunus A. Çengel, John M. Cimbala, Fluid Mechanics: Fundamentals And Applications, McGraw-Hill, 3rd Edition, 2013.

REFERENCE BOOKS

1. Robert W. Fox, Alan T. McDonald, Philip J. Pirtchard John W. Mitchell, Introduction to Fluid Mechanics, 9th Edition, Wiley Publications, 2015.
2. Donald F. Elger, Barbara C. Williams, Clayton T. Crowe, John A. Roberson, Engineering Fluid Mechanics, John Wiley & Sons, 10th Edition, 2013.
3. V.L. Streeter, Fluid Mechanics, McGraw Hill Book Co., 2010.

4ME4-03: Internal Combustion Engines and Gas Turbines

Credit: 3Max **Marks: 100(IA: 30, ETE: 70)**

3L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To introduce students to the working of spark ignition and compression ignition engines and their systems.
2. To introduce students to the cooling and lubrication system of spark ignition and compression ignition engines.
3. To teach students about the usage of alternate fuels for IC engines.
4. To enhance the understanding of students in engine emissions, pollution and their control.
5. To introduce students to the recent trends in IC Engines like stratification, multi-point injection, plasma ignition etc.

Course Outcomes

Student will be able to -

1. Apply the laws of thermodynamics to the working of I.C engines.
2. Compare the merits and demerits of different types of fuel injection systems used in IC engines
3. Determine performance and combustion characteristics of SI and CI engines
4. Propose design modifications for the existing turbochargers and superchargers
5. Demonstrate the developments to enhance the efficiency and performance of IC engines and gas turbine.
6. Get introduced to electric vehicles, understand how are EVs different from ICE vehicles and identify various parts of an electric vehicle.

S. No	Contents	Hours
1	**Introduction:** Basic components and terminology of IC engines, working of four stroke/two stroke - SI and CI engines with PV and Valve Timing Diagrams, classification and application of IC engines, engine performance and emission parameters **IC engines performance**: Performance test - Measurement of Brake power, Indicated power, Fuel consumption, Air consumption; Heat balance test, Morse test and Retardation test on IC engine.	5
2	**Mixture preparation :** Mixture preparation in Spark Ignition Engines: Spark ignition Engine mixture requirements - Feedback Control Carburetors –Properties of Fuel - Injection systems –Mono-point and Multipoint injection – Gasoline Direct Injection – Air motion. **Mixture preparation in Compression Ignition Engines**: Direct and indirect injection systems – Combustion chambers - Properties of Fuel -Fuel spray behavior - spray structure - spray penetration and evaporation – Air motion- Injectors and nozzles.	7
3	**Combustion in CI and SI Engines:** Stages of combustion in SI and CI engines – Combustion phasing - heat release rate based on	5

	cylinder pressure measurement-Knock in CI and SI engines- Measurement and control of Knock.	
4	**Power Boosting Systems:** Supercharging – Turbocharging - Variable area turbochargers, twin entry turbochargers - waste gate in turbocharger - different arrangements of turbochargers and superchargers - Effect on power and emission - basics of intake manifold tuning.	4
5	**Ignition system:** Conventional & Modern ignition systems Magneto v/s Battery, CB point v/s Electronic ignition, Fuel Ignition Energy requirements. Spark advance, centrifugal, vacuum Firing order, spark plugs. **Engine Friction & Lubrication:** Determination of friction, Lubrication principles, Types of lubrication, Places of lubrication Bearings and piston rings etc., Functions of Lubrication, Properties, Rating and Classification of lubricating oil, Additives, Lubrication systems. Engine Cooling: Requirements of cooling, Areas of heat flow, High temperature regions of combustion chamber. Heat Balance, Cooling Systems, Air, Water Cooling, Cooling system components.	6
6	**Gas Turbine:** Introduction to Gas Turbines, Development, Classification and Application of Gas Turbines. Atkinson cycle, Ericsson cycle, Ideal and Actual Cycles, gas turbine cycle with multi stage compressions. Effect of Inter cooling, Reheating, Regeneration, Combined cycle, and Cogeneration. Velocity triangles, components and overall efficiencies, and velocity ratio, turbine performance, losses.	8

TEXT BOOKS

1. V Ganesan, Internal Combustion Engine, 4th edition, Tata Mc-Graw Hill, 2012.
2. Mathur.M.L & Sharma R.P, Internal Combustion Engine, Dhanpat Rai Publications, 2010.
3. V Ganesan, Gas Turbine, 3rd edition, Tata Mc-Graw Hill, 2017.

REFERENCE BOOKS

1. Richard Stone, Introduction to Internal Combustion Engines, 4thedition, Palgrave Macmillan, 2012.
2. John B.Heywood, Internal Combustion Engine Fundamentals, 2nd Edition, Tata McGraw Hill, 2011.
3. Gupta H.N., Fundamentals of Internal Combustion Engines, Prentice Hall of India
4. F. EdwardObert, Internal Combustion Engines, Harper and Raw Publisher
5. John B. Heyword, Internal Combustion Engines Fundamentals, McGraw Hill
6. Lichty, Internal Combustion Engines, McGraw Hill.
7. Gill, Smith, Ziurs, Fundamentals of Internal Combustion Engines, Oxford & IBH Publishing
8. Rogowsky, IC Engines, International Book Co.

4ME4-04: Industrial Engineering

Credit: 3Max **Marks: 100(IA: 30, ETE: 70)**

3L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To analyze different planning activities needed during the operations stage of a manufacturing or a service industry.
2. To apply productivity techniques for achieving continuous improvement.

Course Outcomes

Student will be able to –

1. Analyze the way price of a product affects the demand for a product for consequent actions and predict demand for a product by making use of different demand forecasting techniques.
2. Explain Break even analysis to determine safe production levels and costing of industrial products.
3. Apply productivity techniques for continuous improvement in different functionalities of an industry.
4. Analyze the existing operations that happen in factories for establishing time standards for different activities.
5. Demonstrate the knowledge of selection of location for the new plant & optimizing the layout within the plant for smooth production.

S. No	Contents	Hours
1	**Plant Location, Plant Layout -** Plant Location: Major factors influencing the location of an industry and choice of site, Plant Layout: Principles of plant layout, use of travel charts, Flow Pattern. Different Types of Layouts Viz. Product, Process and Combination Layouts, Introduction to Layouts Based on GT, JIT and Cellular Manufacturing Systems, Development of Plant Layout. **Material Handling and Plant Maintenance**: Types of Material Handling Equipment, Relationship of Material Handling with Plant Layouts, Operation and Maintenance of Material Handling Equipment. Plant Maintenance: Maintenance policies; preventive, break down and corrective action.	8
2	**Production Planning and Control –** Types of production, Function of production planning and control, Sales Forecasting Techniques, Product Design, Process Planning, Machine Loading, Routing and Scheduling, Dispatching, Controlling, Progress Reporting, Corrective Action. Gantt's Charts. Introduction to CPM and PERT	6
3	**Materials Management and Inventory Control:** Field and scope of material management, Material Requirement Planning and programme, Inventory Control: Classification of Costs, Direct and Indirect Cost, Labour, Material and Over-Head, Prime Cost, Factory Cost, Fixed Cost, Variable Cost, Increment Cost, Allocation of Over-Head Costs, Break even Analysis, Types of Inventories, Determining Economic Order Quantity (EOQ), Quantity Discounts, Lead Time and Re-order Level, ABC, VED, FSN Models, Re-order Cycle Systems, Procedure for Purchase and Storage.	7
4	**Work Study and Motion Study -** Use and Applications, Techniques, Human Factors in the Application of Work Study, Method Study Objectives, Basic Procedure, Various Charting Techniques, Use of Photographic Techniques, SIMO Charts, Principles of Motion Economy, Work Measurement Techniques, Time Study, Work Sampling, Predetermined Motion Time	7

	Standards (PMTS), Analytical Estimation.	
5	**Personnel Management:** Basic Introduction to Acts related to Industries: Labour Legislation: Indian Factory Act, Payment of Wages Acts, Workman's Compensation Act, Trade Union Act, Industrial Dispute Act, Employees State Insurance Act, Minimum Wages Act. Industrial Relations Management: Union Relations, Trade Union Movement and Collective Bargaining, Employee's Participation in Management. Wage Payment System: Job evaluation, Merit Rating Methods of Wage Payment, Time Wages, Piece Wages System and Incentive Schemes.	7

TEXT BOOKS

1. Industrial Engineering and Management, Ravi Shankar, Galgotia, 2nd Ed.
2. Khanna, O.P. - Industrial Engineering and Management, Dhanpat Rai Publishers, New delhi, 2020

REFERENCE BOOKS

1. Maynard's Industrial Engineering Handbook, 5th Edition, Kjell B. Zandin, he McGraw-Hill Companies, Inc
2. Dalela, S. and Mansuor Ali - Industrial Engineering and Management systems, Standard Distributors and Publishers, New Delhi, 2010, 6th Ed.
3. Motion and Time Study: Design and Measurement of Work, 7th Edition, John Wiley, New York.
4. ILO - Introduction to Work Study, International Labor Office , Geneva.
5. Jain, K.C. and Agarwal, L. N. – Production Planning Control & Industrial Management, Khanna Publishers, New Delhi.

4ME4-05: Manufacturing Technology-I

Credit: 3Max **Marks: 100(IA: 30, ETE: 70)**

3L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. The course provides students with fundamental knowledge and principles in material removal processes.
2. In this course, the students apply the fundamentals and principles of metal cutting to practical applications through multiple labs.
3. To develop knowledge and importance of metal cutting parameters.
4. To develop fundamental knowledge on tool materials, cutting fluids and tool wear mechanisms.
5. To develop knowledge and importance of abrasive machining and super finishing processes.

Course Outcomes

Student will be able to -

1. **CO1:** Describe cutting tools by standard tool signature systems.
2. **CO2:** Understand mechanics of metal cutting by single & multi point cutting tools and chip formation.
3. **CO3:** Compute tool life and optimum cutting speed for given data.
4. **CO4:** Understand characteristics of tool material and cutting fluids.
5. **CO5:** Understand abrasive machining and super finishing processes.
6. **CO6 :** Understand basic concept of metrology

S. No	Contents	Hours
1	**Classification of metal removal process and machines**: Geometry of single point cutting tool and tool angles, tool nomenclature in ASA, ORS. Concept of orthogonal and oblique cutting. Deformation of Metal During Machining, Mechanics of Chip Formation, Built-Up Edges.	5
2	**Mechanism of Metal Cutting:** Merchant's circle diagram- determination of cutting and thrust forces; Coefficient of friction; shear plane angle, Velocity and force relationship, shear stress and strain and strain rate in orthogonal cutting. Factors Affecting Tool Forces. Cutting Speed, Feed and Depth of Cut, Surface Finish. Thermal aspects of machining and measurement of chip tool interface temperature.	10
3	**Tool Wear and Machinability:** Different types of Tool Wear and mechanism, Tool Life, Taylor's tool life equation, Factors Governing Tool Life, Machinability, machinability index, factors affecting machinability, Economics of Machining.	7
4	**Cutting Tool Materials & Cutting Fluids:** Various Tool Materials and their characteristics, Types of Cutting Tool Materials, Coated Tools, Cutting Tool Selection, Purpose and Types of Cutting Fluids, Basic Actions of Cutting Fluids, Effect of Cutting Fluid on Tool Life, Selection of a Cutting Fluid.	4
5	**Other machining process:** Milling Machine, Milling Operations, Indexing, Gear cutting, Shaper and Planer Machines: Differences, Quick-Return Mechanism, Drilling Machine, Operations. Grinding Machine: Surface, cylindrical and centreless grinding, Grinding wheels, abrasives, bonding processes, selection of grinding wheels. Honing, lapping, polishing, buffing and super-finishing method.	5

6	**Metrology:** Dimensional and geometrical accuracy of machined surfaces, types of errors, Principles of interchangeable manufacture, standardization, standards of measurement; gauge blocks, I.S.I. system of limits, fits and tolerances, Design of limit gauges and gauge materials. Comparators: mechanical, electrical optical, and pneumatic type. Auto collimators, optical interferometry, measurement of screw threads and gears, Surface roughness, specifications and methods of measurement.	7

TEXT BOOKS

1. P.N. Rao, Manufacturing Technology, Vol. II, Tata McGraw Hill, NewDelhi, 2014
2. Ghosh and Mallik, "Manufacturing Science", East West Press Pvt. Ltd.
3. R. K Jain, A Text Book of Production Technology, Khanna Publishers, NewDelhi. 1999.
4. R. K. Rajput, A Text Book of Manufacturing Technology, Laxmi Publications, India, 2007.
5. P.C. Sharma: A Text Book of Production Technology, S. Chand & Co., New Delhi, 2011

REFERENCE BOOKS

1. S. Kalpakjian, Manufacturing Engineering and Technology, Pearson Education, Singapore
2. S. K. Hajra Choudhry, Elements of Workshop Technology, Vol I, Media Promoters & Publishers Pvt.,Ltd.
3. De Garmo, Materials and Processes in Manufacturing, Prentice Hall of India, New Delhi.
4. J.S. Campbell: Principles of Manufacturing Materials and Processes, Tata McGraw-Hill Company Ltd, New Delhi, 1998.

4ME2-01: Advanced Engineering Mathematics

(Common for AR, ME and MX)

Credit: 3Max **Marks: 100(IA: 30, ETE: 70)**

3L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To make students able to understand Laplace transform and its properties and apply the Laplace transform to solve ordinary and partial differential equations.
2. To make students able to understand the Fourier series, Fourier transforms and Z-transforms with applications in engineering science.
3. To make students able to understand a system of linear equations, interpolations, numerical differentiation and integration

Course Outcomes

After completing this course, students will be able to understand and solve

1. **CO-1:** the Laplace transform and its properties and apply the Laplace transform to solve ordinary and partial differential equations.
2. **CO-2:** the Fourier series, Fourier transforms and Z-transforms with applications in engineering science.
3. **CO-3**: a system of linear equations, interpolations, numerical differentiation and integration

S. No	Contents	Hours
1.	**Laplace transforms:** Definition, Laplace transforms of elementary functions, Properties of Laplace transforms, First shifting theorem, Change of scale property, Laplace transforms of derivatives and integrals, Laplace transform of periodic functions, Heaviside unit step function and Dirac delta function. Inverse Laplace transforms and their properties, Convolution theorem, Applications of Laplace transform for solving differential equation of first and second order with constant coefficients and partial differential equations.	10
2.	**Fourier series:** Fourier series, Fourier series of even and odd functions, Change of intervals, half-range Fourier sine and cosine series, Parseval`s identity **Z-Transform:** Definition, elementary properties and formulae, Convolution theorem, inverse Z-transform.	6
3.	**Fourier Transforms:** Fourier integrals, Fourier sine and cosine integrals. Fourier transform, Fourier sine and cosine transforms and their elementary properties, Convolution theorem, Application of Fourier transforms to BVP.	8
4.	**Numerical Analysis-I:** Forward difference operator, Backward difference operator, Shift operator, Average operator, Central difference operator and their relationship, Roots of non-linear equations: Bisection method, Regula-Falsi method, Newton-Raphson method	6
5.	**Numerical Analysis-II:** Newton‘s forward interpolation formula, Newton’s backward interpolation formula, Stirling‘s Formula; Lagrange‘s interpolation formula, Divided differences, Newton‘s divided difference formula, Gauss‘ Forward central Difference Formula, Gauss‘ Backward central Difference Formula, Numerical differentiation, Numerical Integration, Trapezoidal rule, Simpson‘s one-third rule, Simpson‘s three-eight rule.	10

TEXT BOOKS

1. R. K. Jain and S.R.K. Iyengar, “Advanced Engineering Mathematics”, Narosa Publications.

REFERENCE BOOKS

1. Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley & Sons
2. M. K. Jain, S.R.K. Iyengar and R. K. Jain, "Numerical Methods for Scientific and Engineering Computation", New Age Pvt. Pub, New Delhi..
3. R. K. Jain and S.R.K. Iyengar, “Advanced Engineering Mathematics”, Narosa Publications.

4ME4-20: Theory of Machines Lab-I

Credit: 1Max **Marks: 100(IA: 60, ETE: 40)**

0L+0T+2P

Course Objectives

1. To impart knowledge on various types of Mechanisms and visualize their applications in practical life, cams, followers, governors etc.

Course Outcomes

Upon successful completion of the course the students will be able to;

1. ***CO1:*** Students will be able to understand the mechanism and kinematic analysis of machines
2. ***CO2:*** Students will be able to draw displacement curves for various cams and followers
3. ***CO3:*** Students will be able to understand various brakes, dynamometers and clutches used in engineering applications
4. ***CO4:*** Students will be able to draw controlling force curves for various governors

S. No	Contents	Hours
1	To study inversions of four bar chain: coupling Rod, beam Engine	
2	To undertake position, velocity and acceleration analysis of four bar mechanism	
3	To undertake position, velocity and acceleration analysis of slider crank mechanism	
4	To study inversion of double slider chain, Oldham coupling, Scotch Yoke and elliptical trammel.	
5	Study of various cam-follower arrangements.	
6	To plot displacement v/s angle of rotation curve for various cams.	
7	Study of various types of dynamometers, brakes and clutches.	
8	Determination of Coriolis component of acceleration experimentally.	
9	To study graphical methods of determining velocity and acceleration of various mechanisms	
10	To plot force versus radius and lift versus speed curves for governors on Universal Governor apparatus	

4ME4-21: Fluid Mechanics Lab

(Common for AR, ME and MX)

Credit: 1Max **Marks: 100(IA: 60, ETE: 40)**

0L+0T+2P

Course Objectives

1. To get familiar students about the usage and working principle of different instruments used in fluid mechanics
2. Application of instruments to calculate various parameter such as fluid pressure, discharge, losses in pipes etc.
3. Calibration of instruments

Course Outcomes

Upon successful completion of the course the students will be able to;

1. CO1: Methods of discharge measurements on open channel flow and closed conduit flow
2. CO2 Calibration flow measuring devices used in pipes, channels and tanks assessment
3. CO3 To calculate losses in flow
4. CO4 Verification and characterization of flow through experiments

S. No	Contents	Hours
1	Introduction to various Instruments.	
2	Determination of metacentric height.	
3	Calibration of a venturi meter.	
4	Determination of frictional losses in pipes of different diameters.	
5	Determination of minor losses in pipes.	
6	Calibration of v- notch and rectangular notch.	
7	Reynolds dye experiment for flow characterization.	
8	Determination of Cc, Cv and Cd of an orifice.	
9	Verification of Bernoulli‘s theorem.	
10	Calibration of orifice meter.	
11	Verify the impulse momentum equation (impact of jet).	

Suggested readings

1. Gupta V. P (2009) “Laboratory manual of fluid mechanics and machines” CBS, 9788123900094.

4ME4-22: MATLAB Programming

(Common for AR, ME and MX)

Credit: 1Max **Marks: 100(IA: 60, ETE: 40)**

0L+0T+2P

Course Objectives

1. To Impart the Knowledge to the students with MATLAB software.
2. To provide a working introduction to the MATLAB technical computing environment.
3. To introduce students the use of a high-level programming language, MATLAB.

Course Outcomes

Upon successful completion of the course the students will be able to;

1. Understand the basics of MATLAB
2. Understand solving linear and polynomial equations using MATLAB

S. No	Contents	Hours
1	Study of Introduction to MATLAB	
2	Study of basic matrix operations	
3	Script Files and Function Files	
4	To solve linear equation, Gaussian Elimination	
5	Determination of Eigen values and Eigen vectors of a Square matrix.	
6	Polynomial Curve Fitting, Least Square Curve Fitting	
7	Numerical Integration (Quadrature), Double Integration	
8	A first-order linear ODE, A second-order linear ODE	
9	Synthesis of Four bar chain mechanism	
10	Determination of roots of a polynomial.	
11	Basics of 2-D and 3-D plots	

4ME4-23: Production Engineering Lab

Credit: 1Max **Marks: 100(IA: 60, ETE: 40)**

0L+0T+2P

Course Objectives

1. The course provides students with fundamental knowledge and principles of various measuring equipments.
2. In this course, the students apply the fundamentals and principles of measuring equipments to practical applications using different specimens in industry.
3. To demonstrate the process of grinding on center lathe.
4. Demonstration of force measurement using tool dynamometers.

Course Outcomes

Upon successful completion of the course the students will be able to;

1. **CO1:** Study of various measurement tools will develop understanding of their working principles.
2. **CO2:** Expertise on measuring tools to produce parts of prescribed dimensions.
3. **CO3:** Able to calculate forces developed during machining on various machine tools.
4. **CO4:** Able to avoid accidents during machining by applying proper maintenance schedule.

S. No	Contents (Any ten experiments)	Hours
1	Study of various measuring tools like dial gauge, micrometer, Vernier calliper and telescopic gauges.	
2	Measurement of angle and width of a V-groove by using bevel protector..	
3	(a) To measure a gap by using slip gauges (b) To compare & access the method of small-bore measurement with the aid of spheres.	
4	Measurement of angle by using sine bar.	
5	(a) Measurement of gear tooth thickness by using gear tooth Vernier calliper. (b) To check accuracy of gear profile with the help of profile projector.	
6	To determine the effective diameter of external thread by using three- wire method.	
7	To measure flatness and surface defects in the given test piece with the help of monochromatic check light and optical flat.	
8	To check the accuracy of a ground, machined and lapped surface - (a) Flat surface, (b) Cylindrical surface.	
9	Find out Chip reduction co-efficient (reciprocal of chip thickness ratio) during single point turning.	
10	Cylindrical grinding using grinding attachment in a centre lathe	
11	Forces measurements during orthogonal turning.	
12	Torque and Thrust measurement during drilling.	
13	Forces measurement during plain milling operation.	
14	Measurement of Chip tool Interface temperature during turning using thermocouple technique.	
15	Study of DCC-coordinate measuring machine and exploring few dimensional features of an artefact	
16	To prepare a job using 3 D printing machine.	