ENGINEERING MATHEMATICS – III **[VECTOR CALCULUS, PARTIAL DIFFERENTIAL EQUATIONS and FOURIER ANALYSIS]**								
Code	Category	Periods			Sessional Marks	End Exam Marks	Total Marks	Credits
		L	T	P				
MEC 211	BS	2	1	0	40	60	100	3

Prerequisite: ENGINEERING MATHEMATICS – I, II

Course Objectives: The knowledge of Mathematics is necessary for a better understanding of almost all the Engineering and Science subjects. Here our intention is to make the students acquainted with the concept of basic topics from Mathematics, which they need to pursue their Engineering degree in different disciplines.

Course Outcomes: At the end of the course the student will be able to:	
CO-1	Explain the characteristics of scalar and vector valued functions and provide a physical interpretation of the gradient, divergence, curl and related concepts.
CO-2	Transform line integral to surface integral, surface to volume integral and vice - versa using Green's theorem, Stoke's theorem and Gauss's divergence theorem.
CO-3	Explain analytical methods for solving PDE's like applying separation of variables to solve elementary problems in linear second order partial differential equations (heat and wave equations).
CO-4	Understand the need for a function or its approximation as an infinite Fourier series to represent discontinuous function which occurs in signal processing and electrical circuits.
CO-5	Find different Fourier transforms of non-periodic functions and also use them to evaluate boundary value problems.

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO-1												
CO-2												
CO-3												
CO-4												
CO-5												

Course Outcomes	PSO1	PSO2
CO-1		
CO-2		
CO-3		
CO-4		
CO-5		

CO- Course Outcome; PO- Program Outcome; PSO-Program Specific Outcome; Level- 1: Low, 2: Medium, 3: High

SYLLABUS

UNIT - I	**Periods: 6L+2T=8**

VECTOR DIFFERENTIATION

Scalar and vector point functions – Del applied to scalar point functions – Directional derivative – Del applied to vector point functions – Physical interpretation of divergence and curl – Del applied twice to point functions – Del applied to products of point functions.

Sections: 8.4, 8.5, 8.6, 8.7, 8.8 and 8.9.

UNIT - II	**Periods: 6L+2T=8**

VECTOR INTEGRATION

Integration of vectors – Line integral , circulation, work done – Surface integral , flux – Green's theorem in the plane – Stoke's theorem – Volume integral – Gauss divergence theorem (all theorems without proofs) – Irrotational and solenoidal fields.

Sections: 8.10, 8.11, 8.12, 8.13, 8.14, 8.15, 8.16 and 8.18.

UNIT - III	**Periods: 6L+2T=8**

PARTIAL DIFFERENTIAL EQUATIONS AND THEIR APPLICATIONS

Introduction – Formation of partial differential equations by eliminating arbitrary constants and functions – Solutions of a partial differential equations by direct Integration – Linear equations of the first order (Lagrange's linear equations).

Applications: Method of separation of variables – Vibrations of a stretched string: Wave equation – One dimensional heat flow equation ($\partial u/\partial t=c^{(2)}$ $(\partial^2 u)/(\partial x^2)$), and two dimensional heat flow equation (i.e. Laplace equation : $(\partial^2 u)/(\partial x^2)+(\partial^2 u)/(\partial y^2)=0$).

Sections: 17.1, 17.2, 17.4, 17.5, 18.2, 18.4, 18.5, 18. 6 and 18. 7.

UNIT - IV	**Periods: 6L+2T=8**

FOURIER SERIES

Introduction – Euler's formulae – Conditions for a Fourier expansion – Functions having points of discontinuity – Change of interval – Even and odd functions – Half range series – Parseval's formula.

Sections: 10.1, 10.2, 10.3, 10.4, 10.5, 10.6, 10.7 and 10.9.

UNIT - V	**Periods: 6L+2T=8**

FOURIER TRANSFORMS

Introduction – Definition – Fourier integral theorem(without proof) - Fourier sine and cosine integrals – Fourier transforms – Properties of Fourier transforms – Convolution theorem – Parseval's identity for Fourier transforms – Relation between Fourier and Laplace transforms – Fourier transforms of the derivatives of a function – Applications of transforms to boundary value problems.

Sections: 22.1, 22.2, 22.3, 22.4, 22.5, 22.6, 22.7, 22.8, 22.9 and 22.11.

TEXT BOOKS:	
1.	B. S. Grewal, Higher Engineering Mathematics, 43rd edition, Khanna publishers, 2017.
REFERENCE BOOKS:	
1.	N P. Bali and Manish Goyal, A text book of Engineering mathematics, Laxmi publications,
2.	Erwin Kreyszig, Advanced Engineering Mathematics, 10th edition, John Wiley & Sons, 2011.
3.	R. K. Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, 3rdedition, Alpha
4.	George B. Thomas, Maurice D. Weir and Joel Hass, Thomas, Calculus, 13thedition, Pearson Publishers.

MATERIAL SCIENCE AND METALLURGY								
Code	Category	Periods			Sessional Marks	End Exam Marks	Total Marks	Credits
		L	T	P				
MEC 212	PC	3	0	0	40	60	100	3

Prerequisite: Engineering Chemistry, Engineering Physics

Course Objectives: To give an insight to the student on the fundamentals of materials, their structure, properties, applications and failure mechanisms. Besides, introduce the different heat treatment methods, classify and study ferrous and non-ferrous alloys, composites and basics of Powder Metallurgy

Course Outcomes: At the end of the course the student will be able to:	
CO-1	**Analyse** the fundamental structures of materials and their properties.
CO-2	**Identify** various phases of alloys accompanied with various heat treatment methods.
CO-3	**Classify & explain** various properties and applications of ferrous and non-ferrous alloys and **identify** the properties of various materials based on their composition.
CO-4	**Analyse** the failure of the given component using failure mechanisms.
CO-5	**Identify & synthesize** the composite material and **explain** the principles of powder Metallurgy components.

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO-1	**1**	**2**										
CO-2	**1**	**2**										
CO-3	**1**	**2**				**1**	**1**					
CO-4	**1**	**2**				**1**	**1**					
CO-5	**1**	**2**				**1**	**1**		**1**	**2**		**1**

Course Outcomes	PSO1	PSO2
CO-1	**2**	
CO-2	**2**	
CO-3	**2**	
CO-4	**2**	
CO-5	**2**	

CO- Course Outcome; PO- Program Outcome; PSO-Program Specific Outcome; Level- 1: Low, 2: Medium, 3: High

SYLLABUS

UNIT - I	**Periods: 8L+0T=8**
Engineering Materials & Crystalline Solids:	
Engineering Materials: Properties, Classification of Materials, Necessity of alloying, types of solid solutions, Hume Rotherys rules. **Crystalline Solids:** Unit cells, Crystal systems, Bravais Lattices, Atomic packing factor, Miller Indices for Crystallographic planes and directions. Crystal Defects: point, line and surface defects, Determination of grain size, effect of grain boundaries on the properties of metal/ alloys.	
UNIT - II	**Periods: 10L+0T=10**
Binary Phase Diagrams & Heat treatment of steel:	
Binary Phase Diagrams: Gibbs Phase rule, Lever rule, Invariant reactions, Study of important binary phase diagrams of Cu-Ni-, Al-Cu, Bi-Cd and Fe-Fe_3C. **Heat treatment of steel:** Isothermal transformation curves, Annealing, Normalizing, Hardening, Tempering, Austempering and Martempering of steels, Surface hardening of steels: Carburizing, Nitriding, Cyaniding, Flame and induction hardening methods.	
UNIT - III	**Periods: 10L+0T=10**
Steels and Cast Irons & Non-ferrous metals and alloys	
Steels and Cast Irons: AISI-SAE classification of steel, Structure and properties of plain-carbon steels, low alloy steels, Tool steels, Stainless steels, Types of Cast irons: Grey CI, White CI, Malleable and Spheroidal Graphite irons, Alloy cast irons. **Non-ferrous metals and alloys:** Structure and properties of Copper and its alloys, Aluminium and its alloys, Titanium and its alloys.	
UNIT - IV	**Periods: 10L+0T=10**
Plastic Deformation & Material Failure Mechanisms	
Plastic Deformation: Slip, Twinning, critical resolved shear stress. Strain hardening and other strengthening mechanisms **Material Failure Mechanisms:** Ductile and Brittle fracture, Ductile to Brittle transition, fundamental concepts of creep and fatigue failure, creep curve	
UNIT - V	**Periods: 10L+0T=10**
Composite Materials & Powder Metallurgy	
Composite Materials: Classification, Matrices and reinforcements, polymer matrix composite, ceramic matrix composite and metal matrix composites, Fabrication methods of composites. **Powder Metallurgy:** Principles of Powder Metallurgy Process, Basic steps in Powder Metallurgy, Powder Manufacture, Powder Blending, Powder Compaction, Sintering, Advantages & limitations.	

TEXT BOOKS:	
1.	Introduction to Physical Metallurgy, S.H. Avner, Tata McGraw Hill edition
2.	Material Science and Metallurgy for Engineers, V.D. Kodgire & S.V. Kodgire, Everest Publishing House.
3.	Materials Science and Engineering: An Introduction, William D. Callister Jr., David G. Rethwisch, wiley
4.	Material Science and Engineering, L.H.Van Vleck, 5th edition, Addison Wealey (1985).
REFERENCE BOOKS:	
1.	Structure and Properties of Materials, R.M. Rose, L.A.Shepard and J.Wulff Vol.1, John Willey (1966).
2.	Essentials of Material Science, A.G. Guy ,McGraw-Hill (1976).
3.	Material Science and Engineering, V. Raghavan ,Printice Hall of India
4.	Essential of Materials science and engineering - Donald R.Askeland - Cengage
WEB RESOURCES:	
1.	http://www.edinformatics.com/
2.	http://materials.npl.co.uk/
3.	http://www.wwcomposites.com/

ENGINEERING MECHANICS								
Code	Category	Periods			Sessional Marks	End Exam Marks	Total Marks	Credits
		L	T	P				
MEC 213	PC	2	1	0	40	60	100	3

Prerequisite: Mathematics, Physics.

Course Objectives: To enable the students understand and distinguish different force systems, evaluate the conditions required for their equilibrium, apply the concepts of dry friction, determine the properties of surfaces and solids, distinguish between particle and rigid body mechanics and further apply the principles of dynamics to motion.

Course Outcomes: At the end of the course the student will be able to:	
CO-1	**Determine** the resultant force for the given coplanar and non-coplanar force systems.
CO-2	**Calculate** the forces required to keep the body in equilibrium by considering friction and further **determine** the centroid of plane surfaces and composite areas.
CO-3	**Calculate** the Moment of Inertia of composite sections, mass moment of inertia of regular solids and further **estimate** the forces in a planar truss using the method of joints/sections.
CO-4	**Determine** the kinematic and kinetic parameters of a particle under rectilinear (or) curvilinear translation; and **solve** problems on elastic collision.
CO-5	**Evaluate** the kinematic and kinetic parameters of a rigid body in rotation (or) general plane motion.

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO-1	2	2										
CO-2	2	2										
CO-3	2	2										
CO-4	2	2										
CO-5	2	2										

Course Outcomes	PSO1	PSO2
CO-1	2	
CO-2	2	
CO-3	2	
CO-4	2	
CO-5	2	

CO- Course Outcome; PO- Program Outcome; PSO-Program Specific Outcome; Level- 1: Low, 2: Medium, 3: High

SYLLABUS	
UNIT - I	**Periods: 6L+3T=9**
STATICS	
Statics of Particles: Fundamental concepts and principles- Resultant of coplanar concurrent forces and non-concurrent forces, Principles of superposition and transmissibility. free body diagrams, Equilibrium of particles. Resultant of concurrent forces in space (vector method). **Statics of rigid bodies:** Moment and Couple-Varignon's theorem – Free body diagram Equivalent force and couple – Types of supports and their reactions – Equilibrium of Rigid bodies	
UNIT - II	**Periods: 6L+3T=9**
FRICTION AND CENTROID	
Friction: Laws of static and Dynamic Friction, Cone of friction, Problems on connected bodies, wedges and ladders. **Centroids & Centre of Gravity**: Centroids of lines & areas, C.G of volumes –determination by first principles, Composite areas.	
UNIT - III	**Periods: 6L+3T=9**
MOMENT OF INERTIA AND TRUSSES	
Moment of Inertia: Moment of inertia of an area- Radius of gyration - Parallel and perpendicular axis theorems – Polar moment of inertia - Mass moment of inertia. **Trusses**: Definition of a truss - Simple Trusses - Analysis of planar Trusses - Method of joints- Method of sections.	
UNIT - IV	**Periods: 6L+3T=9**
DYNAMICS OF PARTICLES	
Kinematics of Motion – Rectilinear and Curvilinear motion. Uniform and Non Uniform Motion **Kinetics of Motion** - Newton's laws – D'Alembert's Principle-Work-Energy Equation , Conservative Forces – Impulse and Momentum –Impact of elastic bodies- Impact - direct and central impact – coefficient of restitution.	
UNIT - V	**Periods: 6L+3T=9**
DYNAMICS OF RIGID BODIES	
Rotation of rigid body about fixed Axis, General plane motion –Velocity and Acceleration-Relative Velocity method. Equilibrium of rigid bodies in plane motion- Newton's Laws-D'Alembert's Principle-Work Energy Principle-Principle of impulse momentum for rigid bodies in plane motion. - Simple Harmonic Motion	
TEXT BOOKS:	
1.	Engineering Mechanics by S. Timoshenko and D.H.Young, McGraw-Hill
2.	Engineering Mechanics by S.S.Bhavikatti, New age international publishers
3.	Engineering Mechanics – Statics and Dynamics by A.K.Tayal
4.	Vector Mechanics for Engineers: Statics and Dynamics by Ferdinand P.Beer & E. R. Johnston (9th Edition), Tata McGraw-Hill International Edition.

REFERENCE BOOKS:	
1.	Engineering Mechanics – STATICS by J. L. Meriam and L. G. Kraige, Wiley India
2.	Engineering Mechanics – DYNAMICS by J. L. Meriam and L. G. Kraige, Wiley India
3.	Engineering Mechanics – Statics and Dynamics by Irving Shames, Prentice Hall of
4.	Engineering Mechanics by K.L.Kumar, McGraw-Hill.
WEB RESOURCES:	
1.	https://nptel.ac.in/courses/112/106/112106286/
2.	https://imechanica.org/

MECHANICS OF SOLIDS								
Code	Category	Periods			Sessional Marks	End Exam Marks	Total Marks	Credits
		L	T	P				
MEC 214	PC	2	1	0	40	60	100	3

Prerequisite: Mathematics-I & II

Course Objectives: The objective is to provide the fundamental principles involved in Mechanics of Solids to enable them to apply in the study of advanced subjects. Further the objective is also to make the students understand the effect of forces on deformable bodies under various loading conditions, and thus calculate various types of stresses such as direct stresses, bending stresses, torsional stresses and evaluate deflection of beams.

Course Outcomes: At the end of the course the student will be able to:	
CO-1	**Determine** the principal stresses and strains on an oblique plane for a given structure/mechanical components under complex loading conditions.
CO-2	**Evaluate** the effect of shear force and bending moment on various beams for all types of loading to determine bending stress and shear stresses.
CO-3	**Evaluate** the slope and deflection induced in the beams by using Double integration, Macualay's and Moment Area method.
CO-4	**Determine** the torsional stresses in shafts and further estimate the crippling loads in short and long columns.
CO-5	**Evaluate** the hoop and longitudinal stresses in thin and thick cylinders due to internal and external pressures.

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO-1	2	2							2	2		1
CO-2	2	2							2	2		1
CO-3	2	2							2	2		1
CO-4	2	2							2	2		1
CO-5	2	2	1						2	2		1

Course Outcomes	PSO1	PSO2
CO-1	2	0
CO-2	2	0
CO-3	2	0
CO-4	2	0
CO-5	2	0

CO- Course Outcome; PO- Program Outcome; PSO-Program Specific Outcome;Level- 1: Low, 2: Medium, 3: High

SYLLABUS	
UNIT - I	**Periods: 8L+4T=12**
UNIT TITLE: STRESSES AND STRAINS	
Stress – Strain, Stress Strain diagram for ductile and brittle materials, Poisson's ratio, Elastic constants and their relationship, Generalized Hook's law, Factor of safety, Strain energy, Impact loading, Deformation of simple, compound bars and tapered bar of uniform circular cross section. Thermal stresses, Stresses on an inclined plane under uni-axial, bi-axial, pure shear & combined loading, principal stresses & strains, Mohr's circle for plane stresses.	
UNIT-II	**Periods: 6L+3T=9**
UNIT TITLE: ANALYSIS OF BEAMS	
Types of beams and loads, Shear Force and Bending Moment diagrams for cantilever, simply supported and over hanging beams, Theory of pure bending, flexural formula, shear stress distribution in beams (rectangle, circular, I & T sections).	
UNIT - III	**Periods: 6L+3T=9**
UNIT TITLE: DEFLECTION OF BEAMS	
Relation between curvature, slope and deflection, deflection of simply supported, cantilever and overhanging beams by double integration method, Macaulay's method, moment area method-application to simple cases.	
UNIT - IV	**Periods: 6L+3T=9**
UNIT TITLE: TORSION AND COLUMNS	
Introduction to pure torsion, torsional formula, torsion of circular and hollow shafts. Theory of columns – long and short columns, Euler's theory, crippling load, Rankine's theory.	
UNIT - V	**Periods: 6L+3T=9**
UNIT TITLE: THIN & THICK CYLINDERS	
Stress & Strains in thin cylinders & spherical shells. Introduction to thick cylinder –Lame's equation, cylinder subjected to internal and external pressures.	
TEXT BOOKS:	
1.	"A Text Book of Strength of Materials", R.K. Bansal, Lakshmi Publications Pvt. Ltd., New Delhi
2.	Strength of materials, R.K. Rajput, S. Chand Ltd. Publications.
REFERENCE BOOKS:	
1.	Mechanics of Materials, Gere & Timoshenko, CBS Publishers.
2.	Strength of Materials, S.S. Ramamrutham & R, Narayanan, Dhanpat Rai publications.
3.	Strength of Materials, Dr. Sadhu Singh, Khanna Publications
4.	"Engineering Mechanics of solids" Egor P. Popov, Second edition, Prentice hall of India Pvt. Ltd, New Delhi.
5.	Mechanics of materials, Jhonston Beer and Mazurek Dewol 6th Edition

WEB RESOURCES:	
1.	http://nptel.ac.in/courses/Webcourse-contents/IIT-ROORKEE/strength%20of%20materials/homepage.htm
2.	http://www.aboutcivil.org/solid-mechanics.html
3.	http://web.mit.edu/emech/dontindex-build/
4.	http://web.aeromech.usyd.edu.au/AMME2301/Documents/
5.	http://www.faadooengineers.com/threads/9673-Mechanics-of-Solids-Lecture-Notes-Pdfs-Full-Notes-All-Units-Download
6.	http://www.ijee.ie/OnlinePapers

BASIC THERMODYNAMICS								
Code	Category	Periods			Sessional Marks	End Exam Marks	Total Marks	Credits
		L	T	P				
MEC 215	PC	2	1	0	40	60	100	3

Prerequisite: Engineering Physics - I

Course Objectives: To provide the student with a simplistic and practical approach to the fundamental subject of thermodynamics and create an interest and intuitive understanding of the nuances of this core subject which deals with energy and its different forms and to solve any real time engineering problems.

Course Outcomes: At the end of the course the student will be able to:	
CO-1	Classify thermodynamic systems & analyze the interaction between system & surroundings.
CO-2	Apply the first law of thermodynamics to both flow & non flow processes and evaluate the energy interactions between system & surroundings
CO-3	Apply the second law of thermodynamics and evaluate efficiency of Heat engine and COP of Refrigerator & Heat pump
CO-4	**Assess** the entropy generation & Exergy destruction in a thermodynamic process.
CO-5	Evaluate the properties of gas and gas mixture.

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO-1	**2**	**2**										
CO-2	**2**	**2**										
CO-3	**2**	**2**										
CO-4	**2**	**2**					1					
CO-5	**2**	**2**										

Course Outcomes	PSO1	PSO2
CO-1	-	-
CO-2	-	-
CO-3	-	-
CO-4	-	-
CO-5	-	-

CO- Course Outcome; PO- Program Outcome; PSO-Program Specific Outcome; Level- 1: Low, 2: Medium, 3: High

SYLLABUS

UNIT - I	**Periods: 6L+1T=7**

Basic Concepts

System, Control Volume, Surrounding, Boundaries, Universe, Types of Systems, Macroscopic and Microscopic viewpoints, Concept of Continuum, Thermodynamic Equilibrium, State, Property, Process, Cycle, Quasi – static Process, Energy in State and in Transition, Work and Heat, Path and Point functions.

UNIT - II	**Periods: 6L+3T=9**

Zeroth and First law

Zeroth Law of Thermodynamics – Concept of equality of Temperature –Reference Points – PMM I - Joule's Experiments – First law of Thermodynamics – Corollaries – First law applied to a Non-flow processes and flow process, Heat and Work Transfer, changes in Internal Energy and enthalpy– Steady Flow Energy Equation, throttling & free expansion processes. Limitations of the First Law.

UNIT - III	**Periods: 6L+3T=9**

Second law

Thermal Reservoir, Heat Engine, Heat pump, Parameters of performance, Second Law of Thermodynamics, Kelvin-Planck and Clausius Statements and their Equivalence, Corollaries, PMM-II, Carnot's principle, Reversibility and Irreversibility, Causes of Irreversibility, Carnot cycle, Carnot theorem, Corollary of Carnot theorem, second law efficiency.

UNIT - IV	**Periods: 6L+5T=11**

Entropy and Exergy

Clausius theorem, Entropy-a property, Clausius Inequality, Principle of Entropy Increase, Application of entropy principle. Availability and Irreversibility –Quality of energy, Dead state, Availability in non-flow & flow processes, Gouy–stodola equation, Gibbs and Helmholtz Functions, Maxwell Relations, general expression for C_p and C_v.

UNIT - V	**Periods: 6L+3T=9**

Perfect Gas & Gas mixtures

Unit contents Equation of State, Characteristic and Universal Gas constants — Deviations from perfect Gas Model – Vander Waals Equation of State. Gas mixtures-Daltons law and Gibbs-Dalton law, apparent molecular weight and gas constant, specific heats of gas mixture, volumetric & gravimetric analysis of gas mixtures, adiabatic mixing of perfect gases.

TEXT BOOKS:

1.	Engineering Thermodynamics- P.K.Nag ,Tata McGraw Hill publication. 6th edition, 2017.
2.	Engineering Thermodynamics- Cengel & Boles,TMH publications. 8th edition, 2017.

REFERENCE BOOKS:	
1.	Thermal Science & Engineering by Dr.D.S.Kumar ,S.K.Kataria & sons publication
2.	Thermal Engineering by R.K.Rajput , S.Chand & Co.
WEB RESOURCES:	
1.	http://nptel.ac.in/courses/112108148/
2.	http://nptel.ac.in/courses/112105123/

MANUFACTURING PROCESSES								
Code	Category	Periods			Session Marks	End Exam Marks	Total Marks	Credits
		L	T	P				
MEC216	PC	3	0	0	40	60	100	3

Prerequisite: None

Course Objectives: To familiarize the students with the basics of primarymanufacturing processes like casting, welding, bulk metal and sheet metal forming and to impart knowledge of additive manufacturing.

Course Outcomes: At the end of the course the student will be able to:	
CO-1	**Explain** casting process, **identify** different types of patterns and **evaluate** gating system design
CO-2	**Differentiate** various casting processes and **identify** the casting defects.
CO-3	**Distinguish** welding processes and **analyze** different weld defects.
CO-4	**Illustrate** various bulk metal forming processes and **categorize** various sheet metal operations
CO-5	**Interpret** additive manufacturing and **compare** different Additive Manufacturing processes.

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO-1	2	1						1	1	1		1
CO-2	1	1						1	1	1		1
CO-3	2	1						1	1	1		1
CO-4	1	1						1	1	1		1
CO-5	1	1						1	1	1		1

Course Outcomes	PSO1	PSO2
CO-1	2	
CO-2	1	
CO-3	2	
CO-4	1	
CO-5	1	

CO- Course Outcome; PO- Program Outcome; PSO-Program Specific Outcome;Level- 1: Low, 2: Medium, 3: High

SYLLABUS	
UNIT – I	**Periods: 9L**

Casting

Sand casting-procedure, Pattern-its types, materials, allowances, Basic problems on pattern allowances, Moulding sands-properties and types of moulds, Sand mould making machines, Sand properties testing procedures, Gating system, it's design and characteristics, Gating ratio-problems. Riser-types & design methods - problems on riser design, directional solidification in casting, Core materials and core making, Types of core sands.

UNIT – II	**Periods: 9L**

Melting furnaces and Special Casting processes

Melting furnaces: Blast, cupola, electric arc and electro-magnetic induction furnaces.

Special casting processes: Permanent mould casting processes– Die casting, Shell casting and Centrifugal casting processes, Investment casting, vacuum sealed casting, Continuous casting processes. Advantages, limitations and applications of each casting process, Fettling and finishing of castings, Casting defects, Inspection and Non Destructive Testing.

UNIT – III	**Periods: 12L**

Metal Joining processes

Welding – Introduction, Terminology, Types of weld joints, Weld positions, Oxyacetylene Gas welding and Gas cutting, Arc welding - principle and processes (MMAW, TIG, GMAW, SAW and PAW), Types of metal transfer in GMAW, Basic problems on duty cycle and number of passes, Resistance welding (spot, seam, projection, upset and flash welding techniques) and problems on heat generation. Solid state welding processes (Friction welding, Friction stir welding and Explosion welding), Weld defects –causes and remedies, Inspection and testing. Brazing, Soldering and Braze welding and their applications.

UNIT – IV	**Periods: 9L**

Metal forming processes

Bulk metal forming processes: Elastic and plastic deformation, Concept of strain hardening, Hot working and cold working. Rolling – Principle, Rolling pass sequence, Forging – Principle, Forging operations–Different types of Forging. Extrusion- its types, hydrostatic, impact, cold forging extrusion processes, Wire, Rod and Tube drawing, Rotary swaging.

Sheet metal forming : Shearing, Deep-drawing, Bending, Squeezing, Press working and its classification, Types of dies, Press tool operations – Cutting operations (blanking, punching, notching etc.) and Shaping operations (embossing, coining, spinning, stretch forming etc.), High Energy rate forming processes, Principles of explosive forming and electromagnetic

UNIT – V	**Periods: 9L**
Introduction to Additive manufacturing:	
Introduction to Rapid Prototyping, Traditional Manufacturing vs Additive Manufacturing (AM), Additive Manufacturing Technology (AMT) in product development-Need, Applications in various fields, Introduction to different AM techniques based on materials (liquid based, powder based and solid based) – AM Tooling – Applications, Pre and post processing of AM parts.	
TEXT BOOKS:	
1.	Manufacturing Engineering & Technology, Serope Kalpak Jian, Steven R. Schmid, 7th Edition (2018), Pearson Education Publications.
2.	Manufacturing Technology - Volume-I, P.N. Rao, 5th Edition (2018), Tata McGraw-Hill Publications.
3.	Production Technology- Volume-I, R.K. Jain, 19th Edition (2020),Khanna Publications.
4.	Additive Manufacturing Technologies. Gibson, I., Rosen, D., Stucker, B., Khorasani, M., 3rd Edition (2021), Springer publication.
REFERENCE BOOKS:	
1.	Materials and Processes in Manufacturing, De Garmo, Black and Kohsen, 13th Edition (2019), Prentice Hall of India.
2.	Manufacturing Science ,AmithabaGhosh and Asok Kumar Mallik, 2nd Edition (2010), East West Press Pvt. Ltd.
3.	Additive Manufacturing Technologies. Rapid Prototyping to Direct Digital Manufacturing, Ian Gibson, David W.Rosen, Brent Struker, 1st edition (2010),Springer publication.
WEB RESOURCES:	
1.	https://nptel.ac.in/courses/112/107/112107144/
2.	https://nptel.ac.in/courses/110/106/110106146/

MECHANICS OF SOLIDS LAB								
Code	Category	Periods			Sessional Marks	End Exam Marks	Total Marks	Credits
		L	T	P				
MEC 217	PC	0	0	3	50	50	100	1.5

Course Objectives: The objective of the lab is to enable the students to observe and determine the response of the material under different loads and measure the mechanical properties of materials such as tensile strength, compressive strength, impact strength, hardness, stiffness, modulus of rigidity, and modulus of elasticity.

Further, the student gains knowledge to use appropriate material for a required application in civil, automotive, aerospace, and other industries

Course Outcomes: At the end of the course the student will be able to:	
CO-1	**Measure** and **analyse** the various properties of materials under Tensile/Compressive/Shear and Bending loads using Universal testing machine.
CO-2	**Determine** the Modulus of rigidity of a given material using Torsion and Spring testing equipment's.
CO-3	**Determine** the energy absorbed by a ductile material using impact testing machine.
CO-4	**Determine** the Hardness of ferrous and non-ferrous materials using Brinell, Rockwell and Vickers hardness testing machines.
CO-5	**Determine** the Modulus of Elasticity of mild steel and wood using simply supported and cantilever set-up arrangements.

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO-1	2	1		1				1		2		1
CO-2	2	1		1				1		2		1
CO-3	2	1		1				1		2		1
CO-4	2	1		1				1		2		1
CO-5	2	1		1				1		2		1

Course Outcomes	PSO1	PSO2
CO-1	1	1
CO-2	1	1
CO-3	1	1
CO-4	1	1
CO-5	1	1

CO- Course Outcome; PO- Program Outcome; PSO-Program Specific Outcome; Level- 1: Low, 2: Medium, 3: High

LIST OF EXPERIMENTS (Any 10)

S.NO	NAME OF THE EXPERIMENT	COURSE OUTCOME
1	Calculate Young's modulus , Ultimate strength, Breaking strength, Yield strength , Percentage elongation and Percentage reduction in area for mild steel specimen using universal testing machine	CO1
2.	Determine Compressive strength of wood by using universal testing machine	CO1
3.	Calculate modulus of rigidity of given mild steel specimen using torsion testing machine	CO2
4.	Calculate modulus of rigidity of given helical coil spring wire using Spring testing machine	CO2
5	Determine Impact strength of the given mild steel specimen using Impact testing machine.	CO3
6	Determination of Brinell hardness number by using Brinell hardness testing machine.	CO4
7	Determination of Rockwell hardness number by using Rockwell hardness testing machine.	CO4
8.	Determination of Vickers hardness number by using vickers hardness testing machine.	CO4
9	Determine modulus of elasticity of given mild steel bar, simply supported at the ends.	CO5
10.	Determine modulus of elasticity of given wooden bar, simply supported at the ends.	CO5
11	Determine modulus of elasticity of given mild steel bar, supported like a cantilever.	CO5
12	Determine modulus of elasticity of given wooden bar, supported like a cantilever.	CO5
13	Determine shear strength of the given mild steel specimen by performing shear test using Universal Testing Machine.	CO1
14	Determine bending stress induced in the given mild steel specimen by performing bending test using Universal Testing Machine	CO1

MANUFACTURING LAB								
Code	Category	Periods			Sessional Marks	End Exam Marks	Total Marks	Credits
		L	T	P				
MEC 218	PC	0	0	3	50	50	100	1.5

Course Objective: To demonstrate manual arc welding and spot welding through the practice of fabricating various weld joints. The course also gives an opportunity to the student in preparing moulds for different patterns and further for determining the characteristics of moulding sand.

Course Outcomes: At the end of the course the student will be able to:	
CO-1	**Prepare** sand mould & castings for different patterns.
CO-2	**Evaluate** the properties of moulding sand to check its suitability.
CO-3	**Produce** a spectrum of weld joints by using manual arc welding and spot welding processes.

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO-1	1		2					2		3		
CO-2	1			3				2		3		
CO-3	1		2					2		3		

Course Outcomes	PSO1	PSO2
CO-1	1	
CO-2	1	2
CO-3	1	

CO- Course Outcome; PO- Program Outcome; PSO-Program Specific Outcome; Level- 1: Low, 2: Medium, 3: High

List of Experiments

S.No.	Name of the Experiment	CO
1	Preparation of sand mould for solid flange	CO-1
2	Preparation of sand mould for stepped cone pulley	CO-1
3	Preparation of sand mould for hollow pipe	CO-1
4	Moisture content test	CO-2
5	Clay content test	CO-2
6	Green compression and Shear Strength test	CO-2
7	Sieve analysis	CO-2
8	V-Butt joint using manual metal arc welding	CO-3
9	Corner weld joint using manual metal arc welding	CO-3
10	Double lap weld joint using manual metal arc welding	CO-3
11	Lap joint using Spot welding equipment	CO-3

REFERENCE BOOKS:

1. Manufacturing Technology, P.N.Rao, Mc Graw-Hill Book Company

ENGINEERING MATHEMATICS – IV **[COMPLEX VARIABLES, PROBABILITY & SAMPLING]**								
Code	Category	Periods			Sessional Marks	End Exam Marks	Total Marks	Credits
		L	T	P				
MEC 221	BS	2	1	0	40	60	100	3

Prerequisite: Complex Numbers, Differentiation, Integration, Binomial expansions and

Course Objectives: The knowledge of Mathematics is necessary for a better understanding of almost all the Engineering and Science subjects. Here our intention is to make the students acquainted with the concept of basic topics from Mathematics, which they need to pursue their Engineering degree in different disciplines.

Course Outcomes: At the end of the course the student will be able to:	
CO-1	Analyze limit, continuity and differentiation of functions of complex variables and understand Cauchy-Riemann equations, analytic functions and various properties of analytic functions.
CO-2	Understand Cauchy's theorem and Cauchy's integral formulas and apply these to evaluate complex contour integrals and represent functions as Taylor and Laurent series and determine their intervals of convergence.
CO-3	Be familiar with numerical solution of ordinary differential equations.
CO-4	Examine, analyze and compare Probability distributions.
CO-5	Analyze the Statistical data by using statistical tests and to draw valid inferences about the population parameters.

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO-1												
CO-2												
CO-3												
CO-4												
CO-5												

Course Outcomes	PSO1	PSO2
CO-1		
CO-2		
CO-3		
CO-4		
CO-5		

CO- Course Outcome; PO- Program Outcome; PSO-Program Specific Outcome; Level- 1: Low, 2: Medium, 3: High

SYLLABUS

UNIT - I	**Periods: 6L+2T=8**

FUNCTIONS OF A COMPLEX VARIABLE:

Complex function – Real and imaginary parts of complex function – Limit – Continuity and derivative of a complex function – Cauchy-Riemann equations – Analytic function – E ntire function – Singular point – Conjugate function – Cauchy-Riemann equations in polar form – Harmonic functions – Milne-Thomson method – Simple applications to flow problems – Applications to flow problems – Some standard transformations(Translation, Inversion and Reflection , Bilinear transformations and its fixed points).

Sections: 20.1, 20.2, 20.3, 20.4, 20.5, 20.6 and 20.8.

UNIT - II	**Periods: 6L+2T=8**

COMPLEX INTEGRATION & SERIES OF COMPLEX TERMS:

Complex integration – Cauchy's theorem – Cauchy's integral formula – Series of complex terms: Taylor's series, MaClaurin's series expansion, and Laurent's series (without proofs).

Sections: 20.12, 20.13, 20.14 and 20.16.

UNIT - III	**Periods: 6L+2T=8**

NUMERICAL SOLUTIONS OF ORDINARY DIFFERENTIAL EQUATIONS :

Picard's method – Taylor's series method – Euler's method – Runge-Kutta Method – Predictor - Corrector methods – Milne's method.

Sections: 32.1, 32.2, 32.3, 32.4, 32.7, 32.8 and 32.9

UNIT - IV	**Periods: 6L+2T=8**

PROBABILITY AND DISTRIBUTIONS:

Introduction – Basic terminology – Probability and set notations – Addition law of probability – Independent events – Baye's theorem – Random variable – Discrete probability distribution: Binomial distribution – Continuous probability distributions: Poisson distribution and normal distribution (mean , variance , standard deviation and their properties without proofs).

Sections: 26.1, 26.2, 26.3, 26.4, 26.5, 26.6, 26.7, 26.8, 26.9, 26.14, 26.15 and 26.16.

UNIT - V	**Periods: 6L+2T=8**

SAMPLING THEORY:

Introduction – Sampling distribution – Testing a hypothesis – Level of significance – Confidence limits – Test of Significance of large samples (Test of significance of single mean, difference of means) – Confidence limits for unknown mean – Small samples – Students t-distribution – Significance test of a sample mean – Significance test of difference between sample means – chi square test – Goodness of fit.

Sections: 27.1, 27.2, 27.3, 27.4, 27.5, 27.11, 27.12,27.13, 27.14, 27.15, 26.16, 27.17 and 27.18.

TEXT BOOKS:	
1.	B. S. Grewal, Higher Engineering Mathematics, 43rd edition, Khanna publishers, 2017.
REFERENCE BOOKS:	
1.	N P. Bali and Manish Goyal, A text book of Engineering mathematics, Laxmi publications,
2.	Erwin Kreyszig, Advanced Engineering Mathematics, 10th edition, John Wiley & Sons, 2011.
3.	R. K. Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, 3rdedition, Alpha
4.	George B. Thomas, Maurice D. Weir and Joel Hass, Thomas, Calculus, 13thedition, Pearson Publishers.

BASIC ELECTRICAL ENGINEERING								
Code	Category	Periods			Sessional Marks	End Exam Marks	Total Marks	Credits
		L	T	P				
MEC 222	ES	2	1	-	40	60	100	3

Prerequisite: Basic fundamental knowledge of electricity.

Course Objectives: To acquaint the students with the analysis of circuits by using KCL & KVL, operation and applications of DC & AC machines.

Course Outcomes: At the end of the course the student will be able to:	
CO-1	**Solve** voltage across, current through and power supplied / absorbed by an electrical element.
CO-2	**Analyze** the behavior of the magnetic circuits.
CO-3	**Determine** the performance characteristics of D.C. generator.
CO-4	**Identify** the type of electrical DC motor used for that particular application.
CO-5	**Apply** the requirement of AC machines in power generation, transmission and distribution of electric power and other applications.

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO-1	2	3	1	3	2	1	1	-	-	-	2	1
CO-2	2	3	1	3	2	1	1	-	-	-	2	1
CO-3	2	3	1	3	2	1	1	-	-	-	2	1
CO-4	2	3	1	3	2	1	1	-	-	-	2	1
CO-5	2	3	1	3	2	1	1	-	-	-	2	1

Course Outcomes	PSO1	PSO2
CO-1	1	-
CO-2	1	-
CO-3	2	-
CO-4	2	-
CO-5	2	-

CO- Course Outcome; PO- Program Outcome; PSO-Program Specific Outcome; Level- 1: Low, 2: Medium, 3: High

SYLLABUS	
UNIT – I	**Periods: 6L+3T=9**
UNIT TITLE: ELECTRICAL CIRCUITS	
Circuit Elements, Basic Law's, KVL, KCL, Linearity Principle (Super Position), Mesh and Nodal analysis, Thevenin's and Norton's theorems.	
UNIT – II	**Periods: 6L+3T=9**
UNIT TITLE: MAGNETIC CIRCUITS	
Definitions of magnetic circuit, Reluctance, Magneto-motive force, magnetic flux, Simple problems on magnetic circuits. Faraday's laws of Electromagnetic Induction, Induced E.M.F., Dynamically induced E.M.F., Statically induced EMF, Self-Inductance and Mutual Inductance	
UNIT – III	**Periods: 6L+3T=9**
UNIT TITLE: D.C. MACHINES	
Working principle of D.C. Generator, construction of D.C. generator, E.M.F equation of D.C. generator, Types of D.C. generators, Efficiency, working of D.C. Motors, significance of back E.M.F., Torque equation of D.C. Motors.	
UNIT – IV	**Periods: 6L+3T=9**
UNIT TITLE: TRANSFORMERS	
Working Principle of Transformer, EMF equation of transformer, Losses, Efficiency and regulation of Transformer, OC and SC tests.	
UNIT – V	**Periods: 6L+3T=9**
UNIT TITLE: A. C. MACHINES	
Working Principle of Induction Motor, Torque Equation, Slip-Torque Characteristics, Working Principle of Alternator, Voltage Regulation by EMF method.	
TEXT BOOKS:	

1.	V.K. MEHTA &ROHIT MEHTA Principles of Electrical Engineering S. Chand Publications 2nd edition.
2.	Principles of Electrical and Electronics Engineering by V. K. Mehta, S. Chand& Co.
REFERENCE BOOKS:	
1.	Electrical and Electronics Technology- E. Hughes PSN Publ.
2.	J.B. Gupta A Text book of Electrical Engineering, S.K. Kataria& Sons Publications.
WEB RESOURCES:	
1.	https://www.electrically4u.com/electrical-books/
2.	https://circuitglobe.com/

APPLIED THERMAL ENGINEERING-1								
Code	Category	Periods			Sessional Marks	End Exam Marks	Total Marks	Credits
		L	T	P				
MEC 223	**PC**	2	1	-	40	60	100	3

Prerequisite: Engineering Mathematics, Engineering Mechanics, Basic Thermodynamics

Course Objectives: To acquaint the student with the fundamentals of pure substance, property variation due to phase change and apply these basics in the study of vapor power cycles, refrigeration cycles and thermal power plant equipment's like turbines and condensers.

Course Outcomes: At the end of the course the student will be able to:	
CO-1	**Identify** the phase change process of a pure substance on property plots and **determine** the steam properties using steam table and mollier chart.
CO-2	**Analyze** the working of a simple vapour cycle and further **apply** thermodynamic techniques to enhance its performance.
CO-3	**Distinguish** the various classes of nozzles and condensers, **evaluate** their performance and further **select** suitable nozzle or condenser for specific application.
CO-4	**Compare** the functioning of different classes of steam turbines, compounding techniques and also **evaluate** their performance.
CO-5	**Distinguish** the various refrigeration cycles and **analyze** their performance and further explain psychometric terms, processes and different air conditioning systems.

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO-1	1	1							1	2		1
CO-2	2	2							1	2		1
CO-3	2	2							1	2		1
CO-4	2	2							1	2		1
CO-5	2	2				1	1		1	2		1

Course Outcomes	PSO1	PSO2
CO-1		
CO-2		
CO-3		
CO-4		
CO-5		

CO- Course Outcome; PO- Program Outcome; PSO-Program Specific Outcome; Level- 1: Low, 2: Medium, 3: High

. **SYLLABUS**	
UNIT - I	**Periods: 6L+3T=9**
Properties of Pure Substance:	
Definition of pure substance, phase change of a pure substance, property diagrams for phase change process- T-v, p-v, p-T, T-s, h-s (Mollier diagram), p-v-T surface of pure substance, formation of steam, terms relating to steam formation, external work done during evaporation, internal latent heat, internal energy of steam, entropy of steam, thermodynamic process of steam-isobaric and isentropic processes only, determination of dryness fraction-throttling calorimeter, separating and throttling calorimeter	
UNIT - II	**Periods: 6L+3T=9**
Vapor Power Cycles:	
Simple steam power cycle, Rankine cycle, steam rate, heat rate and thermal efficiency, actual vapor cycle process, comparison of Rankine – Carnot cycles mean temperature of heat addition, methods for improving efficiency of Rankine cycle - reheat cycle, regenerative cycle, reheat-regenerative cycle, feed water heaters, characteristics of ideal working fluid.	
UNIT - III	**Periods: 6L+3T=9**
Steam Nozzles & Steam Condensers:	
Steam Nozzles: Types of nozzles- Flow through nozzles- Condition for maximum discharge- Nozzle efficiency- Super saturated flow in nozzles- Relationship between area velocity and pressure in nozzle flow- Under expansion & over expansion. **Steam Condensers:** Introduction, vacuum, Classification of condensers-Jet and surface condensers, Sources and effects of air leakage in condensers, Vacuum efficiency and Condenser efficiency, Determination of mass of cooling water.	
UNIT - IV	**Periods: 6L+3T=9**
Steam Turbines:	
Introduction, classification of steam turbines, compounding of turbines. **Impulse Turbines**: Velocity diagrams and performance parameters, condition for maximum blade efficiency for single stage impulse turbine, velocity diagram for velocity compounded impulse turbine. **Reaction Turbines**: Velocity diagram, degree of reaction, Parson's reaction turbine, condition for maximum blade efficiency of Parson's turbine.	

UNIT - V	**Periods: 8L+4T=12**

Refrigeration & **Psychometry and air-conditioning**:

Refrigeration: Fundamentals of refrigeration, refrigeration systems, Coefficient of performance, standard rating of refrigeration, air refrigeration systems- closed and open systems, reversed Carnot cycle, Bell-collema cycle, vapor compression refrigeration system,T-s, p-h diagrams, factors effecting performance of vapor compression refrigeration system, simple Vapor absorption refrigeration system, properties of common refrigerants.

Psychometry and air-conditioning: Psychometric terms, psychometric chart and psychometric processes, description of Summer, Winter and year around air conditioning systems.

TEXT BOOKS:

1.	R. K. Rajput, Thermal Engineering 10th edition, Laxmi publication (P) Ltd. 2017.
2.	P. K. Nag, Basic and Applied Thermodynamics 2nd edition, Tata McGraw Hill

REFERENCE BOOKS:

1.	Yunus A. Cengel and Michael A. Boles, Thermodynamics, An Engineering approach 8th edition, Tata McGraw Hill Education (P) Ltd. 2015.
2.	G.Rogers and Mahew ,EngineeringThermodynamics,Work& Heat transfer 4thedition,Pearsons education India(P)Ltd.2002.
3.	Thermodynamics and Heat Engines volume 2-R.Yadav-Central book depot.

WEB RESOURCES:

1.	http://nptel.ac.in/courses/112105123/
2.	http://nptel.ac.in/courses/112104117
3.	http://nptel.ac.in/downloads/112105129/

KINEMATICS OF MACHINERY								
Code	Category	Periods			Sessional Marks	End Exam Marks	Total Marks	Credits
		L	T	P				
MEC 224	PC	2	1	0	40	60	100	3

Prerequisite: Engineering Mechanics

Course Objectives:
To acquaint the students with the fundamentals of mechanisms and their kinematic analysis (graphical, analytical & computational). Further this study is extended to specific applications like steering mechanisms, Hooke's joint, cams, gears and gear trains.

Course Outcomes: At the end of the course the student will be able to:	
CO-1	**Identify** the kinematic pairs & evaluate the mobility of a planar mechanism and further describe the inversions of 4-bar chain, single-slider and double slider crank chains.
CO-2	**Analyze** the given planar mechanism to **calculate** the kinematic parameters by Instantaneous centre, Relative velocity & Complex algebraic methods and further **write** the code for the above to plot the kinematic parameters.
CO-3	**Analyze** applications of mechanisms with lower pairs like straight line mechanisms, steering mechanisms, copier mechanism & Hooke's joint and further **calculate** the kinematic parameters of slider crank mechanism by Approximate analytical method.
CO-4	**Draw** cam profiles based on the prescribed motion of the follower and **calculate** the kinematic parameters of the follower for cams with specified contour.
CO-5	**Calculate** all the gear parameters related to spur gear, and **determine** the speed & torques in epicyclic gear trains using tabulation method.

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO-1	2	1										
CO-2	3	2										
CO-3	3	3			1							
CO-4	3	1										
CO-5	3	1										

Course Outcomes	PSO1	PSO2
CO-1	1	
CO-2	2	
CO-3	3	1
CO-4	1	
CO-5	1	

CO- Course Outcome; PO- Program Outcome; PSO-Program Specific Outcome; Level- 1: Low, 2: Medium, 3: High

SYLLABUS

UNIT - I	**Periods: 8L+4T=12**

BASICS OF MECHANISMS :

Classification of mechanisms – Basic kinematic concepts and definitions – Degree of freedom, Mobility – Kutzbach criterion, Gruebler's criterion – Grashof's Law – Kinematic inversions of four-bar chain, slider crank chain and double slider crank chain – Limit positions – Mechanical advantage – Transmission Angle.

UNIT - II	**Periods: 6L+3T=9**

KINEMATIC ANALYSIS OF MECHANISMS

Velocity & Acceleration Analysis by Relative Velocity Method:
Velocity and acceleration analysis of simple planar mechanisms, Angular velocity and angular acceleration of links, velocity of rubbing, Corioli's component of acceleration.

Velocity Analysis by Instantaneous Center Method:
Definition, Kennedy's theorem, Determination of linear and angular velocity using instantaneous center method, Body centrode and Space centrode.

Only for internal assessment:
Computer aided Kinematic Analysis of four bar and slider crank mechanisms - Velocity and acceleration analysis (complex algebra method).

UNIT - III	**Periods: 6L+3T=9**

LOWER PAIRS

Lower Pairs:-Pantograph – straight line motion mechanisms –Peaucellier mechanism-Watt mechanism. Steering Gear mechanisms-Condition for correct steering-Working principle of Davis & Ackerman's steering gear mechanisms.

Hooke's joint: Ratio of shaft velocities – maximum and minimum speed of driven shaft – condition for equal speeds – Angular acceleration of driven shaft – Double Hooke's joint.

Approximate Analytical Method of Slider Crank Mechanism:
Approximate Analytical Method for Velocity and Acceleration of the Piston & angular velocity and angular acceleration of the connecting rod of reciprocating engine mechanism.

UNIT - IV	**Periods: 6L+3T=9**

HIGHER PAIRS

Higher Pairs:-Classification of cams & followers – terms used in radial cams – displacement, velocity and acceleration diagrams when the follower moves with uniform velocity, uniform acceleration and retardation, simple harmonic motion – construction of cam profiles for radial and offset reciprocating follower (Knife edge, Roller and Flat face). Cams with specified contours – Tangent cam with roller follower

UNIT - V	**Periods: 6L+3T=9**
GEARS & GEAR TRAINS	
Gears: Classification of toothed wheels – terms used in gears - law of gearing – velocity of sliding of teeth – forms of teeth – Cycloidal and involute teeth– length of path of contact-arc of contact– contact ratio- interference in involute teeth - minimum number of teeth to avoid interference, Undercutting. **Gear trains:-**Simple, compound and reverted gear trains – epicyclic gear train – velocity ratio of epicyclic gear train-sun and planet wheels – torques in epicyclic gear train- Automobile Differential.	

TEXT BOOKS:	
1.	Rattan S.S, *Theory of Machines*, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 4th Edition, 2014.
2.	R.S.Khurmi & J.K.Gupta, *Theory of Machines*, S Chand & CO Ltd Publisher, 14th edition.

REFERENCE BOOKS:	
1.	Thomas Bevan, *Theory of Machines*, CBS Publishers & Distributors, New Delhi, 3rd edition.
2.	Ambekar A. G., *Mechanism and Machine Theory*, PHI, 2009.
3.	Shigley J. E. and John Joseph Uicker, Theory of Machines and Mechanisms, McGraw-Hill international edition, 2nd edition.

METAL CUTTING, MACHINE TOOLS & METROLOGY								
Code	Category	Periods			Sessional Marks	End Exam Marks	Total Marks	Credits
		L	T	P				
MEC 225	PC	3	0	0	40	60	100	3

Prerequisite: Manufacturing Processes, Material Science/Metallurgy, Physics, Chemistry

Course Objectives:

To make the students acquainted with the basic concepts of metal cutting, tool nomenclature, standards and tool performance.

Further giving them an overall idea of constructional features of different machine tools such as lathe,drilling, milling, shaping and grinding and parameters related to the machining processes.

The course further deals with basics of Measurements, Metrology, Measuring devices and the concepts of various measurement systems & standards with regards to realistic applications.

Course Outcomes: At the end of the course the student will be able to:	
CO-1	Apply the basics of engineering in computing the cutting parameters, stress, strain, velocity and forces and identify the types of chips in machining process, evaluate tool-life and compute machining time and cost estimations.
CO-2	Explain the geometry of a single and multi point cutting tools, distinguish different machine tools – their kinematic systems and operations and further demonstrate the application of various tool and work holding devices.
CO-3	Identify various surface finishing operations applicable for work-pieces to meet the required design specifications.
CO-4	Select suitable measuring device/gauge or comparator/method of inspection for linear and angular dimensional measurements.
CO-5	Classify and choose appropriate method and instruments for inspection of various gear and thread elements, and surface texture features.

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO-1	3	1	1	1					1	1		
CO-2	1	1	1	1					1	2		
CO-3	1	1	1	1					1	2		
CO-4	2	1	1	1					1	1		
CO-5	2	1	1	1					1	1		

Course Outcomes	PSO1	PSO2
CO-1	2	
CO-2	2	
CO-3	2	
CO-4	1	
CO-5	2	

CO- Course Outcome; PO- Program Outcome; PSO-Program Specific Outcome; Level- 1: Low, 2: Medium, 3: High

SYLLABUS

UNIT – I	**Periods: 12 L**
Mechanics of Metal Cutting	
Classification of machining processes, cutting conditions, cutting parameters, types of chips, orthogonal and oblique cutting, forces in metal cutting, measurement of cutting forces – Dynamometers, Merchant circle diagram, shear angle, velocity relationships, specific cutting energy, stress and strain in chip. Friction in metal cutting, temperature in metal cutting, measurement of interface temperature, tool wear, tool life, tool failure, tool materials, cutting fluids, machinability, economics of machining.	
UNIT-II	**Periods: 12 L**
Machine Tools	
Geometry of single-point (ASA, ORS (ISO Old) & NRS (ISO New) systems) and multi-point cutting tools. Lathes, capstan & turret lathe and drilling machine's – Construction and working principle, kinematic systems, classification, operations, work holding & tool holding devices. Milling machines – Construction and working principle, kinematic system, classification, operations, work holding & tool holding devices, dividing head, indexing, types of indexing. Shaper, planner & slotter, machines – Construction and working principle.	
UNIT - III	**Periods: 8 L**
Finishing and super-finishing processes	
Finishing operation - Working principle of grinding machines, merits and de-merits, types of abrasives, bond materials, grit grade and structure of grinding wheels, specifications of grinding wheels. Super-Finishing Operations – lapping, honing, super finishing, polishing, burnishing, buffing, tumbling and abrasive belt grinding.	
UNIT – IV	**Periods:8 L**
Linear & Angular Measurements	
Measurements Straightness measurement, Slip gauges, Squareness testing, Optical bevel protractor, Sine bar, Angle gauges, Autocollimator, Angle dekkor, Flatness measurement, Roundness measurement. Comparators - Twisted strip mechanical comparator, Optical lever comparator, Optical projector, Electric comparator, Pneumatic comparator.	
UNIT - V	**Periods:8 L**
Metrology of screw threads, gears and surface texture	
Measurement of screw threads, major diameters, Minor diameters and effective diameter, Pitch, Limit gaugesfor internal and external threads, Tool maker's microscope. Measurement of spur gears, pitch, profile, tooth thickness. Surface texture: Introduction to surface finish, Parameters, sampling length, Specification, Order of geometrical irregularities, Stylus instruments Profilometer, CMM, Tomlinson Surface meter and Taylor-Hobson Talysurf for surface roughness measurement. .	

TEXT BOOKS:	
1.	W. A. Knight and G. Boothroyd, Fundamentals of Metal Machining and Machine Tools, CRC Press, 2006.
2.	Work shop technology (Machine Tools) Vol. II (10th Edition) by B.S Raghu Vamshi, Dhanpat Rai & Co (P) Ltd.
3.	I.C Gupta, A text-book of Engineering Metrology, Dhanpat Rai & Sons, Delhi
REFERENCE BOOKS:	
1.	Production Engineering by P.C. Sharma, S. Chand and Company
2.	Metal cutting and Machine Tool Engineering, Pakirappa, Durga Publishing House.
3.	Metal Cutting Principles by M.C. Shaw, MIT Press, Cambridge.
4.	Advanced Methods of Machining by J. A. Mc Geough, Chapman & Hall Publishers.
5.	Manufacturing Engineering & Technology, 7th Edition, Serope Kalpakjian, Steven Schmid, Pearson,
6.	Fundamentals Of Modern Manufacturing: Materials, Processes, And Systems, Mikell P. Groover.
WEB RESOURCES:	
1.	https://www.slideshare.net/ArvindChavan/introduction-to-metrology-106089384
2.	https://nptel.ac.in/courses/112/106/112106179/

COMPUTER AIDED MODELLING								
Code	Category	Periods			Sessional Marks	End Exam Marks	Total Marks	Credits
		L	T	P				
MEC 226	SC	1	-	2	50	50	100	2

Prerequisite: Engineering Graphics, Advanced Engineering Graphics

Course Objectives: The course is designed to familiarize the student with the fundamentals of Computer Aided Modelling software and applying it to create 3D Models of Machine parts ,Assembled models and project orthographic projections of sectioned views and assembly views. The course is also finally intended to impart machine drawing of key couplings, pipe fitting and machine components and production drawing using the software.

Course Outcomes: At the end of the course the student will be able to:	
CO-1	**Create** 2D sketches required for 3D modelling using 3D modelling software
CO-2	**Create** 3D models of Machine parts using 3D modelling software
CO-3	**Create** assembled models of keys, pipe fittings and machine components using a 3D modelling software
CO-4	**Create** orthographic views from a 3D Model using a 3D modelling software
CO-5	**Prepare** Productions drawings and process sheets of machine components.

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO-1	1	1	1		2							1
CO-2	1	1	1		2							1
CO-3	1	1	1		2							1
CO-4	1	1	1		2							1
CO-5	1	1	1		2							1

Course Outcomes	PSO1	PSO2
CO-1	1	2
CO-2	1	2
CO-3	1	2
CO-4	1	2
CO-5	1	2

CO- Course Outcome; PO- Program Outcome; PSO-Program Specific Outcome; Level- 1: Low, 2: Medium, 3: High

SYLLABUS

Module-I

Introduction to 3D modelling software:

Week 1: Modeling Techniques - Wire frame Modeling - Surface Modeling - Solid Modeling- CSG, sweep representation; 2D and 3D transformations, windowing and clipping. File types, layout, view operations, types of modelling.
Exercise:1

Week 2: Reference planes, Sketcher, Sketch procedure, sketch tools, modify and constraints of sketches.
Exercise:2
Exercise:3
Exercise:4

Module- II

Part Modelling :

Week 3: a) Extrusion tools: Creating, adding and removing of the material.
b) Axis of revolution tools: Creating,adding and removing of the material.
Exercise: 5
Exercise: 6

Week 4: creating reference elements, reference planes, modify features- fillet, chamfer, draft.
Exercise:7
Exercise:8
Exercise:9

Week 5: Other features-hole, shell,sweep, loft, pattern.
Exercise:10
Exercise:11
Exercise:12
Exercise:13

Module- III

Assembly modelling:

Week 6: Assembly layout, Bottom-UP Assembly -importing part models, assembly constraints-Fix, Mate/Contact, Tangential
Exercise:14
Exercise:15

Week 7: Top-Down Assembly- creating new parts, checking interference
Exercise:16
Exercise:17

Module- IV

Drafting and Presentation:

Week 8: Creating Drawing Views - Drawing sheet, Title block, Projection view, Section-view, Detail View, Clipping View, Break View, Dimension, Annotation, Ballon Annotation, Inserting BOM(Bill of Materials), Creating Exploded views of assembly.
Exercise:18
Exercise:19
Exercise:20

Module- V	
Machine Drawing and Production Drawing Exercises:	
Week 9: Assembly Drawing: Key couplings **Exercise:21** **Exercise:22** **Week 10:** Assembly drawing: shaft couplings **Exercise:23** **Exercise:24** **Week 11:** Assembly drawings of machine components **Exercise:25** **Exercise:26** **Week 12:** Limits fits tolerances, geometrical tolerance, surface roughness, process sheet **Exercise:27** **Exercise:28**	
REFERENCE BOOKS:	
1.	CAD/CAM- Computer Aided Design & Manufacturing, by M.D.Groover & E.W.Zimmer, 1stEdition, PEARSON Publication, 2003.
2.	Lab Manual for Computer Aided Modelling
3.	CATIA V5 Design Fundamentals Jaecheol Koh ONSIA Inc. ISBN-10:14776889028
4.	Mastering SolidWorks by Matt Lombard, 2019 John Wiley & Sons.
5.	N. D. Bhatt "Machine Drawing" V. M. Panchal, Charotar Publishing House Pvt. Ltd
6.	K.L Narayana, P. Kannaiah and K. Venkata Reddy "Machine Drawing" by, New age international Publishers.
WEB RESOURCES:	
1.	http://www.rajaroy.co.in/p/machine-drawing.html

MACHINE TOOLS LAB								
Code	Category	Periods			Sessional Marks	End Exam Marks	Total Marks	Credits
		L	T	P				
MEC 227	PC	0	0	3	50	50	100	1.5

Course Objective: To study and practice the various operations that can be performed on Lathe, also to investigate the influence of machining parameters on chip formation, cutting forces and shear angle on different Machine tools.

Course Outcomes: At the end of the course the student will be able to:	
CO-1	**Perform** facing, turning, taper turning, knurling, forming and thread cutting operations on the given work-piece using lathe.
CO-2	**Analyse** the characteristics of chips produced through machining process by varying the machining parameters on various work-piece materials.
CO-3	**Measure and analyse** the cutting forces, shear angle and temperature experienced by the cutting tool for varying cutting parameters in machine tools (Lathe and Shaper).
CO-4	**Perform** drilling and tapping operations in Drilling machine and gear cutting in Milling machine.
CO-5	**Generate** tool geometry (tool angles) on a tool blank using Tool and Cutter Grinder and also **measure** surface roughness of a flat surface grinded by Surface grinding machine.

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO-1	2		1	2				2		3		
CO-2	2	1		3				2		3		
CO-3	2	1		3				2		3		
CO-4	2	1	1	1				2		3		
CO-5	2	1	1	3				2		3		

Course Outcomes	PSO1	PSO2
CO-1	2	1
CO-2	2	2
CO-3	2	2
CO-4	2	1
CO-5	2	1

CO- Course Outcome; PO- Program Outcome; PSO-Program Specific Outcome; Level- 1: Low, 2: Medium, 3: High

List of Experiments

S.No.	Name of the Experiment	CO
1	Step turning on Lathe	CO-1
2	Taper turning and knurling on Lathe	CO-1
3	Thread cutting and forming on Lathe	CO-1
4	Step turning and knurling on a round bar using Capstan Lathe	CO-1
5	Experimental study of chip formation in turning	CO-2
6	Measurement of cutting forces on Lathe	CO-3
7	Measurement of shear angle on Lathe	CO-3
8	Measurement of shear angle on Shaper	CO-3
9	Measurement of cutting tool temperature on Lathe	CO-3
10	Drilling and Tapping on Radial Drilling Machine	CO-4
11	Spur Gear cutting in milling machine	CO-4
12	Grinding of a single point cutting tool	CO-5
13	Surface roughness measurement by Talysurf surface roughness tester	CO-5

REFERENCE BOOKS:

1. Manufacturing Technology, Volume 2 and 3rd Edition, P.N.Rao, Mc Graw-Hill Book

BASIC ELECTRICAL & ELECTRONICS ENGINEERING LAB								
Code	Category	Periods			Sessional Marks	End Exam Marks	Total Marks	Credits
		L	T	P				
MEC 228	ES	-	-	3	50	-	50	1.5

Prerequisite: Basic fundamental knowledge of electrical and electronics.

Course Objectives: To acquaint the students with the analysis of circuits by using KCL & KVL, operation and applications of DC & AC machines, various indicating instruments and the concepts of diodes & transistors

Course Outcomes: At the end of the course the student will be able to:	
CO-1	Ability to design and analyze simple electrical circuits
CO-2	Ability to determine the speed characteristic of different electrical machines.
CO-3	To design simple circuits involving diodes and transistors.

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO-1	2	3	1	3	2	1	1	-	-	-	2	1
CO-2	2	3	1	3	2	1	1	-	-	-	2	1
CO-3	2	3	1	3	2	1	1	-	-	-	2	1

Course Outcomes	PSO1	PSO2
CO-1	1	-
CO-2	1	-

CO-3	2	-

CO- Course Outcome; PO- Program Outcome; PSO-Program Specific Outcome; Level- 1: Low, 2: Medium, 3: High

SYLLABUS	
S. No.	**Name of the Experiment**
1.	Verification of Ohm's Law
2.	Verification of KVL and KCL.
3.	Load test on DC Shunt machine.
4.	Swinburne's test.
5.	OC and SC test on Transformer.
6.	Load test on 3 Phase Induction Motor.
7.	Regulation of alternator by EMF method.
8.	V-I Characteristics of Diode.
9.	Half wave and Full wave Diode rectifier circuit.
10.	Transistor based circuits.
11.	Study of CRO and measurement of AC signals.
12.	Study of logic gates (AND, OR and NOT)