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GOVERNMENT COLLEGE OF TECHNOLOGY, COIMBATORE – 641 013
B.E. MECHANICAL ENGINEERING (FULL TIME)

THIRD SEMESTER

Sl. No.	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
THEORY										
1	22MES306	Applied Engineering Mechanics	ES	40	60	100	3	0	0	3
2	22MES307	Solid Mechanics	ES	40	60	100	3	0	0	3
3	22MES308	Fluid Mechanics and Machinery (Common to Mech & Prod)	ES	40	60	100	3	0	0	3
4	22MPC301	Manufacturing Technology I	PC	40	60	100	3	0	0	3
5	22MPC302	Materials Engineering and Metallurgy	PC	40	60	100	3	0	0	3
6	22MPC303	Thermodynamics	PC	40	60	100	3	0	0	3
PRACTICAL										
7	22MES309	Electrical and Electronics Engineering Laboratory	ES	60	40	100	0	0	3	1.5
8	22MES310	Material Testing and Fluid Machines Laboratory	ES	60	40	100	0	0	3	1.5
9	22MPC304	Machine Drawing	PC	60	40	100	0	0	6	3
TOTAL				420	480	900	18	0	12	24

FOURTH SEMESTER

Sl. No.	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
THEORY										
1	22MBS408	Applied Probability and Statistics	BS	40	60	100	3	1	0	4
2	22MPC405	Hydraulics and Pneumatic Controls	PC	40	60	100	3	0	0	3
3	22MPC406	Kinematics of Machines	PC	40	60	100	3	0	0	3
4	22MPC407	Thermal Engineering	PC	40	60	100	3	0	0	3
5	22MPC408	Manufacturing Technology II	PC	40	60	100	3	0	0	3
6	22MPC409	Mechanical Measurements and Control	PC	40	60	100	3	0	0	3
PRACTICAL										
7	22MPC410	Manufacturing Technology Laboratory	PC	60	40	100	0	0	3	1.5
8	22MPC411	Thermal Engineering Laboratory I	PC	60	40	100	0	0	3	1.5
9	22MEE401	Engineering Exploration	EEC	60	40	100	0	0	3	1.5
TOTAL				420	480	900	18	1	9	23.5

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22MES306	APPLIED ENGINEERING MECHANICS	SEMESTER III

PREREQUISITES	CATEGORY	L	T	P	C
ENGINEERING PHYSICS	ES	3	0	0	3

Course Objectives	To study the forces and moments in various types of mechanical systems and to enable students to understand the relationship between processes, kinetics and kinematics.	
UNIT – I	**INTRODUCTION TO MECHANICS AND FORCE CONCEPTS**	**(9 Periods)**
Principles and concepts – laws of mechanics – system of forces – resultant of a force system – resolution and composition of forces – Lami's theorem – moment of a force – physical significance of moment-Varignon's theorem – resolution of a force into force and couple – forces in space – addition of concurrent forces in space – equilibrium of a particle in space, classification of beams based on supports.		
UNIT – II	**FRICTION**	**(9 Periods)**
Frictional resistance – classification of friction- laws of friction – coefficient of friction-angle of friction – angle of repose – cone of friction – free body diagram-advantages-equilibrium of a body on a rough inclined plane – non-concurrent force system - ladder friction – rope friction – wedge friction.		
UNIT – III	**GEOMETRICAL PROPERTIES OF SECTION**	**(9 Periods)**
Centroids – Determination by integration – centroid of an area, centroid of composite sections – bodies with cut parts - moment of inertia – theorems of moment of inertia – moment of inertia of composite sections – principal moment of inertia of plane areas - radius of gyration.		
UNIT – IV	**BASICS OF DYNAMICS**	**(9 Periods)**
Kinematics and kinetics – displacements, velocity and acceleration - equations of motion – rectilinear motion of a particle with uniform velocity, uniform acceleration, varying acceleration – motion curves – motion under gravity – relative motion – curvilinear motion of particles – projectiles – angle of projection – range – time of flight and maximum height. Newton's second law of motion – linear momentum – D'Alembert's principle, dynamics equilibrium – work energy equation of particles– law of conservation of energy – principle of work and energy		
UNIT – V	**IMPULSE MOMENTUM AND IMPACT OF ELASTIC BODIES**	**(9 Periods)**
Principle of impulse and momentum – equations of momentum – laws of conservation of momentum. Impact – time of compression, restitution, collision – coefficient of restitution – types of impact – collision of elastic bodies by direct central impact and oblique impact – collision of small body with a massive body – kinetic energy of a particle.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*Bhavikatti, S.S and Rajashekarappa, K.G., **"Engineering Mechanics"**, New Age International (P) Limited Publishers, 1998*
2	*S.C. Natesan **"Engineering Mechanics"** Umesh Publications, 5-B north market, Naisarak, Delhi, 2002.*

REFERENCES:

1	*F.B. Beer and E.R. Johnson, **"Vector Mechanics for Engineers"**, Tata Mc.Graw Hill Pvt. Ltd, 10th Edition,2013*
2	*S. Timoshenko and Young, **"Engineering Mechanics",** Mc.Graw Hill, 4th Edition, 1995.*
3	*Irving Shames and Krishna MohanaRao, **"Engineering Mechanics"**, Prentice Hall of India Ltd, Delhi, 2006*
4	*R.C. Hibbeller, **"Engineering Mechanics"**, Prentice Hall of India Ltd, 13th Edition, 2013.*
5	*Vela Murali, **"Engineering Mechanics",** Oxford university Press,1st Edition,2010*

COURSE OUTCOMES: On completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the concept of mechanics and system of forces and moments.	K4
CO2	Calculate the frictional properties at different bodies.	K4
CO3	Identify the locations of centre of gravity and moment of inertia for different sections.	K4
CO4	Infer the basics of dynamics of particles	K4
CO5	Calculate the problems in the impulse, momentum and impact of elastic bodies.	K4

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

COs/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO2	PSO3
CO 1	3	2	-	1	-	-	1	-	-	2	1	1	3	1	1
CO 2	3	2	-	1	1	-	1	-	-	2	1	1	3	1	1
CO 3	3	2	-	1	1	-	1	-	-	2	1	1	3	1	1
CO 4	3	2	-	1	1	-	1	-	-	2	1	1	3	1	1
CO 5	3	2	-	1	1	-	1	-	-	2	1	1	3	1	1
22MES306	3	2	-	1	1	-	1	-	-	2	1	1	3	1	1

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO 1	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.4,2.4.1,2.4.3,2.4.4,4.1.1,7.1.1,10.1.1,10.1.2,10.1.3,10.3.1,11.3.1,12.3.1
CO 2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.4,2.4.1,2.4.3,2.4.4,4.1.1,4.3.4,5.1.1,7.1.1,10.1.1,10.1.2, 10.1.3,10.3.1,11.3.1,12.3.1
CO 3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.4,2.4.1,2.4.3,2.4.4,4.1.1,4.3.4,5.1.1,7.1.1,10.1.1,10.1.2, 10.1.3,10.3.1,11.3.1,12.3.1
CO 4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.4,2.4.1,2.4.3,2.4.4,4.1.1,4.3.4,5.1.1,7.1.1,10.1.1,10.1.2, 10.1.3,10.3.1,11.3.1,12.3.1
CO 5	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.4,2.4.1,2.4.3,2.4.4,4.1.1,4.3.4,5.1.1,7.1.1,10.1.1,10.1.2, 10.1.3,10.3.1,11.3.1,12.3.1

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ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	30	20	20	20		100
CAT2	10	30	20	20	20		100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	10	30	20	20	20		100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	10	30	20	20	20		100
ESE	10	30	20	20	20		100

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22MES307	SOLID MECHANICS	SEMESTER III

PREREQUISITES	CATEGORY	L	T	P	C
NIL	ES	3	0	0	3

Course Objectives	To learn the basics techniques to evaluate stresses, strain, bending moment and shear force distribution in engineering structures.	
UNIT – I	**STRESS AND STRAIN**	**(9 Periods)**
Stress and strain at a point-Tension, compression, shear stresses - Hooke's law - Compound bars – lateral strain - Poisson's ratio -Volumetric strain - Bulk modulus - Relationship among elastic constants – stress strain diagrams for mild steel, cast iron-Ultimate stress - Yield stress-Factor of safety - Thermal stresses - Thin cylinders - Strain energy due to axial force - Resilience- Stress due to gradual load, suddenly applied load and Impact load.		
UNIT – II	**SHEAR FORCE AND BENDING MOMENT**	**(9 Periods)**
Beams – Types of Beams - Types of loads, supports - Shear force – Bending moment – shear forces and bending moment diagrams for cantilever, simply supported and over hanging beams with concentrated , uniformly distributed, uniformly varying load and couple-Relationship among rate of loading, shear force, bending moment- Point of contra flexure.		
UNIT – III	**THEORY OF BENDING AND COMPLEX STRESSES**	**(9 Periods)**
Theory of bending-Bending equation-Section Modulus-Stress distribution at a cross section due to bending moment and shear force for cantilever, simply supported beams with point, UDL loads (Rectangular, circular, I & T sections only) -combined direct and bending stresses, Kernel of section (Rectangular, Circular Sections only). 2D State of stress - 2D Normal and shear stresses on any plane-Principal stresses and Principal planes-Introduction to Principal Strains and direction- Mohr's circle of stress (Two dimension only)		
UNIT – IV	**DEFLECTION OF BEAMS AND THEORY OF LONG COLUMNS**	**(9 Periods)**
Determinations of deflection curve – Relation between slope, deflection and radius of curvature – Slope and deflection of beam at any section by Macaulay's method - Concept of Conjugate beam method (Theory only)- Euler's theory of long Columns- Expression of crippling load for various end conditions-Effective length-Slenderness ratio-limitations of Euler equation - Rankine formula for columns.		
UNIT – V	**THEORY OF TORSION**	**(9 Periods)**
Torsion of shafts - Torsion equation - Polar modulus- Stresses in Solid and Hollow circular shafts - Torsional rigidity - Power transmitted by the shaft – Importance of angle of Twist - Strain energy due to Torsion - Modulus of rupture – Torsional resilience – Combined bending and Torsion- Stresses in helical springs - Deflection of helical spring- Introduction to torsion of non-circular sections.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*Sadhu Singh,* ***"Strength of Materials"****, Khana Publishers, New Delhi, 2014.*
2	*Rajput.R. K.,* ***"Strength of Materials"****, S. Chand & Company Ltd., New Delhi 2018.*

REFERENCES:

1	*James M.Gere and Barry J.Goodno ,* ***"Mechanics of Materials"****, Cengage,2022*
2	*Srinath.L,* ***"Advanced Mechanics of Solids"****, McGrawHill, 2017*
3	*Kazimi,* ***"Solid Mechanics",*** *Second edition, Tata McGraw Hill, New Delhi, 2017.*
4	*Jacob Lubliner,* ***"Introduction to Solid Mechanics - An Integrated Approach",*** *Springer NewYork, 2013.*

COURSE OUTCOMES: On completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Evaluate stresses and strains for various types of loading.	K2
CO2	Estimate the Shear force and Bending moment and find the point of contraflexure.	K2
CO3	Create shear stress distribution drawings for simple sections and evaluate principal stresses and strains.	K3
CO4	Use theory of beams and long columns to find slope, deflection, radius of curvature of beams and crippling load of long columns.	K3
CO5	Apply theory of torsion for problems involving torsion of circular shafts and leaf spring.	K3

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

COs/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO 1	3	3	-	2	1	-	-	-	-	-	-	-	-	-	-
CO 2	3	3	-	2	1	-	-	-	-	-	-	-	-	-	-
CO 3	3	3	-	2	1	-	-	-	-	-	-	-	-	-	-
CO 4	3	3	-	2	1	-	-	-	-	-	-	-	-	-	-
CO 5	3	3	-	2	1	-	-	-	-	-	-	-	-	-	-
22MES307	3	3	-	2	1	-	-	-	-	-	-	-	-	-	-

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO 1	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 4.1.1, 4.3.2, 4.3.3, 5.1.2.
CO 2	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 4.1.1, 4.3.2, 4.3.3, 5.1.2.
CO 3	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 4.1.1, 4.3.2, 4.3.3, 5.1.2.
CO 4	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 4.1.1, 4.3.2, 4.3.3, 5.1.2.
CO 5	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 4.1.1, 4.3.2, 4.3.3, 5.1.2.

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	30	50				100
CAT2		50	50				100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	20	30	50				100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2		50	50				100
ESE	10	40	50				100

22MES308	FLUID MECHANICS AND MACHINERY *(Common to Mech & Prodn)*	SEMESTER III

PREREQUISITES	CATEGORY	L	T	P	C
NIL	ES	3	0	0	3

Course Objectives	To understand the Fluid properties, types of fluid flow, dimensional analysis and performance of pumps and turbines.	
UNIT – I	**FLUID PROPERTIES**	**(9 Periods)**
Units and dimensions – fluid properties – density, specific gravity, viscosity, surface tension, capillarity, compressibility and bulk modulus – Pascal's law – pressure measurements – manometers - fluid statics - total pressure and centre of pressure on submerged surfaces.		
UNIT – II	**FLUID KINEMATICS AND DYNAMICS**	**(9 Periods)**
Types of fluid flow and flow lines – control volume – continuity equation in one dimension and three dimension – velocity potential and stream function - energy equation – Euler and Bernoulli's equations – applications of energy equations - flow meters - laminar and turbulent flow through pipes –Hagen Poisullie equation – Darcy Weisbach formula – applications.		
UNIT – III	**DIMENSIONAL ANALYSIS**	**(9 Periods)**
Need for dimensional analysis – dimensional homogeneity – Rayleigh's and Buckingham methods of dimensional analysis –problems. Model study and similitude – scale effects and distorted model.		
UNIT – IV	**TURBINES**	**(9 Periods)**
Classification – construction, working principles and design of Pelton wheel, Francis and Kaplanturbines - work done and efficiency - specific speed - operating characteristics - governing of turbines – problems.		
UNIT – V	**PUMPS**	**(9 Periods)**
Classification of pumps - centrifugal pump - working principle - work done and efficiency – multistage pumps - reciprocating pumps - work done and efficiency - negative slip - air vessels - indicator diagram – problems.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*P.N.Modi and S.N.Seth,* ***"Hydraulics and Fluid Mechanics, Including Hydraulic Machines"****, Standard Book House ,NewDelhi,2015.*
2	*R.K.Bansal,* ***"Fluid Mechanics and Hydraulic Machines"****, Laxmi Publications (P) Ltd., NewDelhi,2018.*

REFERENCES:

1	*SubramanyaK.,* ***"Flow in Open channels"****, TataMcGraw-Hill Publishing Company,2015.*
2	*S.Ramamurtham and R.Narayanan,* ***"Hydraulics Fluid Mechanics and Fluid Machines"*** *Dhanpat Rai Publishing Company(P)Limited,2014.*
3	*R.K.Rajput,****"A Text Book of Fluid Mechanics and Hydraulic Machines"****, S.Chand and Company, NewDelhi,2015.*
4	*D.S.Kumar,* ***"Fluid Mechanics and Fluid Power Engineering"****, S.K.Kataria & Sons, NewDelhi ,2012.*
5	*G.K.Batchelor,****"An Introduction to Fluid dynamics",****Cambridge University Press, June 2012*

COURSE OUTCOMES: On completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Explain fluid properties and its applications.	K4
CO2	Gain knowledge on fluid flows and to solve practical problems	K4
CO3	Apply the concepts of dimensional analysis for fluid flow problems	K4
CO4	Analyze the performance of turbines and design of turbines.	K4
CO5	Analyze the performance of pumps and design of pumps.	K4

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

COs/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	2	1	-	1	-	-	-	-	-	-	-	-	1	-	2
CO2	2	1	-	1	-	-	-	-	-	-	-	-	1	-	2
CO3	2	1	-	1	-	-	-	-	-	-	-	-	1	-	2
CO4	2	1	1	3	-	-	-	-	-	-	-	-	1	-	2
CO5	2	1	1	3	-	-	-	-	-	-	-	-	1	-	2
22MES308	2	1	1	2	-	-	-	-	-	-	-	-	1	-	2

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1, 1.3.1, 1.4.1, 2.1.3, 2.2.3, 2.3.1, 2.4.1, 4.1.2
CO2	1.3.1, 1.4.1, 2.1.3, 2.2.3, 2.3.1, 2.4.1, 4.1.2
CO3	1.2.1, 1.3.1, 1.4.1, 2.1.3, 2.2.3, 2.3.1, 4.1.2
CO4	1.1.1, 1.3.1,2.1.2,2.1.3, 2.3.2, 3.2.2, 3.4.2, 4.1.1, 4.1.3, 4.1.4, 4.2.1, 4.3.1, 4.3.3
CO5	1.1.1, 1.3.1, 2.1.2, 2.1.3, 2.3.2, 3.2.2, 3.4.2, 4.1.1, 4.1.3, 4.1.4, 4.2.1, 4.3.1, 4.3.3

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	30	30	20			100
CAT2	20	30	30	20			100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	20	30	30	20			100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	20	30	30	20			100
ESE	20	30	30	20			100

22MPC301	MANUFACTURING TECHNOLOGY I	SEMESTER III

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	3	0	0	3

Course Objectives	To acquire knowledge about various types of manufacturing processes which includes casting, joining, forming and techniques involved in additive manufacturing, powder metallurgy to produce a product for competitive industrial applications.	
UNIT – I	**METAL CASTING PROCESSES**	**(9 Periods)**
Introduction to Concepts of Manufacturing Process -Sand casting – Sand moulds -Type of patterns – Pattern materials – Pattern allowances – Design of riser and gating – Types of Moulding sand –Properties – Core making – Methods of Sand testing – Special casting processes: Shell casting, investment casting, die casting, centrifugal casting - Melting furnaces – Casting defects and remedies– Inspection methods		
UNIT – II	**JOINING PROCESSES**	**(9 Periods)**
Fusion welding processes – Types of Gas welding – Equipments used – Flame characteristics – Filler and Flux materials - Arc welding equipments - Electrodes –Coating and specifications – Principles of Resistance welding – Spot/butt, seam welding – Percussion welding - Gas metal arc welding, Submerged arc welding – Electro slag welding – TIG welding –Brazing and soldering process-Welding defects: causes and remedies.		
UNIT – III	**BULK DEFORMATION PROCESSES**	**(9 Periods)**
Hot working and cold working of metals – Forging processes – Open and close die forging – Types of Forging Machines – Typical forging operations – Rolling of metals – Flat strip rolling –Mechanism of rolling – Types of Rolling mills – Tube piercing – Principles of Extrusion – Types of Extrusion – Hot and Cold extrusion – Principle of rod and wire drawing.		
UNIT – IV	**SHEET METAL FORMING AND PLASTIC COMPONENTS**	**(9 Periods)**
Typical shearing operations, bending and drawing operations – Formability of sheet metal – Metal spinning – Magnetic pulse forming – Super plastic forming – Types and characteristics of plastics- Moulding of Thermoplastic -Working principle and application of Injection moulding, compression moulding and transfer moulding.		
UNIT – V	**ADDITIVE MANUFACTURING PROCESSES**	**(9 Periods)**
Fundamentals of Additive Manufacturing (AM)-Product Development-Materials for AM- Stereolithography apparatus - STL file - Fused Deposition Modeling- Laminated Object Manufacturing - Selective Laser sintering- 3D Printer – Introduction to powder metallurgy.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*Kalpakjian, S., **"Manufacturing Engineering and Technology",** Pearson Education India 7th Edition, 2013.*
2	*Sharma, P.C., **"A Text book of Production Technology",** S. Chand and Co. Ltd., 2019.*

REFERENCES:

1	*Mikell P. Groover, **"Fundamentals of Modern Manufacturing: Materials, Processes, and System",** John Wiley and Sons Inc, 2010*
2	*Rao P.N., **"Manufacturing Technology: Foundry, Forming and Welding",** McGraw Hill 5th Edition, 2018*
3	*Chua C.K., Leong K.F., and Lim C.S., **"Rapid Prototyping: Principles and Applications",** Third Edition, World Scientific Publishers, 2010.*
4	*R.K. Rajput, **"Manufacturing Technology",** Laxmi Publication Pvt Ltd, 1st Edition, 2007.*
5	*Adithan M. and Gupta A.B. **"Manufacturing Technology",** New Age International Pvt Ltd, 2003.*

COURSE OUTCOMES: On completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Apply the principle of metal casting for engineering applications.	K3
CO2	Identify the suitable welding process to make permanent joints for specific application.	K3
CO3	Familiarize the various forging process and mechanism of flat rolling.	K3
CO4	Select a suitable metal forming and plastic moulding process.	K3
CO5	Familiarize the role of Additive Manufacturing processes and powder metallurgy to interpret with industries requirements.	K3

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	2	2	3	-	-	1	2	-	-	-	1	1	1	1	1
CO2	2	2	3	-	-	1	2	-	-	-	1	1	1	1	1
CO3	2	2	3	-	-	1	2	-	-	-	1	1	1	1	1
CO4	2	2	3	-	-	1	2	-	-	-	1	1	1	1	1
CO5	2	2	3	-	2	1	2	-	-	-	1	1	1	1	1
22MPC301	2	2	3	-	1	1	2	-	-	-	1	1	1	1	1

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.2.1,1.3.1,1.4.1,2.2.2,2.2.3,2.2.4,3.1.1,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.2,3.4.2,6.1.1,6.2.1,7.1.1,7.2.1, 11.1.1,11.3.1,11.3.2,12.1.1,12.1.2,12.2.2,12.3.1,12.3.2
CO2	1.2.1,1.3.1,1.4.1,2.2.2,2.2.3,2.2.4,3.1.1,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.2,3.4.2,6.1.1,6.2.1,7.1.1,7.2.1, 11.1.1,11.3.1,11.3.2,12.1.1,12.1.2,12.2.2,12.3.1,12.3.2
CO3	1.2.1,1.3.1,1.4.1,2.2.2,2.2.3,2.2.4,3.1.1,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.2,3.4.2,6.1.1,6.2.1,7.1.1,7.2.1, 11.1.1,11.3.1,11.3.2,12.1.1,12.1.2,12.2.2,12.3.1,12.3.2
CO4	1.2.1,1.3.1,1.4.1,2.2.2,2.2.3,2.2.4,3.1.1,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.2,3.4.2,6.1.1,6.2.1,7.1.1,7.2.1, 11.1.1,11.3.1,11.3.2,12.1.1,12.1.2,12.2.2,12.3.1,12.3.2
CO5	1.2.1,1.3.1,1.4.1,2.2.2,2.2.3,2.2.4,3.1.1,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.2,3.4.2,5.3.1,6.1.1,6.2.1,7.1.1,7. 2.1,11.1.1,11.3.1,11.3.2,12.1.1,12.1.2,12.2.2,12.3.1,12.3.2

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	60	20				100
CAT2	20	60	20				100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	20	60	20				100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	20	60	20				100
ESE	20	60	20				100

22MPC302	MATERIALS ENGINEERING AND METALLURGY	SEMESTER III

PREREQUISITES	CATEGORY	L	T	P	C
1. ENGINEERING PHYSICS 2. MATERIALS SCIENCE	PC	3	0	0	3

Course Objectives	To study the crystal structure, phase diagrams, phase transformations and heat treatment of alloys and to acquire knowledge on various testing methods of engineering materials.	
UNIT – I	**BASICS OF CRYSTALS STRUCTURES**	**(9 Periods)**
Classification of engineering materials, ABAB stacking of HCP structure, ABCABC Stacking of CCP structure, Voids in closed packed structure, Dislocations, Slip systems, Deformation by twining, Twin-Tilt Boundary, Burger circuit, Stacking fault, Types of solid solutions, Hume Rotherys rules, Intermediate alloy phases and electron compounds, Solid solutions - Substitutional and interstitial.		
UNIT – II	**PHASE DIAGRAMS OF ALLOYS AND STRENGTHENING MECHANISMS**	**(9 Periods)**
Unary Phase diagram, Binary isomorphous and eutectic system, Iron-carbon equilibrium diagram - Experimental methods of construction of equilibrium diagrams, Invariant reactions - Eutectic, Peritectic, Eutectoid and Peritectoid reactions, Strengthening mechanisms: Strengthening by Grain Size Reduction Solute Hardening, chemical hardening, dispersion hardening, cold working, strain hardening, Recovery Recrystallization and Grain Growth.		
UNIT – III	**PHASE TRANSFORMATIONS AND HEAT TREATMENT OF ALLOYS**	**(9 Periods)**
Heat treatment of steel -TTT diagram - annealing process, normalizing, hardening and tempering of steels- Age hardening, austempering, martempering, Isothermal transformation diagrams – Cooling curves superimposed on I.T diagram- Effect of alloying elements on Fe- Fe3C system - hardenability, Jominy-end-quench test,Case hardening- Carburizing-Types, Nitriding, Cyaniding, Carbonitriding, Flame and Induction hardening.		
UNIT – IV	**FERROUS AND NON FERROUS METALS**	**(9 Periods)**
Plain carbon steels – alloy steels - stainless and tool steels – Cast iron- Gray, White,Malleable, Spheroidal graphite - alloy cast irons – Heat resistant steels and Die steels. Alloysof Copper, Aluminum, Nickel, Magnesium, Titanium, Lead, Tin, Composite material, Types-PMCs, MMCs, CMCs, CAMCs, Material Specification and standards.		
UNIT – V	**TESTING OF MATERIALS**	**(9 Periods)**
Grain size determination by Microscopic techniques, Mechanical tests - tension, compression,impact, hardness, Fracture Toughness Test, Low & High Cycle Fatigues tests, Crack Growthstudies – Creep Tests. Non Destructive Testing basic principles and testing method forRadiographic testing, Ultrasonic testing, Magnetic Particle inspection and Liquid penetrantinspection test, Eddy current testing. Basics of X Ray Diffraction test- Bragg's law,Secondary Ion Mass Spectroscopy, Fourier Transform Infra-Red Spectroscopy (FTIR).		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*W. D. Callister, **"Materials Science and Engineering-An Introduction",** Wiley India.,2011*
2	*O.P. Khanna, "**Material Science and Metallurgy**", DhanpatRai Publications, 2014*

REFERENCES:

1	*Dieter, G.E., **"Mechanical metallurgy",** SI metric edition,. McGraw-Hill, 2012*
2	*Sydney H.Avner, **"Introduction to Physical Metallurgy",** Tata McGraw Hill Book Company, 2014.*
3	*Kenneth G.Budinski and Michael K.Budinski**"Engineering Materials"** Prentice-Hall of India Private Limited, 6th Indian Reprint 2012.*
4	*Raghavan.V, **"Materials Science and Engineering",** Prentice Hall of India Pvt. Ltd., 2015*
5	*U. C. Jindal, **"Engineering Materials and Metallurgy",** Pearson, 2011*

COURSE OUTCOMES: On completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Acquire knowledge in the crystal structure and deformation of pure metals and alloys.	K3
CO2	Understand the alloy phase diagrams basics and their strengthening mechanisms.	K4
CO3	Select suitable and heat treatment methods for various metals and alloys.	K4
CO4	Understand the ferrous and nonferrous materials and their application	K2
CO5	Gain knowledge about materials testing methods.	K4

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping														
COs/POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO1	2	1	-	1	-	-	1	-	-	2	1	1	1	1	3
CO2	2	1	-	1	-	-	1	-	-	2	1	1	1	1	3
CO3	2	1	-	1	-	-	1	-	-	2	1	1	1	1	3
CO4	2	1	-	1	-	-	1	-	-	2	1	1	1	1	3
CO5	2	1	-	1	-	-	1	-	-	2	1	1	1	1	3
22MPC302	2	1	-	1	-	-	1	-	-	2	1	1	1	1	3
1 – Slight, 2 – Moderate, 3 – Substantial															

b) CO and Key Performance Indicators Mapping	
CO 1	1.1.1,1.2.1,1.4.1,2.1.1,2.1.3,2.4.4,4.1.1,7.1.1,10.1.1,10.1.2,10.1.3,10.3.1,11.3.1,12.3.1
CO 2	1.2.1,1.4.1,2.1.1,2.1.3,2.4.4,4.1.1,7.1.1,10.1.1,10.1.2,10.1.3,10.3.1,11.3.1,12.3.1
CO 3	1.2.1,1.4.1,2.1.1,2.1.3,2.4.4,4.1.1,7.1.1,10.1.1,10.1.2,10.1.3,10.3.1,11.3.1,12.3.1
CO 4	1.2.1,1.4.1,2.1.1,2.1.3,2.4.4,4.1.1,7.1.1,10.1.1,10.1.2,10.1.3,10.3.1,11.3.1,12.3.1
CO 5	1.1.1,1.2.1,1.4.1,2.1.1,2.1.3,2.4.4,4.1.1,7.1.1,10.1.1,10.1.2,10.1.3,10.3.1,11.3.1,12.3.1

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40	20	20	20			100
CAT2	40	20	20	20			100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	40	20	20	20			100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	40	20	20	20			100
ESE	40	20	20	20			100

22MPC303	THERMODYNAMICS *(Use of Approved Data Book is permitted)*	SEMESTER III

PREREQUISITES	CATEGORY	L	T	P	C
1. APPLIED PHYSICS	PC	3	0	0	3

Course Objectives	To expose thermodynamic first law, second law concepts and entropy applications, processes and cycles for analysing the thermodynamic systems and learn the behaviour of pure substance, ideal gases and moist air.	
UNIT – I	**BASIC CONCEPT AND FIRST LAW**	**(9 Periods)**
Basic concepts - concept of continuum, macroscopic approach, thermodynamic systems - closed, open and isolated. Property, state, path and process, quasi-static process, work, modes of work, Zeroth law of thermodynamics. Concept of ideal and real gases. First law of thermodynamics – application to closed and open systems, internal energy, specific heat capacities, enthalpy, steady flow process with reference to various thermal equipment's.		
UNIT – II	**SECOND LAW AND ENTROPY**	**(9 Periods)**
Second law of thermodynamics – Kelvin's and Clausius statements of second law. Reversibility and Irreversibility. Carnot theorem, Carnot cycle, reversed Carnot cycle, efficiency, COP. Thermodynamic temperature scale, Clausius inequality, concept of entropy, entropy of ideal gas, principle of increase of entropy.		
UNIT – III	**PROPERTIES OF PURE SUBSTANCE AND STEAM POWER CYCLE**	**(9 Periods)**
Properties of pure substances- p-v, p-T, T-s, h-s diagrams, PVT surfaces, thermodynamic properties of steam. Dryness Fraction, Steam Tables, Standard Rankine cycle, Reheat and regenerative cycle, Binary Vapour Cycles.		
UNIT – IV	**THERMODYNAMIC RELATIONS AND IDEAL GAS MIXTURES**	**(9 Periods)**
Maxwell's equations - general relations for du, dh, ds, C_p and C_v - Joule Thomson coefficient, ClausiusClapeyron equation, Phase Change Processes. Equation of state - ideal and real gas, Gas mixtures - Dalton's law of partial pressures - P-V-T behavior of gas mixtures .		
UNIT – V	**PSYCHROMETRY**	**(9 Periods)**
Psychrometry- psychrometric charts, properties of air vapour mixtures, psychrometric chart, psychrometric process – Sensible Heating or Cooling, Cooling and Dehumidification, heating and humidification, Adiabatic - mixing, evaporative cooling.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total:45 Periods**		

TEXT BOOKS:

1	*Nag. P.K., "**Engineering Thermodynamics**", Tata McGraw Hill Company, 6th Edition, 2017.*
2	*YunusACengel, "**Thermodynamics**", Tata McGraw Hill Company, 9th Edition, 2019*

REFERENCES:

1	*R.K. Rajput "**Thermal Engineering**", Laxmi Publications (P) Ltd, 2020.*
2	*Kothandaraman C.P., "**Thermal Engineering**", DhanpatRai& Sons, 2013.*
3	*Borgnakke and Sonnatag, "**Fundamental of Thermodynamics**", Wiley India Edition, 8th Edition , 2016*
4	*Arora C.P, "**Thermodynamics**", McGraw-Hill, New Delhi, 2017*
5	*Prasanna Kumar, "**Engineering Thermodynamics**", Pearson Education, 2013.*
6	*Refer - NPTEL, MOOC videos.*

COURSE OUTCOMES: On completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Apply thermodynamic first law to real life thermodynamic problems	K4
CO2	Apply thermodynamic second law and entropy principle for systems.	K4
CO3	Identify the behavior of steam at different conditions of power generation	K4
CO4	Formulate simple thermodynamic relations for gases	K4
CO5	Apply psychometric processes and its characteristics in an environs	K4

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping														
COs/POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO1	3	2	2	2	2	2	3	1	1	2	1	3	3	2	1
CO2	3	2	1	2	2	2	3	1	1	2	1	3	3	2	1
CO3	3	2	2	2	2	2	3	1	-	2	2	3	3	2	1
CO4	3	2	3	2	2	2	3	1	1	2	2	3	3	2	1
CO5	3	2	2	2	2	2	3	1	1	2	2	3	3	2	1
22MPC303	3	2	2	3	2	2	3	1	1	2	2	3	3	2	1
1 – Slight, 2 – Moderate, 3 – Substantial															
b) CO and Key Performance Indicators Mapping															
CO1	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.3.1, 2.3.2, 2.4.3, 3.1.2, 3.1.3, 3.1.5, 3.2.1, 3.2.3, 3.3.2, 3.4.1, 3.4.2, 4.1.1, 4.1.4, 4.2.1, 4.3.1, 4.3.2, 5.1.1, 5.2.2, 5.3.2, 6.1.1, 7.1.2, 7.2.1, 7.2.2, 8.1.1, 9.1.2, 9.2.4, 10.1.1, 10.2.2, 10.3.1, 11.3.2, 12.1.1, 12.1.2, 12.2.2, 12.3.1, 12.3.2														
CO2	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.3.1, 2.3.2, 2.4.4, 3.1.2, 3.1.6, 3.2.2, 3.4.2, 4.1.1, 4.1.4, 4.2.1, 4.3.1, 4.3.3, 5.1.2, 5.2.2, 5.3.2, 6.1.1, 7.1.2, 7.2.1, 7.2.2, 8.2.2, 9.2.2, 10.1.1, 10.2.2, 10.3.1, 11.3.2, 12.1.1, 12.1.2, 12.2.1, 12.3.1, 12.3.2														
CO3	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.2.1, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 3.1.2, 3.1.3, 3.1.4, 3.1.6, 3.2.3, 3.3.1, 3.4.1, 4.2.2, 4.3.2, 4.3.4, 5.1.1, 5.1.2, 5.3.1, 6.1.1, 7.1.1, 7.1.2, 7.2.2, 8.2.1, 10.1.1, 10.1.3, 10.2.2, 11.1.1, 11.3.1, 11.3.2, 12.1.1, 12.1.2, 12.2.1, 12.3.1, 12.3.2														
CO4	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.3.1, 2.4.1, 2.4.1, 2.4.3, 2.4.4, 3.1.1, 3.1.2, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.3.2, 3.4.1, 3.4.2, 4.1.1, 4.2.1, 4.3.3, 4.3.4, 5.1.1, 5.2.2, 5.3.1, 6.2.1, 7.1.2, 7.2.1, 7.2.2, 8.2.2, 9.1.2, 9.2.4, 10.1.1, 10.2.2, 10.3.1, 11.3.1, 11.3.2, 12.1.1, 12.1.2, 12.2.1, 12.3.1, 12.3.2														
CO5	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.3.1, 2.4.1, 2.4.4, 3.1.1, 3.1.2, 3.1.4, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.4.1, 4.1.1, 4.2.1, 4.3.1, 4.3.3, 5.1.1, 5.2.2, 5.3.1, 6.2.1, 7.1.1, 7.1.2, 7.2.2, 8.1.1, 9.1.2, 9.2.1, 10.1.1, 10.1.3, 10.2.2, 10.3.1, 11.3.1, 11.3.2, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2														

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	40	25	15			100
CAT2	30	30	30	10			100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	30	30	25	15			100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	25	35	20	20			100
ESE	25	30	25	20			100

22MES309	ELECTRICAL AND ELECTRONICS ENGINEERING LABORATORY	SEMESTER III

PREREQUISITES	CATEGORY	L	T	P	C
NIL	ES	0	0	3	1.5

Course Objectives	To familiarize with basic electrical wiring and to provide basic laboratory experience on electronic circuits, DC Machines, AC Machines and transformers.

LIST OF EXPERIMENTS

1. Introductions to measuring instruments – voltmeter, ammeter, wattmeter, multimeter and Digital Storage Oscilloscope.
2. Resonance in RLC circuits, verification of laws in electrical circuits.
3. Measurement of phase difference between voltage and current.
4. No load test on single phase transformer and equivalent test.
5. Load Test on single phase transformer.
6. Swinburne's Test.
7. Speed Control of DC motor.
8. Load test on DC motor.
9. Direction change and load test on three phase induction motor.
10. Staircase and Fluorescent light wiring.
11. Measurement of Power using Power Quality Analyser.
12. Voltage - Current relations in three phase circuit and three phase power measurement
13. Demonstration of AC and DC drives & Demonstration of cut out section of machines

Contact periods:
Lecture: 0 Period Tutorial: 0 Period Practical: 45 Periods Total: 45 Periods

COURSE OUTCOMES: On completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Make electrical connections by wires of appropriate size.	K1
CO2	Acquire exposure to common electrical components and measuring instruments.	K2
CO3	Verify Simple laws using electrical circuits.	K2
CO4	Analyse the characteristics of transformers and Electrical machines.	K3
CO5	Understand the working of AC and DC drives and household wiring.	K4

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	2	3	3	2	1	-	-	-	2	0	-	-	1	-	-
CO2	2	2	3	2	1	-	2	1	2	0	-	-	1	-	-
CO3	3	2	3	2	1	-	-	-	2	1	-	-	1	-	-
CO4	2	3	3	2	-	-	3	-	2	0	-	1	1	-	-
CO5	2	2	3	2	-	-	-	-	2	0	-	-	1	-	-
22MES309	2	2	3	2	1	-	2	1	2	1	-	1	1	-	-

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping	
CO1	1.1.1, 1.2.1, 1.3.1, 2.1.1, 2.1.2, 2.1.3, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.3.3, 5.2.1, 5.2.2, 9.1.1,9.1.2,9.2.2,9.2.3
CO2	1.1.1, 1.2.1, 1.3.1, 2.1.1, 2.1.2, 2.1.3,2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.3.1, 5.2.1, 5.2.2, 7.2.1, 7.2.2, 8.1.1, 9.1.1,9.1.2,9.2.2,9.2.3
CO3	1.1.1, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 5.2.1, 5.2.2, 10.3.1, 9.1.1,9.1.2,9.2.2,9.2.3
CO4	1.1.1, 1.2.1, 1.3.1, 2.1.1, 2.1.2, 2.1.3, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 7.1.1, 7.1.2, 7.2.1, 12.3.1, 12.3.2, 9.1.1,9.1.2,9.2.2,9.2.3
CO5	1.1.1, 1.2.1, 1.3.1, 2.1.1, 2.1.2, 2.1.3,2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.3.3, 9.1.1,9.1.2,9.2.2,9.2.3

22MES310	MATERIAL TESTING AND FLUID MACHINES LABORATORY *(Common to Mech & Prod)*	SEMESTER III

PREREQUISITES	CATEGORY	L	T	P	C
NIL	ES	0	0	3	1.5

Course Objectives	(A) To understand the basics of different testing methods for different materials. (B) To Study the behaviour of fluid systems in Pipes, Pumps and Turbines

22MES310 (A) MATERIAL TESTING LABORATORY

LIST OF EXPERIMENTS:

1. Tension Test on steel rods using Universal Testing Machine.
2. Bending Test on rolled steel Joist Beam.
3. Double shear test on mild steel rod
4. Torsion Test on Mild steel rod
5. Tension and Compression Test on Springs
6. Deflection test on simply supported aluminium beam
7. Deflection Test on Cantilever Beam
8. Hardness tests on metals like Mild Steel, Brass, Copper and Aluminium.
9. Bend Test on Steel rod
10. Compression Test
11. Impact test-Izod and Charpy

22MES310 (B) FLUID MACHINERY LABORATORY

LIST OF EXPERIMENTS:

1. Calibration of Venturimeter
2. Flow through Mouthpiece
3. Determination of Darcy's friction factor
4. Performance Study of Roto dynamic pumps: Centrifugal pump and Submersible pump
5. Performance Study of Positive displacement pumps: Reciprocating pump, Gear oil pump and Single screw pump.
6. Load test on Turbines: Pelton wheel, Francis turbine and Kaplan Turbine.

Contact periods:
Lecture: 0 Period Tutorial: 0 Period Practical: 45 Periods Total: 45 Periods

COURSE OUTCOMES: On completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Apply knowledge of compression, tension, shear and torsion testing procedures on materials.	K3
CO2	Know the deflection and bending behavior of different types of beams.	K3
CO3	Find the hardness of different metals.	K3
CO4	Find the flow properties of fluids at different places.	K3
CO5	Conduct performance tests on pumps and turbines.	K3

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping															
COs/POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO1	1	1	2	0	1	0	1	0	1	0	2	1	1	0	1
CO2	1	0	1	0	1	0	0	0	0	0	2	1	1	0	1
CO3	1	0	1	0	0	0	0	0	1	0	0	1	1	0	1
CO4	0	1	0	2	1	0	1	0	0	0	0	0	0	2	1
CO5	0	1	0	2	1	0	1	0	0	0	0	0	0	2	1
22MES310	1	1	2	2	1	0	1	0	1	0	2	1	1	2	1
1 – Slight, 2 – Moderate, 3 – Substantial															

b) CO and Key Performance Indicators Mapping	
CO1	1.3.1, 2.1.1, 2.1.2, 2.4.2, 2.4.4, 3.1.1, 3.1.4, 3.1.5, 3.2.2, 3.4.1, 3.4.2, 5.1.2, 5.2.1, 7.2.2, 9.1.2, 9.3.1, 11.1.1, 11.1.2, 12.1.2, 12.2.2
CO2	1.1.1, 3.1.1, 3.1.5, 3.1.6, 3.2.3, 5.3.1, 5.3.2, 11.1.1, 11.2.1, 12.1.1, 12.3.2
CO3	1.2.1, 3.1.3, 3.1.4, 3.1.6, 3.4.1, 9.3.1, 12.2.1, 12.3.1
CO4	2.1.2, 2.1.3, 2.3.1, 2.4.2, 4.1.3, 4.2.1, 4.3.1, 4.3.3, 5.2.1, 5.3.2, 7.1.1
CO5	2.1.2, 2.1.3, 2.3.1, 2.4.2, 4.1.3, 4.2.1, 4.3.1, 4.3.3, 5.2.1, 5.3.2, 7.1.1

22MPC304	MACHINE DRAWING	SEMESTER III

PREREQUISITES	CATEGORY	L	T	P	C
1. ENGINEERING GRAPHICS	PC	0	0	6	3

Course Objective	To impart knowledge about standards, tolerances for machine components and to give practice in machine drawing.	
UNIT – I	**INTRODUCTION**	**(25 Periods)**
Introduction – Principles of Drawing - Sections, Conventional Representation, Dimensioning, Standard Abbreviations – Orthographic Projection – Sectional Views – Auxiliary Views, Limits, Tolerance and Fits, Relative magnitude of IT tolerances, Fundamental deviations, method of placing limit dimensions – Surface Roughness – Blueprint reading.		
UNIT - II	**JOINTS AND COUPLINGS**	**(20 Periods)**
Riveted Joints – Threads - Bolts and Nuts -Welded Joints - Shafts, Keys, Cotter and Pin Joints - Couplings and Clutches.		
UNIT – III	**PREPARATION OF ASSEMBLY DRAWING**	**(35Periods)**
Cotter joint, knuckle joint, flange coupling, universal coupling, footstep bearing, Plummer block, connecting rod end, screw jack, lathe tailstock, stop valves – study on industrial drawings.		
UNIT – IV	**AUTOCAD**	**(10 Periods)**
Basic tools and commands of AutoCAD, line types, dimensioning, 2D drawing of machine components.		
Contact periods: **Lecture: 0 Periods Tutorial: 0 Periods Practical: 90 Periods Total:90 Periods**		

TEXT BOOKS:

1	*Ajeet Singh, "**Machine Drawing**" Tata McGraw-Hill - 2010*
2	*K.L. Narayana, P. Kannaiah, K. Venketa Reddy- "**Machine Drawing**", New Age International Pvt Ltd Publishers (2016)*

REFERENCES:

1	*Gopalakrishna K.R., "**Machine Drawing**", Subhas Publishers, Bangalore, 2017.*
2	*Bhatt.N.D, "**Machine Drawing**", Chorotar Publishing House, 2014.*
3	*Gill.P.S., "**Text Book of Machine Drawing**", S.K. Kataria& Sons, Publishers & Distributors, Delhi, 2013.*
4	*James D. "**Engineering Graphics with AutoCAD 2002**", Pearson Education, 2019*
5	*Amit Bhatt, "**AutoCAD 2022 Beginners Guide**", CADFolks, Year: 2021*

COURSE OUTCOMES: On completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Select proper joint for products design	K3
CO2	Understand and initiate proper standards and codes	K3
CO3	Use proper symbols and select proper tolerance values for appropriate applications	K3
CO4	Communicate effectively in Industries through assembly drawing	K3
CO5	Develop the better drawing using Auto CAD software (blueprint) with full technical details as required	K3

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping														
COs/POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO1	3	2	2	1	1	2	0	1	1	3	2	1	2	2	-
CO2	3	1	2	2	1	3	2	1	2	3	2	1	2	2	-
CO3	3	1	2	2	1	3	2	1	2	3	3	1	2	2	-
CO4	3	1	1	1	1	2	2	2	2	3	3	1	2	2	-
CO5	3	1	1	1	1	2	2	2	2	3	3	1	2	2	-
22MPC304	3	1	2	1	1	2	2	1	2	3	3	1	2	2	-
1 – Slight, 2 – Moderate, 3 – Substantial															

b) CO and Key Performance Indicators Mapping	
CO1	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.1.3,2.3.1, 2.3.2, 2.4.2, 3.1.1, 3.1.4, 3.1.6, 3.2.2, 3.3.1, 4.2.2, 4.3.4, 5.1.1, 5.3.1, 8.2.1, 9.1.1, 9.1.2, 10.1.1,10.1.2, 10.1.3, 10.2.2, 10.3.1, 11.1.1,11.1.2, 11.3.1, 12.1.2
CO2	1.1.1,1.1.2,1.3.1,1.4.1,2.1.2,2.2.4,2.3.2,2.4.1,3.1.1,3.1.4,3.1.6,3.2.3,3.3.2,4.1.4,4.2.1,4.3.3,5.1.1,5.2.2,6.1.1,6.2.1,7.1.1,7.2.2,8.2.1,9.1.1,9.1.2,9.2.4,10.1.1,10.1.2,10.1.3,10.2.2,10.3.1, 11.1.1,11.1.2,11.3.1,12.2.1,12.3.2
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.2,2.2.4,2.3.2,2.4.1,3.1.1,3.1.4,3.1.6,3.2.3,3.3.2,4.1.4,4.2.1,4.3.3,5.1.1,5.2.2,6.1.1,6.2.1,7.1.1,7.2.2,8.2.1,9.1.1,9.1.2,9.2.4,10.1.1,10.1.2,10.1.3,10.2.2,10.3.1,11.1.1,11.1.2,11.2.1,11.3.1,12.2.1,12.3.2
CO4	1.1.1,1.1.2,1.3.1,1.4.1,2.2.2,3.1.1,3.1.4,3.1.6,4.1.3,5.1.2,5.3.2,6.1.1,7.1.2,7.2.1,8.2.1,8.2.2,9.1.1,9.1.2,9.2.1,10.1.1,10.1.2,10.1.3,10.2.2,10.3.1,11.1.1,11.1.2,11.2.1,11.3.1,12.1.1,12.3.2
CO5	1.1.1,1.1.2,1.3.1,1.4.1,2.2.2,3.1.1,3.1.4,3.1.6,4.1.3,5.1.2,5.3.2,6.1.17.1.2,7.2.1,8.2.1,8.2.2,9.1.1,9.1.2,9.2.1,10.1.1,10.1.2,10.1.3,10.2.2,10.3.1,11.1.1,11.1.2,11.2.1,11.3.1,12.1.1,12.3.2

22MBS408	PROBABILITY AND STATISTICS	SEMESTER IV

PREREQUISITES	CATEGORY	L	T	P	C
NIL	BS	3	1	0	4

Course Objectives	The main objective of this course is to provide students with the foundations of probabilistic and statistical methods and analysis techniques mostly used in various applications in engineering and science like modeling of processes and predictions based on processes.	
UNIT – I	**PROBABILITY AND RANDOM VARIABLES**	**(9+3 Periods)**
Sample spaces–Events-Probability Axioms–Conditional Probability–Independent Events–Total Probability-Baye'stheorem. Random Variables: Distribution Functions–Expectation–Moments -Moment Generating Functions.		
UNIT – II	**PROBABILITY DISTRIBUTIONS**	**(9+3 Periods)**
Discrete function: Binomial, Poisson, Geometric-Continuous function: Uniform, Exponential, Normal, Gamma, Weibull (Mean, Variance and Simple problems).		
UNIT – III	**TESTING OF HYPOTHESIS**	**(9+3 Periods)**
Large samples: Tests for Mean and proportions– Small samples: Tests for Mean, Variance and Attributes using t,F,Chi–Square distribution..		
UNIT – IV	**DESIGN OF EXPERIMENTS**	**(9+3 Periods)**
Analysis of variance (ANOVA) for One-way classification, two-way classification and Latin Square Design.		
UNIT – V	**STATISTICAL QUALITY CONTROL**	**(9+3 Periods)**
Statistical basis for control charts–Control limits– Control charts for variables:$\overline{X}$, RCharts–Control chart for defective :p,np Chart-Control chart for defects: ccharts.		
Contact Periods: **Lecture: 45 Periods Tutorial: 15 Periods Practical: 0 Periods Total: 60 Periods**		

TEXT BOOKS:

1	*Veerarajan.T,* ***"Probability and Statistics, Random Processes and Queuing Theory and Queuing Networks''****, Second reprint 2016, McGraw Hill Education (India) Private Limited.*
2	*Shelton M.Ross,* ***"Introduction to Probability and Statistics for Engineers and Scientists"****Sixth edition, 2021, Elsevier.*

REFERENCES:

1	*Gupta S.C and Kapoor V.K,* ***"Fundamentals of Mathematical Statistic''****, Sultan Chand & Sons, New Delhi.Reprint 2015.*
2	*Gupta S.P,* ***"Statistical Methods''****, Sultan Chand & Sons, New Delhi.Reprint 2015.*
3	*Douglas C. Montgomery and George C. Runger,* ***"Applied Statistics and Probability for Engineers'' (6th edition)****, 2016, John Wiley & Sons.*
4	*Hwei Hsu,* ***"Schaum's Outline of Probability, Random Variables and Random Processes''****, 2017, McGraw Hill Education.*
5	*Roy D Yates,* ***"Probability and Stochastic Processes a friendly introduction for Electrical and Computer engineers"****, John Wiley & sons, third edition 2015.*

COURSE OUTCOMES: On completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Obtain the concept of probability and the general discrete probability distribution function and continuous probability distribution function.	K3
CO2	Explain the some probability mass functions and probability density functions.	K3
CO3	Describe hypothesis testing in general and in practice.	K3
CO4	Interpret the F probability distribution as the number of groups and the sample size change. Conduct and interpret one-way, two-way and Latin square ANOVA.	K3
CO5	Acquire knowledge on the traditional statistical quality control methods and develop charting techniques.	K3

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2
CO1	3	3	2	2	-	-	-	-	-	-	-	2	-	1
CO2	3	3	2	2	-	-	-	-	-	-	-	2	-	1
CO3	3	3	2	2	-	-	-	-	-	-	-	2	-	1
CO4	3	3	2	2	-	-	-	-	-	-	-	2	-	1
CO5	3	3	2	2	-	-	-	-	-	-	-	2	-	1
22MBS3XX	3	3	2	2	-	-	-	-	-	-	-	2	-	1

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1, 1.1.2, 2.1.1, 2.1.3, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 2.4.4, 2.4.4, 12.2.1
CO2	1.1.1, 1.1.2, 2.1.1, 2.1.3, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 2.4.4, 2.4.4, 12.2.1
CO3	1.1.1, 1.1.2, 2.1.1, 2.1.3, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 2.4.4, 2.4.4, 12.2.1
CO4	1.1.1, 1.1.2, 2.1.1, 2.1.3, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 2.4.4, 2.4.4, 12.2.1
CO5	1.1.1, 1.1.2, 2.1.1, 2.1.3, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 2.4.4, 2.4.4, 12.2.1

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	50	30	-	-	-	100
CAT2	20	50	30	-	-	-	100
Individual Assignment1 /Case Study1 /Seminar 1 /Project 1	20	50	30	-	-	-	100
Individual Assignment2 /Case Study2 /Seminar 2 /Project 2	20	50	30	-	-	-	100
ESE	20	50	30	-	-	-	100

22MPC405	HYDRAULICS AND PNEUMATIC CONTROLS	SEMESTER IV

PREREQUISITES	CATEGORY	L	T	P	C
1. FLUID MECHANICS AND MACHINERY	PC	3	0	0	3

Course Objectives	To develop a measurable degree of competence in the design, construction and operation of fluid power	
UNIT – I	**FLUID POWER SYSTEMS AND HYDRAULIC PUMPS**	**(9 Periods)**
Introduction to fluid power - Advantages of fluid power- Application of fluid power system - Types of fluid power systems - Properties of hydraulic fluids – types of fluids – Fluid power symbols - Basics of hydraulics – Applications of Pascal's Law - Losses in pipe, valves and fittings - Pumping theory – Pump classification – Gear, Vane and piston pumps - construction and working of pumps – pump Selection.		
UNIT – II	**HYDRAULIC CONTROL COMPONENTS AND ACTUATORS**	**(9 Periods)**
Pressure, Flow and Directional control valves - Actuators: Linear hydraulic actuators – Types of hydraulic cylinders – Single acting, double acting special cylinders like Tandem, Rod less, Telescopic - Cushioning mechanism - Construction of double acting cylinder - Rotary actuators - Gear, Vane and Piston motors.		
UNIT – III	**DESIGN OF HYDRAULIC CIRCUITS**	**(9 Periods)**
Reciprocating- sequencing – synchronizing - series and parallel circuits – regenerative – pump unloading – double pump circuits – Drilling, Planning, Shaping, Surface grinding hydraulic circuits - Fork Lift application circuit - Intensifier circuits - Fail-safe circuits - Accumulators –Types of Accumulators – Application circuits.		
UNIT – IV	**PNEUMATIC SYSTEMS AND COMPONENTS**	**(9 Periods)**
Properties of air – Compressors – Filter, Regulator, and Lubricator Unit – Air control valves, Quick exhaust valves, and pneumatic actuators- Control elements – position- pressure sensing – switching- Speed control circuits – Pneumo - hydraulic circuit - Sequential circuit design for simple applications using cascade method, step counter method - Selection of components for pneumatic systems.		
UNIT – V	**ADVANCEMENTS IN FLUID POWER ENGINEERING**	**(9 Periods)**
Need of automations in industries – PLC - Components of PLC – Applications - Operating Cycle - Types of Programming Languages - Ladder logic diagram – Simple Problems. Servo and proportional valves - Construction, types and applications - Industrial internet of things for monitoring control and diagnostics of systems for fluid power applications.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*Anthony Esposito,* ***"Fluid Power with Applications"****, Pearson Education Inc. 2011*
2	*Majumdar S.R.,* ***"Pneumatic systems – Principles and maintenance"****, Tata McGraw-Hill, 2006*

REFERENCES:

1	*Michael J., Pinches and John G.Ashby,* ***"Power Hydraulics"****, Prentice Hall, 1989.*
2	*Lal,* ***"Oil hydraulics in the service of industry"****, Allied publishers, 1982.*
3	*James L. Johnson,* ***"Introduction to Fluid Power"****, Delmar/Thomson Learning,2003.*
4	*John J. Pippenger and Tyler G Hicks,* ***"Industrial Hydraulics"****, McGraw Hill Book Co., 1979.*
5	***"Industrial Hydraulics Manual"*** *5 th Edition, Eaton Hydraulics Training Services, 2008.*

COURSE OUTCOMES: On completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Identify fluid power systems and select the appropriate pumps for industrial applications.	K3
CO2	Demonstrate the applicability of hydraulic power systems for engineering applications.	K3
CO3	Design customized circuits in hydraulics for various industrial needs.	K3
CO4	Choose pneumatic systems and demonstrate the applicability of pneumatic power systems on real life applications.	K3
CO5	Apply and analyze failure of fluid power systems and to solve them using IoT.	K3

COURSE ARTICULATION MATRIX:

COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O 3**
CO1	2	2	3	2	2	2	2	-	-	-	2	2	2	2	2
CO2	2	2	3	2	2	2	2	-	-	-	2	2	2	2	2
CO3	3	2	3	2	2	2	2	-	-	-	2	2	2	2	2
CO4	2	2	3	2	2	2	2	-	-	-	2	2	2	2	2
CO5	2	2	3	2	2	2	2	-	-	-	2	2	2	2	2
22MPC405	2	2	3	2	2	2	2	-	-	-	2	2	2	2	2
1 – Slight, 2 – Moderate, 3 – Substantial															

b) CO and Key Performance Indicators Mapping	
CO1	1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.2.3, 2.2.4, 2.3.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.2,3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 4.1.1, 4.2.1,4.2.2, 4.3.1, 4.3.2, 5.1.1, 5.1.2, 5.2.1, 5.2.1, 5.2.2, 6.1.1, 7.1.1, 7.2.2, 11.1.1, 11.3.1, 11.3.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO2	1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.2.3, 2.2.4, 2.3.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.2,3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 4.1.1, 4.2.1,4.2.2, 4.3.1, 4.3.2, 5.1.1, 5.1.2, 5.2.1, 5.2.1, 5.2.2, 6.1.1, 7.1.1, 7.2.2, 11.1.1, 11.3.1, 11.3.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO3	1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.2.3, 2.2.4, 2.3.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.2,3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 4.1.1, 4.2.1,4.2.2, 4.3.1, 4.3.2, 5.1.1, 5.1.2, 5.2.1, 5.2.1, 5.2.2, 6.1.1, 7.1.1, 7.2.2, 11.1.1, 11.3.1, 11.3.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO4	1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.2.3, 2.2.4, 2.3.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.2,3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 4.1.1, 4.2.1,4.2.2, 4.3.1, 4.3.2, 5.1.1, 5.1.2, 5.2.1, 5.2.1, 5.2.2, 6.1.1, 7.1.1, 7.2.2, 11.1.1, 11.3.1, 11.3.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO5	1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.2.3, 2.2.4, 2.3.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.2,3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 4.1.1, 4.2.1,4.2.2, 4.3.1, 4.3.2, 5.1.1, 5.1.2, 5.2.1, 5.2.1, 5.2.2, 6.1.1, 7.1.1, 7.2.2, 11.1.1, 11.3.1, 11.3.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2

ASSESSMENT PATTERN							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40	30	30				100
CAT2	40	30	30				100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	40	30	30				100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	40	30	30				100
ESE	40	30	30				100

22MPC406	KINEMATICS OF MACHINES	SEMESTER IV

PREREQUISITES	CATEGORY	L	T	P	C
1. ENGINEERING GRAPHICS 2.APPLIED ENGINEERING MECHANICS	PC	3	0	0	3

Course Objective	To familiarize students with the basic of mechanisms, friction drives, to build confidence on the basics of cams, gear theory and its nomenclature.	
UNIT – I	**BASICS OF MECHANISMS**	**(9 Periods)**
Terminology and Definitions- Degree of freedom, mobility-Kutzbach criterion- Grashoff's law- Gruebler's criterion - Mechanical Advantage -Transmission angle – Coupler curves - Kinematic Inversions of 4- bar chain and slider crank chains - Description of common mechanisms -- Ratchets and pawl mechanisms- Indexing mechanisms - Rocking mechanisms - Straight line generators – Steering mechanisms		
UNIT – II	**KINEMATIC ANALYSIS**	**(9 Periods)**
General plane motion - Relative velocity method – Displacement, velocity and acceleration analysis in simple mechanisms - Instantaneous center method, Kennedy theorem – Coincident points – Coriolis component of acceleration Klein's construction for slider crank chain. Synthesis of Mechanism-four bar mechanism only -Inversion method		
UNIT – III	**FRICTION DRIVES**	**(9 Periods)**
Belt and rope drive – Open and cross belt drive – Belt materials – Creep and slip - Ratio of tensions – Effect of centrifugal force – condition for maximum power – Friction in Journal Bearing - Flat pivot bearing - Friction clutches – Single plate – Multi plate – Cone clutches-Brakes - Shoe brake and Internal Expanding brake only.		
UNIT – IV	**CAMS**	**(9 Periods)**
Classifications - Displacement diagrams - Uniform velocity, simple harmonic, uniform acceleration and retardation and cycloidal motions – Graphical layout of plate cam profiles – Derivatives of follower motion – High speed cams – Cams with specified contours - unbalance and wind up - Pressure angle and undercutting – spring surge, jump speed - Analysis of cam.		
UNIT – V	**GEARS**	**(9 Periods)**
Introduction – Types – Terminology – Law of toothed gearing – Velocity of sliding – Involute and cycloidal tooth profiles – Interchangeable gears – Length of path and arc of contact – contact ratio – Interference and under cutting – Minimum number of teeth to avoid interference in pinion and gear – Nonstandard gear teeth. Gear trains –Simple, compound, reverted and epicyclic gear trains – Differentials. Multi speed gear boxes – Speed ratio - Kinematic arrangement – Ray diagram.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*Thomas Bevan, "**Theory of Machines**", Pearson Education Limited, 2010*
2	*Rattan S S, "**Theory of Machines**", Tata mcgraw -Hill Publishers, New Delhi, 2009.*

REFERENCES:

1	*Uicker, J.J., Pennock, G.R and Shigley, J.E., "**Theory of Machines and Mechanisms**", Oxford University Press,New Delhi, 2009.*
2	*Ghosh, A., and Mallick, A.K., "**Theory of Mechanisms and Machines**", Affiliated eastwestpvt. Ltd., New Delhi, 2006.*

3	*Rao, J.S., and Dukkipati, R.V, "**Mechanism and Machine Theory**", New Age International (P) Ltd Publishers. New Delhi, 2007.*
4	*Khurmi, R.S., and Gupta, J.K., "**Theory of Machines**", S.Chand& Company, 2009.*
5	*Norton L Robert, "**Kinematics and Dynamics of Machinery**", Mcgraw Hill, Higher Education, 2009.*

COURSE OUTCOMES: On completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Apply the fundamental concepts in developing various mechanisms	K2
CO2	Synthesis of mechanisms for given conditions.	K3
CO3	Select appropriate type of friction drives gear for a specific application.	K3
CO4	Construct the cam profile for specific follower motion.	K3
CO5	Determine appropriate gears for requirements. Compute the parameters in gear trains and determine the speeds in gear boxes.	K3

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

COs/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	2	2	2	2	2	-	-	-	1	-	-	3	2	2	3
CO2	2	2	3	3	2	-	-	-	1	-	-	3	2	2	3
CO3	2	2	3	3	2	-	-	-	1	-	-	3	2	2	3
CO4	2	2	3	3	2	-	-	-	1	-	-	3	2	2	3
CO5	2	2	3	3	2	-	-	-	1	-	-	3	2	2	3
22MPC406	2	2	3	3	2	-	-	-	1	-	-	3	2	2	3
1 – Slight, 2 – Moderate, 3 – Substantial															

b) CO and Key Performance Indicators Mapping

CO1	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1
CO2	3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2
CO3	4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2
CO4	4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2
CO5	4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	30	30	20			100
CAT2	20	30	30	20			100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	20	30	30	20			100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	20	30	30	20			100
ESE	20	30	30	20			100

22MPC407	THERMAL ENGINEERING	SEMESTER IV

PREREQUISITES	CATEGORY	L	T	P	C
1. THERMODYNAMICS	PC	3	0	0	3

Course Objectives	To acquire keen knowledge on Thermal devices like IC Engines, Refrigerators, Boilers, Compressors, Nozzles and Turbines.	
UNIT – I	**AIR STANDARD CYCLES**	**(9 Periods)**
Air standard cycles - Carnot cycle, Otto cycle, Diesel cycle, Stirling cycle, Ericsson cycle, Dual cycle – Calculation of Mean Effective Pressure and Air Standard Efficiency – Comparison of Otto, Diesel, Dual and Brayton cycle. Brayton cycle.		
UNIT – II	**INTERNAL COMBUSTION ENGINES**	**(9 Periods)**
SI and CI Engines - Classification - Components and their Function - Valve Timing Diagram and Port Timing Diagram - Actual and Theoretical P-V Diagram of Four Stroke and Two Stroke Engines - Simple Carburettor - MPFI, Diesel Pump and Injector System - Ignition Systems - Principles of Combustion and Knocking in SI and CI Engines - Lubrication and Cooling Systems - Performance Characteristics and Testing of IC Engines - Emissions and Emission Control.		
UNIT – III	**REFRIGERATION**	**(9 Periods)**
Methods of Refrigeration-applications - Air Refrigeration Systems-Methods-Introduction, Heating load, Concept of Heat Engine, Refrigerator and Heat Pump. Refrigerants- Introduction, designation, types, properties. Vapour Compression Refrigeration Systems - Introduction, Simple VCR system- Cascade system. – Introduction, Simple Vapour Absorption Refrigeration system, Thermo-electric and Vortex tube refrigeration.		
UNIT – IV	**BOILERS AND COMPRESSORS**	**(9 Periods)**
Steam Generators – Classification of Boilers, Selection of a Boiler, Boiler Terms, High Pressure Boilers Fire Tube Boilers – Simple Vertical Boiler, Water Tube Boilers – Babcock and Wilcox, Boiler Mountings and Accessories. Compressed air system – Introduction, Compressor types, Reciprocating and Rotary Compressors Compressor performance, Compressed air system components, Compressor capacity assessment.		
UNIT – V	**NOZZLES AND TURBINES**	**(9 Periods)**
Flow through Nozzles, Shape of Nozzle, effect of Friction, Critical Pressure Ratio, super saturated flow. Turbines - Pelton wheel, Kaplan and Francis Turbines, velocity diagrams, Impulse and Reaction principles, Steam and Gas Turbines.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*Yunus A Cengel, Michael A Boles., "**Thermodynamics: An Engineering Approach**", McGraw Hill Publications, 8th Edition, 2017.*
2	*Mahesh M Rathore., "**Thermal Engineering**" , McGraw Hill Education, 1st Edition, 2010*

REFERENCES:

1	*P.L. Ballaney., "**Thermal Engineering**", Khanna Publishers, 5th Edition, 2005.*
2	*R.K.Rajput., "**Thermal Engineering**", Lakshmi Publications, 10th Edition, 2015.*
3	*M. L. Mathur, F. S Mehta., "**Thermal Science and Engineering**", Jain Book Agency, 3rd Edition, 2015*
4	*J.W Jones, W.F Stoecker., "**Refrigeration and Air Conditioning**", Mc-Graw Hill Education, 2nd Edition 1982*
5	*B.U Pai., "**Turbo Machines**", Wiley Publications, 2nd Edition, 2013.*

COURSE OUTCOMES: On completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Analyse the Air Standard cycles.	K4
CO2	Understand the working of IC Engine.	K3
CO3	Identify the characteristics of Refrigeration and psychrometry.	K4
CO4	Apply the Thermodynamic Principles on Boilers and Air Compressors	K2
CO5	Describe working principle and process of Turbines and Nozzles	K2

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO1	3	2	2	2	3	2	1	1	-	2	2	2	2	1	3
CO2	1	1	2	3	1	-	3	1	1	2	-	1	2	2	3
CO3	3	2	2	3	3	3	1	1	1	1	2	1	2	2	2
CO4	3	2	2	3	3	-	2	1	-	1	2	1	3	2	1
CO5	3	2	1	2	1	2	-	1	1	2	-	2	3	2	2
22MPC407	3	2	2	3	3	2	2	1	1	2	2	2	2	2	2

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.3, 2.2.4, 2.3.1, 2.4.1, 2.4.2, 3.1.1, 3.1.2, 3.1.3, 3.1.6, 3.2.1, 3.3.1, 3.4.1, 3.4.2, 4.1.2, 4.2.1, 4.3.1, 4.3.3, 4.3.4, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2, 6.1.1, 7.2.2, 8.2.1, 10.1.2, 10.1.3, 10.3.1, 11.1.2, 11.2.1, 12.1.1, 12.2.2, 12.3.2.
CO2	1.1.2, 2.2.2, 2.4.4, 3.1.4, 3.1.5, 3.1.6, 3.2.2, 3.3.2, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.1.4, 4.2.1, 4.2.2, 4.3.2 4.3.3, 4.3.4, 5.1.2, 5.2.2, 7.1.1, 7.1.2, 7.2.1, 8.1.1, 9.2.1, 10.1.1, 10.1.2, 10.2.2, 12.1.1, 12.3.2.
CO3	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.3, 2.4.1, 2.4.4, 3.1.1, 3.1.2, 3.1.3, 3.1.5, 3.1.6, 3.2.1, 3.2.3, 3.3.1, 4.1.1, 4.1.2, 4.1.4, 4.2.1, 4.2.2, 4.3.1, 4.3.3, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2, 6.1.1, 6.2.1, 7.2.1, 8.1.1, 9.1.1, 9.2.4, 10.1.3, 10.3.1, 11.1.2, 11.2.1, 11.3.1, 12.1.2, 12.2.1.
CO4	1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.2.1, 2.2.4, 2.3.1, 2.3.2, 2.4.2, 3.1.1, 3.1.3, 3.2.1, 3.2.2, 3.3.2, 3.4.1, 3.4.2, 4.1.4, 4.2.1, 4.2.2, 4.3.1, 4.3.3, 4.3.4, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2, 7.1.2, 7.2.2, 8.1.1, 10.2.2 11.1.1, 11.3.2, 12.2.2, 12.3.1.
CO5	1.1.1, 1.1.2, 1.3.1, 1.4.1, 2.1.1, 2.1.3, 2.2.3, 2.4.1, 2.4.4, 3.1.6, 3.2.1, 4.1.1, 4.1.4, 4.2.1, 4.3.1, 4.3.4, 5.1.1, 5.3.2, 6.2.1, 8.2.1, 9.1.2, 10.1.2, 10.2.1, 10.3.1, 12.1.1, 12.1.2,12.3.2.

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	30	25	15	10		100
CAT2	20	30	25	15	10		100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	15	35	30	10	10		100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	15	35	30	10	10		100
ESE	20	30	30	10	10		100

22MPC408	MANUFACTURING TECHNOLOGY II	SEMESTER IV

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	3	0	0	3

Course Objectives	To understand the metal cutting theory, mechanism of conventional and non-conventional machining process to make quality product.	
UNIT – I	**THEORY OF METAL CUTTING**	**(9 Periods)**
Mechanics of chip formation – forces in machining – types of chips – cutting tools – single point cutting tool nomenclature – orthogonal and oblique metal cutting – thermal aspects – cutting tool materials – tool wears – tool life – surface finish – cutting fluids and machinability.		
UNIT – II	**LATHE, SHAPING AND PLANING MACHINES**	**(9 Periods)**
Lathe – construction – types – operations – working principle of single and multi - spindle automats – shaping and planning machines – principle – types – construction - mechanism – different shaping operations – work holding devices, introduction to CNC – applications of CNC in various industrial applications		
UNIT – III	**DRILLING, BROACHING AND GRINDING MACHINES**	**(9 Periods)**
Drilling machines – specifications, types - feed mechanism, operations – drill tool nomenclature – broaching – specifications, types, tool nomenclature, broaching operations – grinding – types of grinding machines – grinding wheels, specifications – bonds – mounting and reconditioning of grinding wheels.		
UNIT – IV	**MILLING AND GEAR GENERATING MACHINES**	**(9 Periods)**
Milling – specifications – types - cutter nomenclature – types of cutters – milling processes – indexing – gear forming in milling – gear generation - gear shaping and gear hobbing – specifications - cutters –coated tools & inserts- cutting spur and helical gears - bevel gear generators – gear finishing methods.		
UNIT – V	**NON-CONVENTIONAL MACHINING**	**(9 Periods)**
Classification of machining processes - process selection - Electrical discharge machining – abrasive jet machining – water jet machining - laser beam machining – electron beam machining – plasma arc machining.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*SeropeKalpakjian Steven R. Schmid ,* ***"Manufacturing processes for Engineering Materials"****6th Edition, Pearson India, 2018*
2	*HajraChoudhry S.K. and Bose S.K.,* ***"Workshop Technology Vol II"****, Media Promoters and Publishers Pvt. Ltd., Bombay, 2010*

REFERENCES:

1	*Sharma P.C.,* ***"A Text Book of Production Technology",*** *S.Chand& Company Ltd., New Delhi, 10th Revised edition, 2010*
2	*P.N. Rao,* ***"Manufacturing Technology—Metal Cutting and Machine Tools"****, McGraw Hill 4th edition, 2018*
3	*R.K. Rajput,* ***" A Text Book of Manufacturing Technology"****, lakshmiPublication, 2019*
4	*HMT* ***"Production Technology",*** *HMT publication, 2017*
5	*Richerd R Kibbe, John E. Neely, Roland O. Merges and Warren J.White****"Machine Tool Practices"****, Prentice Hall of India, 2019*

COURSE OUTCOMES: On completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Apply the theory of metal cutting to solve the problems in industries	K3
CO2	Understand the operating mechanism of lathe, shaping, planning and CNC	K3
CO3	Gain knowledge on drilling, boring, grinding machine.	K3
CO4	Familiarize the milling and gear generation process and its uses in industries	K3
CO5	Identify a suitable non-conventional machining process for specific application.	K3

COURSE ARTICULATION MATRIX:

COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	1	1	2	-	-	1	1	-	-	-	1	1	2	1	1
CO2	1	1	2	-	-	1	1	-	-	-	1	1	2	1	1
CO3	1	1	2	-	-	1	1	-	-	-	1	1	2	1	1
CO4	1	1	2	-	-	1	1	-	-	-	1	1	2	1	1
CO5	1	1	2	-	-	1	1	-	-	-	1	1	2	1	1
22MPC408	1	1	2	-	-	1	1	-	-	-	1	1	2	1	1

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.3.1,1.4.1,2.1.2,2.13,2.2.3,2.2.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.2.1,3.2.2,3.2.3,6.1.1,6.2.1,7.1.1,7.1.2,7.2.1 ,11.1.1,11.1.2,11.3.1,11.3.2,12.1.1,12.1.2,12.2.1,12.2.2,12.3.2
CO2	1.3.1,1.4.1,2.1.2,2.13,2.2.3,2.2.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.2.1,3.2.2,3.2.3,6.1.1,6.2.1,7.1.1,7.1.2,7.2.1 ,11.1.1,11.1.2,11.3.1,11.3.2,12.1.1,12.1.2,12.2.1,12.2.2,12.3.2
CO3	1.3.1,1.4.1,2.1.2,2.13,2.2.3,2.2.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.2.1,3.2.2,3.2.3,6.1.1,6.2.1,7.1.1,7.1.2,7.2.1 ,11.1.1,11.1.2,11.3.1,11.3.2,12.1.1,12.1.2,12.2.1,12.2.2,12.3.2
CO4	1.3.1,1.4.1,2.1.2,2.13,2.2.3,2.2.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.2.1,3.2.2,3.2.3,6.1.1,6.2.1,7.1.1,7.1.2,7.2.1 ,11.1.1,11.1.2,11.3.1,11.3.2,12.1.1,12.1.2,12.2.1,12.2.2,12.3.2
CO5	1.3.1,1.4.1,2.1.2,2.13,2.2.3,2.2.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.2.1,3.2.2,3.2.3,6.1.1,6.2.1,7.1.1,7.1.2,7.2.1 ,11.1.1,11.1.2,11.3.1,11.3.2,12.1.1,12.1.2,12.2.1,12.2.2,12.3.2

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	40	30				100
CAT2	30	40	30				100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	30	40	30				100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	30	40	30				100
ESE	30	40	30				100

22MPC409	MECHANICAL MEASUREMENTS AND CONTROL	SEMESTER IV

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	3	0	0	3

Course Objectives	To comprehend about measurement systems and their components, learn about various sensors used for measurement of mechanical quantities and to integrate the measurement systems for process monitoring and control.	
UNIT – I	**FUNDAMENTAL AND MEASUREMENTS FORCE, TORQUE**	**(9 Periods)**
Fundamental Methods of Measurements – Generalized Measuring System – Measurement Standards– Units and Standards – Types of Error – Uncertainty, Estimation of Precision Uncertainty – Strain measurements – Electrical/Metallic Resistance – Strain Gauge - Strain Gauge Ballast / Bridge circuit – Temperature compensation – Calibration – Stress - Strain Relationships – Mechanical Weighing Systems – Elastic Transducers – Load Cells – Ballistics Weighing – Torque Measurement: Mechanical / Electric / Transmission Dynamo-meters -Piezo electric Sensors – Semiconductor sensors – Hall Effects Sensors.		
UNIT –II	**MEASUREMENT OF PRESSURE AND FLUID FLOW**	**(9 Periods)**
Static and Dynamic Pressures – Pressure Measuring Transducers – Gravitational Type Transducers – Elastic Diaphragms – Strain Gauge Pressure Cells – Measurements of Low / High Pressures. Flow Characteristics – Obstruction Meters – Flow Meters - Thermal Anemometry – Doppler shift Measurement.		
UNIT – III	**MEASUREMNT OF TEMPERATURE AND MOTION**	**(9 Periods)**
Bimetal Temperature sensing Elements – Pressure Thermometers – Thermo resistive elements – Thermocouples – Semiconductor – Junction Temperature Sensors – Pyrometry – Measurement of Heat Flux. Vibrometers – Accelerometers – Seismic Instrument – Seismic Accelerometer.		
UNIT – IV CONTROL SYSTEMS		**(9 Periods)**
Elements of Control systems- Concept of open loop and closed loop-Transfer function (definition)- mechanical translational systems,mechanical rotational systems, Electrical systems-Block diagram reduction		
UNIT – V	**SYSTEM MODELS**	**(9 Periods)**
Time response of First and Second order systems (critically damped, undamped, underdamped, over damped) (derivation and problems alone) - time domain & frequency domain specifications (terminologies, definition and formula alone) steady state error - static and dynamic. PID - elementary introduction.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical:0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*Thomas G. Beckwith.,* ***"Mechanical Measurements",*** *Pearson Education India, Revised 6th Edition, 2020.*
2	*William Bolton, "****Instrumentation and Control Systems,"*** *Newnes,3rd Edition ,2021*

REFERENCES:

1	*A.K. Sawhney, PuneetSawhney "****A Course in mechanical measurements and Instrumentation and Control",*** *DhanapatRai& Co, 2012*
2	*S. K. Singh, "****Industrial Instrumentation and Control****", McGraw Hill, 3rd Edition, 2016*
3	*Er. R.K. Jain., "****Mechanical and Industrial Measurements",****Khanna Publishers, 2017*
4	*J. P. Holman****, "Experimental methods for engineers"****,8th edition, Tata McGraw-Hill, 2015*

COURSE OUTCOMES: On completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Familiarize the basic principle and measurement of force and torque.	K3
CO2	Identify to measure the pressure and fluid flow of a system	K3
CO3	Select the suitable instrument to measure temperature and motion	K3
CO4	Familiarize the basic concept in control system	K3
CO5	Identify the mechanical system model equivalent to instrumentation	K3

COURSE ARTICULATION MATRIX:

COs/POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO1	2	1	1	2	-	-	1	-	-	-	-	1	2	1	-
CO2	2	1	1	2	-	-	1	-	-	-	-	1	2	1	-
CO3	2	1	1	2	-	-	1	-	-	-	-	1	2	1	-
CO4	2	1	1	2	-	-	1	-	-	-	-	1	2	1	-
CO5	2	1	1	2	-	-	1	-	-	-	-	1	2	1	-
22MPC409	2	1	1	2	-	-	1	-	-	-	-	1	2	1	-
1 – Slight, 2 – Moderate, 3 – Substantial															

b) CO and Key Performance Indicators Mapping

CO1	1.2.1,1.3.1,1.4.1,2.1.2,2.1.3,2.4.2,2.4.3,3.1.5,3.1.6,4.1.2,4.1.3,4.1.4,4.3.1,12.1.1,12.1.2
CO2	1.2.1,1.3.1,1.4.1,2.1.2,2.1.3,2.4.2,2.4.3,3.1.5,3.1.6,4.1.2,4.1.3,4.1.4,4.3.1,12.1.1,12.1.2
CO3	1.2.1,1.3.1,1.4.1,2.1.2,2.1.3,2.4.2,2.4.3,3.1.5,3.1.6,4.1.2,4.1.3,4.1.4,4.3.1,12.1.1,12.1.2
CO4	1.2.1,1.3.1,1.4.1,2.1.2,2.1.3,2.4.2,2.4.3,3.1.5,3.1.6,4.1.2,4.1.3,4.1.4,4.3.1,12.1.1,12.1.2
CO5	1.2.1,1.3.1,1.4.1,2.1.2,2.1.3,2.4.2,2.4.3,3.1.5,3.1.6,4.1.2,4.1.3,4.1.4,4.3.1,12.1.1,12.1.2

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	40	30				100
CAT2	30	40	30				100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	30	40	30				100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	30	40	30				100
ESE	30	40	30				100

22MPC410	MANUFACTURING TECHNOLOGY LABORATORY	SEMESTER IV

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	0	0	3	1.5

Course Objectives	To provide an understanding of advanced manufacturing methods with idea of the dimensional & form accuracy of products.

LIST OF EXPERIMENTS

1. Facing, Step Turning, Taper Turning using Lathe.
2. External Thread Cutting. Groove Cutting, Knurling and Chamfering using Lathe.
3. Drilling and Counter Sinking using Lathe.
4. Drilling, Reaming, Tapping and Surface Grinding using Surface Grinder and Radial Drilling Machine.
5. External Cylindrical Grinding of Shaft.
6. V-Groove Cutting in Shaping Machine.
7. Spur Gear Milling.
8. Helical Gear Milling in Universal Milling Machine.
9. Gear Shaping.
10. Gear Hobbing.
11. Making Hexagonal Hole using Slotting Machine.
12. Letter Cutting in Vertical Milling Machine.
13. CNC Part Programming for Machining of Facing, Step Turning, Taper Turning, Milling in CNC machine.

Contact Periods:
Lecture: 0 Periods Tutorial: 0 Periods Practical: 45 Periods Total: 45 Periods

COURSE OUTCOMES: On completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Have the capability of selecting suitable manufacturing processes to manufacture the products optimally.	K2
CO2	Maintain the accuracy & tolerance of components produced.	K4
CO3	Set up machines like lathe, shaper, grinding and milling machine for various applications.	K2
CO4	Prepare gears using forming and generating methods of gear manufacturing.	K3
CO5	Write the part programming and perform machining in CNC Machines.	K4

COURSE ARTICULATION MATRIX:

COs/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	2	1	2	2	2	2	1	1	-	-	-	2	1	1	1
CO2	2	2	1	3	3		1		1	-	-	2	1	2	3
CO3	2	2	2	2	2	2	2	1	1	-	-	2	3	2	3
CO4	2	2	2	2	2	2	1		1	-	-	2	3	3	2
CO5	2	1	1	1	2	-	-	-	-	-	-	2	2	1	1
22MPC410	2	2	2	2	2	2	1	1	1	-	-	2	2	2	2
1 – Slight, 2 – Moderate, 3 – Substantial															

b) CO and Key Performance Indicators Mapping	
CO1	1.1.1, 1.1.2, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.3, 2.3.1, 2.4.1, 2.4.2, 3.1.1, 3.1.2, 3.1.3, 3.1.6, 3.2.1, 3.3.1, 3.4.1, 4.1.2, 4.2.1, 4.3.1, 4.3.3, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2, 6.1.1, 7.2.2, 8.2.1, 10.1.2, 10.1.3, 10.3.1, 11.1.2, 11.2.1, 12.1.1, 12.2.2, 12.3.2.
CO2	1.1.2, 2.2.2, 2.4.4, 3.1.4, 3.1.5, 3.1.6, 3.2.2, 3.3.2, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.1.4, 4.2.1, 4.2.2, 4.3.2, 4.3.3, 4.3.4, 5.1.2, 5.2.2, 7.1.1, 7.1.2, 7.2.1, 8.1.1, 9.2.1, 10.1.1, 10.1.2, 10.2.2, 12.1.1, 12.3.2.
CO3	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.3, 2.4.1, 2.4.4, 3.1.1, 3.1.2, 3.1.3, 3.1.5, 3.1.6, 3.2.1, 3.2.3, 3.3.1, 4.1.1, 4.1.2, 4.2.1, 4.2.2, 4.3.1, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2, 6.1.1, 6.2.1, 7.2.1, 8.1.1, 9.1.1, 9.2.4, 10.1.3, 10.3.1, 11.1.2, 11.2.1, 11.3.1, 12.1.2, 12.2.1.
CO4	1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.2.1, 2.2.4, 2.3.1, 2.3.2, 2.4.2, 3.1.1, 3.1.3, 3.2.1, 3.2.2, 3.3.2, 3.4.1, 3.4.2, 4.1.4, 4.2.1, 4.2.2, 4.3.1, 4.3.3, 4.3.4, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2, 7.1.2, 7.2.2, 8.1.1, 10.2.2, 11.1.1, 11.3.2, 12.2.2, 12.3.1.
CO5	1.1.1, 1.1.2, 1.3.1, 1.4.1, 2.1.1, 2.1.3, 2.2.3, 2.4.1, 2.4.4, 3.1.6, 3.2.1, 4.1.1, 4.1.4, 4.2.1, 4.3.1, 4.3.4, 5.1.1, 5.3.2, 6.2.1, 8.2.1, 9.1.2, 10.1.2, 10.2.1, 10.3.1, 12.1.1, 12.1.2,12.3.2.

22MPC411	THERMAL ENGINEERING LABORATORY I	SEMESTER IV

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	0	0	3	1.5

Course Objectives	To demonstrate and analyze the performance characteristics of an internal combustion engines, compressors and blowers.

LIST OF EXPERIMENTS

1. Port timing diagram of single cylinder petrol engine.
2. Valve timing diagram of single cylinder diesel engine.
3. Performance test on variable compression ratio petrol and diesel engines.
4. Economic speed test on diesel engine.
5. Retardation test to find frictional power of a diesel engine.
6. Heat balance test on 4 stroke Diesel Engine.
7. Emission test on internal combustion engine.
8. Performance test on constant speed blower.
9. Performance test on variable speed blower.
10. Performance test on reciprocating air compressor.

Contact periods:
Lecture: 0 Periods Tutorial: 0 PeriodPractical: 45 PeriodsTotal: 45 Periods

COURSE OUTCOMES: On completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Understand the valve timing and port timing diagrams of IC engines	K2
CO2	Analyze the performance characteristics of petrol and diesel engines.	K4
CO3	Interpret the emission characteristics of internal combustion engines.	K4
CO4	Evaluate the performance parameters of blowers.	K5
CO5	Analyze the air compressor characteristics.	K4

COURSE ARTICULATION MATRIX:

COs/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	3	3	3	2	2	3	3	0	0	0	0	2	1	2
CO2	3	2	2	3	2	2	2	3	0	0	0	0	3	2	3
CO3	3	3	2	3	2	3	3	3	0	0	0	0	3	3	3
CO4	3	2	2	3	2	2	2	3	0	0	0	0	3	3	3
CO5	2	2	2	3	2	2	3	3	0	0	0	0	3	3	3
22MPC411	3	2	2	3	2	2	3	3	0	0	0	0	3	3	3
1 – Slight, 2 – Moderate, 3 – Substantial															

b) CO and Key Performance Indicators Mapping

CO1	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.3, 2.2.4, 2.3.1, 2.4.1, 2.4.2, 3.1.1, 3.1.2, 3.1.3, 3.1.6, 3.2.1, 3.3.1, 3.4.1, 3.4.2, 4.1.2, 4.2.1, 4.3.1, 4.3.3, 4.3.4, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2, 6.1.1, 7.2.2, 8.2.1, 10.1.2, 10.1.3, 10.3.1, 11.1.2, 11.2.1, 12.1.1, 12.2.2, 12.3.2.
CO2	1.1.2, 2.2.2, 2.4.4, 3.1.4, 3.1.5, 3.1.6, 3.2.2, 3.3.2, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.1.4, 4.2.1, 4.2.2, 4.3.2,4.3.3, 4.3.4, 5.1.2, 5.2.2, 7.1.1, 7.1.2, 7.2.1, 8.1.1, 9.2.1, 10.1.1, 10.1.2, 10.2.2, 12.1.1,12.3.2.
CO3	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.3, 2.4.1, 2.4.4, 3.1.1, 3.1.2, 3.1.3, 3.1.5, 3.1.6, 3.2.1, 3.2.3, 3.3.1, 4.1.1, 4.1.2, 4.1.4, 4.2.1, 4.2.2, 4.3.1, 4.3.3, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2, 6.1.1, 6.2.1, 7.2.1, 8.1.1, 9.1.1, 9.2.4, 10.1.3, 10.3.1, 11.1.2, 11.2.1, 11.3.1, 12.1.2, 12.2.1.
CO4	1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.2.1, 2.2.4, 2.3.1, 2.3.2, 2.4.2, 3.1.1, 3.1.3, 3.2.1, 3.2.2, 3.3.2, 3.4.1, 3.4.2, 4.1.4, 4.2.1, 4.2.2, 4.3.1, 4.3.3, 4.3.4, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2, 7.1.2, 7.2.2, 8.1.1, 10.2.2,

	11.1.1, 11.3.2, 12.2.2, 12.3.1.
CO5	1.1.1, 1.1.2, 1.3.1, 1.4.1, 2.1.1, 2.1.3, 2.2.3, 2.4.1, 2.4.4, 3.1.6, 3.2.1, 4.1.1, 4.1.4, 4.2.1, 4.3.1, 4.3.4, 5.1.1, 5.3.2, 6.2.1, 8.2.1, 9.1.2, 10.1.2, 10.2.1, 10.3.1, 12.1.1, 12.1.2,12.3.2.

22MEE401	ENGINEERING EXPLORATION	SEMESTER IV

PREREQUISITES	CATEGORY	L	T	P	C
NIL	EE	0	0	3	1.5

Course Objectives	The Students are able to understand the usages of Engineering and Technology in Social life and to learn the Project Management and its activities.	
UNIT – I	**INTRODUCTION TO ENGINEERING AND TECHNOLOGY**	**(15 Periods)**
Difference between Engineering and Technology, Degree(s) of Freedom, Comparison among Machines, Machine Tool and Machining Centres, Ethics and Sustainability, Professional Engineering Societies in India and Abroad, Welding Generators, Welding Electrodes, PPE used in Machine Shop, Occupational Safety and Health- Laboratory Practices using GI/Steel pipes on drilling, joining, cutting, thread making and printing.		
UNIT – II	**INTERDISCIPLINARY MECHANISM**	**(15 Periods)**
Fully Automated Washing Machine, Electronically controlled Fuel Injector, Usage of Arduino and Raspberry Boards in Robotics, Traffic Signal Lights, Home Automation, Usage of Python Programming in Automation, IoT enabled Working Mechanisms and relevant Case Studies.		
UNIT – III	**PROJECT MANAGEMENT**	**(15 Periods)**
Plan a project work using relevant Project Management Tools: Checklist, Timeline, GANTT Chart. Apply Documentation Skills to Prepare, Store and Share project Report-Case studies - Mini Project work at 'Thinkering Laboratory'.		
Contact Periods : **Lecture: 0 Periods Tutorial: 0 Periods Practical: 45 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*Hindustan Machine Tools, "**Production Technology",** Edition 2017.*
2	*O.P.Khanna ,**"Industrial Engineering And Management"**, DhanpatRai Publications, Edition 2018.*

REFERENCES:

1	*S.K.HajraChoudhury, "**Elements of Workshop Technology",** 14th Edition, Media Promoters and Publishers, 2007.*
2	*https://www.**manualslib.com**/manual/776758/Whirlpool-Washing-Machine.html.*
3	*http://**fcdesign.free.fr**/en/FiEcuManV4_060217.pdf.*
4	*https://www.**manualslib.com**/manual/1208079/Arduino-Uno.html.*
5	*Harsh Bhasin, "**Python For Beginners**", 1st Edition, New Age International (P) Ltd Publishers, 2019.*
6	*S.Buffa, "**Modern Production / Operations Management"**, Wiley Publications, 8th Edition, 2007.*

COURSE OUTCOMES: On completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Gain a holistic view of Engineering Profession in an Exploratory manner.	K3
CO2	Understand the importance of Interdisciplinary Skills in solving Engineering Problems.	K3
CO3	Learn the Engineering Design Concepts and Team Work with Sustainability.	K4

COURSE ARTICULATION MATRIX:

COs/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O 3
CO1	3	1	1	3	1	1	3	1	1	3	1	1	2	1	3
CO2	3	1	3	3	1	3	3	1	3	3	1	3	2	2	3
CO3	3	1	2	3	1	2	3	1	2	3	1	2	3	3	3
22MEE401	3	1	2	3	1	2	3	1	2	3	1	2	3	2	3
1 – Slight, 2 – Moderate, 3 – Substantial															
b) CO and Key Performance Indicators Mapping															
CO1	1.2.1, 9.1.1,9.1.32,9.2.1,9.2.2,9.2.3,9.2.4,9.3.1														
CO2	10.1.1,10.1.2,10.1.3,10.2.1,10.2.2,10.3.1,10.3.2														
CO3	11.1.1,11.1.2,11.2.1,11.3.1,11.3.2														