Scheme and Syllabus

B.TECH
(MECHANICAL ENGINEERING)

For Batch 2021 onwards

Department of Mechanical Engineering

Amritsar Group of Colleges, Amritsar

SCHEME OF B.TECH MECHANICAL ENGINEERING

3rd Semester	B.Tech (Mechanical Engineering)							
Course code	**Course Name**	**Load Allocation**			**Marks Distribution**		**Total Marks**	**Credit**
		L	**T**	**P**	**Internal**	**External**		
AGME - 21301	Applied Thermodynamics-I	3	1	-	40	60	100	4
AGME- 21302	Theory of Machines-I	3	1	-	40	60	100	4
AGME- 21303	Strength of Materials	3	1	-	40	60	100	4
AGME- 21304	Engineering Materials and Metallurgy	3	-	-	40	60	100	3
AGME- 21305	Manufacturing Processes	3	-	-	40	60	100	3
AGME- 21306	Strength of Materials Lab	-	-	2	30	20	50	1
AGME- 21307	Engineering Materials and Metallurgy Lab	-	-	2	30	20	50	1
AGME-21308	Manufacturing Processes Lab	-	-	2	30	20	50	1
AGFE - 21301	Functional English - I	-	1	-	50		50	1
AGMC-21301	Indian Constitution/ Essence of Indian Knowledge Tradition (Mandatory Course)	1	-	-	-	-	-	-
AGME-21309	Institutional Training(3rdsem)	-	-	2	60	40	100	1
		16	**4**	**8**	**400**	**400**	**800**	**23**
	Contact Hours	**28**						
AGMD-ME01	Elements of Mechanical Engineering*	3	1	0	40	60	100	4

* to be opted by students of other engineering disciplines for **Minor Degree in Mechanical Engineering**

4th Semester	B.Tech (Mechanical Engineering)							
Course code	**Course Name**	**Load Allocation**			**Marks Distribution**		**Total Marks**	**Credit**
		L	**T**	**P**	**Internal**	**External**		
AGME-21401	Applied Thermodynamics-II	3	1	-	40	60	100	4
AGME-21402	Theory of Machines-II	3	1	-	40	60	100	4
AGME-21403	Mathematics in Mechanical Engineering	3	-	-	40	60	100	3
AGME-21404	Computer Aided Design and Manufacturing	3	-	-	40	60	100	3
AGME-21405	Automobile Engineering	3	-	-	40	60	100	3
AGME-21406	Applied Thermodynamics Lab	-	-	2	30	20	50	1
AGME-21407	Computer Aided Design and Manufacturing Lab	-	-	2	30	20	50	1
AGME-21408	Automobile Engineering Lab	-	-	2	30	20	50	1
AGME- 21409	Theory of Machines Lab	-	-	2	30	20	50	1
AGAP - 21401	Engineering Aptitude - I	-	1	-	50	0	50	1
AGFE - 21402	Functional English - II	-	1	-	50	0	50	1
AGMC-21401	Essence of Indian Knowledge Tradition (Mandatory Course)	1	-	-	-	-	-	-
		16	**4**	**8**	**420**	**380**	**800**	**23**
	Contact Hours=	**28**						
AGMD - ME02	Automobile Engineering*	3	1		40	60	100	4

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SCHEME OF B.TECH MECHANICAL ENGINEERING

5th Semester	B.Tech (Mechanical Engineering)							
Course code	**Course Name**	**Load Allocation**			**Marks Distribution**		**Total Marks**	**Credit**
		L	**T**	**P**	**Internal**	**External**		
AGME-21501	Design of Machine Elements-I	3	1	-	40	60	100	4
AGME-21502	Fluid Mechanics	3	1	-	40	60	100	4
AGME-21503	Mechanical Measurements and Metrology	3	-	-	40	60	100	3
AGME-21504X	Professional Elective Course-I	3	-	-	40	60	100	3
AGME-21505	Machine Drawing (Skill Course-I)	1	-	4	30	20	50	3
AGME-21506	Design of Machine Elements Lab	-	-	2	30	20	50	1
AGME-21507	Fluid Mechanics Lab	-	-	2	30	20	50	1
AGME-21508	Mechanical Measurements and Metrology Lab	-	-	2	30	20	50	1
AGAP - 21502	Engineering Aptitude – II	-	1	-	50		50	1
AGME-21509	Summer Training	-	-	-	60	40	100	1
		13	**3**	**10**	**390**	**360**	**750**	**22**
	Contact Hours=	**26**						
AGMD - ME03x	Minor - 3* (Elective)	3	1		40	60	100	4

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6th Semester	B.Tech (Mechanical Engineering)							
Course code	**Course Name**	**Load Allocation**			**Marks Distribution**		**Total Marks**	**Credit**
		L	**T**	**P**	**Internal**	**External**		
AGME-21601	Design of Machine Elements-II	3	1	-	40	60	100	4
AGME-21602	Fluid Machinery	3	1	-	40	60	100	4
AGME-21603	Heat Transfer	3	-	-	40	60	100	3
AGME-21604X	Professional Elective Course-II	3	-	-	40	60	100	3
AGME-21605	Industrial Automation and Robotics (Skill Course-II)	1	-	4	30	20	50	3
AGME-21606	Fluid Machinery Lab	-	-	2	30	20	50	1
AGME-21607	Heat Transfer Lab	-	-	2	30	20	50	1
AGME-21608	MS Office Lab	-	-	2	30	20	50	1
AGFE - 21603	Functional English – III	-	1	-	50	0	50	1
AGAP - 21603	Engineering Aptitude – III	-	1	-	50	0	50	1
		13	**4**	**10**	**380**	**320**	**700**	**22**
	Contact Hours=	**27**						
AGMD - ME04x	Minor - 4* (Elective)	3	1		40	60	100	4

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5th Sem	PROFESSIONAL ELECTIVE COURSE-I							
Course code	**Course Name**	**Load Allocation**			**Marks Distribution**		**Total Marks**	**Credit**
		L	**T**	**P**	**Internal**	**External**		
AGME – 21504 A	Solid Mechanics	3	-	-	40	60	100	3
AGME – 21504 B	Computer Integrated Manufacturing	3	-	-	40	60	100	3
AGME-21504 C	Mechatronics	3	-	-	40	60	100	3
AGME-21505 D	Machine Tool Design	3	-	-	40	60	100	3

6th Sem	PROFESSIONAL ELECTIVE COURSE-II							
Course code	**Course Name**	**Load Allocation**			**Marks Distribution**		**Total Marks**	**Credit**
		L	**T**	**P**	**Internal**	**External**		
AGME-21604 A	Non Traditional Machining	3	-	-	40	60	100	3
AGME-21604 B	Non Destructive Testing	3	-	-	40	60	100	3
AGME-21604 C	Cryogenic Technology	3	-	-	40	60	100	3
AGME-21604 D	Power Plant Engineering	3	-	-	40	60	100	3

SCHEME OF B.TECH MECHANICAL ENGINEERING

7th Semester	B.Tech (Mechanical Engineering)							
Course code	**Course Name**	**Load Allocation**			**Marks Distribution**		**Total Marks**	**Credits**
		L	**T**	**P**	**Internal**	**External**		
AGME 21701	Refrigeration and Air conditioning	3	1	-	40	60	100	4
AGME 21702	Mechanical Vibrations	3	1	-	40	60	100	4
AGME 21703X	Professional Elective Course-III	3	-	-	40	60	100	3
AGOE 217YY	Open Elective Course	3	-	-	40	60	100	3
AGME 21704	Project	-	-	4	60	40	100	2
AGME 21705	Refrigeration and Air Conditioning Lab	-	-	2	30	20	50	1
AGME 21706	Mechanical Vibration Lab	-	-	2	30	20	50	1
		12	**2**	**8**	**280**	**320**	**600**	**18**
	Contact Hours=	**22**						
AGMD ME05x	Minor - 5* (Elective)	3		1	40	60	100	4

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SCHEME OF B.TECH MECHANICAL ENGINEERING

8th Semester	B.Tech (Mechanical Engineering)							
Course code	**Course Name**	**Load Allocation**			**Marks Distribution**		**Total Marks**	**Credit**
		L	**T**	**P**	**Internal**	**External**		
AGME 21801	Semester Training	-	-	-	300	200	500	12
		0	**0**	**0**	**300**	**200**	**500**	**12**
	Contact Hours=	**0**						

7th Semester	LIST OF PROFESSIONAL ELECTIVE COURSES-III							
Course code	Course Name	Load Allocation			Marks Distribution		Total Marks	Credit
		L	T	P	Internal	External		
AGME 21703A	Modern System Design	3	-	-	40	60	100	3
AGME 21703B	Project Management	3	-	-	40	60	100	3
AGME 21703C	Supply Chain Management	3	-	-	40	60	100	3
AGME 21703D	Industrial Safety	3	-	-	40	60	100	3
AGME 21703E	Surface Engineering	3	-	-	40	60	100	3
AGME 21703F	Sustainable Engineering	3	-	-	40	60	100	3

The above courses shall be taken up by students in online mode through SWAYAM platform. The student shall opt any one subject from this list as per availability on SWAYAM platform. Student shall produce the course completion certificate at the end of the semester and also appear in End-Semester-Examination for these courses for transfer of credits as per the policy of AGC Amritsar.

LIST OF OPEN ELECTIVE COURSES

7th Semester	B. Tech (All Streams)							
Course code	Course Name	Load Allocation			Marks Distribution		Total Marks	Credits
		L	T	P	Internal	External		
Offered by Department of Civil Engineering								
AGOE 21701	Air Pollution and Control	3	-	-	40	60	100	3
AGOE 21702	Disaster Management	3	-	-	40	60	100	3
Offered by Department of Mechanical Engineering								
AGOE 21703	Product Design and Development	3	-	-	40	60	100	3
AGOE 21704	Material Management	3	-	-	40	60	100	3
Offered by Department of Electrical Engineering								
AGOE 21705	Non-Conventional Energy Sources	3	-	-	40	60	100	3
AGOE 21706	Electrical Power Utilization	3	-	-	40	60	100	3
Offered by Department of Computer Science and Engineering								
AGOE 21707	Software Engineering Methodologies	3	-	-	40	60	100	3
AGOE 21708	Fundamentals of Information Security	3	-	-	40	60	100	3
Offered by Department of Management Studies								
AGOE 21709	Management of Human Resources	3	-	-	40	60	100	3
AGOE 21710	Basics of Management	3	-	-	40	60	100	3

The student shall opt any one of the above courses offered by any department other that his/her parent department.

3rd Semester		AGME-21301: Applied Thermodynamics-I			
Internal Marks:	40		**L**	**T**	**P**
External Marks:	60		3	1	0
Total Marks:	100		**Credits**		4

Course Outcomes: After studying the course, students will be able to:	
CO-1	Understand thermodynamics of combustion of fuel in IC engines
CO-2	Understand properties of Steam:
CO-3	Understand steam generators:
CO-4	Learn about Steam Nozzles
CO-5	Understand Steam Turbines
CO-6	Understand Steam condensers

Part	Content	CO
I	**Thermodynamics of Combustion of Fuel in IC engines**:Principle of Combustion; Stoichiometric and non-stoichiometric combustion; Calculations of air fuel ratio: analysis of combustion, conversion of volumetric analysis into gravimetric analysis and vice versa" Actual weight of air supplied, use of mole for solution of combustion problems; Calorific value of fuel; Enthalpy of formation; Enthalpy of reaction/combustion; Various stages of combustion in IC engines; Pressure-time/crank - Angle diagrams; various phenomenon such as turbulence, squish and swirl, dissociation, pre-ignition/auto- ignition, and after burning etc.; Theory of knocking (i.e., detonation) in SI and CI Engines; Emission from boilers and IC engines (SI and CI) and methods to reduce/control them.	CO-1
	Properties of Steam:Pure substance; Steam and its formation at constant pressure: wet, dry, saturated and super-heated steam; Sensible heat (enthalpy), latent heat and total heat (enthalpy) of steam; dryness fraction and its determination; degree of superheat and degree of sub-cool; Entropy and internal energy of steam; Use of Steam Tables and Mollier Chart; Basic thermodynamic processes with steam (isochoric, isobaric, isothermal, isentropic and adiabatic process) and their representation on T-S Chart and Mollier Charts (hs diagrams). Significance of Mollier Charts.	CO-2
II	**Steam Generators**:Classification and Applications of Steam Generators; Working and constructional details of fire-tube and water-tube boilers: (Cochran, Lancashire, Babcock and Wilcox boilers); Merits and demerits of fire-tube and water-tube boilers; Modem high pressure boilers (Benson boiler, La Mont boiler) and Super critical boilers (Once through boilers-Tower type); Advantages of forced circulation; Description of boiler mountings and accessories: Different types of Safety Valves, Water level indicator, pressure gauge, Fusible plug, Feed pump, Feed Check Valve, Blow-off Cock, Steam Stop-Valve, Economizer, Superheater; Air pre-heater and Steam accumulators; Boiler performance: equivalent evaporation, boiler. efficiency, boiler trial and heat balance; Types of draught and Calculation of chimney height.	CO-3
III	**Steam Nozzles:**Definition. types and utility of nozzles; Flow of steam through . nozzles; Condition for maximum discharge through nozzle; Critical pressure ratio. its significance and its effect on discharge Area of throat and at exit for maximum discharge; Effect of friction; Nozzle efficiency; Calculation of Nozzle dimensions (length and diameters of throat and exit).	CO-4
	Steam Turbines: introduction; Classification; Impulse versus Reaction turbines' Simple impulse turbine: pressure and velocity variation, Compounding of impulse turbines: purpose, type and pressure and velocity variation, Velocity. diagrams/triangles;. Combined velocity diagram /triangles and calculations for force,	CO-5

	axial thrust, work, power, blade efficiency, stage efficiency maximum work and maximum efficiency overall efficiency and relative efficiency, effect of blade friction on velocity diagram, effect of speed ratio on blade efficiency, condition for axial discharge' Reaction Turbine: pressure and velocity variation, velocity diagrams/triangles, Degree of reaction, combined velocity diagram/triangle and calculations for force, axial thrust, work, power, blade efficiency, stage efficiency, overall efficiency and relative efficiency, maximum work and maximum efficiency Calculations of blade height; Losses in steam turbines; Co-generation; Economic assessment; Governing of steam turbines.	
	Steam Condensers:Functions Elements of condensing unit; Types of condensers; Dalton's law of partial pressures applied to the condenser problems; Condenser and vacuum efficiencies; Cooling water calculations; Effect of air leakage Methods to check and prevent air infiltration; Description of air pump; Cooling towers: function, types and their operation.	CO-6

References:
• Mahesh M Rathore, Thermal Engineering, McGraw Hill Education Pl't' Ltd'
• D'S.KumarandV.P.Vasandani,HeatEngineering,Metropolitan Book Co.Pvt.Ltd.
• G. Rogers and Y. Mayhew, Engineering Thermodynamics, Pearson'
• W.AJ. Keartan, Steam Turbine: Th6ory and Practice, ELBS Series'
• V. Ganeshan, Internal Combustion Engines, Tata McGraw Hill'

3rd Semester		AGME-21302: Theory of Machines – I			
			L	**T**	**P**
Internal Marks:	40		3	1	0
External Marks:	60				
Total Marks:	100		**Credits**		4

Course Outcomes: After studying the course, students will be able to:	
CO-1	Understand the basic concepts of machines
CO-2	To learn the principles of transmission devices and to determine the tension and power of these devices
CO-3	Understand the basic concepts of cam and to draw cam profile for different types of follower.
CO-4	Compute the essential parameters like fluctuation of speed and energy of a flywheel in a vehicle
CO-5	To learn the principles of steering gear mechanism and universal joint.
CO-6	Understand the parameters involved in the working and application of different types of governor.

Part	Content	CO
I	**Basic Concept:**Link, Mechanism, Kinematic Pair and Kinematic Chain, Principles of Inversion, Inversion of a Four Bar Chain, Slider-Crank-Chain and Double Slider-Crank-Chain. Graphical and Analytical methods for finding: Displacement, Velocity, and Acceleration of mechanisms (including Corliolis Components).	CO-1
II	**Belt Rope and chain:**Material & Types of belt, Flat and V-belts, Rope & Chain Drives, Idle Pulley, Intermediate or Counter Shaft Pulley, Angle and Right Angle Drive, Quarter Turn Drive, Velocity Ratio, Crowning of Pulley, Loose and fast pulley, stepped or cone pulleys, ratio of tension on tight and slack side of belts, Length of belt, Power transmitted by belts including consideration of Creep and Slip, Centrifugal Tensions and its effect on power transmission.	CO-2
	Cam: Types of cams and follower, definitions of terms connected with cams. Displacement, velocity and acceleration diagrams for cam followers. Analytical and Graphical design of cam profiles with various motions (SHM, uniform velocity, uniform acceleration and retardation, cycloidal Motion). Analysis of follower motion for circular profile.	CO-3
III	**Flywheels:** Turning moment and crank effort diagrams for reciprocating machines' Fluctuations of speed, coefficient of fluctuation of speed and energy, Determination of mass and dimensions of flywheel used for engines and punching machines.	CO-4
	Lower and Higher Pair: Universal Joint, Calculation of maximum Torque, Steering Mechanisms including Ackerman and Davis approximate steering mechanism, Engine Indicator, Pentograph, Straight Line Mechanisms, Introduction to Higher Pairs With Examples.	CO-5
IV	**Governors:** Function, types and characteristics of governors. Watt, Porter, Proell and Hartnell governor. Numerical problems related to these governors. Sensitivity, stability, isochronisms and hunting of governors. Governor effort and power, controlling force curve, effect of sleeve friction.	CO-6

References:
• S. S. Rattan, Theory of Machines, Tata McGraw Hill, New Delhi'
• JagdishLal, Theory of Mechanisms & Machines, Metropolitan Book Co'
• V.P. Singh, Theory of Machines DhanpatRai.
• R S Khurmi, Theory of Machines

3rd Semester		AGME-21303: Strength of Materials			
Internal Marks:	40		**L**	**T**	**P**
External Marks:	60		3	1	0
Total Marks:	100		**Credits**		4

Course Outcomes:	After studying the course, students will be able to:
CO-1	Determine the stresses, strains, and displacements in structures and their components due to the acting loads.
CO-2	Understand various fundamental issues of elasto-mechanics, i. e. the mechanics of solids, and deformable bodies, and able to understand concept of complex stresses and strains also can draw Mohr's circle.
CO-3	Draw shear-force and bending-moment diagrams for different types of loading.
CO-4	Understand concept of pure bending and shear stresses for simple, built up and composite sections.
CO-5	Understand the behaviour of axially/laterally/eccentrically loaded columns and torsional behaviour of circular shafts.
CO-6	Understand various theories regarding failure of any column or beam in building.

Part	Content	CO
I	**Simple Stress and Strains**: Introduction; Concept of stress and strain; Stress-strain curves for ductile, brittle materials; Generalized Hooke's law, Stress-strain diagram of ductile and brittle material, statically determinate and indeterminate problems, compound and composite bars, thermal stresses. Elastic constants, relations between various elastic constants and its use; Lateral strain, volumetric strain, poisons ratio	CO-1
	Complex stress and strains: Introduction; Normal stress, tangential stress; Rectangular block subjected to normal stress along and across two planes, combination of normal and tangential stress; Concept of principal stress and its computation; Mohr circle; Principal strains, computation of principal stresses from the principal strains.	CO-2
II	**Shear force and Bending moment diagrams**: General equilibrium equations , Introduction to the concept of reaction diagrams—shear force and bending moment; Role of sign conventions; Types of load, beams, supports; Shear force and bending moment diagrams: simply supported, overhang and cantilever beams subjected to any combination of point loads, uniformly distributed and varying load, and moment; Relationship between load, shear force and bending moment.	CO-3
III	**Bending and Shear Stresses**: Introduction; Assumptions and derivation of flexural formula for straight beams; Centroid of simple and built up section, second moment of area; Bending stress calculation for beams of simple and built up section, composite sections (flitched sections); Shear stress; Variation of bending and shear stress along the depth of section.	CO-4
	Columns and Struts: Stability of Columns; Buckling load of an axially loaded columns with various end conditions; Euler's and Rankine's formula; Columns under eccentric load, lateral load.	CO-5
IV	**Torsion of Circular shafts**: Torsion, basic assumptions, derivation of torsion equation; Sections under combined bending and torsion, equivalent bending and torsion.	
	Springs: Introduction; Classification; Applications **Failure theories**: Maximum principal stress theory, Maximum shear stress theory, Distortion, Energy theory, Strain Energy theory.	CO-6

References:
• Strength of Material by S. Ramamrutham
• Mechanics of Materials: E .Popov
• Strength of Materials: Rajput
• Strength of Materials: Sadhu Singh
• Strength of Materials by Gere, Cengage Learning.

3rd Semester		AGME-21304 Engineering Materials and Metallurgy			
Internal Marks:	40		**L**	**T**	**P**
External Marks:	60		**3**	**0**	**0**
Total Marks:	100		**Credits**		**3**

Course Outcomes: After studying the course, students will be able to:	
CO-1	Understand the significance of the metallurgical characteristics of engineering materials.
CO-2	Explain the role of Phase diagrams, Fe-C and TTT diagram for controlling the desired structure and properties of the materials.
CO-3	Understand the significance of ferrous and metals and their alloys.
CO-4	Analyse various heat treatment processes and their applications for different materials
CO-5	Understand the fundamental principles of improving surface properties of bulk material like hardness, corrosion and wear resistance, etc.
CO-6	Understand the fundamental principles of Powder Metallurgy and recognize related machine tools and parameters of the processes for analyzingthe effect of process parameters on performance.

Part	Content	CO
I	Atomic structure of metals, atomic bonding in solids, crystal structures, crystal lattice of body centered cubic, and face centered cubic, closed packed hexagonal; crystalline and non-crystalline materials; imperfection in solids: theoretical yield strength, point defects, line defects and dislocations, interfacial defects, bulk or volume defects. Diffusion: Diffusion mechanisms, steady-state and non-steady-state diffusion, factors affecting diffusion. Theories of plastic deformation, recovery, re-crystallization.	CO-1
II	General principles of phase transformation in alloys, phase rule and equilibrium diagrams, Equilibrium diagrams of Binary systems. Iron carbon equilibrium diagram and various phase transformations. Time temperature transformation curves (TTT curves): fundamentals, construction and applications.	CO-2
	Introduction, classification, composition of alloys, effect of alloying elements (Si, Mn, Ni, Cr, Mo, W, Al) on the structures and properties of steel.	CO-3
III	Principles and applications. Processes viz. annealing, normalizing, hardening, tempering. Surface hardening of steels: Principles of induction and oxyacetylene flame hardening. Procedure for carburising, nitriding and cyaniding. Harden-ability: determination of harden-ability. Jominy end-quench test. Defects due to heat treatment and their remedies.	CO-4
	Procedure for carburising, nitriding and cyaniding, Cladding. Harden-ability: determination of harden-ability. Jominy end-quench test. Defects due to heat treatment and their remedies.	CO-5
IV	Introduction, advantages, limitations, and applications methods of producing metal powders, briquetting and sintering.	CO-6

References:
• B. Zakharov, Heat Treatment of Metals, University Press.
•T. Goeland R. S. Walia, Engineering Materials & Metallurgy.
•Sidney H Avner, Introduction to Physical Metallurgy, Tata Mcgraw-Hill.
•V. Raghavan, Physical Metallurgy: Principles and Practice, PHI Learning.
•Y. Lakhin, Engineering Physical Metallurgy, Mir Publishers.

3rd Semester		AGME-21305: Manufacturing Processes			
			L	T	P
Internal Marks:	40		3	0	0
External Marks:	60				
Total Marks:	100		Credits		3

Course Outcomes:	After studying the course, students will be able to:
CO-1	To develop the ability to understand the basics of Manufacturing, Creativity and General Trends in Manufacturing
CO-2	To understand the different types of Mouldings, furnaces and casting techniques.
CO-3	To Understand the different types of Welding techniques.
CO-4	To develop the ability to inspect the various Casting and Welding defects with various testing techniques.
CO-5	To develop the ability to understand the tool geometry and chip formation.
CO-6	To develop the ability to understand the various machine tools of Workshop.

Part	Content	CO
I	Classification of manufacturing processes, selection criteria for manufacturing processes, general trends in manufacturing.	CO-1
II	Introduction to metal casting. Patterns: types, materials and allowances. Moulding materials: moulding sand compositions and properties, types of moulds, moulding machines. Cores: function, types, core making process, core-prints, chaplets. Elements of gating system and risers and their design. Melting furnaces, cupola furnace, charge calculations, induction furnaces. Casting processes: sand casting, shell mould casting, investment casting, permanent mould casting, full mould casting, vacuum casting, die casting, centrifugal casting, and continuous casting. Cleaning and finishing of castings.	CO-2
	Introduction and classification of welding processes, to welding processes, weldability, welding terminology, general principles, welding positions, and filler metals. Gas welding: principle and practice, oxy-acetylene welding equipment, oxy-hydrogen welding. Flame cutting. Electric arc welding: principle, equipment, relative merits of AC & DC arc welding. Welding processes: manual metal arc welding, MIG welding, TIG welding, plasma arc welding, submerged arc welding. Resistance welding: principle and their types i.e. spot, seam, projection, up-set and flash. Spot welding machine. Advanced welding processes: friction welding, friction stir welding, ultrasonic welding, laser beam welding, plasma arc welding, electron beam welding, atomic hydrogen welding, explosive welding, thermit welding, and electro slag welding. Other joining processes: soldering, brazing.	CO-3
III	Casting defects, their causes and remedies. Welding defects, their causes and remedies. Destructive and non-destructive testing: visual inspection, x-ray radiography, magnetic particle inspection, dye penetrate test, ultrasonic inspection, eddy current testing, hardness testing, and micro hardness testing.	CO-4
	Introduction to machining processes, classification, Mechanics of chip formation process, tool wear, tool life, machinability. Cutting tools: types, geometry of single point cutting tool, twist drill and milling cutter, tool signature. Cutting tool materials: high carbon steels, alloy carbon steels, high speed steel, cast alloys, cemented carbides, ceramics and diamonds, and CBN. Coolants and lubricants: classification, purpose, function and properties.	CO-5
IV	Lathe: classification, description and operations, kinematic scheme of lathe, and lathe attachments. Shaping and planning machine: classification, description and operations, drive mechanisms. Milling machine: classification, description and operations, up milling and down milling. Drilling machine: classification, description	CO-6

and operations. Boring machine: classification, description and operations. Grinding machines: classification, description and operations, dressing and truing of grinding wheels.

References:

- B. L. Juneja and G. S. Sekhon, *Fundamentals of Metal Cutting & Machine Tools,* New Age International (P) Ltd.
- H.S. Shan, *Manufacturing Processes,* Vol. I&II, , Pearson Publishers
- PC Sharma, *A Text Book of Production Technology,* S. Chand & Company Ltd.
- M. P. Groover, *Fundamentals of Modern manufacturing,* Wiley
- A. Manna, *A Textbook of Manufacturing Science and Technology,* PHI Publishers.
- P. N. Rao, *Manufacturing Technology, Foundry, Forming & Welding,* Tata McGraw Hill.
- R.S. Parmar, *Welding Engineering & Technology,*Khanna Publishers.
- SeropeKalpakjian and Steven R. Schmid, *Manufacturing Engineering and Technology,* Pearson Publishers.

3rd Semester		AGME-21306: Strength of Materials – Lab			
Internal Marks:	30		L	T	P
External Marks:	20		0	0	2
Total Marks:	50		Credits		1

Course Outcomes: After studying the course, students will be able to:

CO-1	Understand the behavior of Ductile and Brittle material in tension
CO-2	Understand the behavior of Ductile and Brittle material in compression
CO-3	Perform Izod and Charpy test to get impact strength.
CO-4	Perform Rockwell & Brinell hardness test to get hardness of a material.
CO-5	Understand the behavior of Ductile and Brittle material in torsion.
CO-6	Exhibit his/her creativity and conceptual understanding of the subject.

Part	Experiment	CO
A	1. Draw Stress Strain curve for Ductile and Brittle material in tension.	CO-1
	2. Draw Stress Strain curve for Ductile and Brittle material in compression.	CO-2
	3. To determine the impact strength by Izod and Charpy test.	CO-3
	4. To determine hardness of given material by Rockwell & Brinell hardness testing machine.	CO-4
	5. Draw shear stress, shear strain curve for ductile / brittle material in torsion strength test.	CO-5
B	To make a mini project that demonstrates a concept, based on the content of AGCE – 21301 (Strength of Materials)	CO-6

3rd Semester		AGME-21307: Engineering Materials and Metallurgy – Lab			
Internal Marks:	30		L	T	P
External Marks:	20		0	0	2
Total Marks:	50		Credits		1

Course Outcomes: After studying the course, students will be able to:

CO-1	Perform Annealing and Hardness Test on steel specimen.
CO-2	Perform Quenching operation on Steel specimen.
CO-3	Specimen preparation with various operations.
CO-4	Study the various microstructures of various materials.
CO-5	Perform Jominy end quench test on steel specimen.
CO-6	Exhibit his/her creativity and conceptual understanding of the subject.

Part	Experiment	CO
A	1 Annealing the steel specimen and study the effect of annealing time and temperature on hardness of steel.	CO-1
	2. Hardening the steel specimen and study the effect of quenching medium on hardness of steel.	CO-2
	3. Practice of specimen preparation (cutting, mounting, polishing, and etching) of mild steel, aluminium and hardened steel specimens.	CO-3
	4. Study of the microstructure of prepared specimens of mild steel, Aluminium and hardened steel and Identification of ferrite and pearlite constituents in given specimen of mild steel.	CO-4
	5. Determination of hardenability of steel by Jominy End Quench Test.	CO-5
B	To make a mini project that demonstrates a concept, based on the content of AGME – 21304 (Engineering Materials and Metallurgy)	CO-6

3rd Semester		AGME-21308: Manufacturing Processes- Lab			
Internal Marks:	30		**L**	**T**	**P**
External Marks:	20		0	0	2
Total Marks:	50		**Credits**		1

Course Outcomes: After studying the course, students will be able to:

CO-1	To study the various machine tools.
CO-2	Perform Grinding operations on cutting tools.
CO-3	Perform various operations on Lathe Machine.
CO-4	Perform Various operations on Shaper Machine
CO-5	Perform Various operations on Milling Machine.
CO-6	Exhibit his/her creativity and conceptual understanding of the subject.

Part	Experiment	CO
A	1. To study constructional features of following machines through drawings/ sketches: a. Grinding machines (Surface, Cylindrical) b. Hydraulic Press c. Draw Bench d. Drawing and Extrusion Dies e. Rolling Mills	CO-1
	2. To grind single point and multipoint cutting tools.	CO-2
	3. To prepare job on Lathe involving specified tolerances; cutting of V- threads and square threads.	CO-3
	4. To prepare job on shaper involving plane surface.	CO-4
	5. Use of milling machines for generation of plane surfaces, spur gears and helical gears; use of end mill cutters.	CO-5
B	To make a mini project that demonstrates a concept, based on the content of AGME – 21305 (Manufacturing Processes)	CO-6

3rd Semester	AGFE-21301: Functional English - I		
		L	**T**	**P**
Internal Marks:	**50**		**0**	**1**	**0**
External Marks:	**0**		**0**	**1**	**0**
Total Marks:	**50**		**Credits**		**1**

Course Outcomes: After studying the course, students will be able to:
CO-1	Self Introduction to prepare students to face one to one interaction.
CO-2	Body Language detail to prepare students in non-verbal communication.
CO-3	Vocabulary based session to improve language proficiency of students.
CO-4	Basic Grammar to make students proficient in English correspondence.
CO-5	Book reading to improve reading skills of students.
CO-6	Formal/ Informal Letter writing to make students proficient in written correspondence.

Part	Content	CO
I	Components of Self Introduction, Exemplary Performances,	CO-1
	Student Performances on Self Introduction along with resume.	CO-2
II	This section includes Common Vocabulary and its usage. Synonyms and Antonyms as a part of vocabulary to be done.	CO-3
	This section includes editing, omission, gap filling, rearranging jumbled sentences to test knowledge of passive voice, reported speech, articles and the other determiners, modals, tense, etc. Basic Grammar such as Tenses, Voice, Narration shall be done.	CO-4
III	Connect The Dots by Rashmi Bansal shall be prescribed for honing reading skills and comprehension in depth.	CO-5
IV	Formal/ Informal Letter Writing, Basic Format, Example, Practice shall be done.	CO-6

References:
• www.Indiabix.com
• English Grammar by Wren and Martin
• www.freshersworld.com
• www.alison.com

3rd Semester	**(Mandatory Course): AGMC-21301: Indian Constitution**			
		L	**T**	**P**
Internal Marks:	**-**	1	0	0
External Marks:	**-**			
Total Marks:	**-**	**Credits**		**0**

Part	Content	CO
-	- Meaning of the constitution law and constitutionalism. - Historical perspective of the Constitution of India. - Salient features and characteristics of the Constitution of India. - Scheme of the fundamental rights. - The scheme of the Fundamental Duties and its legal status. - The Directive Principles of State Policy – Its importance and implementation. - Federal structure and distribution of legislative and financial powers between the Union and the States. - Parliamentary Form of Government in India – The constitution powers and status of the President of India. - Amendment of the Constitutional Powers and Procedure. - The historical perspectives of the constitutional amendments in India. - Emergency Provisions: National Emergency, President Rule, Financial Emergency. - Local Self Government – Constitutional Scheme in India. - Scheme of the Fundamental Right to Equality. - Scheme of the Fundamental Right to certain Freedom under Article 19. - Scope of the Right to Life and Personal Liberty under Article 21	-

3rd Semester		AGME-21309: Institutional Training			
Internal Marks:	60		**L**	**T**	**P**
External Marks:	40		0	0	2
Total Marks:	100		Credits		1

Course Outcomes: After going through this training, students will be able to:

CO-1	Understand the various operations of Foundry and Smithy Shop.
CO-2	Understand the various operations of Welding Shop.
CO-3	Understand the various operations of Carpentry Shop.
CO-4	Understand the various operations of Machine Shop.
CO-5	Understand the various operations of Fitting and Electrical.
CO-6	Exhibit his/her creativity and conceptual understanding of the subject.

Part	Training Activity	CO
A	Pattern – Pattern Materials – types – single piece (solid) and split type only – allowances – moulding – moulding tools and boxes – moulding sands – classifications and properties – green sand moulding – dry sand moulding – casting – sand casting using green and dry sand moulds – cleaning of casting and safety practices in foundry. Sand Testing Teqniques. Forging: Hot working, advantages of hot working – hot working operations – rolling – forging – hammer or smith forging, drop forging, upset forging, press forging – roll forging PRESS WORKING: Types of presses – mechanical and hydraulic presses – press tools and accessories – press working operations – bending operations – angle bending – channel bending – curling – drawing – shearing operations – blanking – piercing – trimming – notching – lancing – shaving – parting off.	CO-1
	Welding: - Arc welding definition – arc welding equipment – arc welding methods – carbon arc, metal arc, metal inert gas (MIG), tungsten inert gas (TIG). Gas welding: definition – oxyacetylene welding – resistance welding – definition – classification of resistance welding – butt – spot – seam projection welding – safety practices in welding	CO-2
	Types of Wood, Seasoning of Wood, General operations on wood, Wood Nails,	CO-3
	LATHE: Definition – specifications – simple sketches – principle parts – headstock – back geared type – all geared type – tumbler gear mechanism – quick change gear box – apron – mechanism – carriage – cross slide – automatic, longitudinal and cross feed mechanism – tailstock and its functions- machining operation done on lathe – straight turning – step turning – taper turning – thread cutting – knurling – facing – boring – chamfering – cutting feed – depth of cut. WORK HOLDING DEVICES: Face plate – three jaw chuck – four jaw chuck – catch plate and carrier – types of centres.	CO-4
	Fuses – selection of fuse – necessity of fuse- fuse switch units. Sensors: Photo electric sensor, Inductive proximity sensors, Temperature sensors. Switches: Push button switch, selector switch, limit switch, pressure switch, temperature switch, float switch and reed switch. Preparation of T-Shape Work piece as per the given specifications. Preparation of U-Shape Work piece which contains: Filing, Sawing, Drilling, Grinding. Practice marking operations.	CO-5
B	**Model/Prototype:** students are required to develop some model/prototype that exhibits their understanding of subject matter and contributes innovatively in the above mentioned areas.	CO-6

4th Semester		AGME-21401: Applied Thermodynamics -II			
Internal Marks:	40		L	T	P
			3	1	0
External Marks:	60				
Total Marks:	100		Credits		4

Course Outcomes:	After studying the course, students will be able to:
CO1	Understand Introduction to compressors and Reciprocating Air Compressors:
CO2	Understand Positive Displacement Rotary Compressors
CO3	Understand Centrifugal Compressor
CO4	Understand Axial Flow Compressor
CO5	Understand Gas Turbine
CO6	Understand Jet Propulsions

Part	Content	CO
I	**Air Compressors**- **Introduction:** Classification of Air Compressors; Application of compressors and use of compressed air in industry and other places; Stag33nation and static values of thermodynamic properties. **Reciprocating Air Compressors:** Single-stage single-acting reciprocating compressor (with and without clearance volume): construction, operation, work input and best value of index of compression, Isentropic, polytropic and isothermal efficiencies and their representation in terms of ratio of areas representing various energy transfers on T-s coordinates, heat rejected to cooling medium, isothermal, overall thermal, isentropic, polytropic, mechanical efficiency, Clearance Volumetric efficiency, Overall volumetric efficiency, effect of various parameters on volumetric efficiency, free air delivery; **Multistage compressors:** purpose and advantages, construction and operation, work input, heat rejected in intercoolers, minimum work input, optimum pressure ratio; *isothermal*, *overall thermal*, *isentropic*, *polytropic* and *mechanical* efficiencies; Performance curves.	CO-1
II	**Positive Displacement Rotary Compressors Introduction:** Comparison of rotary positive displacement compressors with reciprocating compressors; Classification of rotary compressors; Construction, operation, work input and efficiency of positive displacement type of rotary compressors like Roots blower, Lysholm compressor and Vane type Blower. Complete representation of compression process on P-v and T-s coordinates with detailed description of areas representing total work done	CO-2
	Centrifugal Compressors: Stagnation and static values of pressure, Temperature and enthalpy etc. for flow through dynamic rotary machines; Thermodynamic analysis of centrifugal compressor: Stage, polytropic, isentropic and isothermal efficiencies, velocity vector diagrams for centrifugal compressors, power calculation, , pre-guided vanes, pre-whirl, Slip factor, power input factor. Modes of energy transfer in impeller and diffuser. Degree of reaction and its derivation; energy transfer in backward, forward and radial vanes; surging and choking in centrifugal compressors. Various losses occurring in centrifugal compressors and application of centrifugal compressors.	CO-3
III	**Axial Flow Compressor:** Components of axial flow compressor, aerofoil blading, angle of attack, coefficients of lift and drag, turbine versus compressor blades, velocity vector diagrams,	CO-4

	thermodynamic analysis and power calculations. Modes of energy transfer in rotor and stator blade flow passages. Work done factor, Degree of reaction and Blade efficiency, Isentropic polytropic and Isothermal Efficiencies. Surging, choking and stalling in axial flow compressors, characteristic curves for axial flow compressor, flow parameters of axial flow compressor pressure coefficient, flow coefficient, work coefficient and temperature rise coefficient ,specific speed etc. Comparison of axial flow compressor with centrifugal compressor and reaction turbine. Application of axial flow compressors.	
	Gas Turbines: Classification and comparison of the Open and Closed cycles; Classification on the basis of combustion (at constant volume or constant pressure); Comparison of gas turbine with a steam turbine and IC engine; Fields of application of gas turbines; Position of gas turbine in power industry; Thermodynamics of constant pressure gas turbine cycle (Brayton cycle); Calculation of net output, work ratio and thermal efficiency of ideal and actual cycles; Cycle air rate; Thermal refinements like regeneration, inter-cooling and re-heating and their different combinations in the gas turbine cycle and their effects on gas turbine cycle; Closed and Semi-closed gas turbine cycle; Requirements of a gas turbine combustion chamber; Blade materials. Gas turbine fuels.	CO-5
IV	**Jet Propulsion:** Principle of jet propulsion; Description of different types of jet propulsion systems like rockets and thermal jet engines, like (i) Athodyd (ramjet and pulsejet), (ii) Turbojet engine, and (iii) Turboprop engine. Thermodynamics of turbojet engine components; Development of thrust and methods for its boosting/augmentation; Thrust work and thrust power; Propulsion energy, Propulsion and thermal (internal) efficiencies; Overall thermal efficiency; Specific fuel consumption; Rocket propulsion, its thrust and thrust power; Propulsion and overall thermal efficiency; Types of rocket motors (e.g. solid propellant and liquid propellant systems); Various common propellant combinations (i.e. fuels) used in rocket motors; Cooling of rockets; Advantages and disadvantages of jet propulsion over other propulsion systems; Brief introduction to performance characteristics of different propulsion systems; Fields of application of various propulsion units.	CO-6

References:
• Mahesh M Rathore, Thermal Engineering, McGraw Hill Education Pl't' Ltd'
• D'S.KumarandV.P.Vasandani,HeatEngineering,Metropolitan Book Co.Pvt.Ltd.
• G. Rogers and Y. Mayhew, Engineering Thermodynamics, Pearson'
• W.AJ. Keartan, Steam Turbine: Th6ory and Practice, ELBS Series'
• V. Ganeshan, Internal Combustion Engines, Tata McGraw Hill'

4ᵗʰSemester		AGME-21402: Theory of Machines -II			
Internal Marks:	40		**L**	**T**	**P**
External Marks:	60		3	1	0
Total Marks:	100		Credits		4

Course Outcomes: After studying the course, students will be able to:	
CO-1	Understand the basic concepts of static forces and draw free body diagram of different mechanism.
CO-2	Select suitable type of gears for different application in transmission system.
CO-3	To analyse the motion of different elements of gear trains.
CO-4	Understand balancing of rotating and reciprocating parts of machines.
CO-5	Understand the basic concepts of inertia forces & couples applied to reciprocating parts of a machine.
CO-6	Understand the concept of kinematic synthesis.

Part	Content	CO
I	**Static force analysis:** Concept of force and couple, free body diagram, condition of equilibrium, static equilibrium of mechanism, methods of static force analysis of simple mechanisms. Power transmission elements, considerations of frictional forces	CO-1
	Gears: Toothed gears, types of toothed gears and its terminology. Path of contact, arc of contact, conditions for correct gearing, forms of teeth, involutes and its variants, interference and methods of its removal. Calculation of minimum number of teeth on pinion/wheel for involute rack, helical, spiral, bevel and worm gears. Center distance for spiral gears and efficiency of spiral gears	CO-2
II	**Gear Trains:** Types of gear trains, simple, compound and epicyclic gear trains, problems involving their applications, estimation of velocity ratio of worm and worm wheel.	CO-3
III	**Balancing:** Necessity of balancing, static and dynamic balancing, balancing of single and multiple rotating masses, partial unbalanced primary force in an engine, balancing of reciprocating masses, and condition of balance in multi cylinder in line V-engines, balancing of machines, rotors, reversible rotors.	CO-4
IV	**Dynamic force analysis:** Determination of forces and couples for a crank, inertia of reciprocating parts, dynamically equivalent system, analytical and graphical method, inertia force analysis of basic engine mechanism, torque required to overcome inertia and gravitational force of a four bar linkage.	CO-5
	Kinematic synthesis of Mechanism: Freudenstien equation, Function generation errors in synthesis, two and three point synthesis, Transmission angles, least square techniques.	CO-6

References:
• S. S. Rattan, Theory of Machines, Tata McGraw Hill, New Delhi'
• JagdishLal, Theory of Mechanisms & Machines, Metropolitan Book Co'
• V.P. Singh, Theory of Machines DhanpatRai.
• R S Khurmi, Theory of Machines

4th Semester	AGME-21403: Mathematics in Mechanical Engineering				
			L	**T**	**P**
Internal Marks:	40		3	0	0
External Marks:	60		3	0	0
Total Marks:	100		**Credits**		3

Course Outcomes:	After studying the course, students will be able to:
CO1	To enable the students to use the concept of Fourier series and different wave forms.
CO2	Know about piecewise continuous functions, Laplace transforms and its properties; use of Laplace transform. Inverse transform and use for solving initial value problems.
CO3	To enable students solving Partial differential equation , Wave and Heat equations
CO4	To enable the students to know the concept of complex differentiation, complex integration by the concept of Residues
CO5	Apply numerical methods to find the solution of algebraic equations using different methods under different conditions, and numerical solution of system of algebraic equations.
CO6	Solution of differential equation by initial value problem Calculation of data with help of Interpolation and curve fitting.

Part	Content	CO
I	**Fourier Series:** Periodic functions, Euler's formula. Even and Odd functions, half range expansions.	CO-1
II	**Laplace Transforms:** Laplace transforms of various standard functions, properties of Laplace transforms, Transform of derivatives and integrals, Inverse Laplace Transformation (only formula's), Applications to solution of ordinary linear differential equations with constant coefficients.	CO-2
	Partial Differential Equations: Formation of partial differential equations. Solution of Homogenous partial differential equations with constant coefficients. solution of wave and heat equation	CO-3
III	**Function of Complex variable:** Analytic function, Cauchy- Riemann equations, Harmonic functions, Cauchy's integral theorem, Cauchy's integral formula and derivative of analytic Function .Application of residues for finding Integration of function of complex variables.	CO-4
	Solution of Equations: Solution of Algebraic and Transcendental equations by Bisection method, Regula- Falsi method, Newton - Raphson Method. Solution of linear system of equations by Gauss- Elimination method, Guass - jardan method. LU Decomposition. Method. Interpolation.(Newton forward – Backward, Newton divided difference, Lagrange's interpolation).	CO-5
IV	**Curve fitting :** Fitting of Data in straight line, second degree equation, linear curve and Exponential curve by least Square method. Solution of linear differential equations by initial value problems.(Euler methods and R.K order methods).	CO-6

References:
•KreyszingE.. Advanced Engineering Mathematics , Eighth edition. John wiely. New Delhi
•Grewal B.S. Higher Engineering Mathematics. Khanna Publisher. New Delhi.
•Ian N. Sneedon. Elements of Partial differential equation. Mcgraw – Hill. Singapore.
•Bindra. J. S. Applied Engineering. Volume – III. Kataria Publications.
•Advanced Engineering Mathematics, O'Neil.CengageLearing.
•Babu Ram Advance Engineering Mathematics. Pearson Education.
• N.P Bali. Laxmi Publication.Laxmi Publication, 2nd Edition, 2007.

4th Semester	AGME-21404: Computer Aided design and Manufacturing			

			L	T	P
Internal Marks:	40		**3**	**0**	**0**
External Marks:	60		**3**	**0**	**0**
Total Marks:	100		**Credits**		**3**

Course Outcomes: After studying the course, students will be able to:	
CO1	Understand the Introduction to CADM and Geometric modelling
CO2	understand the representation of curves, surfaces and FEM
CO3	learn Geometric Transformations
CO4	Understand NC , CNC , DNC. Adaptive control and rapid prototyping
CO5	Learn CNC Part Programming and Group Technology
CO6	understand Computer aided process planning and computer integrated Manufacturing

Part	Content	CO
I	**Introduction to CAD/CAM**:Introduction to CAD/CAM and its role in Product design and development cycle. CAD/CAM system and its evaluation criteria. CAD/CAM input and output devices, display devices. Functions of a graphics package; Graphics standards. Application areas of CAD. **Geometric Modeling**: Need and types of Geometric Modeling: Wireframe; surface and solid modeling; Geometric Modeling Techniques: Boundary Representation (B-rep); Constructive Solid Geometry (CSG); Parametric Modeling Technique; concepts of hidden-line removal and shading; Mechanical Assembly Kinematics analysis and simulation.	CO-1
II	**Representation of curves and surfaces**: Non-parametric and parametric representation of curves; Parametric representation of Hermite Cubic; Bezier curves; Uniform and Non-uniform B-spline curves; Surface and its analysis. Representation of Analytical and synthetic surfaces(Bilinear Surface; Coons Surface Patch; Bi-cubic Surface Patch; Bezier Surface; Bspline surface). **Finite Element Method overview:** Overview of FEM, Advantages and applications, recent advance in FEM, FEA software Basicprinciples and general procedure of FEM.	CO-2
	Geometric Transformations: Overview of Mathematics preliminaries; matrix representation of 2 and 3 dimensional transformation for translation; scaling; rotation about principal axes; mirror imaging about a plane; principal axes and origin; Concatenation of transformation matrices. Applications of geometric transformations.	CO-3
III	**NC/CNC/DNC Machine Tools**: NC machine tools- basic components coordinate systems; features of NC machine tools. Computerized Numerical Control (CNC): Tooling for NC machines - tool presetting equipment; flexible tooling; tool length compensation; tool path graphics; NC motion control system; Direct Numerical Control. Adaptive control in machining system. Rapid prototyping.	CO-4
	CNC Part Programming: Basic terminology of Parts programming; Block format; Coordinate system; fixed/floating zero; types and classification of machine codes; Manual part programming; Computer aided and computer assisted part programming. **Group Technology**: Basic fundamentals of Group Technology; Part families; part classification and coding system: Group technology machine cells: Advantages of Group Technology.	CO-5
IV	**Computer Aided Process Planning**: Introduction and benefits of CAPP. Types of CAPP systems; machinability data selection systems in CAPP.	CO-6

	Computer Integrated Manufacturing Systems: Basic Concepts of CIM: CIM Definition, The meaning of Manufacturing, Types of Manufacturing systems; Need, Elements, Evolution of CIM; Benefits of CIM; Flexible Manufacturing Systems: Physical Components of an FMS. Types of Flexibility, Layout Considerations; FMS benefits.	

References:

- Groover Mikell P., Emory W. Zimmer's, "CAD/CAM: Computer-Aided Design and Manufacturing", PHI, 2nd Edition, 1984.
- Bedworth D. D., Henderson M. R& P.M. Wolfe, "Computer Integrated Design and Manufacturing", Tata McGraw Hill, 2nd Edition, 1991.
- Ibraham Z., "CAD/CAM - Theory and Practice", Tata McGraw Hill, 2nd Edition, 2009.
- Rao P. N, "CAD/CAM Principles and Applications", Tata McGraw Hill, 2nd Edition, 2004.
- Elanchezhian C., Selwyn Sundar T., Shanmuga Sunder G., "Computer Aided Manufacturing",Laxmi Publication, 2nd Edition, 2007.

4th Semester		AGME-21405: Automobile Engineering			
Internal Marks:	40		**L**	**T**	**P**
External Marks:	60		**3**	**0**	**0**
Total Marks:	100		**Credits**		**4**

Course Outcomes: After studying the course, students will be able to:	
CO-1	Identify different parts of an automobile and to understand the related terminology, and the science behind them.
CO-2	Understand the working characteristics of the power unit, fuel supply systems and fuels used in modern automobiles and the impact of the emissions generated on the environment and how to minimize the effects.
CO-3	Understand the working of various lubrication and cooling systems and rating/characteristics of lubricants and coolants.
CO-4	Understand various types of frames, chassis, suspension systems and wheel & tyre constructional details and their applications
CO-5	Understand the automated/manual transmissions, steering systems with steering geometry and wheel alignment principles.
CO-6	Understand the various braking systems, electronic and electrical systems, ECU and various sensors.

Part	Content	CO
I	Basic structure and terminology, general layout and type of automotive vehicles (i.e. e-vehicles, farm and constructional vehicles), Frameless and unitary construction; position of power unit.	CO-1
	Power requirements –motion resistance and power loss, tractive effort and vehicle performance curves; selection of power unit and engine performance characteristics; pollution due to vehicle emission and exhaust emission control system, silencers, types of pistons and rings. Air cleaner and fuel pumps; Air fuel requirements and carburetion; constructional details of Carter carburettor and fuel injection systems; MPFi (Petrol), Diesel fuel system-cleaning, injection pump, injector and nozzles, Common Rail fuel supply system. Alternate fuel system for CNG, LPG and LNG.	CO-2
II	Necessity of lubrication; Desirable properties of lubricants; various types of lubricants and oil additives; different systems of lubrication-oil filters, oil pumps and oil pressure indicator; crank case ventilation and dilution. Purpose of cooling, air and water cooling systems; radiator, thermostat, pump and fan.	CO-3
III	Loads on the frame, considerations of strength and stiffness, engine mounting, independent suspension systems (MacPherson, Trailing Links, Wishbone), shock absorbers and stabilizers, Air suspension system, wheels and tyres, tyre wear types, constructional details of plies.	CO-4
	Basic requirements and standard transmission systems; constructional features of automobile clutch, gear box, differential (limited slip differential),front and rear axles; over drives, propeller shaft, universal joint and torque tube drive; Rear wheel vs front wheel drive, principle of automatic transmission (CVT –Continuous Variable Transmission), Requirement and steering geometry; castor action, camber and king pin angle, toe-in of front wheels, steering linkages and steering gears; wheel alignment; power steering, Ballre-circulating mechanism	CO-5
IV	General braking requirements; Mechanical, hydraulic, vacuum power and servo brakes; Weight transfer during braking and stopping distances. Classification, Introduction to Conventional and microprocessor based ignition systems; Charging,	CO-6

| | capacity ratings and battery testing; starter motor and drive arrangements: voltage and current regulation, vehicle dashboard components, cruise control system and sensors: RPM sensor, coolant and fuel sensor, speed sensor, GPS, fire sensor. ECU (Electrical Control Unit) | |

References:
• W.H Crouse, Automotive mechanics, McGraw Hill
• J. Heitner, Automotive Mechanics, East West Press
• Kirpal Singh, Automobile Engineering Vol. I and II, Standard Publishers
• J. Webster, Auto Mechanics, Glencoe Publishing Co.

4th Semester	AGME-21406: Applied Thermodynamics – Lab			
Internal Marks:	**30**		**L**	**T**	**P**
External Marks:	**20**		**0**	**0**	**2**
Total Marks:	**50**		**Credits**		**1**

Course Outcomes: After studying the course, students will be able to:	
CO-1	understand the construction and operation of 2 stroke and 4 stroke Petrol and Diesel engines
CO-2	Understand the actual valve timing diagram of a 4 stroke petrol and diesel engines
CO-3	Calculate dryness fraction of steam using Seperating Calorimeter.
CO-4	Calculate the brake power, indicated power, friction power and mechanical efficiency of a multi-cylinder petrol engine
CO-5	Calculate the brake power, indicated power, and mechanical efficiency of a single-cylinder diesel engine
CO-6	Exhibit his/her creativity and conceptual understanding of the subject.

Part	Experiment	CO
A	To study the construction and operation of 2 stroke and 4 stroke Petrol and Diesel engines using actual engines or models.	CO-1
	To study the actual valve timing diagram of a 4 stroke petrol and diesel engines and learn its impact on the performance of engine.	CO-2
	To determine dryness fraction of steam using Seperating Calorimeter.	CO-3
	To determine the brake power, indicated power, friction power and mechanical efficiency of a multi-cylinder petrol engine running at constant speed (Morse Test).	CO-4
	To conduct performance testing of a single-cylinder diesel engine from no load to full load (at constant speed) in terms of brake power, indicated power, mechanical efficiency, specific fuel consumption, break thermal efficiency and volumetric efficiency, and to make the heat balance sheet.	CO-5
B	To make a mini project that demonstrates a concept, based on the content of AGCE – 21301 (Applied Thermodynamics)	CO-6

4th Semester	AGME-21407: Computer aided design and Manufacturing - Lab			

Internal Marks:	30		L	T	P
External Marks:	20		0	0	2
Total Marks:	50		Credits		1

Course Outcomes: After studying the course, students will be able to:

CO-1	Understand and learn the commands related to Draw menu
CO-2	Understand and learn the commands related to Modify menu
CO-3	Understand and learn the commands related to dimensioning and layers
CO-4	Understand commands related to 3d drawing.
CO-5	Learn the CNC programming
CO-6	Exhibit his/her creativity and conceptual understanding of the subject.

Part	Experiment	CO
A	Draw a 2D drawing using commands related to Draw menu	CO-1
	Draw a 2D drawing using commands related to Draw and Modify menu.	CO-2
	Draw a 2D drawing using dimensioning and layers.	CO-3
	Draw a 3D Drawing using 3d commands.	CO-4
	Write a simple CNC program for a 2 D drawing.	CO-5
B	To make a mini project that demonstrates a concept, based on the content of AGCE – 21301 (Computer aided design and Manufacturing))	CO-6

4th Semester	AGME-21408: Automobile Engineering - Lab

Internal Marks:	30		L	T	P
External Marks:	20		0	0	2
Total Marks:	50		Credits		1

Course Outcomes: After studying the course, students will be able to:

CO-1	Understand the significance of meta-centre of floating vessels.
CO-2	Verify Bernoulli's equation and interdependence of various heads.
CO-3	Calibrate and use orifice-meter for measurement of discharge through pipes.
CO-4	Calibrate and use venturi-meter for measurement of discharge through pipes.
CO-5	Compute discharge flowing through an open channel using a notch.
CO-6	Exhibit his/her creativity and conceptual understanding of the subject.

Part	Experiment	CO
A	1. Trouble shooting in cooling system of an automotive vehicle.	CO-1
	2. Trouble shooting in the ignition system, setting of contact breaker points and spark plug gap.	CO-2
	3. Demonstration of steering system and measurement of steering geometry angles and their impact on vehicle performance.	CO-3
	4. Trouble shooting in braking system with specific reference to master cylinder, brake shoes, overhauling of system and the adjusting of the system and its testing.	CO-4
	5. Fault diagnosis in transmission system including clutches, gearbox assembly and differential.	CO-5
B	To make a mini project that demonstrates a concept, based on the content of AGME – 21305 (Automobile Engineering)	CO-6

4th Semester	AGME-21409: Theory of Machines- Lab			
Internal Marks: 30		**L**	**T**	**P**
External Marks: 20		**0**	**0**	**2**
Total Marks: 50		**Credits**		**1**

Course Outcomes: After studying the course, students will be able to:	
CO-1	Calculate the torque and power of shaft.
CO-2	Understand the working of cam and follower.
CO-3	Understand the working of governor.
CO-4	Balance Rotating parts of a system.
CO-5	Understand the concepts of gear train and able to design gear train.
CO-6	Exhibit his/her creativity and conceptual understanding of the subject.

Part	Experiment	CO
A	1. To study the various types of dynamometers.	CO-1
	2. To study cam profile analysis & draw graph between follower displacement and Angle of cam rotation.	CO-2
	3. Conduct experiments on various types of governors and draw graphs between height and equilibrium speed of a governor.	CO-3
	4. Balancing of rotating masses	CO-4
	5. Determination of gear- train value of compound gear trains and epicyclic gear trains.	CO-5
B	To make a mini project that demonstrates a concept, based on the content of AGME – 21302 & AGME 21402 (Theory of Machines - I & Theory of Machines - II)	CO-6

4th Semester	AGAP-21401: Engineering Aptitude - I			
Internal Marks:	50	**L**	**T**	**P**
External Marks:	0	**0**	**1**	**0**
Total Marks:	50	**Credits**		**1**

Course Outcomes: After studying the course, students will be able to:	
CO-1	Develop a Proper Understanding of the Number system
CO-2	Understand the Concept of HCF &LCM to solve problems related to Racetracks, Traffic lights etc.
CO-3	Recognize parts and wholes both visually and numerically
CO-4	Recognize and apply Ratios ,Proportions and Percentage to solve real-life problems
CO-5	Recognize company's revenues and expenditures over a specified period of time,
CO-6	Understand the concept of time value of money

Part	Content	CO
I	**Number System:** Various types of numbers ,Face Value & Place value of a digit in a numeral, Divisibility Tests **Problems on Numbers:** To find Unknown numbers	CO-1
II	**HCF &LCM:** Factors and multiples to find Highest Common Factor and Least Common Multiple of fractions, Comparison of Fraction	CO-2
	Decimal and Fractions: Operations on Decimal and Fractions	CO-3
III	**Ratio & Proportion :**Tricks to Find ratio and Proportions **Percentage:** Concept of Percentage , Tricks to find Percentage	CO-4
IV	**Profit & loss:** Cost Price, Selling Price, Profit, Loss, Profit Percentage and Loss Percentage	CO-5
	Simple & Compound Interest: Interest computed annually, half yearly and Quarterly..	CO-6

References:
• Quantitative Maths : Arihant Publishers. • Objective Mathematics : R S Aggarwaal. • Quantitative Maths : TMH Publications

4th Semester	AGFE-21402: Functional English - II			
		L	**T**	**P**
Internal Marks: 50		**0**	**1**	**0**
External Marks: 0				
Total Marks: 50		**Credits**		**1**

Course Outcomes: After studying the course, students will be able to:	
CO-1	Self Introduction and Body Language to prepare students to face one to one interaction.
CO-2	Spoken Activity such as Topic Presentation or extempore to hone spoken skills of students.
CO-3	Vocabulary based session to improve language proficiency of students.
CO-4	Basic Grammar to make students proficient in English correspondence.
CO-5	Book reading to improve reading skills of students.
CO-6	Formal/ Informal Letter writing to make students proficient in written correspondence.

Part	Content	CO
I	Components of Self Introduction, Exemplary Performances, Student Performances on Self Introduction along with resume.	CO-1
II	This section includes Spoken Activity such as Topic Presentation or extempore to hone spoken skills of students.	CO-2
	This section includes Root words and its usage.	CO-3
III	This section includes editing, omission, gap filling, rearranging jumbled sentences to test knowledge of passive voice, reported speech, articles and the other determiners, modals, tense, etc. Basic Grammar such as Tenses, Voice, Narration shall be done.	CO-4
IV	IKIGAI shall be prescribed for honing reading skills and comprehension in depth.	CO-5
	Formal/ Informal Letter Writing, Basic Format, Example, Practice shall be done.	CO-6

References:
- www.Indiabix.com
- English Grammar by Wren and Martin
- www.freshersworld.com
- www.alison.com

4th Semester	(Mandatory Course): AGMC-21402: ESSENCE OF INDIAN KNOWLEDGE TRADITION			
Internal Marks:	**-**		**L**	**T**	**P**
External Marks:	**-**		**1**	**0**	**0**
Total Marks:	**-**		**Credits**		**0**

Part	Content	CO
-	**INTRODUCTION TO TRADITIONAL KNOWLEDGE:** Define traditional knowledge, nature and characteristics, scope and importance, kinds of traditional knowledge, the physical and social contexts in which traditional knowledge develop, the historical impact of social change on traditional knowledge systems. Indigenous Knowledge (IK), characteristics, traditional knowledge vis-à-vis indigenous knowledge, traditional knowledge Vs western knowledge traditional knowledge vis-à-vis formal knowledge

PROTECTION OF TRADITIONAL KNOWLEDGE: Protection of traditional knowledge: The need for protecting traditional knowledge Significance of TK Protection, value of TK in global economy, Role of Government to harness TK.

LEGAL FRAMEWORK AND TK:
The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006,Plant Varieties Protection and Farmer's Rights Act, 2001 (PPVFR Act); The Biological Diversity Act 2002 and Rules 2004, the protection of traditional knowledge bill, 2016.Geographical indicators act 2003.

TRADITIONAL KNOWLEDGE AND INTELLECTUAL PROPERTY
Certain non IPR mechanisms of traditional knowledge protection, Patents and traditional knowledge, Strategies to increase protection of traditional knowledge, global legal FORA for increasing protection of Indian Traditional Knowledge.

TRADITIONAL KNOWLEDGE IN DIFFERENT SECTORS: Traditional knowledge and engineering, Traditional medicine system, TK and biotechnology, TK in agriculture, Traditional societies depend on it for their food and healthcare needs, Importance of conservation and sustainable development of environment, Management of biodiversity, Food security of the country and protection of TK. 139. | - |

References:
- **Traditional Knowledge System in India**, by Amit Jha, 2009.
- **Traditional Knowledge System and Technology in India** by Basanta Kumar Mohanta and Vipin KumarSingh, Pratibha Prakashan 2012.
- **Knowledge Traditions and Practices of India,** Kapil Kapoor1, Michel Danino2

Course Outcomes:
1. Understand the concept of traditional knowledge and its importance
2. Know the need and importance of protecting traditional knowledge.
3. Know the various enactments related to the protection of traditional knowledge.
4. Understand the concepts of Intellectual property to protect the traditional knowledge.
5. Understand significance of traditional knowledge in different sectors

5th Semester	AGME-21501: Design of Machine Elements-I			
		L	**T**	**P**
Internal Marks: 40		3	1	0
External Marks: 60				
Total Marks: 100		**Credits**		4

Course Outcomes: After studying the course, students will be able to:

CO-1	Understand the basics of Design, Creativity, Design failures conditions of machines.
CO-2	Understand the Concept of concurrent engineering, FOS and various manufacturing considerations.
CO-3	Design the rivets for boilers and structures
CO-4	Design the cotter and knuckle joint.
CO-5	Design the shafts under different loading conditions.
CO-6	Design the various keys and couplings.

Part	Content	CO
I	Meaning of design with special reference to machine design, definition and understanding of various types of design, design process, design and creativity, general design considerations, concept of tearing, bearing, shearing, crushing, bending and fracture.	CO-1
	Concept of concurrent engineering in design, Manufacturing considerations in machine design, stress concentration, factor of safety under different loading conditions, design for static loading, design for variable loading for both limited and unlimited life, concept of fatigue and endurance strength.	CO-2
II	Design of rivets for boiler joints, lozenge joints.	CO-3
III	Design of spigot and socket cotter joint, knuckle joint.	CO-4
	Design of solid and hollow shafts for transmission of torque, bending moments and axial forces, Design of shaft for rigidity.	CO-5
IV	Design of keys, design of splines, design of sleeve and solid muff coupling, clamp or compression coupling, rigid and flexible flange coupling.	CO-6

References:
- Joseph E. Shigley, Charles Russell Mischke, Richard Gordon Budynas, Mechanical
- Engineering Design, McGraw-Hill
- Robert C. Juvinall Fundamentals of machine component design, Wiley
- V.K Jadon, Analysis and design of machine elements, I.K. International
- V.B Bhandari, Design of Machine elements, Tata Mc. Hill
- S.S Jolly, Design of machine elements-I, Dhanpat Rai and Co.

5th Semester		AGME-21502: Fluid Mechanics			
			L	**T**	**P**
Internal Marks:	40		3	1	0
External Marks:	60				
Total Marks:	100		**Credits**		4

Course Outcomes	: After studying the course, students will be able to:
CO-1	To learn the concept of Fluid, Properties of fluid, Viscosity, Surface Tension and Capillarity
CO-2	To understand the concept of Fluid Statics, Buoyancy, Floatation and Metacentric height
CO-3	To Learn the concept of velocity, acceleration, Continuity Equation, velocity potential function and stream function
CO-4	To understand the concept of Fluid dynamics.
CO-5	To study about the Dimensional Analysis and Similitude
CO-6	To describe about the Internal Flows and flow Measurements

Part	Content	CO
I	Introduction; Applications; Concept of fluid; Difference between solids, liquids and gases; Concept of continuum; Ideal and real fluids; Fluid properties: density, specific volume, specific weight, specific gravity, viscosity (dynamic and kinematic), vapour pressure, compressibility, bulk modulus, Mach number, surface tension and capillarity; Newtonian and non-Newtonian fluids	CO-1
	Fluid Statics: Concept of static fluid pressure; Pascal's law and its engineering applications; Hydrostatic paradox; Manometers construction and working, Action of fluid pressure on a plane submerged surface (horizontal, vertical and inclined): resultant force and centre of pressure; Force on a curved surface due to hydrostatic pressure; Buoyancy and flotation; Stability of floating and submerged bodies; Metacentric height and its determination; Periodic time of oscillation; Pressure distribution in a liquid subjected to :(i) Constant acceleration along horizontal, vertical and inclined direction (linear motion), (ii) Constant rotation	CO-2
II	Fluid Kinematics: Classification of fluid flows; Lagrangian and Euler flow descriptions; Velocity and acceleration of fluid particle; Local and convective acceleration; Normal and tangential acceleration; Path line, streak line, streamline and timelines; Flow rate and discharge mean velocity; One dimensional continuity equation; Continuity equation in Cartesian (x,y,z), polar (r,θ) and cylindrical (r,θ,z) coordinates	CO-3
III	Fluid Dynamics: Derivation of Euler's equation of motion in Cartesian coordinates, and along a streamline; Derivation of Bernoulli's equation (using principle of conservation of energy and equation of motion) and its applications to steady state ideal and real fluid flows; Representation of energy changes in fluid system (hydraulic and energy gradient lines.	CO-4
IV	Internal Flows: Laminar and Turbulent Flows: Reynolds number, critical velocity, critical Reynolds number, hydraulic diameter, flow regimes; Darcy equation; Head losses in pipes and pipe fittings; Flow through pipes in series and parallel; Concept of equivalent pipe; Roughness in pipes.	CO-5
	Pressure and Flow Measurement:; Pitot tubes; Various hydraulic coefficients; Orifice meters; Venturi meters; Borda mouth pieces; Notches (rectangular, V and Trapezoidal) and Rotameters.	CO-6

References:

- D.S. Kumar, Fluid Mechanics and Fluid Power Engineering, S.K. Kataria and Sons Publishers.
- S.K. Som, G. Biswas and S. Chakraborty, Introduction to Fluid Mechanics and Fluid Machines, Tata McGraw Hill.
- J.F. Douglas and J.M. Gasiorek, J.A. Swaffield and L.B. Jack, Fluid Mechanics, Pearson.
- B.R. Munson, D.F. Young, T.H. Okiishi and W.W. Huebsch, Fundamentals of Fluid Mechanics, John Wiley and Sons.

5th Semester		AGME-21503 Mechanical Measurements and Metrology			
			L	**T**	**P**
Internal Marks:	40		3	0	0
External Marks:	60				
Total Marks:	100		**Credits**		3

Course Outcomes: After studying the course, students will be able to:	
CO-1	Understand the need of instruments and learn how they work, design and planning of experiments.
CO-2	Demonstrate various types of measurements standards used in industry and Understand the different types of errors and calibration standards.
CO-3	Demonstrate various types of measurements equipment used to measure linear dimension, angular dimension and surface roughness of object.
CO-4	Understanding the pressure, flow measurement, flow visualization techniques.
CO-5	Understand the concepts behind sensors and transducers involved in measurements of temperature.
CO-6	Understand the concepts of speed, force, torque and shaft power.

Part	Content	CO
I	Need and classification of measurements and instruments; basic and auxiliary functional elements of a measurement system; Mechanical versus electrical / electronic instruments; primary, secondary and working standards.	CO-1
II	Range and span, accuracy and precision, calibration, hysteresis and dead zone, sensitivity and linearity, threshold and resolution; speed of response, lag, fidelity and dynamic error, dead time and dead zone. Sources of errors, systematic and random errors.	CO-2
	Line, end and wavelength standards; linear measurements - vernier scale and micrometre, vernier height gauge and depth gauge; comparators - their types, relative merits and limitations; Angular measurements - sine bar, clinometer, angle gauge; concept and measurement of straightness and flatness by interferometry; surface roughness - specifications and measurement by Talysurf, Measurement of major diameter, minor diameter, effective diameter, pitch, angle and form of threads for internal and external threads; measurement of tooth thickness, pitch and checking of profile for spur gears.	CO-3
III	Bourdon tube, diaphragm and bellows, vacuum measurement-Mcleodguage, thermal conductivity gauge and ionization gauge; Dead weight gauge tester. Electromagnetic flux meters, ultra-sonic flow meters and flow visualisation techniques.	CO-4
	Thermal expansion methods - bimetallic thermometers, liquid-in-glass thermometer and filled-in-system thermometers; thermo-electric sensors - common thermo couples, special materials and configurations; metal resistance thermometers and thermistors; optical and total radiation pyrometers; calibration standards.	CO-5
IV	Mechanical tachometers, vibration reed tachometer and stroboscope; proving ring, hydraulic and pneumatic load cells, torque on rotating shafts; Absorption, transmission and driving dynamo meters.	CO-6

References:
• E.O Doebelin, Measurement System: Application and Design, McGraw Hill
• J.P Holman, Experimental Methods for Engineers, McGraw Hill
• D.S Kumar, Mechanical Measurement and Control, Metropolitan Book Co.
• R.K Jain, Engineering Metrology, Khanna Publishers
• B.C Kuo, Automatic Control systems, Prentice Hall

5ᵗʰ Semester		**AGME-21504 A : Solid Mechanics**			
			L	**T**	**P**
Internal Marks:	40		**3**	**0**	**0**
External Marks:	60				
Total Marks:	100		**Credits**		**3**

Course Outcomes: After studying the course, students will be able to:	
CO-1	Understand the fundamental of solid mechanics.
CO-2	Understand the concepts of stress & Strain.
CO-3	Understand the energy method.
CO-4	Understand the torsional components & its effects.
CO-5	Understand the theory of symmetrical & unsymmetrical solids.
CO-6	Understand the buckling of solids.

Part	Content	CO
I	Stress analysis: Body force, surface force, stress/traction vector, state of stress at a point, normal and shear components, plane stress, stress transformations, Mohr's circle, principal stresses, principal planes.	CO-1
	Stress Strain Temperature Relations: Idealization/Types of stress strain curves, thermal strains, stress strain temperature relations for linear elastic isotropic body, interpretation of different elastic constants.	CO-2
II	Energy methods: Strain energy, reciprocal theorem, principle of virtual work, Castigliano's theorem, principle of minimum potential energy, Rayleigh-Ritz method for approximate solutions.	CO-3
III	Torsion: Torsion of circular straight rods, torsion of shafts with rectangular cross-sections, torsion of hollow shafts, torsion of thin tubes, shafts subjected to combined loads Torsion of shafts with arbitrary cross-sections.	CO-4
	Bending: Stress and deflections in symmetrical elastic beams, symmetrical beams subjected to combined loads, bending of unsymmetrical beams, bending of curved beams.	CO-5
IV	Buckling: Equilibrium approach, potential energy approach, eigenvalue problems, beam buckling with various boundary conditions, approximation of buckling loads using potential energy methods.	CO-6

References:
• Saad, M. H., Elasticity: Theory, Applications and Numerics
• Timoshenko, S. P., Theory of Elasticity
• Srinath, L. S, Advanced Mechanics of Solids
• Crandal, S, Lardner, T, Dahl, N and Sivakumar, M. S., An Introduction to Mechanics of Solids

5th Semester	AGME-21504 B : Computer Integrated Manufacturing			
		L	**T**	**P**
Internal Marks: 40		3	0	0
External Marks: 60		**Credits**		3
Total Marks: 100				

Course Outcomes: After studying the course, students will be able to:	
CO-1	Understand the principle of automation.
CO-2	Compare NC and CNC machines.
CO-3	Know the constructional features of CNC machines.
CO-4	Construct part programmers using ISO format for given simple components
CO-5	Develop an FMS (Flexible Manufacturing System) with computer aided process planning
CO-6	Recognize the use of robotics, in the field of manufacturing.

Part	Content	CO
I	INTRODUCTION TO CIM & AUTOMATION: CIM –definition, scope and elements of CIM system-benefits, Production system facilities low-medium-high-Manufacturing support systems-Automation in production systems, Automated manufacturing systems-Computerized Manufacturing Support Systems-Reasons for Automating, Automation principles, Automation –definition-Basic elements of an automated system -Levels of automation	CO-1
	NC AND CNC MACHINES: Fundamentals of NC Technology-Basic Components of an NC System-NC Coordinate Systems-Motion Control Systems, Applications of NC-Machine Tool Applications-Other NC Applications-Advantages and Disadvantages of NC, Computer Numerical Control Features of CNC-The Machine Control Unit for CNC-CNC Software, CNC Applications Advantages and Disadvantages of CNC, DNC-Direct Numerical Control-Distributed Numerical Control	CO-2
II	CONSTRUCTION OF CNC MACHINES: Construction of CNC machines-Machine structure-Static load-Dynamic load-Thermal load, Guide ways-Friction guide ways-V guide ways-Flat &dovetail guide ways-Cylindrical guide ways-Anti frictional linear motion guide ways, Feed drives-Servomotors-Mechanical transmission system, Spindle and spindle bearings-Hydrodynamic bearings.	CO-3
III	CNC PART PROGRAMMING: Introduction to Part Programming-Coordinate system-Dimensioning-Axes & motion nomenclature Definition and importance of various positions like machine zero, home position, and work piece zero, CNC part programming.	CO-4
	GROUP TECHNOLOGY AND CAPP: Group technology-Definition-Advantages and limitations of GT-Part family formation Classification and coding-Opitz coding system, Applications & benefits of GT, Cellular manufacturing-Machining cell designs-Machining cell planning, Computer aided process planning-Approaches to CAPP	CO-5
IV	ROBOTICS: Introduction-definition of robot-Elements of a robotic system-Need for using robots-Types of robots-Classification of robots based on mechanical configuration, robot-Freedom of motion, End effectors-grippers & tools, Drive systems, Control systems.	CO-6

References:
• Automation, Production Systems, and Computer Aided Manufacturing, by Mikell P. Groover.
• Mechatronics, McGraw Hill Educations.
• CNC Machines, Pabla B.S., Adithan M
• Industrial Robotics, McGraw Hill Education.

5th Semester		AGME-21504 C : Mechatronics			
			L	**T**	**P**
Internal Marks:	40		3	0	0
External Marks:	60		3	0	0
Total Marks:	100		**Credits**		3

Course Outcomes: After studying the course, students will be able to:	
CO-1	Understand the importance of mechatronics systems & its applications.
CO-2	To understand the applications of Sensors and Transducers.
CO-3	Understand the significance of signals system.
CO-4	Understand the Pneumatic and Hydraulic Equipment.
CO-5	To understand the components of EAS
CO-6	Understand the Microprocessor and its application.

Part	Content	CO
I	Introduction to Mechatronics: Definition and approach of Mechatronics, Measurement and Control Systems, Microprocessor based controllers and Mechatronics Approach.	CO-1
	Sensors and Transducers: Performance Terminology, Displacement, velocity, Position, Proximity, force, fluid pressure, liquid level, temperature, light sensors, procedure for selection.	CO-2
II	Signal Conditioning: Op Amp, Protection, digital signals, Multiplexes and digital signal processing, pulse modulation.	CO-3
III	Pneumatic and Hydraulic Systems: Actuation systems, Directions, pressure and process control valve, Pneumatic and hydraulic systems.	CO-4
	Electrical Actuation System: Mechanical Switches, Solid State Switches, Solenoid, DC/AC Motors, Stepper Motors.	CO-5
IV	Microprocessor and Its Application: Architecture of Microprocssor 8085, Instruction set, Embedding a microprocessor into a Mechatronics system. Assemble a suitable system using microprocessor kit for its control.	CO-6

References:
• W. Bolton, Mechatronics, Pearson Education.
• Rafiquzzaman, Microprocessors.
• S. Boennett, Real time computer controls, Prentice Hall.
• Benjamin C. Kuo, Automatic Control Systems, Prentice Hall.

5th Semester		AGME-21504 D : Machine Tool Design			
			L	**T**	**P**
Internal Marks:	40		3	0	0
External Marks:	60				
Total Marks:	100		**Credits**		3

Course Outcomes:	After studying the course, students will be able to:
CO-1	Understand the importance of tool & its design.
CO-2	Understand the kinematics of different types of machine tools.
CO-3	Design the Kinematics Scheme of various machine drives.
CO-4	Design the speed box of machine tools..
CO-5	To understand the Spindle Design & Bearings.
CO-6	To understand the Machine Control System.

Part	Content	CO
I	Introduction: General requirements to machine tools, Machine tool design recommendations, Classification of motions to shape surface, Machine tool drives for rectilinear motion, Periodic motion, reversing motion etc.	CO-1
	Kinematics of Machine Tools: Kinematics or gearing diagram of Lathe, drilling Machine, Milling Machine etc. Main drive and feed drive, principles specification of Machine tool.	CO-2
II	Design of Kinematics Scheme: Methods to determine transmission ratios for drives. Development of Kinematics scheme, minimum of transmission groups, Determination of number of teeth on gears.	CO-3
III	Speed and Feed Boxes: General requirement Design of gear trains, speed boxes types, speed changing devices, Feed boxes characteristics of feed mechanism, types of Rapid traverse mechanisms, variable devices.	CO-4
	Spindle Design and Spindle Bearings: Main requirement, Materials and details of spindle design, Spindle bearings, bearings, types of bearings and their selections, Bearing Materials BED	CO-5
IV	Machine Tools Control Systems: Requirement of control system selection and construction of control systems Mechanical control system, predilection control, remote control safety devices. Dynamic performance, dynamic and elastic system of Machine, tools. Dynamics of cutting forces, tool chatter.	CO-6

References:

- Sen and Bhattacharya, Machine Tools Design, CBS Publishers.
- N.K. Mehta, Machine Tool Design, Tata McGraw Hill.
- N. Acherkan, Machine Tool Design, Four Volumes, Mir Publishers.
- S.K. Basu and D.K. Pal, Design of machine tools, Oxford and IBH.

5th Semester		AGME-21505: Machine Drawing (Skill Course-I)			
Internal Marks:	30		**L**	**T**	**P**
External Marks:	20		1	0	4
Total Marks:	50		**Credits**		3

Course Outcomes:	After studying the course, students will be able to:
CO-1	Read the blue prints with detail of dimension, section, tolerance and machining symbols.
CO-2	Understand to read the thread geometry and able to draw riveted and welded joints.
CO-3	Understand the drawing of various types of couplings and clutches.
CO-4	Find the details of various components from the assembly drawing.
CO-5	Draw the views of assembly with the given details of various components.
CO-6	Recommend the appropriate pipe joint as per position and application.

Part	Content	CO
I	Principles of Drawing, Requirements of production drawing, Sectioning and conventional representation, Dimensioning, symbols of standard tolerances, Machining Symbols, introduction and Familiarization of Code IS: 296	CO-1
	Various types of screw threads, types of nuts and bolts, screwed fasteners, welding joints and riveted joints.	CO-2
II	Couplings: Solid or Rigid Coupling, Protected Type Flange coupling, Pin type flexible coupling, muff coupling, Oldham, universal coupling, claw coupling, cone friction clutch, free hand sketch of single plate friction clutch.	CO-3
III	Bearings: Swivel bearing, thrust bearing, Plummer block, angular plumber block, Miscellaneous: Screw Jack, Drill Press Vice, Crane hook, Tool Post, Tail Stock, and Drilling Jig.	CO-4
	IC Engine Parts: Piston, connecting rod, Boiler Mountings: Steam stop valve, feed check valve, safety valve, blow off cock.	CO-5
IV	Knuckle and cotter joints Pipe and Pipe Fittings: flanged joints, spigot a socket joint, union joint, hydraulic an expansion joint	CO-6

References:

- N.D. Bhatt, Machine Drawing, Charotar publications.
- N. Sidheshwar, Machine Drawing, Tata McGraw Hill.
- P.S. Gill, Machine Drawing, BD Kataria and Sons.
- V Lakshmi Narayanan and Mathur, Text-book of Machine Drawing.

5th Semester		AGME-21506: Design of Machine Elements-I Lab			
			L	**T**	**P**
Internal Marks:	**30**		**0**	**0**	**2**
External Marks:	**20**				
Total Marks:	**50**		**Credits**		**1**

Course Outcomes: After studying the course, students will be able to:

CO-1	Design the product used in daily life.
CO-2	Understand the material properties of component and also find the other suitable material.
CO-3	Design the wall bracket.
CO-4	Design the knuckle joint used in daily practices.
CO-5	Design the shaft under different loading conditions.
CO-6	Exhibit his/her creativity and conceptual understanding of the subject.

Part	Experiment	CO
A	Select a daily use product and study its design by applying the design process.	CO1
	Take a mechanical component and know their materials and suggest some alternative materials for the each one of them.	CO2
	Design a wall bracket, which is being used in real life by actual measurement of load in case of Riveted Joint.	CO3
	Design, draw and assemble a knuckle joint used in some practical application, by actual working and loading conditions	CO4
	Design a shaft used in some practical application, by actual working and loading conditions.	CO5
B	To make a mini project that demonstrates a concept based on the content of AGME-21501 (Design of Machine Elements-I)	CO6

5th Semester		AGME-21507: Fluid Mechanics Lab			
			L	**T**	**P**
Internal Marks:	**30**		**0**	**0**	**2**
External Marks:	**20**				
Total Marks:	**50**		**Credits**		**1**

Course Outcomes: After studying the course, students will be able to:

CO-1	Understand how to find metacentric height of floating vessel
CO-2	Understand the flow through a variable area duct and verify Bernoulli's energy equation how
CO-3	Understand how to find discharge coefficient for a V- notch or rectangular notch
CO-4	Understand how to find the Reynolds's number
CO-5	Find the coefficient discharge of venture meter or orifice meter
CO-6	Exhibit his/her creativity and conceptual understanding of the subject.

Part	Experiment	CO
A	To determine the metacentric height of a floating vessel under loaded and unloaded conditions	CO1
	To study the flow through a variable area duct and verify Bernoulli's energy equation	CO2
	To determine the discharge coefficient for a V- notch or rectangular notch.	CO3
	To study the transition from laminar to turbulent flow and to ascertain the lower critical Reynolds number.	CO4
	To determine the coefficient of discharge for an obstruction flow meter (venture meter/ orifice meter	CO5
B	To make a mini project that demonstrates a concept, based on the content of AGME- 21502 (Fluid Mechanics)	CO6

5th Semester		AGME-21508: Mechanical Measurements and Metrology Lab				
				L	T	P
Internal Marks:	30			0	0	2
External Marks:	20					
Total Marks:	50			Credits		1

Course Outcomes: After studying the course, students will be able to:

CO-1	Understand how to find angle through sine bar
CO-2	Understand how to find linear dimensions with the help of Vernier Caliper.
CO-3	Understand the working of micrometre.
CO-4	Understand the working of tool maker microscope.
CO-5	Understand the working of stroboscope.
CO-6	Exhibit his/her creativity and conceptual understanding of the subject.

Part	Experiment	CO
A	Measurement of an angle with the help of sine bar.	CO1
	Measurement of dimensions using a vernier calliper.	CO2
	Measurement of diameter of circular object using micrometre.	CO3
	Measurement of thread elements by tool maker microscope.	CO4
	Use of stroboscope for measurement of speed of shaft.	CO5
B	To make a mini project that demonstrates a concept, based on the content of AGME- 21503 (Mechanical Measurements and Metrology)	CO6

5th Semester		AGME-21509: Summer Training				
				L	T	P
Internal Marks:	60			0	0	0
External Marks:	40					
Total Marks:	100			Credits		1

Course Outcomes: After studying the course, students will be able to:

CO-1	Communicate effectively with peers.
CO-2	Differentiate the layout of various industrial shops.
CO-3	Participate constructively and ethically in the industrial process.
CO-4	Describe detailed specifications of machinery/equipment/tool/software.
CO-5	Analyse the scope of training received towards his/her career goals.
CO-6	Write the report on an industrial project.

Part	Activities during 4 weeks Training	CO
A	Interaction with HR and communicate the details of the supervisor to the department	CO1
	General layout of Industry/Plant.	CO2
	Participation in assigned tasks (Ethical & Constructive).	CO3
	Description of machinery/equipment/tools/software used during training.	CO4
	Analyse the scope of training received towards his/her career goals.	CO5
B	Report writing on the industrial project.	CO6

6th Semester	AGME-21601 Design of Machine Elements-II			
		L	**T**	**P**
Internal Marks: 40		3	1	0
External Marks: 60		**Credits**		4
Total Marks: 100				

Course Outcomes: After studying the course, students will be able to:	
CO-1	Understand the design procedure of sliding Journal bearing and roller bearing.
CO-2	Understand the design procedure of flywheel.
CO-3	Understand the design procedure of springs
CO-4	Understand the design procedure of clutches.
CO-5	Design different types of brakes.
CO-6	Understand the design procedure of levers.

Part	Content	CO
I	Principle of hydrodynamic lubrication, modes of lubrication, Reynolds equation, bearing performance parameters, slider bearing design Roller: Types, selection guidelines, static and dynamic load carrying capacity, Stribeck's equation, equivalent bearing load, load life relationship, selection of bearing, comparison of roller and slider bearing	CO-1
	Introduction, Energy stored in a flywheel, stresses in a rim, design considerations.	CO-2
II	Types, end styles of helical compression spring, surge in spring; nipping of leaf spring; Design of close-coil helical spring and multi leaf spring	CO-3
III	Design of contact clutches i.e. plate, multi-disc, cone and centrifugal clutches.	CO-4
	Design of band, disc, block with shoe and internal expanding brakes.	CO-5
IV	Design of levers (foot lever and hand lever)	CO-6

References:
• Joseph E. Shigley, Charles Russell Mischke, Richard Gordon Budynas, Mechanical Engineering Design, McGraw Hill.
• Robert C. Juvinall Fundamentals of machine component design, JohnWiley Eastern
• V.K Jadon, Analysis and design of machine elements, I.K. International
• .B Bhandari, Design of Machine elements, Tata Mc-Graw. Hill
• S.S Jolly, Design of machine elements-II, Dhanpat Rai and Co.

6th Semester	AGME 21602 – Fluid Machinery			
		L	**T**	**P**
Internal Marks: 40		**3**	**1**	**0**
External Marks: 60				
Total Marks: 100		**Credits**		**4**

Course Outcomes: After studying the course, students will be able to:	
CO-1	Recognize basic components of turbo machines and understand related fundamental laws/ principles and apply these for calculation of various parameters like work done, force efficiency etc.
CO-2	Know about constructional details, working and design aspects of runner/wheel and evaluate the performance of various turbines like Pelton
CO-3	Understand abaut the working and velocity tringle diagram of Francis and Kaplan turbines
CO-4	Know about constructional details, working and evaluate the performance of centrifugal pump under different vane shape conditions
CO-5	Know about constructional details, working and evaluate the performance of reciprocating pump and evaluate the effect of various deviations from the ideal conditions on the work done.
CO-6	Know about constructional details and working of hydraulic devices like fluid coupling, accumulator and intensifier.

Part	Content	CO
I	General Concepts: Impulse momentum principle; jet impingement on stationary and moving flat plates, and on stationary or moving vanes with jet striking at the centre and tangentially at one end of the vane; calculations for force exerted, work done and efficiency of jet. Basic components of a turbo machine and its classification on the basis of purpose, fluid dynamic action, operating principle, geometrical features, path followed by the fluid and the type of fluid etc.	CO-1
	Pelton Turbine: Component parts and operation; velocity triangles for different runners, work output; Effective head, available power and efficiency; design aspects such as mean diameter of wheel, jet ratio, number of jets, number of buckets with working proportions.	CO-2
II	Francis and Kaplan Turbines: Component parts and operation velocity triangles and work output; working proportions and design parameters for the runner; Degree of reaction; Draft tubes - its function and types. Function and brief description of commonly used surge tanks.	CO-3
III	Centrifugal Pumps: Layout and installation; Main elements and their functions; Various types and classification; Pressure changes in a pump - suction, delivery and manometric heads; vane shape and its effect on head-capacity relationships; Departure from Euler's theory and losses; pump output and efficiency; Minimum starting speed and impeller diameters at the inner and outer periphery; Priming and priming devices, Multistage pumps - series and parallel arrangement; submersible pumps. Construction and operation; Axial and mixed flow pumps; Trouble shooting - field problems, causes and remedies.	CO-4
IV	Reciprocating Pumps: Components parts and working; pressure variations due to piston acceleration; acceleration effects in suction and delivery pipes; work done against friction; maximum permissible vacuum during suction stroke; Air vessels.	CO-5
	Hydraulic Devices and Systems: Const., operation and utility of simple and differential accumulator, intensifier, fluid coupling, Air lift and jet pumps; gear, vane and piston pumps, Hydraulic Rams, Hydraulic lift, Hydraulic crane.	CO-6

References:
- R.L. Daughaty, Hydraulic Turbines, McGraw Hill
- Jagdish Lal, Hydraulic Machines by Metropolitan Book Co
- D.S. Kumar, Fluid Mechanics and Fluid Power Engineering, SK Kataria and Sons,
- K. Subramaniam, Hydraulic Machines, Tata McGraw Hill
- R.K. Purohit., Hydraulic Machines, Scientific Publishers

6th Semester		AGME-21603 : HEAT TRANSFER			
			L	**T**	**P**
Internal Marks:	40		3	0	0
External Marks:	60				
Total Marks:	100		**Credits**		3

Course Outcomes: After studying the course, students will be able to:

CO-1	Understand concept of basic modes of heat transfer.
CO-2	Understand theory of conduction heat transfer**.**
CO-3	Understand theory of heat transfer in extended surfaces.
CO-4	Understand theory of convection heat transfer.
CO-5	Understand theory of heat transfer in boiling and condensation phase.
CO-6	Understand theory heat transfer through radiation process.

Part	Content	CO
I	Introduction: Concept of heat transfer, Difference between the subject of "Heat Transfer" and its parent subject "Thermodynamics". Different modes of heat transfer - conditions, convection, and radiation.	CO-1
	Conduction: Fouier's law of heat conduction, coefficient of thermal conductivity, effect of temperature and pressure on thermal conductivity of solids, liquids and gases and its measurement. Three dimensional general conduction equation in rectangular, cylindrical and spherical coordinates involving internal heat generation and unsteady state conditions. Derivation of equations for simple one dimensional steady state heat conduction from three dimensional equations for heat conduction though walls, cylinders and spherical shells (simple and composite), Introduction to unsteady heat transfer, Newtonian heating and cooling of solids; definition and explanation of the term thermal diffusivity. Numerical.	CO-2
II	Theory of Fins: Concept of fin, classification of fins and their applications. Straight fins of uniform cross-section; e.g. of circular, rectangular or any other cross-section). Straight fins with varying cross-sectional area and having triangular or trapezoidal profile area. Circumferential fins of rectangular cross section provided on the circumference of a cylinder. Fin performance: fin effectiveness and fin efficiency, total fin effectiveness, total fin efficiency. Optimum design of straight fin of rectangular and triangular profile area. Application of fins in temperature measurement of flow through pipes and determination of error in its measurement. Numerical.	CO-3
III	Convection: Free and forced convection. Derivation of three-dimensional mass, momentum and energy conservation equations Boundary layer formation, laminar and turbulent boundary layers (simple explanation only and no derivation). Theory of dimensional analysis and its application to free and forced convective heat transfer. Analytical formulae for heat transfer in laminar and turbulent flow over vertical and horizontal tubes and plates. Newton's law of cooling. Overall coefficient of heat transfer. Different design criterion for heat exchangers.	CO-4
	Convection with Phase Change (Boiling and Condensation): Pool boiling, forced convection boiling, heat transfer during pool boiling of a liquid. Nucleation and different theories of nucleation, different phases of flow boiling (theory only), Condensation, types of condensation, film wise condensation on a vertical and inclined surface, Numerical.	CO-5
IV	Radiation: Process of heat flow due to radiation, definition of emissivity, absorptivity, reflectivity and transmissivity. Concept of black and grey bodies, Plank's law of nonchromatic radiation. Kirchoff's law and Stefan Boltzman's law. Interchange factor. Lambert's Cosine law and the geometric factor. Intensity of Radiation.	CO-6

References:

- P.S. Ghoshdastidar, Heat Transfer, Oxford Press
- D.S. Kumar, Fundamentals of Heat and Mass Transfer, SK Kataria & Sons
- A.J. Chapman, Heat Transfer, McGraw Hill Book Company, New York.
- Eckert & Drake, Heat and Mass Transfer, McGraw Hill Book Company, New York.

6th Semester		AGME-21604 A : Non Traditional Machining			
Internal Marks:	40		**L**	**T**	**P**
External Marks:	60		**3**	**0**	**0**
Total Marks:	100		**Credits**		**3**

Course Outcomes: After studying the course, students will be able to:	
CO-1	Understand the non-traditional machining process and need for it.
CO-2	Understand the constructional features and performance of USM, AJM, and WJM.
CO-3	Understand the constructional features and performance of ECM AND CHM
CO-4	Understand the constructional features and performance of EDM AND PAM
CO-5	Understand the constructional features and performance of LBM
CO-6	Understand the constructional features and performance of EBM.

Part	Content	CO
I	Introduction to Non-traditional machining, Need for Nontraditional machining process, Comparison between traditional and non-traditional machining, general classification Nontraditional machining processes, classification based on nature of energy employed in machining, selection of non-traditional machining processes, Specific advantages, limitations and applications of non-traditional machining processes.	CO-1
	Ultrasonic Machining (USM): Introduction, Equipment and material process, Effect of process parameters: Effect of amplitude and frequency, Effect of abrasive grain diameter, effect of slurry, tool &work material. Process characteristics: Material removal rate, tool wear, accuracy, surface finish, applications, advantages &limitations of USM. Abrasive Jet Machining (AJM): Introduction, Equipment and process of material removal, process variables: carrier gas, type of abrasive, work material, stand-off distance(SOD).Process characteristics-Material removal rate, Nozzle wear, accuracy &surface finish. Applications, advantages &limitations of AJM. Water Jet Machining (WJM): Equipment &process, Operation, applications, advantages and limitations of WJM.	CO-2
II	Introduction, Principle of electro chemical machining: ECM equipment, elements of ECM Operation, Chemistry of ECM. ECM Process characteristics: Material removal rate, accuracy, Surface finish. Process parameters: Current density, Tool feed rate, Gap between tool &work piece, velocity of electrolyte flow, type of electrolyte, its concentration temperature, and choice of Electrolytes. ECM Tooling: ECM tooling technique &example, Tool &insulation materials. Applications ECM: Electrochemical grinding and electrochemical honing process. Advantages, disadvantages and application of ECM. CHM Elements of the process: Resists (maskants), Etchants. Types of chemical machining process chemical Blanking process, chemical milling process. Process characteristics of CHM: material removal rate, accuracy, surface finish, advantages, limitations and applications of chemical machining process.	CO-3
III	Introduction, mechanism of metal removal, EDM equipment: spark erosion generator (Relaxation type), dielectric medium-its functions &desirable properties, electrode feed control system. Flushing types; pressure flushing, suction flushing, side flushing, pulsed flushing. EDM process parameters: Spark frequency, current &spark gap, surface finish, Heat Affected Zone. Advantages, limitations &applications of EDM, Electrical discharge grinding, Traveling wire EDM. PLASMA ARC MACHINING (PAM) Introduction, non-thermal generation of plasma, equipment mechanism of metal removal, Plasma torch, process parameters, process characteristics. Safety precautions. Safety Precautions, applications, advantages and limitations.	CO-4
	LASER BEAM MACHINING (LBM) Introduction, generation of LASER, Equipment and mechanism of metal removal, LBM Parameters and characteristics, Applications, Advantages &limitations.	CO-5
IV	ELECTRON BEAM MACHINING (EBM) Introduction, Principle, equipment and mechanism of metal removal, applications, advantages and limitations.	CO-6

References:

- Modern Machining Processes by P.C Panday and H. S Shah Tata McGraw-Hill Education, India Pvt.Ltd. 2000
- Non Traditional Machining by Kestor Praveen Suggi publication 2018

6th Semester		AGME-21604 B : Non- Destructive Testing			
			L	**T**	**P**
Internal Marks:	40		3	0	0
External Marks:	60				
Total Marks:	100		**Credits**		3

Course Outcomes: After studying the course, students will be able to:	
CO-1	Understand the applications of Non Destructive Testing in Industry.
CO-2	Understand the practical applications of Radiographic.
CO-3	Understand the Magnetic particle inspection.
CO-4	Understand the principles electro analytical methods.
CO-5	Understand the theory of Ultrasonic Process.
CO-6	Understand the technique for measuring and visualizing.

Part	Content	CO
I	**Introduction:** Classification of techniques of material testing, Need and Significance of Non Destructive Testing methods, type of Non Destructive testing methods. Practical applications and industrial applications.	CO-1
	Radiographic Examination: Radiant energy and radiography, practical applications, X-ray and Gamma –ray equipment, effect of variables on radiographs, requirement of a good radiograph, interpretation of radiograph, safety precautions, Xeroradiography.	CO-2
II	**Magnaflux methods:** Basic principles, scope and applications, magnetic analysis of steel bars and tubing magnetization methods, equipment, inspection medium, preparation of surfaces Fluorescent Penetration inspection, Demagnetization.	CO-3
III	**Electrical Methods**: Basic principles, flaw detection in rails and tubes (Sperry Detector), Ultrasonic testing surface roughness, moisture in wood, Detection of defects in ferrous and non-ferrous metals.	CO-4
	Ultrasonic Methods: Measurement of thickness, hardness, stiffness, sonic material analyzer, proof tests, and concrete test hammers.	CO-5
IV	**Photo elasticity:** Introduction, Concept and applications of Plane and circular polarization, Photo stress, models.	CO-6

References:
- H.E. Davies, G.E Troxell and GFW Hauck, The testing of Engg materials, Mc Graw Hill. - Non-traditional Processes, Marcel Dekker Inc. - Hassan Abdel, Gawad Fundamentals of Machining Processes: Conventional and Nonconventional Processes, Taylor & Francis - W.H Armstrong, Mechanical Inspection, Mc Graw Hill.G

6th Semester		AGME-21604 C : Cryogenic Technology			
Internal Marks:	**40**		**L**	**T**	**P**
External Marks:	**60**		**3**	**0**	**0**
Total Marks:	**100**		**Credits**		**3**

Course Outcomes: After studying the course, students will be able to:	
CO-1	Understand the application of cryogenic engineering.
CO-2	Understand the process used in cryogenic techniques.
CO-3	Understand the significance of heat transfers in cryogenic.
CO-4	Understand the insulation process.
CO-5	Understand the theory of temperature measurement.
CO-6	Understand the advance techniques used in Cryogenic.

Part	Content	CO
I	Introduction: History of cryogenic engineering, application of cryogenics Properties of Oxygen, Nitrogen and Argon, and Hydrogen, Helium and rare gases Thermal, mechanical and electrical properties of engineering materials at low temperature, Introduction to the phenomenon of superconductivity and its applications.	CO-1
	Thermodynamics Process: Liquefaction cycles, Joule-Thomson effect, Linde cycle precooled linde cycle, Claude, Heylandt, and kapitza cycles, Liquefaction of hydrogen and helium.	CO-2
II	Heat exchangers & effectiveness: Coiled tube (hampson type) and brazed Aluminum heat exchangers, Cryogenic expansion engines and turbines, Principal of binary Distillation.	CO-3
III	Cryogenic insulation: Types of insulations (Foam, fiber, and powder vacuum) Liquid cryogen storage vessels and cryogen transfer line, Advantages & Uses in industry.	CO-4
	Measurement of temperature: gas and vapors pressure Thermometers, thermocouple, RTD and semiconductor sensors.	CO-5
IV	Application Cryogenic: Safety in cryogenic systems fir, asphyxiation, cold burns and pressure problems	CO-6

References:
• Randall F. Barron, Cryogenic Systems, McGraw-Hill.
• Marshall Sitting and Stephen Kidd D, Cryogenic Research amd Applications, Van Norstad
• Russell Burton, Scott Cryogenic engineering, Van Nostrand

6th Semester	AGME-21604 D : Power Plant Engineering			
		L	**T**	**P**
Internal Marks: 40		3	0	0
External Marks: 60				
Total Marks: 100		**Credits**		3

Course Outcomes: After studying the course, students will be able to:	
CO-1	Understand the concept of power plant engineering.
CO-2	Understand the hydel power system.
CO-3	Understand the thermal power plant engineering.
CO-4	Understand the theory of gaseous power plant and its components.
CO-5	Understand the theory of nuclear study used in power plant and its effects
CO-6	Understand the advance energy convection system.

Part	Content	CO
I	Introduction: Energy sources for generation of electric power, Principles types of power plants-their special features and applications, Present status and future trends.	CO-1
	Hydro-Electric Power Plants: Classifications, Components and their general layout, Hydroelectric survey, rainfall run-off, hydrograph, flow duration curve, mass curve, storage capacity, Site selection.	CO-2
II	Steam Power Plant: General Introduction, Developing trends, Essential features, Site Selection, Coal-its storage, preparation, handling, feeding and burning, Ash handling, dust collection, High pressure boilers.	CO-3
III	Diesel and Gas Turbine Power Plants: Field of use, components, Plant layout, Comparison with stream power plants, Operation of combined steam and gas power plants.	CO-4
	Nuclear Power Plant: Nuclear fuels, nuclear energy, Main components of nuclear power plant, Nuclear reactors-types and applications, Radiation shielding, Radioactive waste disposal, Safety aspects.	CO-5
IV	Direct Energy Conversion Systems: Thermoelectric conversion system, Thermionic conversion system, Photo voltaic power system, Fuel Cells, Magneto-hydrodynamic system.	CO-6

References:
• P.K.Nag, Plant Engineering, Tata McGraw Hill.
• G.R. Nagpal, Power Plant Engineering, Khanna Publishers.
• S.C. Arora and S. Domkundwar, Power Plant Engineering, Dhanpat Rai.

6th Semester		AGME-21605 Industrial Automation and Robotics (Skill Course-II)			
			L	**T**	**P**
Internal Marks:	**30**		**1**	**0**	**4**
External Marks:	**20**				
Total Marks:	**50**		**Credits**		**3**

Course Outcomes: After studying the course, students will be able to:

CO-1	Understand the need of Automation, its social impact and its various types.
CO-2	Understand the concept of Fluid power, working of cylinders and various valves.
CO-3	Understand the concept of Truth tables, Boolean algebra, Logic gates and Coanda Effect.
CO-4	Understand the various Electric and electronic controls used in Automation
CO-5	Understand the concept of various transfer devices and feeders.
CO-6	Understand the concept of Robotics, its programming and its Industrial applications.

Part	Content	CO
I	Concept and scope of automation: Socio economic impacts of automation, Types of Automation, Low Cost Automation.	CO-1
	Fluid power control elements Standard graphical symbols Fluid power generators Hydraulic and pneumatic Cylinders - construction, design and mounting; Hydraulic and pneumatic Valves for pressure, flow and direction control.	CO-2
II	Boolean algebra, Truth Tables, Logic Gates, Coanda effect.	CO-3
III	Basics of Programmable logic controllers (PLC) Architecture & Components of PLC Ladder Logic Diagrams.	CO-4
IV	Classification, Constructional details and Applications of Transfer devices Vibratory bowl feeders, Reciprocating tube, Centrifugal hopper feeders.	CO-5
	Introduction, Classification based on geometry, control and path movement, Robot Specifications, Robot Performance Parameters, Robot Programming, Machine Vision, Teach pendants, Industrial Applications of Robots.	CO-6

References:

- Anthony Esposito, Fluid Power with applications, Pearson
- S. R Majumdar, Pneumatic Control, McGraw Hill
- S. R Deb, Robotic Technology and Flexible Automation, Tata Mc Hill
- Saeed B. Niku Introduction to Robotics, Wiley India
- Ashitava Ghosal, Robotics, Oxford

6th Semester	AGME 21606 – Fluid Machinery Lab			
		L	**T**	**P**
Internal Marks: 30		0	0	2
External Marks: 20				
Total Marks: 50		**Credits**		1

Course Outcomes: After studying the course, students will be able to:

CO-1	Understand how to find work done of Francis turbine/Kaplan Turbine
CO-2	Understand about various parts of Pelton Turbine
CO-3	Understand the various characteristics of Centrifugal pump
CO-4	Understand the effect of vane shape and vane angle on the performance of centrifugal fan/Blower.
CO-5	Understand about the various turbines installed in the power station
CO-6	To make a mini project that demonstrates a concept, based on the content of AGME- 21606 (Fluid Machinery)

Part	Experiment	CO
A	To draw characteristics of Francis turbine/Kaplan Turbine.	CO1
	To draw the characteristics of Pelton Turbine.	CO2
	To draw the various characteristics of Centrifugal pump	CO3
	Determine the effect of vane shape and vane angle on the performance of centrifugal fan/Blower.	CO4
	To study the constructional features of reciprocating pump and to perform test on it for determination of pump performance	CO5
B	To make a mini project that demonstrates a concept, based on the content of AGME- 21606 (Fluid Machinery) along with A visit to any Hydroelectric Power Station	CO6

6th Semester	AGME 21606 – Heat Transfer Lab			
		L	**T**	**P**
Internal Marks: 30		0	0	2
External Marks: 20				
Total Marks: 50		**Credits**		1

Course Outcomes: After studying the course, students will be able to:

CO-1	Determine the thermal conductivity.
CO-2	Determine the coefficient of heat transfer.
CO-3	Understand the concept pool boiling.
CO-4	Find the Stefan Boltzmann's constant.
CO-5	Understand the surface extended by different boundary conditions.
CO-6	Exhibit his/her creativity and conceptual understanding of the subject.

Part	Experiment	CO
A	Determination of thermal conductivity of a solid insulating material by slab method.	CO-1
	Determination of coefficient of heat transfer for free/forced convection from the surface.	CO-2
	To plot the pool boiling curves for water and to determine its critical point.	CO-3
	Determination heat transfer coefficient by radiation and hence find the Stefan Boltzman's constant using two plates/two cylinders of same size by making one of the plates/cylinders as a black body	CO-4
	To plot the temperature profile and to determine fin effectiveness and fin efficiency for a rod fin when its tip surface is superimposed by different boundary conditions.	CO-5
B	To make a mini project that demonstrates a concept, based on the content of AGME– 21606 (Heat Transfer)	CO-6

6th Semester		AGME -21608 MS Office Lab			
			L	**T**	**P**
Internal Marks:	30		0	0	2
External Marks:	20				
Total Marks:	50		**Credits**		1

Course Outcomes: After studying the course, students will be able to:	
CO-1	Understand the concept of MS office.
CO-2	Understand the various tools used in MS Word.
CO-3	Understand the Various tools used in MS Excel.
CO-4	Understand the various tools used in MS PowerPoint.
CO-5	Understand the various table formats in MS office
CO-6	To make effective project report.

Part	Experiment	CO
A	To understand the various commands and shortcuts of MS office.	CO1
	Create a document using MS Word.	CO2
	Create a document using MS Excel also used various calculation commands like addition, subtraction, multiplying.	CO3
	Create a PPT using MS PowerPoint.	CO4
	Create various tables using MS word, Excel and PowerPoint.	CO5
B	To make a mini project report that demonstrates a concept, based on the content of AGME-21608 (MS Office).	CO6

7th Semester	AGME 21701: REFRIGERATION AND AIR-CONDITIONG			
Internal Marks:	**40**	**L**	**T**	**P**
External Marks:	**60**	**3**	**1**	**0**
Total Marks:	**100**	**Credits**		**4**

Course Outcomes: After studying the course, students will be able to:

CO-1	Enhance the understanding of different types of refrigeration & their selection.
CO-2	Understand the concept of different refrigeration cycles, different types of refrigerants.
CO-3	Learn various refrigerants available and have knowledge of non-conventional refrigeration system.
CO-4	Knowledge to study the different conditions at different rates and alternate refrigeration system.
CO-5	Understand the air conditioning concept, psychometric process.
CO-6	Learn various refrigeration and air conditioning equipment and able to calculate refrigeration & air conditioning cooling/heating load.

Part	Content	CO
I	Definition of Refrigeration and Air conditioning, Difference between Refrigeration and Air conditioning, Applications of Refrigeration and Air conditioning, Definitions of refrigerant, cooling/ Refrigeration effect, cooling capacity, heating effect, heating capacity. Units of refrigeration, Coefficient of performance and Energy Efficient Ratio, COP of a refrigerator and COP/EPR of a heat pump, Single Phase Reversed Carnot cycle and its limitations and Two Phase Reversed Carnot cycle and its limitations	CO-1
	Bell Coleman/Reversed Brayton / Reversed Joule Cycle and its analysis and Numerical, optimum COP and pressure ratio, Applications of Gas Cycle Refrigeration, Necessity of aircraft refrigeration and air conditioning, Classification of aircraft refrigeration and air conditioning systems, Simple/basic aircraft refrigeration and air conditioning system, Boot Strap aircraft refrigeration and air conditioning system, Dry versus wet compression, expansion versus throttling of liquid refrigerant, Analysis of Simple/Theoretical vapour compression refrigeration cycle, Determination of properties of sub cooled, saturated and superheated refrigerant by using saturated properties & specific heat tables/saturated & superheated properties Effect on performance and cooling capacity due to change in evaporator pressure, condenser pressure, sub cooling of liquid refrigerant, super heating of suction vapours, use of liquid - vapour regenerative heat exchanger, Effect on performance and cooling capacity due to heat exchange of vapours with compressor cylinder walls, pressure drop in suction (wire drawing)and discharge valves, pressure drop inevaporator and condenser.	CO-2
II	Classification and nomenclature of refrigerants, Desirable thermodynamic, chemical and physical properties of refrigerants; comparative study of commonly used refrigerants and their fields of application, Azeotropes, zeotrope, Effect of moisture and oil miscibility, Refrigerants dying agents and antifreeze solution, leak detection and charging of refrigerants, environmental aspects of conventional refrigerants, Eco-friendly refrigerants.	CO-3

III	Dry Air, Moist Air, Basic laws obeyed by Dry Air and Moist Air, Psychrometric properties of air, Dry bulb, wet bulb and dew point temperatures, Relative and specific humidity, degree of saturation adiabatic saturation temperature, enthalpy of air and water vapors, Psychrometric chart and its us, Adiabatic mixing of moist air streams without condensation and with condensation, Numerical. Steam Jet Refrigeration, Mixed Refrigeration Systems, Vortex Tube Refrigeration, Cascade Refrigeration System, cryogenics and its engineering applications.	CO-4
	Sensible heat process, Latent heat process, Total heat process, Evaporative cooling, cooling with dehumidification, Heating with dehumidification, By-pass factor, Contact factor, Psychrometric processes in air conditioning equipment, Cooling coils, Heating coils.	CO-5
IV	Brief description of compressors, condensers, evaporators and expansion devices, Cooling towers, Ducts; dampers, grills, air filters, fans, room air conditioners, split units, Package and central air conditioning plants. Sources of heat load sensible and latent heat load, Cooling and heating load estimation, Apparatus dew point temperature.	CO-6

References:

- C.P.Arora,Refrigeration and Conditioning, Tata Mc Graw Hill
- Manohar Prasad, Refrigeration and Conditioning, Wiley Eastern Limited
- Jordan and Priester, Refrigeration and Conditioning, Prentice Hall of India
- W.F. Stoecker, Refrigeration and Conditioning, Mc Graw Hill.

7th Semester	AGME 21702: Mechanical Vibrations			
		L	**T**	**P**
Internal Marks: 40		3	1	0
External Marks: 60				
Total Marks: 100		**Credits**		4

Course Outcomes: After studying the course, students will be able to:
CO-1	Knowledge of vibration analysis, different types of vibrations, Simple and harmonic motion.
CO-2	Compute the natural frequency of damped and undamped vibrations.
CO-3	Determination of natural frequency of two degree of freedom system
CO-4	Learn concept of vibration control and principles of various vibration absorbing methods and equipment.
CO-5	Determination of natural frequency of several degree of freedom system
CO-6	Understand the frequencies in practical components and continuous system after considering its natural frequency.

CO-1	Knowledge of vibration analysis, different types of vibrations, Simple and harmonic motion.
CO-2	Compute the natural frequency of damped and undamped vibrations.
CO-3	Determination of natural frequency of two degree of freedom system
CO-4	Learn concept of vibration control and principles of various vibration absorbing methods and equipment.
CO-5	Determination of natural frequency of several degree of freedom system
CO-6	Understand the frequencies in practical components and continuous system after considering its natural frequency.

Part	Content	CO
I	**Fundamental of Vibrations:** Introduction, Addition of two harmonic motions and beat phenomenon, Fourier series and harmonic analysis, Vibration analysis procedure.	CO-1
	Free Vibration of Single Degree of Freedom Systems: Undamped free vibration, Energy method, Damped free vibration, Viscous damped systems and logarithmic decrement, Coulomb damping.	CO-2
II	**Forced Vibration of Single Degree of Freedom Systems:** Harmonic excitations, Magnification factor and frequency response curve, Rotating unbalance, Excitation of the support, Vibration isolation and force transmissibility.	CO-3
III	**Vibration Measuring Instruments & Vibration Absorbers:** Transducers and vibration pickup, Vibrometer, Accelerometer, Velocity pickup or Velometer, Phase distortion and frequency measurement, Undamped dynamic vibration absorber, tuned absorber, Damped dynamic vibration absorber, optimally tuned vibration absorber.	CO-4
	Vibration of Two Degree of Freedom Systems: Undamped free vibration, Principal modes of vibration, combined rectilinear and angular modes, Damped free vibration, Undamped forced vibration with harmonic excitation.	CO-5
IV	**Vibration of Multi Degree of Freedom Systems:** Undamped free vibration, Eigen values and eigen vectors, Flexibility influence coefficients, Stiffness influence coefficients, Static and dynamic coupling, matrix method, matrix iteration method, Holzer's, Stodola method.	CO-6

References:
• G.K. Grover, Mechanical Vibrations, Hem Chand and Bros.
• K.K. Pujara, Mechanical Vibrations, Dhanpat Rai and Sons.
• Shrikant Bhave, Mechanical Vibrations: Theory and Practice, Pearson Education India.
• V.P Singh, Mechanical Vibrations, Dhanpat Rai and Co.

7th Semester	AGME 21703A : Modern System Design			
Internal Marks: 40		**L**	**T**	**P**
External Marks: 60		3	0	0
Total Marks: 100		**Credits**		3

Course Outcomes: After studying the course, students will be able to:
CO-1	Describe the productivity improvement techniques.
CO-2	Develop skills to analyze work methods to identify inefficiencies and opportunities for improvement.
CO-3	Evaluate the impact of method study on work system performance using key performance indicators.
CO-4	Explain the principles, concept and significance of time study in work system design.
CO-5	Identify and categorize different types of allowances.
CO-6	Develop accurate work standards by integrating data from work sampling and performance rating techniques.

Part	Content	CO
I	**Work system design:** Introduction to work system design, introduction and concept of productivity, productivity measures, productivity measurement models, factors influencing productivity, causes of low productivity, productivity improvement techniques.	CO-1
	Work study: Basic concept, steps involved in work study, concept of work content, techniques of work study, human aspects of work study. .	CO-2
II	**Method study:** Basic concept, steps involved in method study, recording techniques, operation process charts, string diagrams, principles of motion economy, micro-motion study, SIMO charts, memo-motion study, cycle graph and chrono - cycle graph, critical examination techniques, development and selection of new method, installation and maintenance of improved methods	CO-3
III	**Time study and work measurement:** Basic concept, techniques of work measurement, objectives of time study, steps involved in time study, time study equipment.	CO-4
	Allowances: Interference allowance, relaxation allowance, process allowance, contingency allowance, special allowance.	CO-5
IV	**Work Sampling:** Basics, procedure of work sampling study, introduction to synthetic data and PMTS, introduction to MTM and MOST. **Performance Rating:** Performance rating, westinghouse system of rating, synthetic rating, objective rating, skill and error rating, physiological evaluation of performance level, computation of standard time	CO-6

References:
• Adedeji B. Badiru, Sharon C. Bommer, Work System Design, CRC Press.
• Dr. K P Parthiban & Dr. S Muthu Vijaya Pandian , Work System Design, Notion Press.
• Mikell P. Groover, Work Systems: The Methods, Measurement & Management of Work, Pearson Education.
• Anup Goel, Mechanical System Design, Technical Publications.

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7ᵗʰ Semester	AGME 21703B : Project Management			
Internal Marks:	40	**L**	**T**	**P**
External Marks:	60	**3**	**0**	**0**
Total Marks:	100	**Credits**		**3**

Course Outcomes: After studying the course, students will be able to:
CO-1	Describe the concept of project management.
CO-2	Identify potential risks that could impact the project.
CO-3	Develop skills in both quantitative and qualitative analysis techniques to evaluate decision options.
CO-4	Use techniques to optimize project schedules for time, cost and resource efficiency.
CO-5	Calculate EVM metrics and analyze project performance data to assess project health.
CO-6	Discuss how to analyze activities and paths in a GERT network.

Part	Content	CO
I	**Theoretical framework for managing projects:** Introduction to project management, agile project management, project management process, the project environment & ecosystem -- essential elements.	CO-1
	Risk management in projects: Project stakeholder and risk management, project risk management analysis, contingency planning, a model for adaptative project management.	CO-2
II	**Decision analysis:** Analytic hierarchy process for project selection, criteria used for project selection, decision tree analysis, solving project management decision problems, application of utility theory in project management.	CO-3
III	**Project scheduling and control:** Building a suitable monitoring & control system, concept of critical path method (CPM), introduction to program evaluation review technique (PERT), aspects and applications of CPM and PERT, concepts of a project life cycle.	CO-4
	Earned value management (EVM): Earned value management, key components of earned value management, budgeted cost of work scheduled (BCWS), actual cost of work progressed (ACWP), budgeted cost of work progressed (BCWP), schedule variance (SV) and schedule performance index (SPI), cost variance (CV) and CPI (cost performance index).	CO-5
IV	**Graphical evaluation and review technique (GERT):** Introduction to graphical evaluation and review technique, advantages and disadvantages of GERT in project management, GERT vs other network diagrams, application of GERT in project management.	CO-6

References:
• Jack R. Meredith, Samuel J. Mantel, Shafer, Project Management, Wiley.
• Kalpesh Ashar, Project Management Essentials, Vibrant Publishers.
• Ashok Kumar, Project Management, Notion Press.
• Jarnail Singh, D.N.S Dhakal, Project Appraisal Risk Analysis and Risk Management Techniques, Konark Publishers Pvt. Ltd.

7th Semester	AGME 21703C : Supply Chain Management			
Internal Marks:	40	**L**	**T**	**P**
External Marks:	60	3	0	0
Total Marks:	100	**Credits**		3

Course Outcomes: After studying the course, students will be able to:	
CO-1	Describe the concept of supply chain management.
CO-2	Develop skills to effectively communicate forecasting results and collaborate with other departments to align supply chain strategies.
CO-3	Create aggregate plans that align with organizational goals.
CO-4	Determine optimal inventory levels that balance holding costs, ordering cost and stockout cost.
CO-5	Develop skills to create efficient job shop schedules that minimize production time and optimize resource allocation.
CO-6	Design and optimize transportation networks to minimize costs, reduce transit times and improve service reliability.

Part	Content	CO
I	**Introduction to supply chain management:** Introduction to supply chain management, value of information, process view, decision phases, supply chain strategies, supply chain drivers.	CO-1
	Forecasting: Introduction (Challenges, Methodologies), time series models, simple exponential smoothing, linear models, regression, holt's , seasonality ,winter's model, causal models, goodness of forecast.	CO-2
II	**Capacity and aggregate planning:** Aggregate planning, tabular method, linear programming, transportation model, dynamic programming, backordering, quadratic model, demand and capacity planning.	CO-3
III	**Inventory management:** Inventory models - costs, EOQ model, EOQ model graphs, with backordering, models for all quantity and marginal quantity discount, multiple quantity discount, multiple item inventory- constraint on numbers of orders, constraint on money value, space, equal number of orders, combining orders, production consumption model with backordering, supply chain inventory, lot sizing, safety stock.	CO-4
	Scheduling models and applications: Sequencing and scheduling - assumptions, objectives and shop settings, single machine sequencing, two machine flow shop - johnson's algorithm, flow shop scheduling - three machines, johnson's algorithm, heuristics. **Job shop scheduling** - Gantt chart, different dispatching rules, shifting bottleneck heuristic.	CO-5
IV	**Transportation decision:** Transportation and distribution models, bin packing and travelling salesman problems, vehicle routing problems.	CO-6

References:

- Richard B. Chase, Ravi Shankar, F Robert Jacobs, Operations and Supply Chain Management, Mc Graw Hill.
- Sunil Chopra, Dharam Vir Kalra , Supply Chain Management, Pearson.
- Sunil Sharma, Supply Chain Management, Oxford University Press POD.
- Nada R. Sanders, Sidhartha S. Padhi, Supply Chain Management, Wiley.

7th Semester	AGME 21703D : Industrial Safety			
		L	**T**	**P**
Internal Marks: 40		3	0	0
External Marks: 60				
Total Marks: 100		**Credits**		3

Course Outcomes: After studying the course, students will be able to:	
CO-1	Understand role of Industrial Safety.
CO-2	Analyses and selection of different techniques to control hazard.
CO-3	About safety barrier and risk assessment.
CO-4	Apply the suitable safety process and its repair intensities.
CO-5	Identify the human error and its causes.
CO-6	Examine accident investigation and virtual reality.

Part	Content	CO
I	**Introduction to Industrial Safety:** Introduction, key concepts, terminologies, and safety quantification, safety by design, Safety Engineering & Accident causing mechanisms.	CO-1
	Hazard Identification Techniques: Preliminary Hazard List, Preliminary Hazard Analysis, Hazard and operability study (HAZOP), Failure Modes and Effects Analysis (FMEA)- Identification of Failure Modes, Application of Hazard Identification Techniques.	CO-2
II	**Fault Tree and Event Tree Analysis:** Fault Tree Analysis (FTA)- Construction, Gate By Gate Method, Cut-Set Method, Importance measures, Event Tree Analysis (ETA).	CO-3
III	**Safety function deployment:** Safety Function Deployment, Ranking of Design Solutions: AHP approach, Safety vs reliability, Quantification of Basic Events for Non-repairable Components, Hazard Rate, Exponential Distribution, Weibull Distribution, Failure to Repair Process, Combined Process, Failure & Repair Intensities.	CO-4
	Human error analysis and safety: Human Error, Classification and Causes, Human Error Identification, Human Reliability Assessment, Human Error Quantification from Experts' opinions - Fuzzy Set Approach, Need of Agronomics.	CO-5
IV	**Accident investigation and analysis:** : Accident Investigation & Analysis: Descriptive Analytics, Control Chart Analysis, Accident Data Analysis: Regression, Classification Tree.	CO-6

References:
• R.K. Jain, Sunil S. Rao, Industrial Safety, Health and Environment Management System, Khanna Publishers.
• Pravin M. Pathak, Jayant P. Khairnar , Industrial Safety Management, Notion Press.
• Raj Kishore Ojha, Industrial Safety Management System, 24by7 Publishing.
• Delilah Sam, Safety Engineering, Discovery Publishing House.

7thSemester	AGME 21703E : Surface Engineering

Internal Marks:	40		**L**	**T**	**P**
External Marks:	60		**3**	**0**	**0**
Total Marks:	100		**Credits**		**3**

Course Outcomes: After studying the course, students will be able to:	
CO-1	Describe the concept of surface engineering.
CO-2	Classify the different wear mechanisms.
CO-3	Explain the significance of fractography.
CO-4	Analyse the surface modification techinques.
CO-5	Assess the life cycle of the product.
CO-6	Discuss the mitigation methods of surface degradation in Surface Engineering.

Part	Content	CO
I	**Introduction:** Introduction to surface degradation mechanisms, Surface Degradation: A Commercial Perspective, Adhesive wear mechanism, Abrasive wear mechanism, Wear Phenomena Defined by Dimensionless Parameter.	CO-1
	Surface degradation: Erosive and cavitation wear, fatigue, fretting, melting and diffusive wear mechanisms, fracture surface degradation, heat and radiation on surface degradation, role of fatigue & fracture mechanisms in wear debris formation.	CO-2
II	**Surface deterioration and fractography:** Synergistically combined degradation mechanism, Environmental assisted surface deterioration, fractography	CO-3
III	**Surface modification techniques:** Carburizing, nitriding, plasma carburizing & plasma nitriding, Vaccum based surface modification, laser alloying, weld surfacing, laser cladding, an overview of testing methods its significance and applications.	CO-4
	Failure analysis/ Life cycle assessment: Principle component analysis, Failure/ Fault Analysis, Failure Mode and Effect Analysis.	CO-5
IV	**Mitigation methods:** An Introduction, Life Cycle Impact Assessment, Economic Losses by Corrosion Degradation, Quantification of Economic Losses caused by Corrosion Degradation.	CO-6

References:
• Ramnarayan Chattopadhyay, Advanced Thermally Assisted Surface Engineering Processes, Kluwer Academic Publishers, 2004
• Sudarshan T S, Surface Modification Technologies – An Engineer's Guide; Marcel Dekkar, Newyork, 1989.
• Varghese C D, Electroplating and Other Surface Treatments – A Practical Guide, TMH, 1993.
• Adamson A W and Gast A P, Physical Chemistry of Surfaces, 6th Ed., John Willey & Sons 1997.
• Stanley J.Dapkunas, Surface Engineering Measurement Standards for inorganic materials.

7th Semester	**AGME 21703F : Sustainable Engineering**

Internal Marks:	40		L	T	P
External Marks:	60		3	0	0
Total Marks:	100		Credits		3

Course Outcomes: After studying the course, students will be able to:	
CO-1	Describe the concept of sustainability.
CO-2	Explain different practices to move industries towards sustainability.
CO-3	Recognize the various challenges for sustainable service system design.
CO-4	Discuss the environmental impact assessment in real time problems.
CO-5	Differentiate between conventional and non-conventional forms of energy.
CO-6	Discuss various methods to implement green technology.

Part	Content	CO
I	**Introduction to sustainable engineering:** What is sustainability, sustainable development and why do we need it, evolution of sustainability within design.	CO-1
	Sustainable industrialization and urbanization: Sustainable urbanization, industrialization, material selection, pollution prevention, industrial ecology, industrial symbiosis, poverty reduction.	CO-2
II	**Sustainable product-service system design:** Definition, types & examples, transition path and challenges.	CO-3
III	**Tools for sustainability:** Designing for sustainable product-service system methods and tools, grades levels and its applications, environmental auditing, environmental impact analysis.	CO-4
	Renewable energy resources: Conventional and non-conventional forms of energy, solar energy, fuel cell, wind energy, small hydro plants, biogas systems, geothermal energy, conservation of energy.	CO-5
IV	**Green technology and green business:** Sustainable business, green technology, green energy, green construction, green transportation, green computing, design thinking in business strategies, marketing strategies and execution works in operations and productions.	CO-6

References:
- D. T. Allen and D. R. Shonnard. Sustainability Engineering: Concepts, Design and Case Studies, 1 st Edition, Prentice Hall, 2011.
- A.S. Bradley, A. O. Adebayo, P.Maria. Engineering applications in sustainable design and development, 1st Edition, Cengage learning, 2016.
- R. L. Rag and Lekshmi Dinachandran Remesh. Introduction to Sustainable Engineering, 2nd Edition, PHI Learning Pvt. Ltd., 2016
- Bhavik R. Bakshi, Sustainable Engineering, Cambridge University Press.

7th Semester	AGOE 21703: Product Design and Development			
Internal Marks:	40	**L**	**T**	**P**
External Marks:	60	3	0	0
Total Marks:	100	Credits		3

Course Outcomes: After studying the course, students will be able to:

CO-1	Describe the product design and role of designer in product design.
CO-2	Explain the basic principle of value engineering in product design.
CO-3	Discuss the various types of fasteners and joining details.
CO-4	Classify various design tools and understand the concept of ergonomics in product design.
CO-5	Explain the design guidelines, manufacturing and economics aspects.
CO-6	Develop proficiency in 3D printing techniques and identify real-world applications of 3D printing.

Part	Content	CO
I	**Introduction to product design:** Introduction to course, product life-cycle, product policy of an organization. selection of a profitable product, product design process, product analysis.	CO-1
	Value engineering and functional analysis: Value engineering in product design; advantages, applications in product design, problem identification and selection, anatomy of function, functional analysis system technique (FAST).	CO-2
II	**Product detailing:** Standard fastening and joining details in different materials, temporary and permanent joints, detailing for plastic products and fabricated products in sheet metal.	CO-3
III	**Product Design Tools:** Introduction to product design tools, QFD, Computer Aided Design, Robust design, DFX, DFM, DFA, Ergonomics in product design.	CO-4
	Design Guidelines: DFMA guidelines, Product design for manual assembly, Design guidelines for metallic and non-metallic products to be manufactured by different processes such as casting, machining, injection molding etc.	CO-5
IV	Rapid prototyping, needs, advantages, working principle of SLA, LOM and SLS.	CO-6

References:

- W.H. Mayal, Industrial Design for Engineers, London Liifee Books Ltd.
- Huchingson R. Dale, New Horizons for Human Factors in Design, McGraw Hill.
- N.L. Svensson, Engineering Design, London: Pitman.
- R. Matousek, Engineering Design, Blackie & Son.
- K.J. Mccormick (Ed), Human Factor Engineering, McGraw Hill.

7th Semester		AGOE 21704: Material Management			
			L	**T**	**P**
Internal Marks:	40		3	0	0
External Marks:	60				
Total Marks:	100		**Credits**		3

Course Outcomes: After studying the course, students will be able to:
CO-1	Describe the concept of material management.
CO-2	Explain the basic techniques of material planning.
CO-3	Identify and analyze the key factors that influence consumer purchase decisions.
CO-4	Provide students with a comprehensive understanding of fundamental principles and concepts of inventory control and management.
CO-5	Familiarize students with inventory management tools that aid in monitoring of physical inventory.
CO-6	Design efficient storage layouts to maximize space utilization and improve workflow in warehouses.

Part	Content	CO
I	**Introduction:** Meaning, definition, functions of materials management, Concept of integrated material management, Relationship of material management with other Organizational functions.	CO-1
	Material Planning & Budgeting: Need for material planning, Factors affecting material planning, Techniques of material planning, Material classification, codification and standardization, Material budgeting - meaning and need, techniques of material budgeting.	CO-2
II	**Purchasing:** Purchasing principles, procedures and systems, Functions of purchasing, Make-or-buy decision, Vendor development and vendor rating. Factors affecting purchase decisions, Legal aspects of purchasing, Documentation and procedure for import.	CO-3
III	**Inventory Control:** Need and meaning of inventory, types of inventory, functions of inventory control, Inventory costs.	CO-4
	Physical control of inventory: Fixed order, Two bin and Kardex systems - Material requirement planning (MRP-I), Spare parts control for maintenance purposes. Evaluation of inventory control performance. Concept of Just-in-Time(JIT). Use of computers for inventory control.	CO-5
IV	**Storage:** Functions and importance of store keeping, types of stores, store accounting and store verification, Legal aspects of store keeping, Management of surplus, scrap and obsolete items. Importance of material handling in store keeping, handling equipment.	CO-6

References:
• M.M. Verma, Materials Management, S. Chand and Co.
• Gopal Krishnan and Sundaresan, Material Management - An Integrated Approach, Prentice Hall
• Dobbler and Burt, Purchasing and materials management, Tata McGraw Hill
• M. Starr and D. Miller, Inventory control, Prentice Hall.

7th Semester		AGME 21704 : Project			
Internal Marks:	40		**L**	**T**	**P**
External Marks:	60		**0**	**0**	**4**
Total Marks:	100		**Credits**		**2**

Course Outcomes: After studying the course, students will be able to:	
CO-1	Identify the current issues related to mechanical engineering local/ regional/ national/global.
CO-2	Analyse the existing research, identify the gray areas, and articulates specific objectives.
CO-3	Create time bound project execution plan.
CO-4	Organise and analyse the research data.
CO-5	Articulate specific research findings after analysing the results.
CO-6	Create/prepare a research document in the form of a report.

Part	Content	CO
I	**Selection of topic and its justification:** A topic should be short, specific and should represent the quantum of work covered under the project domain.	CO-1
	Review of literature, research gap, and objectives: The student shall study the existing literature related to the project domain. On the basis of research gaps, the student shall frame specific objectives that he will be working on during the project work.	CO-2
II	**Methodology, execution plan and scheduling:** The methodology shall clearly present the flow of work, its scheduling and expected time of completion of project.	CO-3
III	**Project execution/result analysis:** The student shall carry out the project work as per the planned methodology and analyse the results of study to understand their trends and patterns.	CO-4
	Conclusions: The student shall explicitly present the project findings in the form of specific conclusions. These conclusions should be in line with the framed objectives.	CO-5
IV	**Report writing:** A clear and concise report shall be prepared which should clearly present the topic, its justification, literature review, methodologies, results and discussions, conclusions and references.	CO-6

References:
• All research articles/books/codes related to the selected area of project

7thSemester	AGME 21705 : Refrigeration and Air Conditioning Lab			
		L	**T**	**P**
Internal Marks: 30		**0**	**0**	**2**
External Marks: 20				
Total Marks: 50		**Credits**		**1**

Course Outcomes: After studying the course, students will be able to:	
CO-1	To understand the vapour compression refrigeration system.
CO-2	To know the working of domestic refrigerator.
CO-3	To know the working of Electrolux refrigerator.
CO-4	To learn about the working of water cooler.
CO-5	To learn about the performance and working of window air conditioner.
CO-6	Exhibit his/her creativity and conceptual understanding of the subject.

Part	Experiment	CO
A	Study of various elements of a vapor compression refrigeration system through cut sections models/actual apparatus.	CO-1
	Study and performance testing of domestic refrigerator.	CO-2
	Study the performance testing of Electrolux refrigerator.	CO-3
	Study and performance testing of water cooler.	CO-4
	Study and performance testing of window type room air conditioner.	CO-5
B	To make a mini project that demonstrates a concept, based on the content of AGME- 21701 (Refrigeration and Air Conditioning)	CO-6

7thSemester	AGME 21706 : Mechanical Vibration Lab			
		L	**T**	**P**
Internal Marks: 30		**0**	**0**	**2**
External Marks: 20				
Total Marks: 50		**Credits**		**1**

Course Outcomes: After studying the course, students will be able to:	
CO-1	Determine the oscillations of rotating pendulum.
CO-2	Understand the concept of compound pendulum.
CO-3	Examine the need vibrations absorber.
CO-4	Calculate undamped free vibrations of single degree of freedom.
CO-5	Analyses of forced vibrations under multi degree of freedom.
CO-6	Exhibit his/her creativity and conceptual understanding of the subject.

Part	Experiment	CO
A	Determine the viscosity of given fluid by single wire torsional pendulum.	CO-1
	To study the oscillations of compound pendulum.	CO-2
	Study of a dynamic absorber.	CO-3
	To study the undamped free vibrations of spring mass system.	CO-4
	Study of forced vibration of a two degree of freedom system under harmonic excitation.	CO-5
B	To make a mini project that demonstrates a concept, based on the content of AGME-21702 (Mechanical Vibrations).	CO-6

8ᵗʰ Semester	AGME 21801: Semester Training			
Internal Marks:	**300**	**L**	**T**	**P**
External Marks:	**200**	**0**	**0**	**0**
Total Marks:	**500**	**Credits**		**12**

Course Outcomes: After going through this training, students will be able to:	
CO-1	Communicate effectively with peers.
CO-2	Differentiate the layout of various industrial shops.
CO-3	Participate constructively and ethically in the industrial process.
CO-4	Describe detailed specifications of machinery/equipment/tool/software.
CO-5	Analyse the scope of training received towards his/her career goals.
CO-6	Write the report on an industrial project.

Part	Training Activity	CO
-	Interaction with HR and communicate the details of the supervisor to the department.	CO-1
	General layout of Industry/manufacturing plant.	CO-2
	Participation in assigned tasks (Ethical & Constructive).	CO-3
	Description of machinery/equipment/tools/software used during training.	CO-4
	Analyse the scope of training received towards his/her career goals.	CO-5
	Report writing on the industrial project.	CO-6