SYLLABUS

For

B.Tech. PROGRAMME

In

MECHANICAL ENGINEERING

UNIVERSITY OF KASHMIR
SRINAGAR

NOVEMBER – 2021

(Applicable to Batch 2020 & Onwards)

Department of Mechanical Engineering

Institute of Technology, University of Kashmir,

Zakura Campus, Srinagar

COURSE STRUCTURE, B.Tech MECHANICAL ENGINEERING

THIRD SEMESTER TO EIGHTH SEMESTER

ESC	Engineering Science Courses
BSC	Basic Science Courses
PCC	Professional Core Course
PEC	Professional Elective Course
OEC	Open Elective Course
HSM	Humanities and Social Sciences including Management
PSI	Project work, Seminar and Internship

ISE	Internal Semester Evaluation **(50 Marks)**	
	MSE	Mid Semester Evaluation **(35 Marks)**
	IA	Internal Assessment **(Assignment + Quiz/ Viva Voce (10 Marks) + Attendence (5 Marks)**
ESA	End Semester Evaluation	

Semester - 3 (Three)						**Examination Scheme (Distribution of Marks)**			
Course Code	**Course Title**	**L**	**T**	**P**	**Credits**	**ISE**		**ESE**	**Total**
						MSE	**IA**		
ESC_ME301	Fundamentals of Dynamics	2	1	0	3	35	15	50	100
PCC_ME302	Computer Aided Machine Drawing	0	0	6	3	35	15	50	100
PCC_ME303	Materials Engineering	2	1	0	3	35	15	50	100
PCC_ME303L	Materials Engineering Lab	0	0	2	1	50		50	100
PCC_ME304	Basic Engineering Thermoynamics	2	1	0	3	35	15	50	100
PCC_ME305	Manufacturing Technology-I	2	1	0	3	35	15	50	100
PCC_ME305L	Manufacturing Technology-I Lab	0	0	2	1	50		50	100
PCC_ME306	Fluid Mechanics	3	1	0	4	35	15	50	100
PCC_ME306L	Fluid Mechanics Lab	0	0	2	1	50		50	100
		11	**5**	**12**	**22**				**900**
	Total Hours	**28**							

Semester - 4 (Four)						**Examination Scheme (Distribution of Marks)**			
Course Code	**Course Title**	**L**	**T**	**P**	**Credits**	**ISE**		**ESE**	**Total**
						MSE	**IA**		
BSC_ME401	Laplace, Fourier and Z -Transforms	2	1	0	3	35	15	50	100
PCC_ME402	Solid Mechanics-I	3	1	0	4	35	15	50	100
PCC_ME402L	Solid Mechanics-I Lab	0	0	2	1	50		50	100
PCC_ME403	Theory of Machines-I	3	1	0	4	35	15	50	100
PCC_ME403L	Theory of Machines-I Lab	0	0	2	1	50		50	100
PCC_ME404	Manufacturing Technology-II	2	1	0	3	35	15	50	100
PCC_ME404L	Manufacturing Technology-II Lab	0	0	2	1	50		50	100
PCC_ME405	Applied Thermodynamics	2	1	0	3	35	15	50	100
PCC_ME405L	Applied Thermodynamics Lab	0	0	2	1	50		50	100
PCC_ME406	Measurement and Intrumentation	2	1	0	3	35	15	50	100
PCC_ME406L	Measurement and Intrumentation Lab	0	0	2	1	50		50	100
		14	**6**	**10**	25				**1100**
	Total Hours	**30**							

Semester - 5 (Five)						Examination Scheme (Distribution of Marks)			
Course Code	Course Title	L	T	P	Credits	ISE		ESE	Total
						MSE	IA		
BSC_ME501	Complex Analysis	2	1	0	3	35	15	50	100
PCC_ME502	Heat Transfer	3	1	0	4	35	15	50	100
PCC_ME502L	Heat Transfer Lab	0	0	2	1	50		50	100
PCC_ME503	Fluid Machinery	2	1	0	3	35	15	50	100
PCC_ME503L	Fluid Machinery Lab	0	0	2	1	50		50	100
PCC-ME504	Theory of Machines-II	3	1	0	4	35	15	50	100
PCC_ME504L	Theory of Machines-II-Lab	0	0	2	1	50		50	100
PCC_ME505	Solid Mechanics-II	3	1	0	4	35	15	50	100
OEC_ME506	Automation in Manufacturing	2	1	0	3	35	15	50	100
OEC_ME506L	Automation in Manufacturing Lab	0	0	2	1	50		50	100
		15	**6**	**8**	25				**900**
	Total Hours	**29**							

Semester - 6 (Six)						Examination Scheme (Distribution of Marks)			
Course Code	Course Title	L	T	P	Credits	ISE		ESE	Total
						MSE	IA		
HSM_ME601	Industrial Engineering-I	2	1	0	3	35	15	50	100
HSM_ME601L	Industrial Engineering-I Lab	0	0	2	1	50		50	100
HSM_ME602	Operations Research	2	1	0	3	35	15	50	100
PEC_ME603	Internal Combustion Engines **(PEC1-ME603)**/ Automobile Engineering **(PEC2-ME603)/** Electrical Engineering Technology **(PEC3-ME603)**	2	1	0	3	35	15	50	100
PEC_ME603L	Internal Combustion Engines Lab **(PEC1-ME603L)**/ Automobile Engineering Lab **(PEC2-ME603L)/** Electrical Engineering Technology Lab **(PEC-ME603L)**	0	0	2	1	50		50	100
PCC_ME604	Design of Machine Elements-I	2	1	0	3	35	15	50	100
PCC_ME605	Compressible Flow and Machines	3	1	0	4	35	15	50	100
PCC_ME605L	Compressible Flow and Machines Lab	0	0	2	1	50		50	100
PSI_ME606	Seminar	0	0	6	3	50		50	100
		11	**5**	**12**	22				**900**
	Total Hours	**28**							

Semester - 7 (Seven)						Examination Scheme (Distribution of Marks)			
Course Code	Course Title	L	T	P	Credits	ISE		ESE	Total
						MSE	IA		
HSM_ME701	Industrial Engineering-II	2	1	0	3	35	15	50	100
HSM_ME701L	Industrial Engineering-II Lab	0	0	2	1	35	15	50	100
PEC_ME702	Power Plant Engineering **(PEC1_ME702)**/ Energy Systems and Management **(PEC2_ME702)**	2	1	0	3	35	15	50	100
PCC_ME703	Heating Ventilation and Air Conditioning	3	1	0	4	35	15	50	100
PCC_ME703L	Heating Ventilation and Air Conditioning Lab	0	0	2	1	50		50	100
PCC_ME704	Design of Machine Elements-II	3	1	0	4	35	15	50	100
OEC_ME705	Automatic Control **(OEC1_ME705)**/ Introduction to Project Management **(OEC2_ME705)**	2	1	0	3	35	15	50	100
PSI_ME706	Final Year Project (Stage-I)	0	0	8	4	100		100	200
		12	**5**	**12**	23				**900**
	Total Hours	**29**							

Semester - 8 (Eight)						Examination Scheme (Distribution of Marks)			
Course Code	Course Title	L	T	P	Credits	ISE		ESE	Total
						MSE	IA		
PEC_ME801	Fundaments of Tribology **(PEC1_ME801)**/ Composite Materials **(PEC2_ME801)**	2	1	0	3	35	15	50	100
PEC_ME801L	Fundaments of Tribology Lab **(PEC1_ME801L)**/ Composite Materials Lab **(PEC2_ME801L)**	0	0	2	1	50		50	100
OEC_ME802	Value Engineering **(OEC1_ME802)**/ Total Quality Management **(OEC2_ME802)**	2	1	0	3	35	15	50	100
OEC_ME803	Numerical Methods for Engineers **(OEC1_ME803)**/ Mechatronic Systems **(OEC2_ME803)**	2	0	2	3	35	15	50	100
PSI_ME804	Final Year Project (Stage-II)	0	0	16	8	200		200	400
PSI_ME805	Internship	0	0	0	4	50		50	100
		6	**2**	**20**	**22**				**900**
	Total Hours	**28**							

Professional Elective Courses (PEC)					
Course Code	**Course Title**	**L**	**T**	**P**	**Credits**
Semester- 6 (Six)					
PEC1_ME603	Internal Combustion Engines	2	1	0	**3**
PEC1_ME603L	Internal Combustion Engines Lab	0	0	2	**1**
PEC2_ME603	Automobile Engineering	2	1	0	**3**
PEC2_ME603L	Automobile Engineering Lab	0	0	2	**1**
PEC3_ME603	Electrical Engineering Technology	2	1	0	**3**
PEC3_ME603L	Electrical Engineering Technology Lab	0	0	2	**1**
Semester- 7 (Seven)					
PEC1_ME702	Power Plant Engineering	2	1	0	**3**
PEC2_ME702	Energy Systems and Management	2	1	0	**3**
Semester- 8 (Eight)					
PEC1_ME801	Fundaments of Tribology	2	1	0	**3**
PEC1_ME801L	Fundaments of Tribology Lab	0	0	2	**1**
PEC2_ME801	Composite Materials	2	1	0	**3**
PEC2_ME801L	Composite Materials Lab	0	0	2	**1**

Open Elective Courses (OEC) Pool					
Courses from Department of Mechanical Engineering					
Course Code	**Course Title**	**L**	**T**	**P**	**Credits**
OEC_ME506	Automation in Manufacturing	2	1	0	**3**
OEC_ME506L	Automation in Manufacturing Lab	0	0	2	**1**
OEC1_ME705	Automatic Control	2	1	0	**3**
OEC2_ME705	Introduction to Project Management	2	1	0	**3**
OEC1_ME803	Value Engineering	2	1	0	**3**
OEC2_ME803	Introduction to Project Management	2	1	0	**3**
OEC3_ME803	Total Quality Management	2	1	0	**3**
OEC1_ME804	Numerical Methods for Engineers	2	1	0	**3**
OEC2_ME804	Mechatronic Systems	2	1	0	**3**
Courses from Department of Electrical Engineering					
Course Code	**Course Title**	**L**	**T**	**P**	**Credits**
Semester- 5 (Five)					
OEC1EE504	Communication Systems	2	1	0	**3**
OEC2EE504	Thermal Engineering	2	1	0	**3**
OEC3EE504	DSP	2	1	0	**3**
Semester- 6 (Six)					
OEC1EE605	8085 Microcontroller	2	1	0	**3**
OEC2EE605	Energy Audit and Management	2	1	0	**3**
OEC3EE605	Python Data Analytics	2	1	0	**3**
Semester- 7 (Seven)					
OEC1EE703	SCADA Systems	2	1	0	**3**
OEC2EE703	Fuzzy Logic and Neural Networks	2	1	0	**3**
OEC3EE703	Energy Management in Buildings	2	1	0	**3**

Courses from Department of Electronics and Communication Engineering					
Course Code	**Course Title**	**L**	**T**	**P**	**Credits**
Semester- 8 (Eight)					
OEC_ECE80121E	Internet of Things	2	1	0	**3**
OEC_ECE80221E	Internet of Things Lab	0	0	2	**1**
OEC_ECE80321E	Sensors and Atuators for IoT	2	1	0	**3**
OEC_ECE80421E	Sensors and Atuators for IoT Lab	0	0	2	**1**
OEC_ECE80521E	Deep learning	2	1	0	**3**
OEC_ECE80621E	Deep learning Lab	0	0	2	**1**
OEC_ECE80721E	Industrial IoT	2	1	0	**3**
OEC_ECE80821E	Industrial IoT Lab	0	0	2	**1**
OEC_ECE80921E	Robotics Engineering	2	1	0	**3**
OEC_ECE81021E	Robotics Engineering Lab	0	0	2	**1**
OEC_ECE81121E	Mechatronics	2	1	0	**3**
OEC_ECE81221E	Mechatronics Lab	0	0	2	**1**
Courses from Department of Civil Engineering					
Course Code	**Course Title**	**L**	**T**	**P**	**Credits**
Semester- 3 (Three)					
CVLOE1	Human Resource Development and Organizational Behavior	2	1	0	**3**
Semester- 5 (Five)					
CVLOE2	Metro Systems and Engineering	2	1	0	**3**
Semester- 6 (Six)					
CVLOE3	Environmental Laws and Policies	2	1	0	**3**
Semester- 7 (Seven)					
CVLOE4	High Speed Rail Engineering	2	1	0	**3**
Courses from Department of Computer Science Engineering					
Course Code	**Course Title**	**L**	**T**	**P**	**Credits**
Semester- 7 (Seven)					
OEC2071	E-Commerce and Cyber Laws	2	1	0	**3**
OEC2072	Latex	2	1	0	**3**
Semester- 8 (Eight)					
OEC2081	Ent. and Professional Development	2	1	0	**3**
OEC2082	Multimedia Communication	2	1	0	**3**

Course Code	**ESC_ME301**				
Category	**Engineering Science Courses**				
Course Title	**Fundamentals of Dynamics**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 3 (Three)**
	2	**1**	**0**	**3**	
Pre requisites	**Engineering Mechanics-statics, Engineering Physics, Engineering Mathematics**				

Objectives:

To provide an introductory treatment of Engineering Mechanics (Dynamics) to all the students of engineering, with a view to prepare a good foundation for taking up advanced courses in the area in the subsequent semesters

M.No:	**Topic**	**No. of Hrs**
Module 1.	Kinematics of rigid bodies- translation and fixed axis rotation, general plane motion- velocity, instantaneous center of rotation, general plane motion- acceleration, analyzing motion with respect to a rotating frame, motion of a rigid body in space, motion (velocity and acceleration) relative to a moving reference frame.	8
Module 2.	Planar kinetics of a rigid body- equations of motion for a rigid body, angular momentum of a rigid body in plane motion, plane motion of a rigid body, kinetic energy, the work of a force, the work of a couple moment, principle of work and energy, conservation of energy, impulse and momentum- linear and angular momentum, principle of impulse and momentum, systems of rigid bodies, conservation of momentum, eccentric impact, solution of problems involving the motion of a rigid body, systems of rigid bodies, constrained plane motion.	12
Module 3.	Three-dimensional kinematics of a rigid body- rotation about a fixed point, the time derivative of a vector measured from either a fixed or translating-rotating system, general motion, relative motion analysis using translating and rotating axes.	10
Module 4.	Three-dimensional kinetics of a rigid body- angular momentum of a rigid body in three dimensions, applying the principle of impulse and momentum to the three-dimensional motion of a rigid body, kinetic energy of a rigid body in three dimensions, rate of change of angular momentum, Euler's equations of motion, motion of a rigid body about a fixed point, rotation of a rigid body about a fixed axis, equations of motion of a gyroscope, Eulerian angles, steady precession, motion of an axisymmetric body under no force.	12
Total number of Hours		**42**

Course Outcomes:

At the end of the course, the student will be able to:

- ***Apply*** fundamental concepts of kinematics and kinetics of rigid bodies to the analysis of simple, practical problems **(L3).**
- ***Apply*** basic knowledge of maths and physics to solve real-world problems **(L3).**
- ***Understand*** basic kinematics concepts – displacement, velocity and acceleration (and their angular counterparts) **(L2).**
- ***Understand*** and be able to ***apply*** Newton's laws of motion **(L2, L3).**

S.No:	**Text Books**	**Author**	**Publisher**
1.	Engineering Mechanics: Dynamics	Anthony Bedford and Wallace Fowler	Pearson
	References		
1.	Engineering Mechanics: Statics and Dynamics	R.C Hibbeler	Pearson
2.	Engineering Mechanics: Dynamics	J.L Meriam and L.G Kraige	Wiley

3.	Vector Mechanics for Engineers: Statics and Dynamics	Ferdinand P. Beer E. Russell Jhonston	McGraw Hill Education

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Course Code	**PCC_ME302**				
Category	**Professional Core courses**				
Course Title	**Computer Aided Machine Drawing (CAMD)**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 3 (Three)**
	2	**0**	**2**	**3**	
Pre requisites	**Engineering Drawing, Computer Aided Drawing**				

Objectives:

To create drawings in either 2*d*/ 3*d* inorder to visualize the construction of machine parts. and to assemble and disassemble various machine components for clear visualization.

M.No:	**Topic**	**No. of Hrs**
Module 1.	Assembly drawing of different couplings- rigid coupling, muff, flanged, non-aligned couplings universal coupling, oldham's coupling.	08
Module 2.	2d drawings of bearings - solid, bushed and pedestal (plummer block).	08
Module 3.	Assembly drawing of automobile parts - connecting rod, piston and clutch.	10
Module 4.	Assembly drawings of parts and accessories - screw jack, pipe joints (flanged type hydraulic joint).	06
Module 5.	Introduction of solid modelling, various components/ parts of machine elements using 3d modelling software (Solid Works/ Autodesk Inventor) *such as*, nut and bolt, universal joint, cotter joint, gears (spur gear).	10
Total number of Hours		**42**

Course Outcomes:

At the end of the course, the student will be able to:

- ***Understand*** various creating and editing commands in CAD softwares **(L2).**
- ***Understand*** the advantages of using CAD in comparison with conventional methods of drawing.
- ***Interpret*** the object with the help of given sectional and orthographic views **(L5)**.
- ***Draw*** machine element using keys, cotter, and bolted joints **(L3)**
- ***Assemble*** details of any given part. i.e. engine parts, Gears , Bearings etc **(L6)**.

S.No:	**Text Books**	**Author**	**Publisher**
1.	Textbook of Machine Drawing	K.C John	Prentice Hall India Learning Private Limited
2.	Computer Aided Machine Drawing	R Gopala Krishna, A S Ravindra	Subhas Stores
	References		
1.	Machine Drawing	N. D. Bhat, V. M. Panchal	Charotar Publishing House
2.	Machine Drawing	K. L. Narayana	New Age International Publishers
3.	Machine Drawing	P. S. Gill	S.K. Kataria & Sons

Course Code	**PCC_ME303**				
Category	**Professional Core Courses**				
Course Title	**Materials Engineering**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 3 (Three)**
	2	**1**	**0**	**3**	
Pre requisites	-				

Objectives:

To give basic knowledge of science behind materials & physical metallurgy. Introduce the concept of structure property relations and to give students a feel of how material science is useful in engineering practices.

M.No:	**Topic**	**No. of Hrs**
Module 1.	Introduction to material science and engineering. importance of material science and engineering, classification of materials, modern and advanced materials, human needs and materials selection and design considerations, primary bonds and secondary bonds, energy related concepts, concept of unit cells and lattice arrangements, metallic crystal structures (*FCC, BCC, HCP*), crystal systems, crystallographic directions and planes, single crystals. polycrystalline materials. anisotropy, non-crystalline solids.	10
Module 2.	Theoretical density computations, atomic densities (linear and planar), polymorphism and allotropy, ceramic crystal structures, polymer structure. thermoplastic and thermosetting polymers, *X*-ray diffraction and determination of crystal structures.	10
Module 3.	Imperfections in solids. point defects, line defects and volume defects. grain size determination. diffusion mechanism, diffusion in solids, steady state diffusion, non steady state diffusion, factors that influence diffusion	10
Module 4.	Deformation of metals, concept of stress strain, elastic deformation, plastic deformation. hardness, deformation mechanism, slip systems. plastic deformation of polycrystalline metals, deformation by twinning, strengthening mechanisms, strengthening by grain size reduction, solid solution strengthening, strain hardening. recovery, recrystallization, grain growth, heat treatment processes, phase, solubility limit, phase diagrams, microstructure and phase equilibria, unary phase diagrams, binary phase diagrams, interpretation of phase diagrams, iron carbon system, development of microstructure in iron carbon alloys, introduction to creep & fatigue.	12
Total number of Hours		**42**

Course Outcomes:

At the end of the course, the student will be able to:

- ***Understand*** the crystal structures, crystallographic planes, directions, and voids in metallic materials **(L2)**.
- ***Develop*** knowledge of imperfections in crystalline solids, plastic deformation and strengthening mechanisms in metals **(L6).**
- ***Acquire*** knowledge about deformation and strengthening mechanisms in metals **(L3).**

S.No:	**Text Books**	**Author**	**Publisher**
1.	Fundamentals of Materials Science and Engineering	Callister. W.D	John Wiley & Sons, 2011
	References		
1.	Physical Metallurgy	Cahn. R.W., Haasen. P	North-Holland, 1991
2.	Mechanical Metallurgy	George E. Dieter	McGraw Hill

Course Code	**PCC_ME303L**				
Category	**Professional Core Courses**				
Course Title	**Materials Engineering Lab**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 3 (Three)**
	0	**0**	**2**	**1**	
Pre requisites					

M.No:	**Topic**
Module 1.	To study 2D & 3D lattices.
Module 2.	To study crystal structures using appropriate models.
Module 3.	To study Bravais Lattices using appropriate models.
Module 4.	To study crystal imperfections using appropriate models.
Module 5	To study three dimensional close packing using appropriate models.
Module 6.	Specimen preparation for micro structural examination.
Module 7.	To study microstructure of metals/alloys.
Module 8.	To study Heat Treatment Processes of steel.
Module 9.	To study creep behaviour of a given specimen(*e.g.* lead, zinc, solder wire).

Course Code	**PCC_ME304**				
Category	**Professional Core Courses**				
Course Title	**Basic Engineering Thermodynamics**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 3 (Three)**
	2	**1**	**0**	**3**	
Pre requisites	**None**				

Objectives:

To understand various gas laws and equations of state and apply them to solve problems of estimating enthalpy, entropy, specific heat and internal energy and to use the various Laws of Thermodynamics to estimate the potential for thermo-mechanical energy conversion in aerospace power and propulsion systems.

M. No:	**Topic**	**No. of Hrs**
Module 1.	Basic concepts- the concept of continuum, macroscopic approach, thermodynamic systems, and their properties, state, path, process and cycle, quasistatic process, Zeroth law of thermodynamics, the concept of temperature and heat, thermometry and temperature scales, energy transfer.	06
Module 2.	Thermodynamic properties of pure substances in solid, liquid and vapour phases. Phase rule, *P-V, P-T, T-V, PVT* surfaces, gas mixtures – properties ideal and real gases, equation of state, Avogadro's law, Van Der Waals equation of state, compressibility factor, compressibility chart, Dalton's law of partial pressure.	07
Module 3.	First law of thermodynamics- concepts of internal energy, specific heat capacities, enthalpy, energy balance for closed and open systems, steady-flow engineering devices.	07

Module 4.	Second law of thermodynamics- Kelvin Planck and Clausius statements, heat engines, carnot theorem, Carnot cycle, the thermodynamic temperature scale, refrigerator and heat pump.	07
Module 5.	Clausius inequality, concept of entropy, principle of increase of entropy, reversible and irreversible processes, entropy change of pure substances, property diagrams (*T-S, H-S* diagrams), the entropy change of ideal gases, reversible steady-flow work. exergy analysis, second law efficiency.	10
Module 6.	Exact differentials, *T-D* relations, Maxwell's relations. Clausius Clapeyron equations, Joule –Thomson coefficient.	05
Total number of Hours		**42**

Course Outcomes:

At the end of the course, the student will be able to:

- ***Describe*** basic concepts of thermodynamics such as system, state, state postulate, equilibrium, process, and cycle **(L1).**
- ***Review*** concepts of temperature, temperature scales, pressure, and absolute and gauge pressure **(L1)**.
- ***Define*** the concept of heat and work and transfer of energy by heat and work **(L1).**
- ***Judge*** the properties of pure substances **(L5).**
- ***Illustrate*** the *P-v, T-v*, and *P-T* property diagrams and *P-v-T* surfaces of pure substances **(L4).**
- ***Demonstrate*** the procedures for determining thermodynamic properties of pure substances from tables of property data **(L3).**
- ***Describe*** and ***apply*** the ideal-gas equation of state in the solution of typical problems **(L2, L3).**
- ***Identify*** the first law of thermodynamics as simply a statement of the conservation of energy principle for closed systems and ***formulate*** the general energy balance applied to closed systems via heat and work transfer **(L1, L6)**.
- ***Apply*** the first law of thermodynamics to the open systems **(L3).**
- ***Describe*** the Kelvin–Planck and Clausius statements of the second law of thermodynamics.and ***assess*** its thermodynamic applications **(L1, L5).**
- ***Examine*** the Carnot heat engines, refrigerators, and heat pumps and ***determine*** their expressions for the thermal efficiencies and coefficients of performance **(L4, L3).**
- ***Define*** a new property called entropy to quantify the second law effects **(L1).**
- ***Develop*** the isentropic efficiencies for various steady-flow devices **(L6)**.
- ***Define*** the maximum useful work obtained from the system **(L1).**
- ***Generate*** mass and energy balance equations for gas-vapor mixtures **(L6)**.

S.No:	Text Books	Author	Publisher
1.	Engineering Thermodynamics	Nag.P.K.	Tata McGraw-Hill
	References		
1.	Thermodynamics, An Engineering Approach	Cengel,	Tata McGraw-Hill
2.	Fundamentals of Engineering Thermodynamics	Moran, J. Shapiro, H. N., Boettner, D. D., & M. Bailey	John Wiley & Sons.
3.	Fundamentals of Thermodynamics	R. E. Sonntag, C. Borgnakke, & G. J. V Wylen.	John Wiley & Sons.

Course Code	**PCC_ME305**				
Category	**Professional Core Courses**				
Course Title	**Manufacturing Technology-I**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 3 (Three)**
	2	**1**	**0**	**3**	
Pre requisites	**Basic knowledge of material science, fluid mechanics and heat transfer.**				

Objectives:

To emphasize the importance of manufacturing sciences in day-to-day life, and to study the basic manufacturing processes, tools and various conventional manufacturing processes like casting, metal forming process *etc*.

M.No:	**Topic**	**No. of Hrs**
Module 1.	Introduction, manufacturing cycle, manufacturing processes and their selection, engineering materials and their selection.	03
Module 2.	Casting- patterns, gating system design, riser design, defects, other casting processes- investment, die casting, centrifugal and continuous casting, basic design considerations in casting.	10
Module 3.	Metal forming- plastic deformation, hot and cold working, forming operations-rolling, extrusion, drawing processes, sheet metal operations, sheet metal die design, high velocity forming processes, heat treatment processes.	12
Module 4.	Processing of plastics- extrusion, injection moulding, blow moulding, rotational moulding, thermo-forming and compression moulding, processing of polymer matrix composites & applications.	13
Module 5.	Powder metallurgy processing- production of metal powders, compaction and sintering processes.	04
	Total number of Hours	**42**

Course Outcomes:

At the end of the course, the student will be able to:

- ***Select*** suitable manufacturing processes to manufacture the products optimally **(L1).**
- ***Recommend*** the appropriate design of gating systems, forming processes **(L5).**.
- ***Develop*** simplified manufacturing processes with the aim of reduction of cost and manpower **(L6).**
- ***Identify*** the appropriate process parameters, and possible defects of manufacturing processes so as to remove them **(L1).**

S.No:	**Text Books**	**Author**	**Publisher**
1.	Manufacturing Science	Amitabha Ghosh, Asok Kumar Mallik	East-west press pvt ltd
2.	Manufacturing Technology. Tata	P N Rao.	McGraw-Hill Publishing Co. Ltd., New Delhi.
	References		
1.	Manufacturing Engineering and Technology.	S Kalpakjian.	Addison-Wesley (India).
2.	Materials and Processes in Manufacturing.	E P DeGarmo, J T Black and R Kosher.	Macmillan International.

Course Code	**PCC_ME305L**				
Category	**Professional Core Courses**				
Course Title	**Manufacturing Technology-I Lab**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 3 (Three)**
	0	**0**	**2**	**1**	
Pre requisites	**Basic knowledge of material science, fluid mechanics and heat transfer.**				

M. No:	**Topic**
Module 1.	Testing molding sand for permeability, shear strength and compressive strength.
Module 2.	Prepare a mould for sand casting for a given pattern.
Module 3.	Prepare a Plastic product using injection Molding machine.
Module 4.	Prepare a wooden split pattern.
Module 5.	Perform dye penetrant test for inspection of casted product.
Module 6.	Study and observe the plain and grooved Rolling techniques through demonstration.
Module 7	Study and observe the Powder Metallurgy techniques through demonstration.

Course Code	**PCC_ME306**				
Category	**Professional Core Course**				
Course Title	**Fluid Mechanics**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 3 (Three)**
	3	**1**	**0**	**4**	
Pre requisites	**Engineering Mechanics, Engineering Physics**				

Objectives:

To introduce and explain fundamentals of Fluid statics, kinematics and dynamics, which is used in the applications of aerodynamics, hydraulics, marine engineering, gas dynamics etc.

M. No:	**Topic**	**No. of Hrs**
Module 1.	Definitions, fluids, types of fluids, continuum approach to stress, fluid properties, fluid statics, pressure distribution in hydrostatics, manometers.	11
Module 2.	Forces on plane and curved surfaces, buoyancy and the concept of stability of floating and submerged bodies.	07
Module 3.	Scalar and vector fields, Eulerian and Lagrangian approaches, velocity and acceleration, streamline, streak line and path line, deformation, rotation and vorticity, circulation.	07
Module 4.	Continuity equation, momentum equation, energy equation, Euler's equation, Bernoulli equation and applications, Navier-Stokes equations, exact solutions.	12
Module 5.	Pipe flow, friction factor, fully developed pipe flow, pipe bends, pipe losses, Hydraulic grade line.	06
Module 6.	Laminar boundary layer, boundary layer equations, momentum- integral equation of boundary layer, Introduction to laminar-turbulent transition, dimensional analysis and model testing.	09
Total number of Hours		**52**

Course Outcomes:

At the end of the course, the student will be able to:

- ***Define*** fluid and its properties, ***Explain*** Newton's law of viscosity **(L1,L2).**
- ***Understand*** Newton's law of viscosity and ***Classify*** fluids based on Newton's law of viscosity **(L2)**
- ***Apply*** the principle of manometry to measure gauge and differential pressure, stability of floating bodies and to determine metacentric height **(L3)**.
- ***Analyze*** and **calculate** Hydrostatic Force and its Location for a plane surface *etc* **(L4)**
- ***Understand*** the concept of Eularian and Lagragian approaches of fluid motion, vector and acceleration field **(L2)**.
- ***Analyze*** the streamline, pathlines and streakline **(L4)**.
- ***Apply*** concepts of mass, momentum and energy conservation to flows **(L3).**
- ***Understand*** Navier-Stokes equation and ***apply*** for simple one/ two dimensional pipe flow/ flow through parallel plates **(L2, L3)**
- ***Apply*** Bernoulli's equation for real flow and ***deduce*** expressions for orifice meter and Venturimeter **(L3, L4)**.
- ***Understand*** major and Minor losses **(L2)**
- ***Analyze*** Darcy-Weichbach equation to calculate friction losses **(L4).**
- ***Understand*** boundary layer flow and flow past immersed bodies the basic ideas of turbulence **(L2).**

S.No:	Text Books	Author	Publisher
1.	Introduction to Fluid Mechanics and Fluid Machines	S K Som, Gautam Biswas,S Chakraborty	McGraw Hill Education;/ 3rd edition/ 2017
2.	Fluid Mechanics	Robert. W. Fox	John Wiley
	References		
1.	Fundamental of Fluid Mechanics	Munson. B.R	John Wiley
2.	Introduction to Fluid Mechanics	Cengel. Y	McGraw Hill
3.	Fluid Mechanics	White. F.M	McGraw-Hill

Course Code	**PCC_ME306L**				
Category	**Professional Core Courses**				
Course Title	**Fluid Mechanics Lab**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 3 (Three)**
	0	**0**	**2**	**1**	
Pre requisites	**Engineering Mechanics, Engineering Physics**				

Objectives:

To discuss and practice standard measurement techniques of fluid mechanics and their applications. To determine the various parameters related to fluid flow in pipes and to correlate various flow measuring devices such as Venturimeter, orifice meter and notches etc.

M.No:	Experiments
Module 1.	Measurement of viscosity.
Module 2.	Study of pressure measuring devices.
Module 3.	Determination of metacentric height.
Module 4.	Hydrostatics force on flat surfaces/ curved surfaces.
Module 5.	Verification of Bernoulli's theorem.
Module 6.	Determination of friction factor as a function of Reynolds number in pipe flow.
Module 7.	Determination of coefficient of discharge of Venturimeter/ Orifice meter.

Module 8.	Studying laminar-turbulent transition for flow in a tube.
Module 9.	Determination of friction factor as a function of Reynolds number in pipe flow
Module 10.	Flow Visualisation around a body/ over surface
Module 11.	Boundary layer flow over a flat plate

Course Code	**BSC_ME401**				
Category	**Basic Science Courses**				
Course Title	**Laplace, Fourier and Z-Transforms**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester - 4 (Four)**
	2	**1**	**0**	**3**	
Pre Requisites	**Limits, Improper integrals, A.P and G.P series.**				

Objectives:

To understand various transformation techniques and their use to solve boundary value problems and various linear differential equations

M. No:	**Topic**	**No. of Hrs**
Module 1.	Laplace transform- Laplace transform, condition for the existence of Laplace transform, Laplace transform of some elementary functions, differentiation and integration of laplace transform, laplace transform of periodic functions, shifting theorem, Laplace transforms of different functions, Heaviside's unit function, dirac delta function its Laplace transforms, Heaviside's expansion theorem .	10
Module 2.	Inverse Laplace transforms- initial and final value theorems, convolutions theorem and applications, uses of Laplace transforms in the solutions of linear differential equations.	05
Module 3.	Fourier series- Fourier series, odd and even functions, half range Fourier sine and cosine series.	05
Module 4.	Fourier transform- Finite Fourier transforms, fourier integral formula, properties of fourier transform, Fourier sine and cosine transform, convolution theorem, parseval's identity for fourier transform Fourier integral formula, applications to solutions of boundary value problems.	10
Module 5.	Z-transform- definition, linearity property, Z-transform of elementary functions, shifting theorems, initial and final value theorem, convolution theorem.	07
Module 6.	inverse Z-transform- inversion of Z-transforms, use of Z-transforms in solving difference equations .	05
	Total number of Hours	**42**

Course Outcomes:

At the end of the course, the student will be able to:

- ***Evaluate*** Laplace and Inverse Laplace transforms of various functions and related problems **(L5)**.
- ***Evaluate*** Fourier and Inverse Fourier transforms of various functions and related problems **(L5)**.
- ***Apply*** the methods of laplace and Fourier transforms in solving ODE,and PDE **(L3)**.

S.No:	**Text Books**	**Author**	**Publisher**
1.	Schaum's outlines laplace transform	M. R. Spiegel	Tata Mc-Graw Hill
	References		
1.	Advanced Engg mathematics	Erwin Kreysing	Wiley Eastern. Pub.
2.	Higher Engg Mathematics	B.S. Grewal	Khanna publishers
3.	Advanced Engg Mathematics	Michael D Greenberg	PHI,2001

Course Code	**PCC_ME402**				
Category	**Professional Core Course**				
Course Title	**Solid Mechanics-I**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester - 4 (Four)**
	3	**1**	**0**	**4**	
Pre requisites	**Statics and Dynamics**				

Objectives:

To understand the nature of stresses developed in simple geometries such as bars, cantilevers, beams, shafts, cylinders and spheres for various types of simple loads. To calculate the elastic deformation occurring in various simple geometries for different types of loading.

M. No:	Topic	No. of Hrs
Module 1.	An introduction to stress and strain, stress-strain diagram, Poisson's ratio, multiaxial loading- generalized Hooke's law, dilatation and bulk modulus, shearing strain, deformations under axial loading, stress concentrations, plastic deformations, residual stresses, elastic constants and their relations, statically indeterminate problems, problems involving temperature change.	16
Module 2.	Transformation of plane stress, transformation equations, principal stresses and maximum shearing stress, Mohr's stress, general state of stress, three dimensional analysis of stress, transformation of plane strain, transformation equations, Mohr's circle for plane strain, three dimensional analysis of strain, measurement of strain and strain rosette.	12
Module 3.	Torsion, stresses and deformation in circular and hollow shafts, stepped shafts, deflection of shafts fixed at both ends stresses and deflection of helical springs	12
Module 4.	Theory of bending of beams, bending stress distribution and neutral axis, shear stress distribution, shear stresses in beams of rectangular and circular cross section, shear stresses in the webs of beams with flanges, shear centre concept and its determination for thin walled members.	12
Module 5.	Thin and thick walled pressure vessels, stresses in thick and thin cylindrical and spherical pressure vessels subjected to internal pressure, deformation of thick and thin cylinders, deformation in spherical shells subjected to internal pressure.	12
Total number of Hours		**52**

Course Outcomes:

At the end of the course, the student will be able to:

- ***Recognise*** various types of loads applied on machine components of simple geometry and understand the nature of internal stresses that will develop within the components **(L1).**
- ***Evaluate*** the strains and deformation that will result due to the elastic stresses developed within the materials for simple types of loading **(L5).**

S.No:	Text Books	Author	Publisher
1.	Mechanics of Materials	Beer and Johnston	McGraw Hill, 2015
	References		
1.	Mechanics of Materials	J.M. Gere and S.P. Timoshenko	Cengage Learning, 1997
2.	Introduction to Solid Mechanics	I.H. Shames and J.M. Pitarresi	Prentice Hall of India,1999
3.	Engineering Mechanics of Solids	Popov. E.P	Prentice Hall of India, 2004

Course Code	**PCC_ME402L**				
Category	**Professional Core Course**				
Course Title	**Solid Mechanics-I Lab**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 4 (Four)**
	0	**0**	**2**	**1**	
Pre requisites	-				

Objectives:

To understand the measurement of mechanical properties of materials. To understand the deformation behaviour of materials. To understand the kinematic and dynamic characteristics of mechanical devices

M. No:	**Topic**
Module 1.	Tensile test of mild steel and aluminum bars.
Module 2.	Shear test on specimens of two different metals.
Module 3.	Charpy and Izod Impact test on a metallic specimen.
Module 4.	Brinnell and Rockwell hardness tests on metallic specimens.
Module 5.	Bending deflection test on beams.
Module 6.	Strain measurement using rosette strain gauge.
Module 7.	Torsion test on specimens of different metals for determining the angle of twist for a given torque.
Module 8.	Compressive test of a specimen.
Module 9.	Shear test on specimens of two different metals.

Course Code	**PCC_ME403**				
Category	**Professional Core Course**				
Course Title	**Theory of Machines-I**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 4 (Four)**
	3	**1**	**0**	**4**	
Pre requisites	**Statics and Dynamics**				

Objectives:

To develop a solution oriented approach by in depth knowledge of Theory of Machines and to address the underlying concepts, methods and application of different machines.

M. No:	**Topic**	**No. of Hrs**
Module 1.	Introduction, kinematic chain, planar mechanisms, lower pairs & higher pairs, degree of freedom (DOF), Kutzbach criterion and Grubler's equation, Grashof's law, inversions of simple mechanisms, quick return motion mechanisms, mechanical advantage	06
Module 2.	Instantaneous centre, Arnold Kennedy theorem, method of locating instantaneous centres in a mechanism, velocity and acceleration analysis of mechanism by graphical and analytical approach (application to simple mechanisms and their inversions).	06
Module 3	Bearings, working and analysis of pivot, collar/ thrust & journal bearings, friction circle and friction axis of journal bearings, rolling contact bearings, friction clutches, single plate clutch and multi disc clutch, centrifugal clutch, brakes,	13

	classification, working and analysis of simple block brake, double block brakes, long shoe brake, band brake, braking of vehicle.	
Module 4	Working and analysis of different types of governors (watt, porter, Hartnell and Proell), sensitivity, stability, hunting, isochronism, effort and power of a governor, working and analysis of flywheel	06
Module 5.	Classification of cams and followers, terminology for cams, types of motion curves and their analytical expressions, graphical construction of cam profile for different types of followers, pressure angle , force analysis of cam-follower systems.	07
Module 6	Rolling contact and positive drive, classification of gears, nomenclature, law of gearing, conjugate teeth, involute and cycloidal profile system of gear teeth, Length of path of contact, arc of contact, contact ratio, gear ratio, interference and undercutting, helical and spiral gears.	06
Module 7	Gear trains, classification, Types, simple gear train, speed ratios, compound, reverted, epicyclic gear train, tabulation and algebraic method, compound epicyclic train.	04
Module 8	Processional motion and angular acceleration, gyroscopic couple, reaction couple. effects on an aeroplane, naval ship.	04
Total number of Hours		**52**

Course Outcomes:

At the end of the course, the student will be able to:

Perform synthesis of mechanism by analytical and graphical method **(L2).**

Analyze Influence of Inertia upon Velocity & Acceleration **(L4).**

Demonstrate & perform Gravity and spring control governors evaluation **(L3)**.

Demonstrate flywheel and its effect on dynamics of the system **(L3).**

Design cam profile for given follower motions and ***understand*** cam Jump phenomenon, advance cam curves **(L6)**.

Understand fundamentals of gear theory **(L2)**.

Perform force analysis of Spur, Helical, Bevel, Worm gear **(L3)**.

Demonstrate & perform gyroscope evaluation **(L3)**.

S.No:	**Text Books**	**Author**	**Publisher**
1.	Theory of Mechanisms and Machines	Amitabha Ghosh and Ashok Kumar Mallik	EWP, 2007
	References		
1.	Theory of Machines	Shigley	McGraw Hill, 1995
2.	Theory of Machines	Bevan	C.B.S Publication, 1997

Course Code	**PCC_ME403L**				
Category	**Professional Core Course**				
Course Title	**Theory of Machines-I Lab**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 4 (Four)**
	0	**0**	**2**	**1**	
Pre requisites	-				

M. No:	**Topic**
Module 1	Study of kinematic pairs.
Module 2.	Study slider crank motion, reciprocating engine mechanism, Inversion of four bar chain, oscillating cylinder mechanism and whitworth quick return mechanism.

Module 3	Study the working of various models of brakes.
Module 4.	Study the working of various models of clutch.
Module 5.	Study the characteristics of a Watt Governor, Proell Governor, Porter Governor and Hartnell Governor.
Module 6.	Study characteristics of various types of cams and followers.
Module 7	Determine the velocity of precession of a given motorized gyroscope.

Course Code	**PCC_ME404**				
Category	**Professional Core Course**				
Course Title	**Manufacturing Technology-II**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 4 (Four)**
	2	**1**	**0**	**3**	
Pre requisites					

Objectives:

To emphasize the importance of manufacturing sciences in day-to-day life, and to study the basic manufacturing processes and tools. To study the basics of metal machining and mechanics of metal machining and different cutting tool materials & geometry of cutting tools.

M. No:	**Topic**	**No. of Hrs**
Module 1.	Metal cutting- tool materials, tool geometry and nomenclature in *ASA, ORS* and *NRS,* cutting fluids, single and multipoint cutting operations, production of gears and screw threads, grinding and finishing processes, specification of grinding wheels, honing, lapping, tool-workpiece interaction (Merchant circle diagram).	12
Module 2.	Machine tools- primary and secondary drives, guideway and slideways, structure. Introduction to *NC, CNC* and *DNC* machining and part programming.	10
Module 3.	Non-conventional machining methods: process capabilities and limitations of *AJM*, *USM, WJM, ECM, ECG, EDM, EBM* and *LBM* processes.	08
Module 4.	Joining processes- conventional welding processes, heat affected zone, testing of welded joints, solid state welding processes, weld defects, brazing and soldering, process selection, adhesive bonding, mechanical fastening processes, inspection of welding joints.	08
Module 5.	Process variables, metrology- limits, fits and tolerances, hole basis and shaft basis system, Taylor's principles of gauge design.	04
Total number of Hours		**42**

Course Outcomes:

At the end of the course, the student will be able to:

- ***Understand*** the basic concept of machining, tool geometry, mechanism of chip formation, and the factors affecting the machining process **(L1).**
- ***Select*** cutting fluids, tool materials and coatings to control tool wear and temperature **(L1).**
- ***Understand*** the mechanics of grinding, economy of machining and grinding, advanced technology of machining and grinding **(L1).**
- ***Understand*** basic concepts of NC, CNC and DNC machining and part programming **(L2).**
- ***Explain*** and analyse the conventional machining processes **(L3).**
- ***Analyse*** the welding process behaviour for fusion and solid state welding techniques **(L4)**

- ***Understand*** the basics of limits, fits and tolerances in manufacturing **(L5).**

S.No:	Text Books	Author	Publisher
1.	Manufacturing Science	Amitabha Ghosh, Asok Kumar Mallik	East-west press pvt ltd
2.	Manufacturing Technology.	P N Rao.	Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
	References		
1.	Manufacturing Engineering and Technology.	S Kalpakjian.	Addison-Wesley (India).
2.	Materials and Processes in Manufacturing.	E P DeGarmo, J T Black and R Kosher.	Macmillan International.
3.	Fundamentals of Manufacturing Processes.	G K Lal and S K Choudhary.	Narosa Publishing House, New Delhi.
4.	Non conventional Machining.	P K Mishra.	Narosa Publishing House, New Delhi.

Course Code	**PCC_ME404L**				
Category	**Professional Core Course**				
Course Title	**Manufacturing Technology-II Lab**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 4 (Four)**
	0	**0**	**2**	**1**	
Pre requisites					

Objectives:

To impart hands-on practical exposure on manufacturing processes and equipment. To study and practice the various machining operations that can be performed in lathe and equip students with the practical knowledge required in the manufacturing/production companies.To understand the arc welding, gas welding and resistance welding equipment for the fabrication of welded joints.

M. No:	Topic
Module 1.	Performing step turning and taper turning on a lathe machine.
Module 2.	Performing drilling and boring operations on a lathe machine.
Module 3.	Performing external thread cutting on a lathe machine.
Module 4.	Study of a surface grinding machine performing surface grinding on washers.
Module 5.	Setting of oxy-acetylene welding equipment and setting of flame.
Module 6.	Setting up an arc welding machine and accessories, and striking an arc.
Module 7.	Deposit straight line bead on MS plate in flat position.
Module 8.	Testing of weld joints by visual inspection.
Module 9.	Carry out dye penetrant test on welded joints.
Module 10.	Use of sine bars and slip gauges for angle measurement.
Module 11	Use of bevel protector and dial gauges.

Course Code	**PCC_ME405**				
Category	**Professional Core Course**				
Course Title	**Applied Thermodynamics**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 4 (Four)**
	2	**1**	**0**	**3**	
Pre requisites	**Basic Engineering Thermodynamics**				

Objectives:

To provide an overview of the application of thermodynamic principles to the design and optimization of Thermal Engineering Systems.

M. No:	**Topic**	**No. of Hrs**
Module 1.	Combustion- combustion analysis, air requirement, air/fuel ratio, standard heat of reaction,heat of formation.	05
Module 2.	Boilers- steam generators-classification, working of fire-tube and water-tube Boilers, boiler mountings and accessories.	07
Module 3.	Vapour power cycles- carnot vapour power cycle,rankine cycle, modified rankine cycle, working of steam power plant, binary vapour cycle.	08
Module 4.	Nozzles- flow through nozzle, variation of velocity, area and specific volume, choked flow, nozzle efficiency, off design operation of nozzle, super saturated flow.	07
Module 5.	Steam turbines- classification of steam turbine, compounding of impulse turbine, velocity diagrams, reaction turbine, degree of reaction, work output, governing of turbine.	08
Module 6.	Condensers- type of condensers, air leakage, condenser performance parameters	05
	Total number of Hours	**42**

Course Outcomes:

At the end of the course, the student will be able to:

- ***Define*** air/fuel ratio and **calculate** stoichiometric air/fuel ratio for different fuels **(L1)**.
- ***Define*** steam boilers and **classify** the boilers based on circulation,position,tube,method of firing,pressure **(L1)**.
- ***Understand*** the different boiler mountings and accessories **(L1)**.
- ***Analyse*** the different vapour power cycles **(L4)**.
- ***Compare*** the work ratio,efficiency,SSC, net work output for different vapour power cycles **(L5)**.
- ***Explain*** the operation of steam turbines **(L2)**.
- ***Analyze*** the energy conversion in various thermal devices such as nozzles,condensers,steam turbines **(L4)**.
- ***Understand*** the working of steam condensers and classify the condenser based on working **(L1)**.

S.No:	**Text Books**	**Author**	**Publisher**
1.	Applied Thermodynamics for Engineering Technologist.	T. D. Eastop & McConkey	Pearson Education
	References		
1.	Engineering Thermodynamics	P K Nag	Mc Graw Hill
2.	Fundamentals of Engineering Thermodynamics	Moran M J and H N Shapiro	Wiley

Course Code	**PCC_ME405L**				
Category	**Professional Core Course**				
Course Title	**Applied Thermodynamics Lab**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 4 (Four)**
	0	**0**	**2**	**1**	
Pre requisites	**Basic Engineering Thermodynamics**				

Objectives:

To identify various boiler mountings and accessories and to to find power output & efficiency of a steam turbine.

M. No:	Topic
Module 1.	Study the working of different Boilers.
Module 2.	Calculation of heat balance sheet of a boiler.
Module 3.	Calculation of dryness fraction of steam.
Module 4.	To study the working of impulse and reaction steam turbines.
Module 5.	To study various types of steam condenser.

Course Code	**PCC_ME406**				
Category	**Professional Core Course**				
Course Title	**Measurement and Instrumentation**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 4 (Four)**
	2	**1**	**0**	**3**	
Pre requisites	**Engineering Physics, Laplace Transform, Basic electronics**				

Objectives:

To introduce the basics of measurements and different error analysis methods. To understand concepts of various electrical and electronic measuring instruments.

M. No:	Topic	No. of Hrs
Module 1.	Definitions, significance, fundamental methods of measurement, generalized measurement system, types of input quantities, standards, calibration, classification of instruments, errors, methods of correction, generalized performance characteristics, static characteristics, static calibration, dynamic characteristics, zero and first order instruments, time constant, second-order instruments, transient response characteristics.	10
Module 2.	Transducer elements, motion and vibration measurements, force measurement-balance principle of force measurement, hydraulic and pneumatic load cell, elastic force devices.	9
Module 3.	Torque and power measurement- dynamometer (absorption, driving and transmission type).	4
Module 4.	Pressure measurement- Instruments for high, mid and low pressure measurement, dead weight and null type, elastic element gauges, differential pressure cell, high pressure measurement, Low pressure measurement, Pirani gauges & Mcleod pressure gauge.	7

Module 5.	Flow Measurement: orifice meters, Venturimeter, Pitot tube, flow nozzle, variable area meters, rotameter, design and accuracy, positive displacement flow meter, turbine flow meter, electromagnetic flow meter, ultrasonic flow meters	6
Module 6.	Temperature measurement: non electrical and electrical methods of temperature measurement, radiation methods	6
Total number of Hours		**42**

Course Outcomes:

At the end of the course, the student will be able to:

- ***Explain*** the working of different electromechanical indicating instruments **(L2)**
- ***Define*** the static and dynamic characteristics of measurement systems.
- ***Define*** the different transducers.
- ***Understand*** the functioning and use of temperature measuring instruments.
- ***Analyze*** the instrumentation for displacement, strain, velocity, force, toque, power, pressure.

S.No:	**Text Books**	**Author**	**Publisher**
	Instrumentation, Measurements & Analysis	Nakra B.C.	Tata McGrawHill, N.Delhi
	References		
	Mechanical Measurements	Beckwith, B	Pearson Education Int.
	Measurement systems	Doeblin, E.O	McGraw Hill

Course Code	**PCC_ME406L**				
Category	**Professional Core Course**				
Course Title	**Measurement and Instrumentation Lab**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester - 4 (Four)**
	0	**0**	**2**	**1**	
Pre requisites					

Objectives:

To measure different input quantities using various types of transducers. and to make use of different flow measuring devices.

M. No:	**Topic**
Module 1.	To measure displacement using *LVDT*.
Module 2.	Measurement of strain using strain gauge.
Module 3.	To study characteristics of various temperature measuring instruments like thermocouple, thermistor and *RTD*.
Module 4.	To measure flow rate using different flow measurement devices.
Module 5.	To study the working of Bourdon pressure gauge and to check the calibration of the gauge in a deadweight pressure gauge calibration set up.

Course Code	**BSC_ME501**				
Category	**Basic Science Course**				
Course Title	**Complex Analysis**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 5 (Five)**
	2	**1**	**0**	**3**	
Pre requisites	**Set theory, Calculus of real functions, Algebra of complex numbers.**				

Objectives:

To study the techniques of complex variables and functions together with their derivatives. and classification of singularities, calculus of residues and its applications in the evaluation of integrals, and other concepts and properties.

M. No:	**Topic**	**No. of Hrs**
Module 1.	Analytic functions- function of a complex variable, limit, continuity and differentiability of complex function, analytics functions, harmonic functions, necessary and sufficient conditions for a complex function to be analytic, polar form of cauchy riemann equations, construction of analytic function whose real and imaginary part is given.	10
Module 2.	Complex integration- definite Integrals of functions w(t), *ML* theorem, Cauchy's fundamental theorem, Cauchy's integral formula, Cauchy's integral formula for derivatives, Cauchy's inequality, Liouville's theorem, Morera's theorem.	9
Module 3.	Taylor and Laurent series- Taylor's and Laurent's Expansion, classifications of singularities, removable singularity, zeros of a function, poles and behaviour of a function at a pole , essential singularity.	9
Module 4.	Residue theorem and applications- residues, residue at a pole, residue at infinity, Cauchy's residue theorem, residues at finite pole, evaluation of integrals by the method of residues (contour integration).	9
Module 5.	Mobius transformation, properties and classification, fixed point and cross ratio.	5
Total number of Hours		**42**

Course Outcomes:

At the end of the course:

Demonstrate understanding of the basic concepts underlying complex analysis and their role in modern mathematics and applied contexts **(L3)**.

Demonstrate familiarity with a range of examples of these concepts **(L3)**.

Apply the methods of complex analysis to evaluate definite integrals and infinite series **(L3).**

Apply problem-solving using complex analysis techniques to diverse situations in physics, engineering and other mathematical contexts **(L3)**.

S.No:	**Text Books**	**Author**	**Publisher**
1.	Complex Variables and Application	James Ward Brown and Ruel Churchill	McGraw-Hill International Book Company.
	References		
1.	Advanced Engineering Mathematics	R.K. Jain & S.R.K. Iyengar	Narosa Publishing House
2.	Theory of Functions of Complex Variables	E.T. Copson	Oxford University Press
3.	Foundation of Complex Analysis	S. Ponnusamy	Narosa Publishing House

Course Code	**PCC_ME502**				
Course Category	**Professional Core Course**				
Course Title	**Heat Transfer**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 5 (Five)**
	3	**1**	**0**	**4**	
Pre requisites	**Basic Thermodynamics, Fluid Mechanics**				

Objectives:

To understand the fundamentals of heat transfer mechanisms in fluids and solids and their applications in various heat transfer equipment in process industries

M. No:	**Topic**	**No. of Hrs**
Module 1.	Conduction heat transfer, one-dimensional steady and unsteady state problems, fins, multidimensional problems.	15
Module 2.	Convection mode of heat transfer, external flows, boundary layer flow on a heated flat plate, thermally and hydro-dynamically fully developed flow through a pipe, turbulent flow, Dittus Boelter's and Sieder-Tate correlation.	12
Module 3.	Natural convection, non-dimensional numbers, natural convection over surfaces, natural convection from finned surfaces and *PCB*s	7
Module 4.	Heat exchangers and their types, the overall heat transfer coefficient, analysis of heat exchangers, the LMDT, counter-flow heat exchangers, multi-pass and cross-flow heat exchangers, the effectiveness-*NTU* method, selection of heat exchangers.	09
Module 5.	Radiation- fundamental concepts, black body radiation, surface emission, surface properties, Kirchoff's law, view factor, black body radiation exchange.	09
	Total number of Hours	**52**

Course Outcomes:

At the end of the course, the student will be able to:

- ***Understand*** the basic modes of heat transfer **(L2).**
- ***Compute*** one dimensional steady state heat transfer with and without heat generation
- ***Understand*** and analyze heat transfer through extended surfaces**(L2, L4).**
- ***Understand*** one dimensional transient conduction heat transfer **(L2).**
- ***Interpret*** and analyze forced and free convective heat transfer **(L5)**.
- ***Understand*** the principles of radiation heat transfer **(L2)**.
- ***Design*** of heat exchangers using LMTD and NTU methods **(L6).**

S.No:	**Text Books**	**Author**	**Publisher**
1.	Heat & Mass Transfer	by P.K. Nag,	McGraw Hill
2.	Heat Transfer.	S P Sukhatme.	Orient Longman Ltd.
	References		
1.	Heat and Mass Transfer: Fundamentals and Application	Yunus Cengel,	McGraw Hill
2.	Fundamental of Heat and Mass Transfer	Incropera and Dewitt,	Wiley Publication
3.	Heat Transfer	Mills and Ganesan	Pearson Education
4.	Heat Transfer	J P Holman	McGraw Hill

Course Code	**PCC_ME502L**				
Category	**Professional Core Course**				
Course Title	**Heat Transfer Lab**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 5 (Five)**
	0	**0**	**2**	**1**	

Objectives:

To understand experimentally, the modes of heat transfer mechanisms viz conduction based using composite wall apparatus, heat transfer coefficients in case of Convection (forced and natural types) and Heat exchangers, emissive power calculations of gray bodies.

M. No:	**Topic**
Module 1.	To determine the thermal conductivity of given metal rod.
Module 2.	To determine the thermal conductivity of the given composite wall.
Module 3.	To determine the thermal conductivity insulating powder.
Module 4.	Heat pipe demonstration (superconductivity of material).
Module 5.	To determine Stefan Boltzmann constant experimentally.
Module 6.	To determine heat transfer coefficient by forced convection.
Module 7.	To determine heat transfer coefficient by natural convection.
Module 8.	To determine the overall heat transfer coefficient of shell and tube type heat exchangers.
Module 9.	To determine the emissivity of a gray body.
Module 10.	To study drop & film wise condensation & determine the film coefficient.
Module 11.	To measure convective heat transfer co-efficient and effectiveness of the fin under forced convection.
Module 12.	To measure convective heat transfer co-efficient and effectiveness of the fin under natural convection.

Course Code	**PCC_ME503**				
Category	**Professional Core Course**				
Course Title	**Fluid Machinery**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 5 (Five)**
	2	**1**	**0**	**3**	
Pre requisites	**Fluid Mechanics, Dynamics**				

Objectives:

To introduce application of conservation of angular in turbomachines, the basic theory of hydraulic machines, design principles of turbines and pumps and to use them in engineering applications..

M. No:	**Topic**	**No. of Hrs**
Module 1.	Introduction to fluid machinery, classification of fluid machines, energy transfer in turbomachines, application of dimensional analysis and model testing for turbomachines, dimensionless groups and specific speed.	10
Module 2.	Hydraulic turbines, classification of turbines, efficiencies of turbine, impulse turbines (pelton turbine), components of pelton turbine, analysis of Pelton wheel.	06

Module 3.	Radial-flow turbines—Francis turbines, analysis of Francis runner, axial-flow turbines—Propeller and Kaplan turbines, analysis of Kaplan/ Propeller runner, turbine characteristics, inlet and outlet elements of the turbine.	06
Module 4.	Heads of pump installation, energy gradient line of pumping system, centrifugal pump impeller and velocity triangles, axial flow or propeller pump, velocity triangle and analysis, pump and system characteristics, pumps in series and parallel, inlet and outlet elements of pumps.	06
Module 5.	Head losses in components of turbine and pump systems, pipes, cavitation in turbines and pumps, water hammer.	05
Module 6.	Introduction to reciprocating pumps, acceleration head, air vessels, double acting pumps, multi cylinder pumps.	04
Module 7.	Hydraulic systems, hydraulic accumulator, hydraulic lift and hydraulic press, fluid coupling and torque converter, hydraulic ram.	03
Total number of Hours		**42**

Course Outcomes:

At the end of the course, the student will be able to:

- ***Understand*** different types of turbomachines **(L2).**
- ***Develop*** the Euler equation for turbomachine and connect the same to transport theorem **(L6).**
- ***Describe*** the method of drawing velocity triangles and calculate energy transfer and degree of reaction in turbomachines **(L1).**
- ***Application*** of free and forced vortex flows in turbomachinery **(L3)**.
- ***Apply*** Buckingham pi theorem and ***express*** the efficiency of pump and turbine in terms of various relevant dimensionless numbers **(L3, L2).**
- ***Understand*** the principle of operation and nature of energy transfer in hydraulic turbines **(L2).**
- ***Study*** the performance characteristics of hydraulic turbines **(L1).**
- ***Explain*** the principle of operation and advantages of centrifugal and axial pumps **(L5).**
- ***Discuss*** the performance characteristics of centrifugal and axial pumps **(L2)**.
- ***Summarize*** the necessities and limitations of pumps in series and in parallel **(L5).**
- ***Explain*** the inception of cavitation, probable damages and methods to avoid it **(L5).**
- ***Describe*** the concepts of net positive suction head, Thoma's cavitation parameter **(L1).**
- ***Understand*** the basic principles of operation and nature of energy transfer in positive displacement machines **(L2).**

M. No:	**Text Books Recommended**	**Author**	**Publisher**
1.	Turbomachinery	Maneesh Dubey BVSSS Prasad Archana Nema	McGraw Hill Education
	References		
1.	Principles of Turbomachinery	R.K Turton	Chapman and Hall
2.	Turbomachinery Design and Theory	Rama S. R. Gorla, Aijaz A. Khan	Marcel Dekkeirnc
3.	Hydraulic Machines: Turbines and Pumps	Grigori Krivchenko	Lewis Publishers

Course Code	**PCC_ME503L**				
Category	**Professional Core Course**				
Course Title	**Fluid Machinery Lab**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 5 (Five)**
	0	**0**	**2**	**1**	
Pre requisites					

S.No:	**Topic**
Module 1.	Impact of jet of water on vane (To find the coefficient of impact of jet on flat circular and hemispherical vanes).
Module 2.	Study of Pelton turbine (To conduct performance test on the Pelton turbine).
Module 3.	Study of Francis turbine (To conduct performance test on the Francis turbine).
Module 4.	Study of Kaplan turbine (To conduct performance test on the Kaplan turbine).
Module 5.	Study of centrifugal Pump (To analyse the pump and system characteristics).

Course Code	**PCC_ME504**				
Category	**Professional Core Course**				
Course Title	**Theory of Machines-II**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 5 (Five)**
	2	**1**	**0**	**3**	
Pre requisites	**Statics, Dynamics and Solid Mechanics.**				

Objectives:

To learn how to treat the vibration phenomena by transforming the physical model into a mathematical model and solve it by using the appropriate mathematical operations.

M. No:	**Topic**	**No. of Hrs**
Module 1.	Importance of the study of vibration, terminology for vibration analysis basic concepts of vibration, classification of vibration, procedure of vibration analysis, spring elements, mass or inertia elements, damping elements, types of damping, harmonic motion, phenomena of beats, non harmonic motions, harmonic analysis.	06
Module 2.	Modeling of *SDOF* systems, free vibration of *SDOF* systems, equilibrium and energy methods for determining natural frequency, Rayleigh's methods, D'Alembert's principle, equivalent systems, systems with compound springs, standard Form of differential equation governing SDOF systems, free vibrations of an damped system (underdamped, critically damped, over damped).	10
Module 3.	Forced vibration of undamped *SDOF* systems, forced response of a viscously damped *SDOF* system, response due to harmonic excitation of support, transmissibility, vibration isolation and commercial isolators, principles of vibration measuring instruments, power consumption in vibrating system.	10
Module 4.	Free undamped vibration of two degrees of freedom systems, natural frequencies and mode Shapes, static and dynamic coupling, un-damped dynamic vibration absorber, friction damper, approximate solution of vibration problems of light flexible shafts with and without damping, vibrations of continuous systems.	05

Module 5.	Force analysis of mechanisms, dynamic force analysis, equivalent dynamic system, dynamic analysis of reciprocating engines.	06
Module 6.	Balancing of four-bar linkage and slider crank mechanism balancing of radial, in line, V-and locomotive engines.	05
Total number of Hours		**42**

Course Outcomes:

At the end of the course, the student will be able to:

- ***Analyse*** the vibration phenomena as a mathematical model and solve it to obtain the response **(L4).**
- ***Understood*** the parameters and variables of a vibrating system **(L2).**
- ***Analyze*** the mathematical modeling of the two degrees of freedom systems **(L4)**.
- ***Determine*** the natural frequency of transverse vibrations of the shaft and torsional vibrations of rotor systems **(L5).**
- ***Explain*** the modal analysis of a vibrating system **(L5)**.
- ***Determine*** natural frequencies of the beam and rotor systems **(L5)**.

S.No:	**Text Books**	**Author**	**Publisher**
1.	Mechanical Vibrations Theory and Applications	S. Graham Kelly	Cengage Learning
	References		
1.	Theory of Vibrations with applications	Thomson. W.T	Pearson Education, 2010
2.	Elements of vibration analysis	Meirovitch	McGraw Hill, 2011
3.	Theory of Vibrations with applications	Thomson. W.T	Pearson Education, 2010

Course Code	**PCC_ME504L**				
Category	**Professional Core Course**				
Course Title	**Theory of Machines-II Lab**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 5 (Five)**
	0	**0**	**2**	**1**	

M. No:	**Topic**
Module 1.	Study time period of different pendulums.
Module 2.	Compare the time periods of rod and thread pendulum.
Module 3.	Verify radius of gyration of a given pendulum.
Module 4.	Study free undamped vibrations of equivalent spring mass systems.
Module 5.	Study forced undamped vibrations of equivalent spring mass system.
Module 6.	Study undamped torsional vibrations of single rotor shaft system.
Module 7.	Study damped torsional vibrations and determine damping coefficient of single rotor shaft system.
Module 8.	Study forced (damped & undamped) vibration of a simply supported beam with damping.
Module 9.	Study and observe the effect of unbalanced reciprocating masses in an engine

Course Code	**PCC_ME505**				
Category	**Professional Core Course**				
Course Title	**Solid Mechanics-II**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester - 5 (Five)**
	3	**1**	**0**	**4**	
Pre requisites	**Statics**				

Objectives:

Understanding the deflection and analysis of structural members, concept of elastic stability of structural members and the reasons and criteria of failure of machine elements and structural components.

M. No:	**Topic**	**No. of Hrs**
Module 1.	Deflection of beams, differential equations of the deflection curve, deflections of statically determinate and indeterminate beams by integration of the bending-moment equation, method of superposition, moment-area method, Macaulay method or use of singularity function and Castigliano's theorem.	14
Module 2.	Bending of curved bars, bars of small and large initial curvatures, stress in a circular ring, chain link, deflection of curved bars.	14
Module 3.	Columns, buckling and stability, beam column equation, columns with pinned ends, columns with other support conditions, Rankine formula, columns with eccentric axial loads, the secant formula for columns, elastic and inelastic column behavior.	12
Module 4.	Theories of failure, maximum principal stress theory, maximum principal strain theory, maximum shear stress theory, total strain energy theory, distortion energy theory, octahedral stress theory, Mohr's theory.	12
	Total number of Hours	**52**

Course Outcomes:

At the end of the course, the student will be able to:

- ***Analyse*** the structural members and predict the failure **(L4).**
- ***Analyse*** the structural members for its maximum deflection/stress/strain/buckling **(L4).**
- ***Apply*** the failure theories to design structural members or machine elements **(L3).**

S.No:	**Text Books**	**Author**	**Publisher**
	Mechanics of Materials	Beer and Johnston	McGraw Hill, 2015
	References		
	Mechanics of Materials	J.M. Gere and S.P. Timoshenko	Cengage Learning, 1997
	Engineering Mechanics of Solids	Popov. E.P	Prentice Hall of India, 2004
	Mechanics of Materials	Hibbeler R.C	Pearson Education, 2007

Course Code	**OEC_ME506**				
Category	**Open Elective Course**				
Course Title	**Automation in Manufacturing**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester - 5 (Five)**
	2	**1**	**0**	**3**	
Pre requisites	**Manufacturing Technology**				

Objectives:

the students will get a comprehensive picture of computer based automation of manufacturing operations

M. No:	**Topic**	**No. of Hrs**
Module 1.	Introduction to *CAD, CAM, CIM*, rigid automation, part handling, machine tools. flexible automation, computer control of machine tools and machining centers, *NC* and *NC* part programming, *CNC*-adaptive control, automated material handling, assembly, flexible fixturing, introduction to cellular manufacturing and flexible manufacturing systems.	15
Module 2.	Computer aided design- fundamentals of *CAD*, hardware in *CAD*-computer graphics software and database, geometric modeling for downstream applications and analysis methods- computer aided manufacturing, *CNC* technology, *PLC*, micro-controllers.	10
Module 3.	Low cost automation- mechanical & electro mechanical systems, pneumatics and hydraulics, illustrative examples and case studies.	05
Module 4.	Introduction to modeling and simulation: product design, process route modeling, optimization techniques, case studies & industrial applications, introduction to additive manufacturing.	07
Module 5.	Elements of integration– controllers, sensors, robots, automated machines- *AGVs, AS, RS*, *etc*.	05
Total number of Hours		**42**

Course Outcomes:

At the end of the course, the student will be able to:

- ***Understand*** the importance of automation in the off field machine tool based manufacturing **(L2).**
- ***Remember*** various elements of manufacturing automation – *CAD/CAM*, sensors, pneumatics, hydraulics and CNC **(L1).**
- ***Understand*** the basics of product design and the role of manufacturing automation **(L2).**

S.No:	**Text Books**	**Author**	**Publisher**
1.	Automation, Production Systems, and Computer-integrated Manufacturing	Mikell P. Groover,	Prentice Hall
	References		
1.	Manufacturing–Engineering and Technology.	Serope Kalpakjian and Steven R. Schmid,	Pearson/ 7th Edition
2.	Computer control of manufacturing system	Yoram Koren,	
3.	CAD/CAM: Theory & Practice	Ibrahim Zeid ,	

Course Code	**OEC_ME506L**				
Category	**Open Elective Course**				
Course Title	**Automation in Manufacturing Lab**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 5 (Five)**
	0	**0**	**2**	**1**	
Pre requisites	**-**				

Objectives:

The students will get a comprehensive picture of computer based automation of manufacturing operations

M. No:	**Topic**
Module 1.	CNC lathe programming, turning, multipoint turning cycles.
Module 2.	CNC milling programming, pocket milling, pattern repetition.
Module 3.	CAD modelling using Autodesk inventor/ Solid works.
Module 4.	CAM using Solid works/ Inventor.

Course Code	**HSM_ME601**				
Category	**Humanities and Social Sciences including Management course**				
Course Title	**Industrial Engineering-I**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 6 (Six)**
	2	**1**	**0**	**3**	
Pre requisites	**-**				

Objectives:

To impart knowledge in the area of method study and time study, principles and techniques to improve productivity in manufacturing and Service sectors. To explain the general principles that governs the interaction of humans and their working environment for improving worker performance and safety.

M. No:	Topic	No. of Hrs
Module 1.	Introduction to industrial engineering and its various techniques, definitions and explanation of productivity with significance in industries, productivity measurements, factors affecting productivity, basic work content and excess work content, industrial applications to calculate total and partial productivities.	08
Module 2.	Introduction to work study and its basic procedures, definitions and concept of work study with examples, human factors in the application of work study, factors for selecting the work study, ergonomics, scope and objectives of ergonomics, application of human factors in engineering workplace design, *etc.*	08
Module 3.	Introduction to method study and the selection of jobs, record, examine and develop, objectives and basic procedure of method study, recording techniques (process charts and diagrams), outline *PC*, flow process charts, two hand process charts, *MAC*, simo chart, flow diagram, string diagram, cycle graph, chronocycle graph, travel chart, principles of motion economy.	12
Module 4.	Work measurement and its applications, time study, work sampling, rating and their methods, breaking the jobs into elements, types of elements, allowances and their calculations, calculation of standard time, examples of time study, pmt systems, synthetic data, various applications and examples.	14
Total number of Hours		**42**

Course Outcomes:

At the end of the course, the student will be able to:

- Understand the concept and applications of industrial engineering with a focus on productivity, work design and work study. **(L1, L2)**
- Analyse & apply the method study techniques in relation to a particular job environment.**(L3)**
- Analyse & evaluate various engineering work measurement techniques designed to establish the time for a qualified worker to carry out a specific job at a defined level of performance. **(L4)**
- Attain a grasp of the fundamental principles of experimental design, collection of data related to work study, their analysis and interpretation. **(L3, L4)**

S.No:	Text Books	Author	Publisher
1.	Motion and Time Study, Design & Measurement of Work	Barnes. R. L.	John Wiley & Sons, 1990
	References		
1.	Introduction to Work Study	International Labor Office, Geneva	Geneva, 1991
2.	Work Study	Currie R.M	ELBS & Pitman, London, *1977.*
3.	Motion and Time Study, 5th Edition	Mundel, M.E.	Prentice Hall, Englewood Cliff, NewYork, *1978.*

Course Code	**HSM_ME601L**				
Category	**Humanities and Social Sciences including Management course**				
Course Title	**Industrial Engineering-I lab**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester - 6 (Six)**
	0	**0**	**2**	**1**	

Objectives:

To demonstrate human factors/ergonomic principles (*HF/E*) that influence the design, performance and safety of work systems. To apply *HF/E* guidelines and use standard HF/E in the design of work systems.
To model work systems using standard techniques, such as flow diagrams, process charts, operation charts, activity charts, block diagrams, and process maps, for purposes of work system documentation, analysis, and design. To determine the time required to do a job using standard data, occurrence sampling time study, and predetermined time systems.

M. No:	**Topic**
Module 1.	Ergonomic design study (present/proposed/new) of a product, equipment or work environment (human-machine interface).
Module 2.	To assemble a product (electrical holder, etc.), record the cycle time and draw the learning curve of the operator performing the assembly.
Module 3.	Draw out line process chart and two hand flow process charts for the assembly performed in experiment no. 2, and analyse the present method and also suggest improved method/s.
Module 4.	Study and draw of flow process charts (some suitable assembly operation)
Module 5.	Study and draw a multi activity chart of a suitable method and propose better method/s (for man and machine).
Module 6.	Study suitable movements/travel of man, material or equipment, and draw string diagrams, travel charts and flow diagrams.
Module 7	To calculate the standard time of a suitable job, using predetermined time standard techniques.
Module 8	Develop a simulation model in *WITNESS* software and get results in chart format.

Course Code	**HSM_ME602**				
Category	**Humanities and Social Sciences including Management courses**				
Course Title	**Operations Research**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 6 (Six)**
	2	**1**	**0**	**3**	
Pre requisites	**None**				

Objectives:

To impart knowledge in concepts and tools of operations research and to understand mathematical models for analyzing different situations in the industrial/ business scenario involving limited resources and finding the optimal solution within constraints.

S.No:	**Topic**	**No. of Hrs**
Module 1.	Operations research- introduction, scope, or methodology and application, linear programming problems, formulation of *LPP*, graphical and simplex solutions (big M method and two phase method), duality.	12

Module 2.	Introduction to transportation and transhipment problems, initial basic feasible solutions and optimality tests, introduction to assignment problems, Hungarian method.	10
Module 3.	Introduction to project management, project life cycle, network diagrams, basic scheduling (deterministic and probabilistic model), time-cost trade-off, resource allocation, project monitoring.	10
Module 4.	Job sequencing, Johnson algorithm, queueing model- Markovian distributions, single server model and applications.	10
Total number of Hours		**42**

Course Outcomes:

At the end of the course, the student will be able to:

- ***Analyze*** a real life system with limited constraints and depict it in the form of a linear programming model **(L4).**
- ***Obtain*** the optimal solution of that model **(L3).**.
- ***Determine*** the optimal solutions of Assignment and Transportation models **(L5).**
- ***Plan***, ***schedule*** and ***control*** the project **(L6).**
- ***Understand*** different queuing situations and find the optimal solutions using models for different situations **(L2).**
- ***Utilize*** the machines in an industry in a way to minimise the idle time **(L2)**.

S.No:	Text Books	Author	Publisher
1.	Operations Research- An Introduction	Hamdy A. Taha	Pearson education
	References		
1.	Operations Research	S.R. Yadav, A.K. Malik	Oxford Higher Education
2.	Introduction to operations Research	Frederick S. Hillier	Tata McGraw Hill
3.	Operations research	P.K. Gupta, D.S. Hira	S. Chand, New Delhi

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Course Code	**PEC1_ME603**					
Category	**Professional Elective Courses**					
Course Title	**Internal Combustion Engines**					
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 6 (Six)**	
	2	**1**	**2**	**3**		
Pre requisites	**Basic Engineering Thermodynamics, Heat Transfer**					

Objectives:

To present a problem oriented in depth knowledge of internal combustion engines and to address the underlying concepts, methods and application of internal combustion engines.

M. No:	Topic	No. of Hrs
Module 1.	Classification of engines according to fuels, cycle of operation and number of strokes, review of air standard cycles, deviation of actual cycles from fuel air cycles, various influencing factors.	06

Module 2.	Review of fuels for *IC* engines with particular reference to velocity, ignition quality and knock rating, variable compression ratio engines.	06
Module 3.	Air-fuel ratios and mixture requirements of *SI* engines, stoichiometric fuel air ratio, carburetor principle, types and venturi, fuel orifice sizes, charge stratification and distribution.	06
Module 4.	Fuel-air requirement in *CI* engines, methods of fuel oil distribution and injection, flame front and normal combustion, detonation in *SI* and knocking *CI* engines, comparative analysis, ignition systems in *SI* and *CI* engines.	06
Module 5.	Engine friction and lubrication, effect of engine variables, total engine friction, requirements of lubricants and lubricating systems.	04
Module 6	Cooling systems, heat transfer rates, heat rejected to coolant, air and water cooling systems and components, two-stroke engines, scavenging systems, supercharging, methods of supercharging with special emphasis on turbochargers, engine testing and performance.	08
Total number of Hours		**42**

Course Outcomes:

At the end of the course, the student will be able to:

- ***Understand*** working and performance of IC Engines through thermodynamic cycles **(L1).**
- ***Identify*** the different kind of fuel metering and fuel supply systems for different types of engines **(L3).**
- ***Understand*** the theories of combustion in *SI* and *CI* engines, methods of reduction of detonation and knock. Combustion chamber types in *SI* and *CI* engines,factors influencing combustion chamber design **(L4).**
- ***Understand*** basic knowledge of supercharging, turbocharging of *IC* engines **(L6)**
- ***Evaluate*** methods for improving the *IC* engine performance **(L1 & L2).**
- ***Understand*** the latest developments in *IC* Engines and alternate fuels **(L2).**
- ***Identify*** the necessity of lubrication & cooling systems of *IC* engines. Properties of lubricating oils, lubricating systems, and the basic knowledge of air- and water-cooling systems of *IC* engines **(L5).**

S.No:	Text Books	Author	Publisher
1.	Internal Combustion Engine Fundamentals	John B. Heywood	McGraw-Hill Book Company
	References		
2.	I.C. Engines	V. Ganeshan	Tata McGraw Hill
3.	Engineering Fundamentals of I.C. Engines	W.W. Pulkrabek	Prentice Hall India
4.	Alternative Transportation Fuels	M K Gajendra Babu and K. A. Subramanian	CRC Press

Course Code	**PEC1_ME603L**				
Category	**Professional Elective Course**				
Course Title	**Internal Combustion Engines Lab**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 6 (Five)**
	0	**0**	**2**	**1**	
Pre requisites	-				

Objectives:

To describe the performance and operating characteristics of internal combustion engines and to explain the parts and type of fuels used in *IC* engines and its performance analysis. To describe combustion process phenomena in IC engines.

M. No:	**Topic**
Module 1.	To determine the full load performance of 4 stroke single cylinder spark ignition engine.
Module 2.	To determine the part load performance of 4 stroke single cylinder spark ignition engine
Module 3.	To determine brake mean effective pressure of 4 stroke single cylinder spark ignition engine at part load.
Module 4.	Experimental Study of spark ignition engine with alternative fuels.

Course Code	**PEC2_ME603**				
Category	**Professional Elective Courses**				
Course Title	**Automobile Engineering**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester - 6 (Six)**
	2	**1**	**0**	**3**	
Pre requisites	**Basic Engineering Thermodynamics, Mechanics, I.C. Engines**				

Objectives:

To study basics of principles, importance and features of actual automobile systems *such as* axle, differential, brakes, Steering, suspension, and balancing *etc.*

M. No:	**Topic**	**No. of Hrs**
Module 1.	Introduction to automobiles- classification and basic structure, chassis construction.	02
Module 2.	Transmission- clutches- requirements of clutches, dry friction clutches and types, clutch operation, clutch components and materials, functions of transmission system, resistance to vehicle motion and tractive effort, manual transmission system, sliding mesh and constant mesh gear box, synchromesh gear box, transfer box, all wheel drive, introduction to automatic transmission, epicyclic gear box, freewheel unit and overdrives.	11
Module 3.	Driveline- propeller shafts, Hooke' joint and analysis, final drive and differential, rear axle drives and rear axle shaft support.	05
Module 4.	Braking system- classification of brakes, principle and construction details of drum brakes and disc brakes, brake actuating system-mechanical, hydraulic and pneumatic, factors affecting brake performance, power brakes, anti-lock braking system.	06
Module 5.	Steering system- front axle and wheel alignment, steering requirements, steering geometry, steering mechanisms, steering linkages and steering gears, power steering.	07

Module 6.	Suspension systems- need of suspension system, types of suspensions, factors influencing ride comfort, suspension spring- construction details and characteristics of leaf springs.	07
Module 7.	Wheels and tyres- types of wheels, types of tyres and their construction details, tyre materials and designation, wheel balancing, tyre rotation, tyre wear, effect of air pressure and temperature on tyre performance.	04
Total number of Hours		**42**

Course Outcomes:

At the end of the course, the student will be able to:

- ***Understand*** the basic fundamentals and anatomy of Automobile Engineering **(L2).**
- ***Understand*** the location and importance of each automobile parts **(L2)**
- ***Apply*** knowledge of automotive engineering & practices to pursue a successful career in the field of automotive technology **(L6).**
- ***Understand*** the functioning of the engine and its accessories, gear box, clutch, brakes, steering, axles and wheels **(L2).**
- ***Understand*** suspension, frame, springs and other connections **(L2).**
- ***Understand*** Emissions, ignition, controls, electrical systems and ventilation **(L2).**

S.No:	**Text Books**	**Author**	**Publisher**
	Automobile Engineering, Vol I and II.	Dr Kripal Singh	Standard publications
	References		
	Automotive Mechanics	Crouse/Anglin	TMH
	Motor Vehicle.	Garrett T. K., Newton, K., & Steeds W	Butterworth-Heinemann
	Automobile Engineering	Anil Chhikara	Satya Prakashan, New Delhi

Course Code	**PEC2_ME603L**				
Category	**Professional Elective Course**				
Course Title	**Automobile Engineering Lab**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 6 (Six)**
	0	**0**	**2**	**1**	
Pre requisites					

M. No:	**Topic**
Module 1.	Study of an automobile chassis.
Module 2.	Study of Differential Mechanism of an Automobile.
Module 3.	Study the clutch of an Automobile.
Module 4.	Study of braking systems (Hydraulic / Air Brake).
Module 4.	Study and demonstration of different circuits of carburetors.
Module 5.	Calibration of Bourdon's tube pressure gauge.
Module 6.	Study the assembly of car engines.
Module 7.	Air Pollution testing of CO_x, *CO*, *HC*, *NO*, NO_x.

Course Code	**PEC3_ME603**				
Category	**Professional Elective Courses**				
Course Title	**Electrical Engineering Technology**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 6 (Six)**
	2	**1**	**0**	**3**	
Pre requisites	**Principles of Electrical Engineering**				

Objectives:

To introduce fundamental concepts and analysis techniques in electrical engineering such as about domestic wiring, various electrical apparatus and their safety measures, basic knowledge of electrical quantities such as current, voltage, power, energy and frequency, knowledge about the basic DC and AC electric circuits and magnetic circuits, concepts of generators, motors, transformers and their applications.

M. No:	**Topic**	**No. of Hrs**
Module 1.	*DC* circuit analysis- loop and nodal methods of circuit analysis, superposition theorem, Thevenin's and Norton's theorems, maximum power theorem, delta - star (y) transformation;	7
Module 2.	*AC* circuit analysis- basic terminology and definitions, phasor and complex number representation, solutions of sinusoidally excited *RLC* circuits, power and energy relations in *AC* circuits, series and parallel *AC* circuits (*RL, RC, RLC*), power factor, concepts of active & reactive powers.	9
Module 3.	Introduction to electrical machines, *AC* circuits & magnetic circuits	4
Module 4.	Transformers- construction, classifications, *emf* equations, equivalent circuit, open and short circuit tests, losses and efficiency.	6
Module 5.	*DC* machines- generators and motors, classification and principle of operation, Emf and torque equation, characteristics, speed control of *DC* motor, applications.	8
Module 6.	*AC* machine- *AC* machinery fundamentals, types, principle of operation, losses and efficiency, speed control of *AC* motor, applications.	8
	Total number of Hours	**42**

Course Outcomes:

At the end of the course, the student will be able to:

- ***Recall*** basic concepts of Electrical Engineering **(L1).**
- ***Illustrate*** basics of AC circuits **(L4).**
- ***Explain*** operative principle of transformer with background of magnetic circuits **(L5).**
- ***Classify*** and compare different types of Electrical machines **(L2).**
- ***Demonstrate*** an understanding of basic concepts of transformers and their application in transmission and distribution of electric power **(L2, L4).**
- ***Apply*** the basic concepts in Electrical engineering for multi-disciplinary tasks **(L4).**

S.No:	**Text Books**	**Author**	**Publisher**
1.	Fundamental of Electric Circuits	Charles K. Alexander, Matthew N.O. Sadiku	McGraw Hill Education
2.	Electrical Machinery Fundamentals	Chapman	McGraw Hill Education
	References		
1.	Electric Machines	Nagrath and Kothari	McGraw Hill Education
2.	Electric Machine and Power Electronics	P C Sen	Wiley

Course Code	**PEC3_ME603L**				
Category	**Engineering Science Course**				
Course Title	**Electrical Engineering Technology Lab**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 6 (Six)**
	0	**0**	**2**	**1**	

M. No:	**Topic**
Module 1.	To verify Superposition principle.
Module 2.	To verify the Thevenin and Norton Theorem.
Module 3.	To verify the maximum power transfer theorem.
Module 4.	To measure power factor and ac power in single phase circuits with different linear loads.
Module 5.	To perform polarity test on single phase transformer.
Module 6.	To perform open and short circuit tests on single phase transformer.
Module 7.	To study the constructional details of the *DC* machines.
Module 8.	To study the constructional details of the Induction machine.
Module 9.	To study the construction details of synchronous machines.
Module 10.	To plot external characteristics of *DC* machines.
Module 11.	To perform no load and block rotor test on an induction machine.
Module 12.	To determine the torque speed characteristics of the induction motor.

Course Code	**PCC_ME604**				
Category	**Professional Core Course**				
Course Title	**Design of Machine Elements-I**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester - 6 (Six)**
	2	**1**	**0**	**3**	
Pre requisites	**Engineering Mechanics, Solid Mechanics**				

Objectives:

This course seeks to provide an introduction to the design of machine elements commonly encountered in mechanical engineering practice through strong background in mechanics of materials based failure criteria underpinning the safety-critical design of machine components.

M. No:	**Topic**	**No. of Hrs**
Module 1.	Introduction to design, need of design, basic procedure of machine design.	02
Module 2.	Review of static theories of failure, introduction to dynamic load, stress concentration, rotating beam test and *S-N* curve, endurance strength and its modifying factors, design for finite and infinite life, failure criteria for fluctuating stresses (Goodman, Soderberg and Gerber).	08
Module 3.	Riveted joints and its types, failure modes of riveted joint and strength equations, welded joints and types, strength equations. eccentric loading in riveted and welded joints.	08
Module 4.	Threaded fasteners- types and design, thread forms, eccentric loading, bolt of uniform strength, bolt tightening and initial tension, design of power screws.	05
Module 5.	Design of shafts- strength and rigidity considerations, keys- types and design.	08
Module 6.	Design of knuckle joint, cotter joint, gib and cotter joint.	04

Module 7	Springs-types and materials, design of helical springs under static and dynamic load, design of leaf springs.	07
Total number of Hours		**42**

Course Outcomes:

At the end of the course, the student will be able to:

- ***Understand*** the origins, nature and applicability of empirical design principles, based on safety considerations **(L1)**
- ***Understand*** component behavior subjected to loads and identify the failure criteria **(L2).**
- ***Analyze*** **t**he stresses and strains induced in a machine element **(L4).**
- ***Overview*** of codes, standards and design guidelines for different elements **(L3).**
- ***Understand*** the concepts of principal stresses, theories of failure, stress concentration and fatigue loading **(L2).**
- ***Appreciation*** of parameter optimization and design iteration (**L5)**
- ***Appreciation*** of the relationships between component level design and overall machine system design and performance (**L5)**
- ***Overview*** of the design methodologies employed for the design of various machine components (**L5)**.

S.No:	**Text Books**	**Author**	**Publisher**
1.	Design of Machine Elements	V.B. Bhandari	Tata McGraw Hill, New Delhi
	References	**Author**	**Publisher**
1.	Machine Elements in Mechanical Design	Robert L. Mott	Pearson Education
2.	Mechanical Engineering Design	Shigley, Budynas, Nisbett	McGraw Hill, New York
3.	Machine design	Robert L. Norton	Pearson Education

Course Code	**PCC_ME605**				
Category	**Professional Core Course**				
Course Title	**Compressible Flow and Machines**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 6 (Six)**
	3	**1**	**0**	**4**	
Pre requisites	**Fluid Mechanics, Basic Engineering Thermodynamics**				

Objectives:

This course seeks to provide an introduction to compressible flows, and understand some important features of different categories of compressible flows of ideal gas, isentropic and non isentropic flows including flows across normal shock waves and its application to gas turbines jet and rocket propulsion, fans and compressors.

M. No:	**Topic**	**No. of Hrs**
Module 1.	Basics of compressible flow, velocity of sound, compressibility effects in fluids and mach number, isentropic flow, stagnation conditions.	07
Module 2.	One dimensional flow for constant area duct, one dimensional flow with heat addition (Rayleigh flow), one dimensional flow with friction (Fanno flows), normal shock relations, oblique shock and expansion waves.	12
Module 3.	Quasi one dimensional flow, isentropic flow through variable area duct (without friction), diffusers.	07

Module 4.	Gas turbine, Brayton cycle and modification, velocity triangles, stage parameters, performance characteristics, jet propulsion, thrust power and propulsive efficiency, ramjet, turbojet, turbofan and turboprop engines, rocket engines.	10
Module 5.	Centrifugal and axial fans, velocity diagrams, specific work, stage parameters, slip factor, performance characteristics.	08
Module 6.	Centrifugal and axial compressors, specific work, stage parameters, performance characteristics, reciprocating compressors.	08
Total number of Hours		**52**

Course Outcomes:

At the end of the course, the student will be able to:

- ***Recognize*** the basic differences between incompressible and compressible flows and be able to ***derive*** the governing equations for compressible flows **(L2)**.
- ***Analyze*** compressible flow having normal shock **(L4)**
- ***Apply*** governing equations to compressible flow through a constant area duct with friction and heat addition **(L3)**.
- ***Analyze*** one-dimensional isentropic flows, flow across a normal shock and flow with friction and heat addition **(L4)**.
- **Apply** gas dynamics principles to jet and space propulsion systems **(L3)**
- ***Describe*** the different thermodynamic cycles of gas turbine **(L1)**
- ***Analyze*** the velocity triangles for a stage for gas turbines **(L4)**
- ***Understand*** the performance characteristics of gas turbines **(L2)**
- ***Explain*** the applications of Euler's equation for centrifugal and axial compressors **(L2)**
- ***Demonstrate*** the specific work on *h-s* diagram for centrifugal/ axial compressors and fans **(L3)**
- ***Analyze*** the velocity triangles for a stage for centrifugal/ axial compressors and fans **(L4)**
- ***Describe*** the performance characteristics of compressors including choking, surging and stalling phenomenon.

S.No:	**Text Books Recommended**	**Author**	**Publisher**
1.	Modern Compressible Flow with Historical perspective	John. D Anderson	McGraw Hill
2.	Turbomachinery	Maneesh Dubey BVSSS Prasad Archana Nema	McGraw Hill Education/ 2019
S.No:	**References**		
1.	The-Dynamics-and Thermodynamics-of Compressible Fluid-Flow	Ascher H Shapiro	Ronald Press Company
2.	*Compressible fluid flow*	Micheal A Saad	Prentice Hall/ 1993
3.	Gas turbine theory	Cohen, Rogers and Saravanamuttoo	PHI
4.	Fundamentals of Gas Turbines	Bathie	

Course Code	**PCC_ME605L**				
Category	**Professional Core Course**				
Course Title	**Compressible Flow and Machines Lab**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 6 (Six)**
	0	**0**	**2**	**1**	

M. No:	**Topic**
Module 1.	To study the velocity of sound in different solids and fluids.
Module 2.	To study the wave propagation at different Mach No.
Module 3.	To study Isentropic flow from variable area ducts.
Module 4.	To study flow through a constant area duct with Friction (Fanno Flow).
Module 5.	To study flow through a constant area duct with heat addition (Rayleigh Flow).
Module 6.	To study Isothermal flow from a constant area duct.
Module 7.	To study Shock waves generated in the flow field.
Module 8.	To study flow through supersonic wind tunnels.
Module 9.	To study thrust generated by jet engines.
Module 10.	To study performance of centrifugal and axial compressors.

Course Code	**PSI_ME606**				
Course Category	**Project work, Seminar and internship**				
Course Title	**Seminar**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 6 (Six)**
	0	**0**	**6**	**3**	
Pre requisites	**NA**				

Course Objectives:

The seminar curriculum pedagogy is designed to understand core concepts, principles, and practices underlying effective professional communication. The course focuses on approaches for planning, creating, and transmitting technical information within a variety of technical situations found in the global employment and professional marketplace and marketspace. The seminar curriculum will adhere to the domains of workplace professional writing, employment communication, successful and effective presentation design (verbal, non-verbal and data visualisation) in the emerging communication scenario.

Course Plan:

Each student shall identify a topic of current relevance mechanical engineering branch, get approval of faculty concerned, collect sufficient literature on the topic, study it thoroughly, prepare a presentation and report and will be later on assessed before an expert committee constituted by the concerned department on the basis of:

- Quality of content presented
- Proper planning for presentation.
- Effectiveness of presentation.
- Report writing based on the Literature, fundamentals of the topic,and state of art application.

Course Outcomes:

The objectives and learning outcomes of the seminar are:

- To ensure that students are made ***aware*** about the basic and core communication frameworks, tools, frameworks and typologies.
- To ensure that students are able to ***enhance*** their personal, professional communication skills through seminar mode teaching-learning pedagogy.
- To ***understand*** the individual and team/group level communication styles through experiential understanding, learning and application of emerging communication techniques.
- To ***develop*** problem solving and analytical skills in global-cross cultural business communication and awareness of challenges required for successful communication within and outside multinational organizations.
- To ***enhance*** the communication skills across variety of formal and informal networks.
- To ***understand*** the ethical approach for roles and responsibilities as business communicators through case discussions of technical/business dilemmas and problems
- To ensure ***application*** of the modern data analysis and visualisation software's for enhanced presentation/communication modules so that to incorporate the professional use of technology in communications.

Course Code	**HSM_ME701**				
Category	**Humanities and Social Sciences including Management course**				
Course Title	**Industrial Engineering-II**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 7 (Seven)**
	2	**1**	**0**	**3**	
Pre requisites	**Industrial Engineering-I**				

Objectives:

This course covers selected topics in the vast field of Industrial Engineering which is primarily concerned to meet with the challenges for contemporary professional practice; be able to adapt and solve the increasingly complex problems faced by industry; embrace innovation through intellectual diversity and creative problem solving; and continue to develop holistically as a learner to become leaders of tomorrow.

M. No:	Topic	No. of Hrs
Module 1.	Introduction to facility location problems, factors affecting the plant location, break even analysis and their application, subjective, qualitative and semi-quantitative techniques of facility location, single facility location problem, minimax location problem, gravity problem and their applications.	08
Module 2.	Line balancing, introduction to facility layout and their objectives, classification of layouts, with advantages and disadvantages of each, layout design procedures (*CRAFT, CORELAP, ALDEP*), material handling systems, make or buy decisions, planning and control of batch production, characteristics of batch production, determination of batch size, minimum cost batch size, maximum profit batch size, sequencing and scheduling for batch production.	10
Module 3.	Inspection and quality control**,** concept and definition of quality, concepts of inspection and quality control, objectives of inspection, function of inspection and their types, concept of statistical quality control (*SQC*), process variation, sampling inspection, concepts and types of control charts, acceptance sampling, application of control charts.	12
Module 4	Materials management and inventory control, integrated materials management and their components, functions and objectives of material management, introduction and concepts of inventory management, purchase model with instantaneous replenishment and without shortage, manufacturing model without shortages, purchase model with shortages, manufacturing model with shortages, probabilistic inventory concepts with lead time, selective inventory management- *ABC , FSN, VED* analysis.	12
Total number of Hours		**42**

Course Outcomes:

At the end of the course, the student will be able to:

- ***Understand*** the concept of organization structure **(L1)**
- ***Analyse*** & ***design*** facility location and layout using various techniques and softwares **(L4, L6)**.
- ***Demonstrate*** the ability to use the methods of statistical quality control and process control for effective designing of Industrial Quality Monitoring Systems **(L3)**.
- ***Demonstrate*** the ability to ***apply*** the techniques of material management and inventory control for effective designing and systematic implementation of various MM methods and inventory systems in manufacturing set-up **(L3)**

S.No:	Text Books	Author	Publisher
1.	Production and Operations Management	Everett, E.A., Ronald J.E	Prentice Hall of India
	References		
1.	Plant Layout & Material Handling.	Apple, J.M,	John Wiley & Sons, New York.
2.	Industrial Engineering Hand Book.	Maynard	McGraw Hill, New York
3.	Statistical Quality Control	Grant, E.L; Leavenworth R.S	Tata Mcgraw Hill

Course Code	**HSM_ME701L**				
Category	**Humanities and Social Sciences including Management course**				
Course Title	**Industrial Engineering-II lab**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 7 (Seven)**
	0	**0**	**2**	**1**	
Pre requisites	-				

M. No:	**Topic**
Module 1.	Study the layout in an organization and draw existing and proposed layouts in WITNESS software.
Module 2.	Develop a simulation model in *WITNESS* software and get results in Gantt chart format.
Module 3.	Study any process sheet with corresponding factory elements and use *WITNESS* simulation software to find out existing operational bottlenecks & carry possible line balancing to achieve proposed outcome.
Module 4.	To measure the variable characteristics (diameter of pins, with micrometer) and prepare a frequency histogram. Calculate values of $\bar{X}$ and sigma.
Module 5.	To conduct Process capability study of a machine tool and to specify the tolerances for a job.
Module 6.	To verify the theorem "the standard deviation of the sum of any number of independent variables is the square root of the sum of the squares of the *S.D*s of the independent variable. Determine statistically, the permissible tolerance of mating components, when the tolerance of the assembly is given (using statistical analysis software).
Module 7	To draw a control chart for percent defectives after inspecting a sample and sorting out the defective units.

Course Code	**PEC1_ME702**				
Category	**Professional Elective Courses**				
Course Title	**Power Plant Engineering**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 7 (Seven)**
	2	**1**	**0**	**3**	
Pre requisites	**Basic Engineering Thermodynamics**				

Objectives:

To provide an overview of power plants and the associated energy conversion issues.

M. No:	**Topic**	**No. of Hrs**
Module 1.	Coal based thermal power plants, layout of modern coal power plants, super critical boilers, *FBC* boilers, turbines, condensers, steam and heating rates, subsystems of thermal power plants, fuel and ash handling, draught system, feed water treatment.	07
Module 2.	Gas turbine and combined cycle power plants, components of gas turbine power plants, combined cycle power plants, integrated gasifier based combined cycle (*IGCC*) systems.	06
Module 3.	Basics of nuclear energy conversion, layout and subsystems of nuclear power plants, boiling water reactor (*BWR*), pressurized water reactor (PWR), *CANDU* reactor, pressurized heavy water reactor (*PHWR*), fast breeder reactors (*FBR*), gas cooled and liquid metal cooled reactors, safety measures for nuclear power plants.	07
Module 4.	Hydroelectric power plants, classification, typical layout and components, principles of wind, tidal, solar *PV* and solar thermal, geothermal, biogas and fuel cell power systems.	05
Module 5.	Energy, economic and environmental issues, power tariffs, load distribution parameters, load curve, capital and operating cost of different power plants, pollution control technologies including waste disposal options for coal and nuclear plants.	05
Total number of Hours		**42**

Course Outcomes:

At the end of the course, the student will be able to:

- ***Understand*** the principles of operation for different power plants and their economics **(L2).**
- ***Analyze*** economics of power plants and list factors affecting the power plants **(L4).**
- ***Determine*** performance of power plants based on load variations **(L5).**

S.No:	**Text Books Recommended**	**Author**	**Publisher**
1.	Power Plant Engineering	Nag P.K	Tata McGraw Hill
	References		
1.	Power Plant Engineering	Elliot T.C., Chen K and Swanekamp R.C	Tata McGraw Hill
2.	Power Plant Engineering	El Wakil M.M	Tata McGraw Hill
3.	Modern Power Plant Engineering	Joel W Roy E	Prentice-Hall Ltd.

Course Code	**PEC2_ME702**				
Category	**Professional Elective Courses**				
Course Title	**Energy Systems and Management**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 7 (Seven)**
	2	**1**	**0**	**3**	
Pre requisites	-				

Objectives:

To study the various energy systems and the status for energy sources and technologies, their environmental interactions and the relevant global energy policies.

M. No:	Topic	No. of Hrs
Module 1.	Introduction to thermodynamics, fluid flow and heat transfer.	05
Module 2.	Heat transfer media- water, steam, thermal fluids, air-water vapour mixtures heat transfer equipment- heat exchangers.	05
Module 3.	Steam plant energy storage systems- thermal energy storage methods, energy saving, thermal energy storage systems.	06
Module 4.	Energy conversion systems- furnaces, turbines.	05
Module 5.	Heat recovery systems- incinerators, regenerators and boilers.	05
Module 6.	Energy management- principles of energy management, energy demand estimation, organising and managing energy management programs.	06
Module 7.	Energy pricing energy audit- purpose, methodology with respect to process industries, characteristic method employed in certain energy intensive industries.	05
Module 8.	Economic analysis: scope, characterization of an investment project.	05
	Total number of Hours	**42**

Course Outcomes:

At the end of the course, the student will be able to:

- ***Understand*** principles of energy management and its influence on the environment **(L2).**.
- ***Comprehend*** methods of energy production for improved utilization **(L2)** .
- ***Improve*** the performance of thermal systems using energy management principles **(L6).**
- ***Analyse*** the methods of energy conservation for air conditioning, heat recovery and thermal energy storage systems **(L4).**
- ***Evaluate*** energy projects on the basis of economic and financial criteria **(L5).**

S. No:	Text Books	Author	Publisher
1.	Energy Management Hand book.	Turner, W. C., Doty, S. and Truner, W. C.,	7th edition, Fairmont Press, 2009
	References		
2.	Energy Management audit & Conservation	De, B. K.,	Vrinda Publication, 2nd Edition, 2010.
3.	Energy Management	Murphy, W. R.,	Elsevier, 2007.
4.	Energy Management Principles,	Smith, C. B.,	Pergamon Press, 2007.

Course Code	**PCC_ME703**				
Category	**Professional Core Courses**				
Course Title	**Heating Ventilation and Air Conditioning**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 7 (Seven)**
	3	**1**	**0**	**4**	
Pre requisites	**Basic Engineering Thermodynamics**				

Objectives:

To apply the principles of Thermodynamics to analyze different types of refrigeration and air conditioning systems and to understand the functionality of the major components

M. No:	Topic	No. of Hrs
Module 1.	Introduction to air conditioning, psychometric properties and their definitions, psychrometric chart, different psychrometric processes, applications of *AC* systems, sensible heat factor (*SHF*), by pass factor, grand sensible heat factor (*GSHF*), apparatus dew point (*ADP*), concept of enthalpy potential, thermal analysis of human body, effective temperature and comfort chart, human comfort.	8
Module 2.	Review of vapour compression cycle, effect of superheating, subcooling, condenser pressure and evaporator pressure on *CoP*, presentation of cycle on *P-h* and *T-s* chart, absorption refrigeration systems and their components.	8
Module 3.	Classification of refrigerants, *CFC, HFC, HCFC,* azeotropic, zeotropic, natural refrigerant, secondary refrigerant, antifreeze solution, desired properties of refrigerants and applications, properties and uses of commonly used refrigerant, greenhouse effect, global warming.	4
Module 4.	Ventilation- introduction, purpose of ventilation, natural ventilation, mechanical ventilation, tunnels ventilation, mine ventilation, natural ventilation, and mechanical ventilation.	4
Module 5.	Air conditioning system- introduction, unitary system, central air conditioning system, direct expansion system, all water system, all air system, air water system.	4
Module 6.	Load calculation- solar radiation, heat gain through glass- calculation of solar heat gain through ordinary glass tables, shading devices, fabric heat gain, overall heat transfer coefficient through walls and roofs, infiltration- stack effect, wind effect, infiltration load, internal heat loads, system heat gains, break-up of ventilation and effective sensible heat factor, cooling and heating load estimation, psychrometric calculation for cooling, evaporative cooling, building requirements and energy conservation in air conditioning buildings.	12
Module 7.	Air distribution- room air distribution- types of supply air outlets, mechanism of flow through outlets, selection and location of outlets, distribution patterns of outlets, materials for ducts and its specification, friction loss in ducts- grills, diffusers, registers, rectangular equivalent of circular duct. air duct designs, duct construction, duct design procedures, equal friction method, static regain method, velocity reduction method.	8
Module 8.	Air conditioning apparatus- fans and blowers, types of fans, fan characteristic, centrifugal fans, axial fans, fan arrangements, suction line, discharge line (hot-gas line), liquid line, location and arrangement of piping, basic elements of the control system	6
Total number of Hours		**52**

Course Outcomes:

At the end of the course, the student will be able to:

- ***Understand*** basic concepts of HVAC and various HVAC systems **(L2).**
- ***Understand*** the basics of psychometry and utilize the principles of psychometric in the design of air conditioning equipment **(L2).**
- ***Apply*** the concepts of psychrometry to design HVAC systems for different applications **(L6).**

- ***Understand*** the ventilation and basics of duct design **(L2)**.
- ***Model, analyse*** and ***design*** different refrigeration as well as air conditioning processes and components **(L4, L6).**
- ***Evaluate*** applications and design calculations of HVAC & R systems **(L5).**
- ***Apply*** the basic laws for thermodynamic analysis of different processes involved in HVAC systems **(L6).**

S.No:	Text Books Recommended	Author	Publisher
1.	Refrigeration and Air Conditioning	Arora.C.P	Tata McGraw Hill
	References		
1.	Refrigeration and Air conditioning	Stockers W.F and Jones J.W.	McGraw Hill international edition
2.	Basics of refrigeration and Air Conditioning	Ananthanarayana	Tata McGraw Hill

Course Code	**PCC_ME703L**				
Category	**Professional Core Courses**				
Course Title	**Heating Ventilation and Air Conditioning Lab**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 7 (Seven)**
	0	**0**	**2**	**1**	
Pre requisites	**Basic Engineering Thermodynamics**				

Objectives:

To have a good understanding of the working principles of refrigeration and air-conditioning systems.

S.No:	Topic
Module 1.	Test on domestic refrigerator for evaluation of energy efficiency ratio (*EER).*
Module 2.	Test on vapour compression test-rig.
Module 3.	Test on air-conditioning test-rig.
Module 4.	Visit to vapour-absorption refrigeration plant.
Module 5.	Estimation of cooling load of simple air-conditioning system (Case Study).
Module 6.	Case study on cold storage.
Module 7.	Visit to any air conditioning plant.
Module 8.	Thermal analysis of refrigeration cycle using suitable software.
Module 9.	Installation and servicing of split air conditioner.

Course Outcomes:

At the end of the course, the student will be able to:

Apply Refrigeration cycles and Conduct test on refrigeration and air conditioning test units to study their performance **(L3).**

Understand and ***Draw*** performance curves of these machines/systems **(L2).**

Analyse and ***calculate*** the results obtained from the tests **(L4)**.

Evaluate conclusions based on the results of the experiments **(L5).**

Course Code	**PCC_ME704**				
Category	**Professional Core Course**				
Course Title	**Design of Machine Elements-II**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 7 (Seven)**
	2	**1**	**0**	**3**	
Pre requisites					

Objectives:

This course seeks to provide an introduction to the design of machine elements commonly encountered in mechanical engineering practice through a strong background in mechanics of materials.

M. No:	**Topic**	**No. of Hrs**
Module 1.	Couplings, rigid couplings, muff couplings, flange couplings and flexible couplings	08
Module 2.	Design of sliding bearings, bearing materials, fluid viscosity, hydrodynamic lubrication, Petroff's equation, Raimondi and Boyd chart, heat dissipation, rolling element bearings- types, catalogue information (Timken and *SKF* bearings), bearing life, radial and thrust load.	09
Module 3.	Rope drive, belt drive and chain drive.	05
Module 4.	Gear design- spur, helical and worm gears, gear tooth profile, gear geometry, module, contact ratio, gear train, gear tooth bending strength, gear tooth surface fatigue analysis, gear material.	13
Module 5.	Clutches and brakes- single and multi-plate clutch, constant wear and constant pressure theories for plate clutches, materials, shoe drum brakes, internal and external shoe brakes	07
Total number of Hours		**42**

Course Outcomes:

At the end of the course, the student will be able to:

- ***Design*** of Sliding contact bearing in industrial applications **(L6).**
- ***Understand*** and ***apply*** principles of gear design to spur gears, Helical and Bevel Gear **(L2).**
- ***Design*** belt drives and selection of belt, rope and chain drives **(L6)**.
- ***Analyze*** the pressure distribution and design journal bearings **(L4).**

S.No:	**Text Books**	**Author**	**Publisher**
	Design of Machine Elements	V.B. Bhandari	Tata McGraw Hill, New Delhi
	References		
	Machine Elements in Mechanical Design	Robert L. Mott	Pearson Education
	Mechanical Engineering Design	Shigley, Budynas, Nisbett	McGraw Hill, New York
	Machine design	Robert L. Norton	Pearson Education

Course Code	**OEC1_ME705**				
Category	**Open Elective Course**				
Course Title	**Automatic Control**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester - 7 (Seven)**
	2	**1**	**0**	**3**	
Pre requisites	**Laplace Transforms**				

Objectives:

To Develop mathematical models of dynamic systems in differential equation form and transfer function form. To use solution methods for dynamic systems and to analyze different systems in time and frequency domains. To study transient response and block diagram models.

M. No:	**Topic**	**No. of Hrs**
Module 1.	Introduction to control systems, examples of control systems, closed-loop control versus open-loop control.	02
Module 2.	Mathematical modelling of control systems, inertial and non-inertial frames of reference, transfer functions, block diagrams, signal flow graphs.	06
Module 3.	Transient and steady-state response analyses first-order systems, second-order systems, higher-order systems, performance characteristics of control systems.	07
Module 4.	Basic control actions, effects of proportional,derivative and integral contour actions on system performance, steady-state errors in unity-feedback control systems.	09
Module 5.	Stability, asymptotic stability, bounded input bounded output (*BIBO*) stability, Routh's stability criterion.	06
Module 6.	Control systems analysis and design by root-locus method.	06
Module 7	Control systems analysis and design by frequency-response method.	08
	Total number of Hours	**42**

Course Outcomes:

At the end of the course, the student will be able to:

- ***Understand*** the principles of machine dynamics **(L2).**
- ***Derive*** mathematical models for mechanical, electrical and thermal systems **(L3)**.
- ***Use*** different solution methods for dynamic models **(L3).**
- ***Understand*** the feedback control theory **(L2)**.
- **Model, analyse, design** and simulate automatic control systems in the time domain and frequency domain **(L4, L6)**.
- ***Apply*** methods of block diagram, root locus, Bode plot and feedback control theory to ***analyse*** and design automatic control systems **(L6, L4).**

S.No:	**Text Books**	**Author**	**Publisher**
1.	Modern control Engineering	Ogata. K	Prentice Hall,2020
	References		
1.	Automatic Control	Raven.H	McGraw Hill, 1998

Course Code	**OEC2-ME705**				
Category	**Open Elective Course**				
Course Title	**Introduction to Project Management**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 7 (Seven)**
	2	**1**	**0**	**3**	
Pre requisites	**Basic Probability & Statistics, Basic Operations Research**				

Objectives:

To understand the general and advanced concepts of Project Management for managing projects under costs and time constraints

S.No:	**Topic**	**No. of Hrs**
Module 1.	Project management- concepts and definitions, project management cycle, stages and methods of project management, project management for a process.	08
Module 2.	Risk management in projects- project risk management,project management and decision analysis, decision tree analysis, application of utility theory in project management, work breakdown structure.	12
Module 3.	Project scheduling and control- concept, aspects and applications of *CPM* and *PERT*, project life cycle, scheduling and crashing of jobs, resource levelling and resource constraint.	10
Module 4.	Introduction to *GERT* and earned value management- earned value management and its key components, graphical evaluation and review technique.	09
	Total number of Hours	**42**

Course Outcomes:

At the end of the course, the student will be able to:

- ***Analyze*** the different stages of the project **(L4).**
- ***Determine*** the different methods of project management **(L5).**
- ***Understand*** the ways to perform network analysis using *PERT* and *CPM* **(L2)**.
- ***Determine*** the ways to minimize the duration of crashing activities **(L5).**

S.No:	**Text Books**	**Author**	**Publisher**
1.	Project Management Core Textbook	S J Mantel, Jr., J R Meredith, S M Shafer	John Wiley
	References		
1.	Project Management: The Managerial Process	C F Gray, E W Larson	Tata McGraw Hill

Course Code	**PSI_ME706**				
Category	**Project work, Seminar and Internship**				
Course Title	**Final Year Project (Stage-I)**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 7 (Seven)**
	0	**0**	**10**	**5**	
Pre requisites	-				

Objectives:

Final Year Project represents the culmination of study at the end of the B.Tech degree. It helps the students to explore and strengthen the practical knowledge by performing hands-on real-time projects. In this part of the curriculum, students can use the best facilities and platforms like hardware & software, where engineers can showcase their talent while performing innovative projects that strengthen their profile and increase the chance of employability at large.

Course Plan:

Projects will be undertaken individually or in small groups (Max of 5). Assessment will be by means of a presentation, submission of a report, and a demonstration of work undertaken. The emphasis is necessarily on facilitating student learning in technical, project management and presentation spheres.

Each student/ group of students shall identify a topic(s) from mechanical engineering discipline or interdisciplinary type, approved from **Project and Training Incharge (PTI)** and eventually, it will be later on assessed before an expert committee constituted by the concerned department on the basis of:

- Quality of content presented.
- Proper planning for presentation.
- Effectiveness of presentation.
- Report writing based on the start of art, fundamentals of the topic and its viability.

Course Code	**PEC1_ME801**				
Category	**Professional Elective Course**				
Course Title	**Fundamentals of Tribology**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 8 (Eight)**
	2	**1**	**0**	**3**	
Pre requisites	**Material science, Machine Design, Fluid Mechanics and Heat Transfer**				

Objectives:

To provide the knowledge and importance of Tribology in Design, friction, wear and lubrication aspects of machine components. To understand the field of tribology and its historical development and also learn the surface phenomena related to relative motion and the nature of friction. To understand the role of tribology in industry and also reveal the basic understanding of friction. To Introduce the concept of lubricants, compare boundary lubrication, mixed lubrication hydrodynamic lubrication, hydrostatic lubrication.

M. No:	Topic	No. of Hrs
Module 1.	Introduction to tribology and its historical background, factors influencing tribological phenomena engineering surfaces - surface characterization, computation of surface parameters, surface measurement techniques, apparent and real area of contact, contact of engineering surfaces- Hertzian and non-Hertzian contact, contact pressure and deformation in non-conformal contacts.	12
Module 2.	Genesis of friction, friction in contacting rough surfaces, sliding and rolling friction, various laws and theory of friction, stick slip friction behavior, frictional heating and temperature rise, friction measurement techniques, friction in tribo-systems, frictional devices in mechanical systems.	14
Module 3.	Wear and wear types, mechanism of wear-adhesive, abrasive, corrosive, erosion, fatigue, fretting, etc., wear of metals and non-metals, Wear models- asperity contact, constant and variable wear rate, geometrical influence in wear models, wear damage, Wear in various mechanical components, wear controlling techniques.	09
Module 4.	Introduction to lubrication regimes- boundary lubrication, hydrodynamic, hydrostatic, elastohydrodynamic lubrication and their applications.	07
	Total number of Hours	**42**

Course Outcomes:

At the end of the course, the student will be able to:

- ***Understand*** principles of Friction **(L2).**
- ***Understand*** the wear rate, its causes and prevention means **(L2)**.
- ***Understand*** the lubrication studies such as hydrodynamics and hydrostatics **(L2).**
- ***Apply*** the basic theories of friction, wear and lubrication to predictions about the frictional behavior of basic tribology related problems **(L6)**.

S.No:	Text Books	Author	Publisher
1.	A system approach to science and Technology of Friction, Lubrication and Wear	Czichos, H.	Volume I, Tribology series, Elsevier Publications, 1978.
2.	Friction, wear, Lubrication	Ludema, K.C.	CRC Press, NY., 1996
	References		
1.	Wear control Handbook	Peterson M.B.,Winner W.O	Sponsored by The Research Committee on Lubrication, 1980.
2.	The principles of Lubrication	Cameron A.	Longman, London, 2000

Course Code	**PEC1_ME801L**				
Category	**Professional Elective Course**				
Course Title	**Tribology Lab**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 8 (Eight)**
	0	**0**	**2**	**1**	
Pre requisites	**Material science, Machine design, Heat transfer and Fluid Mechanics**				

Objectives:

To impart hands-on practical exposure on tribological tests and equipment. To study and practice the various tribological tests that can be performed on pin-on-disk tribometer and equip students with the practical knowledge required in the tribological field.

S.No:	**Topic**
Module 1.	Preparation of samples for tribological tests.
Module 2.	Tribological study of different tribopairs in dry conditions at room temperature.
Module 3.	Tribological study of different tribopairs in dry conditions at high temperature.
Module 4.	Tribological study of different tribopairs in lubricating conditions at room temperature.
Module 5.	Tribological study of different tribopairs in lubricating conditions at high temperature.

Course Code	**PEC2_ME801**				
Category	**Professional Elective Courses**				
Course Title	**Composite Material**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 8 (Eight)**
	2	**1**	**0**	**3**	
Pre requisites	**Materials Engineering**				

Objectives:

To train students to be able to design composite structures, select composite materials, conduct stress analyses of selected practical applications using laminated plate theories and appropriate strength criteria, and be familiar with the properties and response of composite structures subjected to static and cyclic loading.

M. No:	**Topic**	**No. of Hrs**
Module 1.	Introduction, classifications of engineering materials, concept of composite materials; matrix and reinforcement, characteristics of fibers and matrices, types of reinforcements, types of matrices, types of composites, properties of composites in comparison with standard materials, applications of metal, ceramic and polymer matrix composites, mechanical properties of fibres, engineering potential of composites	9
Module 2.	Manufacturing methods, hand and spray lay-up, injection molding, resin injection. filament winding, pultrusion, centrifugal casting and prepregs, fibre/ matrix interface, measurement of interface strength, characterization of systems- carbon fibre/epoxy, glass fibre/ polyester, *etc. manufacturing defects in composites.*	11
Module 3.	Mechanical properties- stiffness and strength, geometrical aspects, volume and weight fraction, unidirectional continuous fibres, discontinuous fibers, short fiber	10

	systems, woven reinforcements, mechanical testing- determination of stiffness and strengths of unidirectional composites- tension, compression, flexure and shear.	
Module 4.	Laminates, plate stiffness and compliance, assumptions, strains, stress resultants, plate stiffness and compliance, computation of stresses, types of laminates- symmetric laminates, antisymmetric laminates, balanced laminates, quasi-isotropic laminates, cross-ply laminates, angle ply laminates, orthotropic Laminates. Laminate Moduli. hygrothermal stresses, joining methods and failure theories, advantages and disadvantages of adhesive and mechanically fastened joints, typical bond strengths and test procedures.	12
Total number of Hours		**42**

Course Outcomes:

At the end of the course, the student will be able to:

- ***Explain*** the mechanical behavior of layered composites compared to isotropic materials **(L5).**
- ***Apply*** constitutive equations of composite materials and understand mechanical behavior at micro and macro levels **(L3).**
- ***Determine*** stresses and strains relation in composites materials **(L3).**

S.No:	**Text Books**	**Author**	**Publisher**
1.	Mechanics of Composite Materials,	M. Mukhopadhyay	University Press
2.	Mechanics of Composite Materials	R. M. Jones	CRC Press
	References		
1.	Structural Composite Materials	F.C. Campbell	ASM International
2.	Principles of Composite Material Mechanics	Gibson R.F	second edition, McGraw Hill

Course Code	**PEC2_ME801L**				
Category	**Professional Elective Course**				
Course Title	**Composite Material Lab**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 8 (Eight)**
	0	**0**	**2**	**1**	
Pre requisites					

M. No:	**Topic**
Module 1.	Manufacturing of fibre reinforced composites with different types of orientation of fibers (0^0,90^0, 45^0 & combination of them) by hand and spray lay-up method.
Module 2.	Manufacturing of fibre reinforced composites with different types of orientation of fibers (0^0,90^0, 45^0 & combination of them) by resin transfer moulding method.
Module 3.	Compare tensile & compressive strength of identical fibre reinforced composites, manufactured by hand and spray lay-up method and resin transfer moulding method.
Module 4.	Compare shear strength of identical fibre reinforced composites, manufactured by hand and spray lay-up method and resin transfer moulding.
Module 5.	Methods of identifying *manufacturing defects in composites.*
Module 6.	Study of failure modes viz. Delamination, fibre pull out, matrix cracking etc. in fibre reinforced composites

Course Code	**OEC1_ME802**				
Category	**Open Elective Course**				
Course Title	**Value Engineering**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 8 (Eight)**
	2	**1**	**0**	**3**	
Pre requisites	**None**				

Objectives:

To understand various phases of value engineering.

M. No:	**Topic**	**No. of Hrs**
Module 1.	Introduction to value engineering & value analysis, value management, value analysis versus traditional cost reduction techniques, applications, advantages and limitations of value analysis.	12
Module 2.	Value engineering job plan- introduction, orientation, information phase, speculation phase, analysis phase, selection and evaluation of value engineering projects, project selection, methods selection, value standards, application of value engineering methodology.	15
Module 3.	Value engineering technique- advanced value engineering techniques- function, cost-worth analysis (*FCWA*) technique, function analysis system (*FAST*) technique, weighted evaluation method, evaluation matrix, break even analysis, life cycle cost (*LCC*), applications of value analysis/ value Engineering.	15
Total number of Hours		**42**

Course Outcomes:

At the end of the course, the student will be able to:

- ***Analyze*** the function, approach of function and evaluation of function **(L4).**
- ***Determine*** the worth and value **(L3).**
- ***Understand*** the different value engineering techniques **(L2).**
- **Emphasize** the use of FAST,FCWA,WEM **(L4).**
- ***Determine*** the sales volume, also known as the break-even point **(L3).**

S.No:	**Text Books**	**Author**	**Publisher**
1.	Value Engineering- A Systematic Approach	Arthur E. Mudge	McGraw Hill
	References		
1.	Techniques of value Analysis and Engineering	Miles L.D	McGraw Hill Book
2.	Value Engineering: Concepts Techniques and applications	Anil Kumar	SAGE Publications

Course Code	**OEC3_ME802**				
Category	**Open Elective Course**				
Course Title	**Total Quality Management**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester - 8 (Eight)**
	2	**1**	**0**	**3**	
Pre requisites	**Industrial Engineering, Statistical Quality Control**				

Objectives:

Provides the knowledge required to assess and improve product quality through process control procedures and quality improvement techniques.

M. No:	**Topic**	**No. of Hrs**
Module 1.	Quality management- meaning and significance of 'quality', fitness levels of quality- characteristic features and limitations of each type, essential components of quality, product features, freedom from deficiencies, characteristics and attributes under each for products and services, phases or elements of building quality in a product: quality of design, quality of conformance, quality of performance, history of quality, evolution of the concepts of quality, big q vs small q: changing scope of quality activities, Ishikawa's seven quality tools, quality circles, *TQM* meaning and tqm culture.	10
Module 2.	Quality system economics- different obvious quality costs, hidden quality costs, economic models of quality costs: conventional and modern models, cost curves: different zones and actions to be taken for each zone.	08
Module 3.	Quality control:control charts for variables,underlying principle, advantages, limitations and applications of- $\overline{X}$ & R charts, $\overline{X}$ & S charts, *X* & *MR* charts, control charts for attributes, underlying principle, advantages,limitations and applications of- *P*, *NP, C* and *U* charts.	10
Module 4.	Tools and techniques for quality management- quality functions development (*QFD*), failure mode and effect analysis (*FMEA*), seven new management tools, poka yoke, total preventive maintenance (*TPM*), implementing *TQM*, an integrated system's approach.	10
	Total number of Hours	**42**

Course Outcomes:

At the end of the course, the student will be able to:

- ***Analyze*** various obvious and hidden quality costs of a firm for quality system economics **(L4)**.
- ***Apply*** various quality control tools for troubleshooting to reduce sporadic quality problems **(L6).**
- ***U*nderstand** the different definitions of quality **(L2).**
- ***Und*erstand** the various techniques for quality management **(L2).**

S.No:	**Text Books**	**Author**	**Publisher**
1	Quality Planning & Analysis ,.	Juran and Gryna,	McGraw Hill
2	Statistical Quality Control	Grant, E. L.	McGraw Hill
	References		
1.	Total Quality Control	Armand V.Feignbaum	McGraw Hill

Course Code	**OEC1_ME804**				
Category	**Open Elective Course**				
Course Title	**Numerical Methods for Engineers**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 8 (Eight)**
	2	**1**	**0**	**3**	
Pre requisites	**Engineering Mathematics, Programming language.**				

Objectives:

To provide the student with different numerical techniques in order to find approximate numerical solutions to the numerical problems where exact solutions are not available. To develop the concepts of making and solving mathematical models of different engineering problems. To develop the concepts of writing computer programs for solving engineering problems.

M. No:	**Topic**	**No. of Hrs**
Module 1.	Numerical solution of nonlinear equations, Regula-Falsi method, Bolzano's process or bisection of intervals, Newton-Raphson method and its geometrical significance, convergence of iterative methods, solutions of systems of nonlinear equations by Newton Raphson method and method of successive approximations.	10
Module 2.	Solution of system of linear equations, Jacobi and Gauss Siedel Method, Eigen value problem and power method.	06
Module 3.	Interpolation and approximation, finite differences and difference tables, Newton's methods of Interpolation, Lagrange's Interpolation formula, error propagation in difference and error estimation in interpolation, Gauss interpolation formula.	08
Module 4.	Curve fitting, method of least squares, fitting a straight line, polynomial, geometric curve, hyperbola, exponential curve and trigonometric functions, multiple regression.	06
Module 5.	Numerical differentiation and integration, differentiation of tabulated functions with equal and unequal intervals, Simpson's one-third and three-eight rules, trapezoidal Rule, double integrals and Improper integrals.	06
Module 6.	Numerical solution of ordinary and partial differential equations, numerical solution of ordinary differential equations, Taylor's series method, Runge-Kutta methods, system of differential equations, classification of partial differentiation equations, finite difference method for solving partial differential equations.	06
	Total number of Hours	**42**

Note: ***In each module and for each numerical technique the algorithms and MATLAB programs must be used to solve the problems.***

Course Outcomes:

At the end of the course, the student will be able to:

- ***Write*** algorithms for solving mathematical problems using numerical techniques **(L1).**
- ***Write*** programs in the programming language *(MATLAB)* to solve mathematical problems **(L1).**
- ***Solve*** the mathematical problems using numerical techniques **(L3).**

S.No:	**Text Books**	**Author**	**Publisher**
1.	Introductory Methods of Numerical analysis	S.S.Sastry	Prentice -Hall of India
	References		
1.	Numerical Methods using MATLAB	George Lindfield and John Penny	Academic Press
2.	An introduction to MATLAB programming and Numerical Methods for Engineers	Timmy Siauw and Alexandre .M Bayen	Academic Press
3.	Numerical Methods for Engineering & Scientists	Joe. D Hofmann	CRC Press

Course Code	**OEC2_ME804**				
Category	**Open Elective Course**				
Course Title	**Mechatronic Systems**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 8 (Eight)**
	2	**1**	**0**	**3**	
Pre requisites	**Automatic Control**				

Objectives:

To impart knowledge about the elements and techniques involved in Mechatronics systems which are very much essential to understand the emerging field of automation.

M. No:	**Topic**	**No. of Hrs**
Module 1.	Introduction to mechatronics, mechatronic design approach, system interfacing, instrumentation and control systems, microprocessor based controllers and microelectronics, mechatronics a new direction in nano-, micro- and mini- scale, electromechanical system design, physical system modelling, electromechanical system structures and materials, modelling of mechanical systems for mechatronic applications.	10
Module 2.	Sensors and actuators, fundamentals of time and frequency, sensor and actuator characteristics, linear and rotational sensors, acceleration sensors, force measurement, torque and power measurement, flow measurement, temperature measurement, distance measuring and proximity sensors, light detection- image, and vision systems, integrated micro sensors, actuators- electromechanical actuator, electrical machines, piezoelectric actuators, hydraulic and pneumatic actuation systems.	14
Module 3.	Micro transducer analysis, design and fabrication, role of controls in mechatronics, role of modelling in mechatronics design, response of dynamics systems, introduction to computer and logic systems.	10
Module 4.	Logic concepts and design system interfaces, communication and computer networks, fault analysis in mechatronic systems, logic system design, programmable logic controllers, software and data acquisition.	08
	Total number of Hours	**42**

Course Outcomes:

At the end of the course, the student will be able to:

- ***Define*** the interdisciplinary applications of Electronics, Electrical, Mechanical and Computer Systems for the Control of Mechanical, Electronic Systems and sensor technology **(L1).**
- ***Define*** Define sensor, transducer and understand the applications of different sensors and transducers **(L1).**
- ***Explain*** the signal conditioning and data representation techniques **(L2).**
- ***Design*** pneumatic and hydraulic circuits for a given application **(L3).**
- ***Apply*** a PLC program using Ladder logic for a given application **(L3 L4).**
- ***Understand*** applications of microprocessor and micro -controller ***(L2).***
- ***Analyse*** *PI*, *PD* and *PID* controllers for a given application **(L4).**

S.No:	**Text Books**	**Author**	**Publisher**
	Mechatronic system design	Shetty. D and Richard A. K	Cengage learning, 2011
	References		
	Mechatronics	Dan. S. N	Prentice Hall, 2002

Course Code	**PSI_ME806**				
Category	**Project work, Seminar and Internship**				
Course Title	**Final Year Project (Stage-II)**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 8 (Eight)**
	0	**0**	**16**	**8**	
Pre requisites	-				

Course Plan:

- It is a continuation of **Final Year Project (Stage-I)** started in semester - **7 (Seven)**
- The student has to submit the report in departmental prescribed format/ template
- The candidate has to prepare a detailed project report consisting of introduction of the problem, problem statement, literature review, objectives of the work, methodology (experimental set up or numerical details as the case may be) of solution and results and discussion.
- The report must bring out the conclusions of the work and future scope for the study. The work has to be presented in front of the examiners panel consisting of an approved external examiner and Head/coordinator and corresponding Supervisor from the Institute.
- The candidate has to be in regular contact with his/ her Supervisor / co- Supervisor

Guidelines for awarding Marks in End of the Semester		
Evaluated by	**Evaluation percentage**	**Max. Marks Evaluation Criteria / Parameter**
Supervisor(s)	10.0	Punctuality during project work
	10.0	Work Progress over all
	30.0	Quality of the work throughout
	10.0	Analytical / programming / experimental Skills
	10.0	Report preparation in a standard format/ template
External Examiner	20.0	Presentation
	50.0	Quality of work
	30.0	Innovations, society applicable and future scope.
	20.0	Viva-voce

Course Outcomes:

At the end of this course, students will be able to:

- ***Use*** different experimental techniques and will be able to use different software/ computational /analytical tools **(L3).**
- ***Design*** and develop an experimental set up/ equipment/ test rig **(L6)**.
- ***Explore*** results***/ demonstrate*** on existing set ups/ equipment and draw logical conclusions from the results after analysing them, either work in a research environment or in an industrial environment **(L3)**.
- ***Present*** and convince their topic of study to the engineering community supported with technical report writing.

Course Code	**PSI_ME806**				
Category	**Project work, Seminar and Internship**				
Course Title	**Internship**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 8 (Eight)**
	0	**0**	**0**	**4**	

Objectives:

Internships are educational and career development opportunities, providing practical experience in a field or discipline. They are structured, short-term, supervised placements often focused around particular tasks or projects with defined timescales. An internship may be compensated, non-compensated or some time may be paid. The internship

- Will ***expose*** Technical students to the industrial environment, which cannot be simulated in the classroom and hence creating competent professionals for the industry **(L3).**
- ***Provide*** possible opportunities to learn, ***understand*** and sharpen the real time technical / managerial skills required at the job **(L2, L3).**
- will ***Expose*** to the current technological developments relevant to the subject area of training **(L3).**
- will ***Create*** conditions conducive to quest for knowledge and its applicability on the job **(L6).**
- will ***Learn*** to apply the technical knowledge in real industrial situations **(L1).**
- To ***Write*** Technical reports/ projects by gaining experience.
- To ***Expose*** students to the engineer's responsibilities and ethics **(L3).**
- Familiarize yourself with various materials, processes, products and their ***application*** along with relevant aspects of quality control **(L3).**.
- Expose the students to future employers **(L3).**.
- ***Understand*** the social, economic and administrative considerations that influence the working environment of industrial organizations **(L2).**
- ***Understand*** the psychology of the workers and their habits, attitudes and approach to problem solving **(L3).**

Internships may be full-time or part-time; they are full-time in the vacation and part-time during the academic session. The Framework for Internship as per AICTE Guidelines.

Schedule	**Duration**	**Activities**
During Vacation after 5th Semester	4-6 weeks	Industrial/Govt./ NGO/MSME/ Rural Internship/ Innovation / Entrepreneurship
During Vacation after 7th Semester	4-6 weeks	Industrial/Govt./ NGO/ MSME/ Rural Internship/ Innovation / Entrepreneurship

Monitoring/ surprise visit by Project and Training Incharge (PTI)/ staff

PTI/ Staff of the institutes will make a surprise visit to the internship site, to check the student's presence physically, if the student is found absent without prior intimation to the PTI, entire training will be cancelled. Students should inform the PTI, as well as the industry supervisor at least one day prior to availing leave by email. Students are eligible to avail 1-day leave in 4 weeks and 2 days leave in 6 weeks of the internship period apart from holidays and weekly offs.

Evaluation through Seminar Presentation/ Viva-Voce

The student will give a seminar based on his training report, before an expert committee constituted by the concerned department on the basis of:

- Quality of content presented
- Proper planning for presentation.
- Effectiveness of presentation.
- Depth of knowledge and skills.
- Attendance record, daily diary