ANNA UNIVERSITY, CHENNAI – 600 025

UNIVERSITY DEPARTMENTS

R - 2023

B.E. MECHANICAL ENGINEERING (PART-TIME)

I - VIII SEMESTER CURRICULA AND SYLLABI

SEMESTER I

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	PTMA3151	Matrices and Calculus	BSC	3	1	0	4	4
2.	PTPH3151	Engineering Physics	BSC	3	0	0	3	3
3.	PTCY3151	Engineering Chemistry	BSC	3	0	0	3	3
4.	PTGE3151	Engineering Mechanics	ESC	3	1	0	4	4
			TOTAL	**12**	**2**	**0**	**14**	**14**

SEMESTER II

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	PTMA3251	Ordinary Differential Equations and Transform Techniques	BSC	3	1	0	4	4
2.	PTEE3202	Basics of Electrical and Electronics Engineering	BSC	3	0	0	3	3
3.	PTME3251	Design Thinking	BSC	3	0	0	3	3
4.	PTCE3201	Fluid Mechanics and Machinery	PCC	3	0	0	3	3
5.	PTCY3251	Environmental Science and Sustainability	BSC	2	0	0	2	2
			TOTAL	**14**	**1**	**0**	**15**	**15**

SEMESTER III

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	PTME3301	Mechanics of Materials	PCC	3	0	0	3	3
2.	PTME3302	Kinematics of Machinery	PCC	3	0	0	3	3
3.	PTME3303	Manufacturing Technology	PCC	3	0	0	3	3
4.	PTME3304	Engineering Materials and Metallurgy	PCC	3	0	0	3	3
5.	PTME3305	Thermodynamics	PCC	3	0	0	3	3
			TOTAL	**15**	**0**	**0**	**15**	**15**

SEMESTER IV

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	PTME3401	Dynamics of Machines	PCC	3	0	0	3	3
2.	PTME3402	Applied Thermodynamics	PCC	3	0	0	3	3
3.	PTME3403	Metal Cutting and Machine Tools	PCC	3	0	0	3	3
4.	PTME3404	Power Generation Technologies	PCC	3	0	0	3	3
PRACTICAL								
5.	PTME3411	Thermal Engineering Laboratory	PCC	0	0	3	3	1.5
			TOTAL	**12**	**0**	**3**	**15**	**13.5**

SEMESTER V

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	PTME3501	Operations Research	PCC	3	0	0	3	3
2.	PTME3502	Computer Aided Design and Manufacture	PCC	3	0	0	3	3
3.	PTME3503	Design of Machine Elements	PCC	3	0	0	3	3
4.	PTME3504	Finite Element Analysis	PCC	3	0	0	3	3
5.	PTME3505	Hydraulics and Pneumatics	PCC	3	0	0	3	3
			TOTAL	**15**	**0**	**0**	**15**	**15**

SEMESTER VI

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	PTME3601	Design of Transmission Systems	PCC	3	0	0	3	3
2.	PTME3602	Metrology and Measurements	PCC	3	0	0	3	3
3.	PTGE3851	Human Values and Ethics	PCC	2	0	0	2	2
4.		Professional Elective – I	PEC	3	0	0	3	3
PRACTICAL								
5.	PTME3611	Simulation and Analysis Laboratory	PCC	0	0	3	3	1.5
			TOTAL	**11**	**0**	**3**	**14**	**12.5**

SEMESTER VII

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	PTME3701	Mechatronics and IOT	PCC	3	0	0	3	3
2.	PTME3702	Computer Integrated Manufacturing	PCC	3	0	0	3	3
3.	PTME3703	Refrigeration and Air Conditioning	PCC	3	0	0	3	3
4.	PTME3704	Advanced Vehicle Engineering	PCC	3	0	0	3	3
5.		Professional Elective – II	PEC	3	0	0	3	3
			TOTAL	**15**	**0**	**0**	**15**	**15**

SEMESTER VIII

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	PTME3801	Heat and Mass Transfer	PCC	4	0	0	4	4
2.		Professional Elective – III	PEC	3	0	0	3	3
3.		Professional Elective – IV	PEC	3	0	0	3	3
PRACTICAL								
4.	PTME3811	Project Work	EEC	0	0	6	6	3
			TOTAL	**10**	**0**	**6**	**16**	**13**

TOTAL NO. OF CREDITS = 113

PROFESSIONAL ELECTIVES COURSES

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	PTME3001	Additive Manufacturing	PEC	2	0	2	4	3
2.	PTME3002	Conventional and Futuristic Vehicle Technology	PEC	3	0	0	3	3
3.	PTME3003	Digital Manufacturing	PEC	2	0	2	4	3
4.	PTME3004	Lean Manufacturing	PEC	3	0	0	3	3
5.	PTME3005	Modern Robotics	PEC	2	0	2	4	3
6.	PTME3006	Green Manufacturing Design and Practices	PEC	3	0	0	3	3
7.	PTME3007	Environment Sustainability and Impact Assessment	PEC	3	0	0	3	3
8.	PTME3008	Green Supply Chain Management	PEC	3	0	0	3	3
9.	PTME3009	Casting and Welding Processes	PEC	3	0	0	3	3
10.	PTME3010	Composite Materials and Mechanics	PEC	3	0	0	3	3
11.	PTME3011	Computational Fluid Dynamics and Heat Transfer	PEC	3	0	0	3	3
12.	PTME3012	Failure Analysis and NDT	PEC	3	0	0	3	3
13.	PTME3013	Design Codes and Standards	PEC	3	0	0	3	3
14.	PTME3014	Design for X	PEC	3	0	0	3	3
15.	PTME3015	Design of Pressure Vessels	PEC	3	0	0	3	3
16.	PTME3016	Bioenergy Conversion Techniques	PEC	3	0	0	3	3
17.	PTME3017	Energy Conservation in Industries	PEC	3	0	0	3	3
18.	PTME3018	Ergonomics in Design	PEC	3	0	0	3	3
19.	PTME3019	New Product Development	PEC	3	0	0	3	3
20.	PTME3020	Product Life Cycle Management	PEC	3	0	0	3	3
21.	PTME3021	Energy Efficient Buildings	PEC	3	0	0	3	3
22.	PTME3022	Renewable Energy Technologies	PEC	3	0	0	3	3
23.	PTME3023	Energy Storage Devices	PEC	3	0	0	3	3
24.	PTME3024	Surface Engineering	PEC	3	0	0	3	3
25.	PTME3025	Hybrid and Electric Vehicle Technology	PEC	3	0	0	3	3
26.	PTME3026	Thermal Management of Batteries and Fuel Cells	PEC	3	0	0	3	3
27.	PTME3027	Drone Technologies	PEC	3	0	0	3	3
28.	PTME3028	Integrated Product Design and Manufacturing Using GD&T	PEC	3	0	0	3	3

29.	PTME3029	Non-traditional Machining Processes	PEC	3	0	0	3	3
30.	PTME3030	Sensors and Instrumentation	PEC	3	0	0	3	3
31.	PTME3031	Process Planning and Cost Estimation	PEC	3	0	0	3	3
32.	PTME3032	Electrical Drives and Control	PEC	3	0	0	3	3
33.	PTME3033	Design Concepts in Engineering	PEC	3	0	0	3	3
34.	PTME3034	Turbo Machines	PEC	3	0	0	3	3

PTMA3151 **MATRICES AND CALCULUS** **L T P C**
3 1 0 4

UNIT I MATRICES (9+3)

Eigen values and Eigen vectors of a real matrix – Properties of Eigen values - Cayley-Hamilton theorem (excluding proof) – Diagonalization of matrices - Reduction of Quadratic form to canonical form by using orthogonal transformation - Nature of a Quadratic form.

UNIT II FUNCTIONS OF SEVERAL VARIABLES (9+3)

Limit, continuity, partial derivatives – Homogeneous functions and Euler's theorem - Total derivative – Differentiation of implicit functions - Taylor's formula for two variables - Errors and approximations – Maxima and Minima of functions of two variables – Lagrange's method of undermined multipliers.

UNIT III INTEGRAL CALCULUS (9+3)

Improper integrals of the first and second kind and their convergence – Differentiation under integrals - Evaluation of integrals involving a parameter by Leibnitz rule – Beta and Gamma functions- Properties – Evaluation of integrals by using Beta and Gamma functions – Error functions.

UNIT IV MULTIPLE INTEGRALS (9+3)

Double integrals – Change of order of integration – Double integrals in polar coordinates – Area enclosed by plane curves – Triple integrals – Volume of Solids – Change of variables in double and triple integrals.

UNIT V VECTOR CALCULUS (9+3)

Gradient of a scalar field, directional derivative – Divergence and Curl – Solenoidal and Irrotational vector fields - Line integrals over a plane curve - Surface integrals – Area of a curved surface – Volume Integral - Green's theorem, Stoke's and Gauss divergence theorems – Verification and applications in evaluating line, surface and volume integrals.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

CO1: Use the matrix algebra methods for solving practical problems.
CO2: Use differential calculus ideas on several variable functions.
CO3: Apply different methods of integration in solving practical problems by using Beta and Gamma functions.
CO4: Apply multiple integral ideas in solving areas and volumes problems.
CO5: Apply the concept of vectors in solving practical problems.

TEXT BOOKS:

1. Joel Hass, Christopher Heil, Maurice D.Weir "'Thomas' Calculus", Pearson Education., New Delhi, 2018.
2. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, 44th Edition, New Delhi, 2017.
3. James Stewart, "Calculus with Early Transcendental Functions", Cengage Learning, 6th Edition, New Delhi, 2013.

REFERENCES:

1. Erwin Kreyszig "Advanced Engineering Mathematics", Wiley India Pvt Ltd., New Delhi, 2015.
2. Greenberg M.D., "Advanced Engineering Mathematics", Pearson Education2nd Edition, 5th Reprint, Delhi, 2009.
3. Jain R.K. and Iyengar S.R.K., "Advanced Engineering Mathematics",Narosa Publications, 5 th Edition, New Delhi, 2017.
4. Narayanan S. and Manicavachagom Pillai T. K., "Calculus" Volume I and II, S. Viswanathan Publishers Pvt. Ltd., Chennai, 2009.

5. Peter V.O'Neil, "Advanced Engineering Mathematics", Cengage Learning India Pvt., Ltd, 7 th Edition, New Delhi , 2012.
6. Ramana B.V., "Higher Engineering Mathematics", Tata McGraw Hill Co. Ltd., 11th Reprint, New Delhi, 2010.

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	1	1	2	-	-	-	-	-	3
CO2	3	2	-	1	1	2	-	-	-	-	-	3
CO3	3	2	-	1	1	2	-	-	-	-	-	3
CO4	3	2	-	1	1	2	-	-	-	-	-	3
CO5	3	2	-	1	1	2	-	-	-	-	-	3
AVg.	3	2		1	1	2						3

1' = Low; '2' = Medium; '3' = High

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PTPH3151	ENGINEERING PHYSICS	L	T	P	C
		3	0	0	3

UNIT I MECHANICS OF MATERIALS 9

Rigid Body – Centre of mass – Rotational Energy - Moment of inertia (M.I)- Moment of Inertia for uniform objects with various geometrical shapes. Elasticity –Hooke's law - Poisson's ratio - stress-strain diagram for ductile and brittle materials – uses- Bending of beams – Cantilever - Simply supported beams - uniform and non-uniform bending - Young's modulus determination - I shaped girders –Twisting couple – Shafts. Viscosity – Viscous drag – Surface Tension.

UNIT II OSCILLATIONS, SOUND AND THERMAL PHYSICS 9

Simple harmonic motion - Torsional pendulum –- Damped oscillations –Shock Absorber -Forced oscillations and Resonance –Applications of resonance.- Waves and Energy Transport –Sound waves – Intensity level – Standing Waves - Doppler effect and its applications - Speed of blood flow. Ultrasound – applications - Echolocation and Medical Imaging. Thermal Expansion – Expansion joints – Bimetallic strip – Seebeck effect – thermocouple -Heat Transfer Rate – Conduction – Convection and Radiation.

UNIT III OPTICS AND LASERS 9

Interference - Thin film interference - Air wedge- Applications -Interferometers–Michelson Interferometer -– Diffraction - CD as diffraction grating – Diffraction by crystals -Polarization - polarizers -– Laser – characteristics – Spontaneous and Stimulated emission- population – inversion - Metastable states - optical feedback - Nd-YAG laser, CO_2 laser, Semiconductor laser - Industrial and medical applications - Optical Fibers – Total internal reflection – Numerical aperture and acceptance angle – Fiber optic communication – Fiber sensors – Fiber lasers.

UNIT IV QUANTUM MECHANICS 9

Black body radiation (Qualitative) – Planck's hypothesis – Einstein's theory of Radiation - Matter waves–de Broglie hypothesis - Electron microscope – Uncertainty Principle – The Schrodinger Wave equation (time-independent and time-dependent) – Meaning and Physical significance of wave function - Normalization - Particle in an infinite potential well-particle in a three-dimensional box - Degenerate energy states - Barrier penetration and quantum tunneling - Tunneling microscope.

UNIT V CRYSTAL PHYSICS 9

Crystal Bonding – Ionic – covalent – metallic and van der Walls's/ molecular bonding. Crystal systems - unit cell, Bravais lattices, Miller indices - Crystal structures - atomic packing density of BCC, FCC and HCP structures. NaCl, Diamond, Graphite, Graphene, Zincblende and Wurtzite structures - crystal imperfections- point defects - edge and screw dislocations – grain boundaries. Crystal Growth – Czocharalski method – vapor phase epitaxy – Molecular beam epitaxy- Introduction to X-Ray Diffractometer.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of this course, the students shall be

CO1: Understand the important mechanical properties of materials
CO2: Express the knowledge of oscillations, sound and applications of Thermal Physics
CO3: Know the basics of optics and lasers and its applications
CO4: Understand the basics and importance of quantum physics.
CO5: Understand the significance of crystal physics.

TEXT BOOKS:

1. Raymond A. Serway, John W. Jewett, Physics for Scientists and Engineers, Thomson Brooks/Cole, 2013.
2. D. Halliday, R. Resnick and J. Walker, Principles of Physics. John Wiley & Sons, 10th Edition, 2015
3. N. Garcia, A. Damask and S. Schwarz, Physics for Computer Science Students, Springer-Verlag, 2012.

4. Alan Giambattista, Betty McCarthy Richardson and Robert C. Richardson, College Physics, McGraw-Hill Higher Education, 2012.

REFERENCES:

1. R. Wolfson, Essential University Physics. Volume 1 & 2. Pearson, 2016.
2. D. Kleppner and R. Kolenkow. An Introduction to Mechanics, McGraw Hill Education, 2017.
3. K. Thyagarajan and A. Ghatak. Lasers: Fundamentals and Applications. Springer, 2012

CO-PO & PSO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	1	2	1							
CO2	2	2	1	2	1							
CO3	2	2	2	2	1							
CO4	2	1	1	1	1							
CO5	2	2	2	2	1							
Avg	2	2	1	2	1	-	-	-	-	-	-	-

1’ = Low; ‘2’ = Medium; ‘3’ = High

PTCY3151	ENGINEERING CHEMISTRY	L T P C
		3 0 0 3

UNIT I POLYMER CHEMISTRY

Introduction: Functionality-degree of polymerization. Classification of polymers (Source, Structure, Synthesis and Intermolecular forces). Mechanism of free radical addition polymerization. Properties of polymers: Tg, tacticity, molecular weight-number average, weight average, viscosity average and polydispersity index (Problems). Techniques of polymerization: Bulk, emulsion, solution and suspension.

Engineering Plastics: Polyamides, Polycarbonates and Polyurethanes. Compounding and Fabrication Techniques: Injection, Extrusion, Blow and Calendaring

UNIT II NANOCHEMISTRY

Basics-distinction between molecules, nanomaterials and bulk materials; size-dependent properties (optical, electrical, mechanical, magnetic and catalytic). Types –nanoparticle, nanocluster, nanorod, nanowire and nanotube. Preparation of nanomaterials: sol-gel, solvothermal, laser ablation, chemical vapour deposition, electrochemical deposition and electro spinning. Characterization - Scanning Electron Microscope and Transmission Electron Microscope - Principle and instrumentation (block diagram). Applications of nanomaterials - medicine, agriculture, electronics and catalysis.

UNIT III CORROSION SCIENCE

Electrochemical cell, redox reaction, electrode potential - oxidation and reduction potential. Measurement and its application Introduction to corrosion - chemical and electrochemical corrosions-mechanism of electrochemical and galvanic corrosions-concentration cell corrosion-passivity-soil, pitting, inter-granular, water line, stress and microbiological corrosions-galvanic series-factors influencing corrosion- measurement of corrosion rate. Corrosion control-material selection and design-electrochemical protection- sacrificial anodic protection and impressed current cathodic protection. Protective coatings-metallic coatings (galvanizing, tinning), organic coatings (paints). Paints: Constituents and functions.

UNIT IV ENERGY SOURCES

Batteries - Characteristics - types of batteries – primary battery (dry cell), secondary battery (lead acid, lithium-ion-battery)- emerging batteries – nickel-metal hydride battery, aluminum air battery, batteries for automobiles and satellites - Fuel cells (Types) – H_2-O_2 fuel cell - Supercapacitors-Types and Applications, Renewable Energy: Solar- solar cells, DSSC

UNIT V WATER TECHNOLOGY

Water – sources and impurities – water quality parameters: colour, odour, pH, hardness, alkalinity, TDS, COD, BOD and heavy metals. Boiler feed water – requirement – troubles (scale & sludge, caustic embrittlement, boiler corrosion and priming & foaming. Internal conditioning – phosphate, calgon and carbonate treatment. External conditioning - demineralization. Municipal water treatment (screening, sedimentation, coagulation, filtration and disinfection-ozonolysis, UV treatment, chlorination), Reverse Osmosis.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: To recognize and apply basic knowledge on different types of polymeric materials, their general preparation methods and applications to futuristic material fabrication needs.

CO2: To identify and apply basic concepts of nanoscience and nanotechnology in designing the synthesis of nanomaterials for engineering and technology applications.

CO3: To recognize and apply basic knowledge on suitable corrosion protection technique for practical problems.

CO4: To recognize different storage devices and apply them for suitable applications in energy sectors.

CO5: To demonstrate the knowledge of water and their quality in using at different industries.

TEXT BOOKS:

1. Jain P. C. & Monica Jain., "Engineering Chemistry", 17th Edition, Dhanpat Rai Publishing Company (P) Ltd, New Delhi, 2015.
2. Sivasankar B., "Engineering Chemistry", Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2012.
3. Dara S.S., "A Text book of Engineering Chemistry", Chand Publications, 2004.

REFERENCES:

1. Schdeva M.V., "Basics of Nano Chemistry", Anmol Publications Pvt Ltd, 2011.
2. Friedrich Emich, "Engineering Chemistry", Medtech, 2014.
3. Gowariker V.R., Viswanathan N.V. and Jayadev Sreedhar, "Polymer Science" New AGE International Publishers, 2009.

CO - PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	2									
CO2	2	1		2	2							
CO3	2	2	1	1	2							
CO4	2		2		2							
CO5	3	2	2	1	1							
Avg	2	1	1	1	2	-	-	-	-	-	-	-

1' = Low; '2' = Medium; '3' = High

PTGE3151	ENGINEERING MECHANICS	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for:

1. determining the resultant forces acting on a particle in 2D and 3D and for applying methods of equilibrium on a particle in 2D and 3D.
2. evaluating the reaction forces for bodies under equilibrium, for determining the moment of a force, moment of a couple, for resolving force into a force-couple system and for analyzing trusses
3. assessing the centroids of 2D sections / center of gravity of volumes and for calculating area moments of inertia for the sections and mass moment of inertia of solids.
4. evaluating the frictional forces acting at the contact surfaces of various engineering systems and for applying the work-energy principles on a particle.
5. determining kinetic and kinematic parameters of the rigid bodies subjected to concurrent coplanar forces.

UNIT I STATICS OF PARTICLES 9+3

Fundamental Concepts and Principles, Systems of Units, Method of Problem Solutions, Statics of Particles -Forces in a Plane, Resultant of Forces, Resolution of a Force into Components, Rectangular Components of a Force, Unit Vectors. Equilibrium of a Particle- Newton's First Law of Motion, Space and Free-Body Diagrams, Forces in Space, Equilibrium of a Particle in Space.

UNIT II EQUILIBRIUM OF RIGID BODIES AND TRUSSES 9+3

Principle of Transmissibility, Equivalent Forces, Vector Product of Two Vectors, Moment of a Force about a Point, Varignon's Theorem, Rectangular Components of the Moment of a Force, Scalar Product of Two Vectors, Mixed Triple Product of Three Vectors, Moment of a Force about an Axis, Couple - Moment of a Couple, Equivalent Couples, Addition of Couples, Resolution of a Given Force into a Force -Couple system, Further Reduction of a System of Forces, Equilibrium in Two and Three Dimensions - Reactions at Supports and Connections – Analysis of Trusses – Method of Joints and Method of Sections.

UNIT III DISTRIBUTED FORCES 9+3

Centroids of lines and areas – symmetrical and unsymmetrical shapes, Determination of Centroids by Integration, Theorems of Pappus-Guldinus, Distributed Loads on Beams, Centre of Gravity of a Three-Dimensional Body, Centroid of a Volume, Composite Bodies, Determination of Centroids of Volumes by Integration.

Moments of Inertia of Areas and Mass - Determination of the Moment of Inertia of an Area by Integration , Polar Moment of Inertia , Radius of Gyration of an Area , Parallel-Axis Theorem , Moments of Inertia of Composite Areas, Moments of Inertia of a Mass - Moments of Inertia of Thin Plates , Determination of the Moment of Inertia of a Three-Dimensional Body by Integration.

UNIT IV FRICTION AND WORK PRINCIPLES 9+3

The Laws of Dry Friction. Coefficients of Friction, Angles of Friction, Wedges, Wheel Friction. Rolling Resistance, Ladder friction. Work of a Force, Kinetic Energy of a Particle, Principle of Work and Energy, Principle of Impulse and Momentum, Impact, Method of Virtual Work - Work of a Force, Potential Energy, Potential Energy and Equilibrium.

UNIT V DYNAMICS OF PARTICLES AND RIGID BODIES 9+3

Kinematics - Rectilinear Motion and Curvilinear Motion of Particles. Kinetics- Newton's Second Law of Motion -Equations of Motions, Dynamic Equilibrium, Energy and Momentum Methods – Kinematics of Rigid Bodies and Plane Kinetics.

TOTAL :60 PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

CO1 To determine the resultant forces acting on a particle in 2D and 3D and to apply methods of equilibrium on a particle in 2D and 3D.

CO2 Evaluate the reaction forces for bodies under equilibrium, to determine moment of a force, moment of a couple, to resolve force into a force-couple system and to analyze trusses

CO3 Assess the centroids of 2D sections / center of gravity of volumes and to calculate area moments of inertia for the sections and mass moment of inertia of solids.

CO4 Evaluate the frictional forces acting at the contact surfaces of various engineering systems and apply the work-energy principles on a particle. evaluate the kinetic and kinematic parameters of a particle.

CO5 Determine kinetic and kinematic parameters of the rigid bodies subjected to concurrent coplanar forces.

TEXT BOOKS:

1. Beer Ferdinand P, Russel Johnston Jr., David F Mazurek, Philip J Cornwell, Sanjeev Sanghi, Vector Mechanics for Engineers: Statics and Dynamics, McGraw Higher Education., 12th Edition, 2019.
2. Vela Murali, "Engineering Mechanics-Statics and Dynamics", Oxford University Press, 2018.

REFERENCES:

1. Boresi P and Schmidt J, Engineering Mechanics: Statics and Dynamics, 1/e, Cengage learning, 2008.
2. Hibbeller, R.C., Engineering Mechanics: Statics, and Engineering Mechanics: Dynamics, 13th edition, Prentice Hall, 2013.
3. Irving H. Shames, Krishna Mohana Rao G, Engineering Mechanics – Statics and Dynamics, 4thEdition, Pearson Education Asia Pvt. Ltd., 2005.
4. Meriam J L and Kraige L G, Engineering Mechanics: Statics and Engineering Mechanics: Dynamics, 7th edition, Wiley student edition, 2013.
5. Timoshenko S, Young D H, Rao J V and Sukumar Pati, Engineering Mechanics, 5thEdition, McGraw Hill Higher Education, 2017.

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	2	1	2	-	-	1	-	-	-	2	3	1	2
2	3	2	2	1	2	-	-	1	-	-	-	2	3	1	2
3	3	2	2	1	2	-	-	1	-	-	-	2	3	1	2
4	3	2	2	1	2	-	-	1	-	-	-	2	3	1	2
5	3	2	2	1	2	-	-	1	-	-	-	2	3	1	2
Avg	3	2	2	1	2	-	-	1	-	-	-	2	3	1	2

PTMA3251 ORDINARY DIFFERENTIAL EQUATIONS AND TRANSFORM TECHNIQUES L T P C
3 1 0 4

UNIT I ORDINARY DIFFERENTIAL EQUATIONS (9+3)

Homogeneous linear ordinary differential equations of second order, linearity principle, general solution- Particular integral - Operator method - Solution by variation of parameters - Method of undetermined coefficients - Homogenous equations of Euler–Cauchy and Legendre's type – System of simultaneous linear differential equations with constant coefficients.

UNIT II LAPLACE TRANSFORMS (9+3)

Existence theorem - Transform of standard functions – Transform of Unit step function and Dirac delta function – Basic properties - Shifting theorems - Transforms of derivatives and integrals – Transform of periodic functions - Initial and Final value theorem - Inverse Laplace - Convolution theorem (without proof) – Solving Initial value problems by using Laplace Transform techniques.

UNIT III FOURIER SERIES (9+3)

Dirichlet's conditions – General Fourier series – Odd and even functions – Half-range Sine and Cosine series – Complex form of Fourier series – Parseval's identity – Harmonic Analysis.

UNIT IV FOURIER TRANSFORMS (9+3)

Fourier integral theorem – Fourier transform pair - Fourier sine and cosine transforms – Properties – Transform of elementary functions - Convolution theorem (without proof) – Parsevals's identity.

UNIT V Z – TRANSFORM AND DIFFERENCE EQUATIONS (9+3)

Z-transform – Elementary properties – Inverse Z-transform – Convolution theorem – Initial and final value theorems – Formation of difference equation – Solution of difference equation using Z - transform.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

CO1: Solve higher order ordinary differential equations which arise in engineering applications.
CO2: Apply Laplace transform techniques in solving linear differential equations.
CO3: Apply Fourier series techniques in engineering applications.
CO4: Understand the Fourier transforms techniques in solving engineering problems.
CO5: Understand the Z-transforms techniques in solving difference equations.

TEXT BOOKS:

1. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, 44th Edition, New Delhi, 2017.
2. Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley India Pvt Ltd., New Delhi, 2015.

REFERENCES:

1. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.
2. Greenberg M.D., "Advanced Engineering Mathematics", Pearson Education 2nd Edition, 5th Reprint, Delhi, 2009.
3. Jain R.K. and Iyengar S.R.K., "Advanced Engineering Mathematics",Narosa Publications, 5th Edition, New Delhi, 2017.
4. Peter V.O'Neil, "Advanced Engineering Mathematics", Cengage Learning India Pvt., Ltd, 7th Edition, New Delhi , 2012.
5. Ramana B.V., "Higher Engineering Mathematics", Tata McGraw Hill Co. Ltd., 11th Reprint, New Delhi, 2010.

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	2	3	3	-	-	-	-	-	3
CO2	3	2	-	2	3	3	-	-	-	-	-	3
CO3	3	2	-	2	3	2	-	-	-	-	-	3
CO4	3	2	-	1	3	3	-	-	-	-	-	3
CO5	3	2	-	1	3	2	-	-	-	-	-	3
AVg.	3	2		1	3	2						3

- 1’ = Low; ‘2’ = Medium; ‘3’ = High

PTEE3201 BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING L T P C
3 0 0 3

UNIT – I ELECTRICAL CIRCUITS 9

DC Circuits: Ohm's Law - Kirchhoff's Laws – Independent and Dependent Sources – Nodal Analysis, Mesh analysis with Independent sources only (Steady state) – AC Fundamentals: Waveforms, Average value, RMS Value, Impedance, Instantaneous Power, Real Power, Reactive Power and Apparent Power, Power Factor – Steady State Analysis of RL and RC Circuits - Introduction to Balanced 3-Phase Circuits and power measurement.

UNIT – II ELECTRICAL MACHINES 9

Basic Magnetic Circuit - Construction and Working Principle – DC Separately and Self excited Generators, EMF Equation, Types and Applications. Working Principle of DC motors, Torque Equation, Types and Applications. Transformer - Construction, Working and Applications - Three phase Alternator, Synchronous motor - Single and Three Phase Induction Motor – BLDC motor.

UNIT – III ANALOG AND DIGITAL ELECTRONICS 9

Operation and Characteristics of electronic devices: PN Junction Diodes, Zener Diode, BJT, JFET and MOSFET– Operational Amplifiers (OPAMPs) : Characteristics and basic application circuits-555 timer IC based astable and monostable multivibrator.

Basic switching circuits – Gates and Flip-Flops-Sample and hold circuit- R-2R ladder type DAC-Successive approximation based ADC.

UNIT – IV SENSORS AND TRANSDUCERS 9

Solenoids, electro-pneumatic systems, proximity sensors, limit switches, piezoelectric, hall effect, photo sensors, Strain gauge, LVDT, differential pressure transducer, optical and digital transducers, Smart sensors, Thermal Imagers.

UNIT – V MEASUREMENTS AND INSTRUMENTATION 9

Functional Elements of an Instrument, Error analysis; Operating Principle - Moving Coil and Moving Iron Instruments, Wattmeter, Energy Meter, Instrument Transformers - CT and PT, Multimeter- DSO - Block Diagram Approach.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:

CO 1: Compute and demonstrate the electric circuit parameters for simple problems.

CO 2: Explain the working principles and characteristics of electrical machines, electronic devices and measuring instruments.

CO 3: Identify general applications of electrical machines, electronic devices and measuring instruments.

CO 4: Analyze and demonstrate the basic electrical and electronic circuits and characteristics of electrical machines.

CO 5: Explain the types and operating principles of sensors and transducers.

Mapping of COs with POs and PSOs															
COs/POs & PSOs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	3	2	2	3	-	-	-	1	2	1	1	-	-	-
CO2	2	3	2	3	3	-	-	-	1	2	1	1	-	-	-
CO3	3	2	1	1	3	-	-	-	1	2	1	1	-	-	-
CO4	1	2	2	2	3	-	-	-	1	2	-	1	-	-	-
CO5	1	1	2	2	2	-	-	-	1	2	-	2	-	-	-
CO/PO & PSO Average	**2**	**2.2**	**1.8**	**2**	**-**	**-**	**-**	**-**	**1**	**2**	**1**	**1.2**	**-**	**-**	**-**
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS:

1. Del Toro ‘Electrical Engineering Fundamentals’ Pearson Education, New Delhi, 2022.
2. Alan S. Moris, Principles of Measurements and Instruments, Prentice-Hall of India Pvt. Ltd., New Delhi, 1988.
3. Smarjit Ghosh ‘Fundamentals of Electrical and Electronics Engineering, 2nd Edition 2010.

REFERENCES:

1. Rajendra Prasad ‘Fundamentals of Electrical engineering’, Third Edition, Prentice Hall of India, 2014.
2. Sanjeev Sharma ‘Basics of Electrical Engineering’ Wiley, 2019.
3. John Bird, Electrical Circuits theory and Technology, Taylor & Francis Ltd, Seventh Edition, 2022.
4. Doebelin, E.O., Measurements Systems – Application and Design’, McGrawHill Publishing Co, 2019.
5. D.Roy Choudhury, Shail B. Jain, Linear Integrated Circuits, New age international Publishers, 2018.
6. H.S. Kalsi, ‘Electronic Instrumentation’, Tata McGraw-Hill, New Delhi, 2010

PTME3251	DESIGN THINKING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

To impart the importance of design in today's context of global competition.

UNIT I DESIGN THINKING FOR NEED IDENTIFICATION 9

Introduction to New Product Development (NPD) & Design Thinking – A Framework of Design Thinking– Nine Criteria of an Inspirational Design Brief– Customer Experience Mapping– The Visualize, Empathize, and Ideate Method–Design Heuristics–Prototypes in Design Thinking – Integrating Design into the Fuzzy Front End (FFE) – Four Pillars of Innovation for Enabling Design Thinking.

UNIT II PRODUCT DEVELOPMENT PROCESS 9

The six phases of generic development–Concept Development–Opportunity Identification Process – Five step process of product planning – Process of Identifying Customer Needs – Process of Product Specifications–Concept generation method–Methods of Concept Selection & Concept Testing.

UNIT III PRODUCT ARCHITECTURE AND INDUSTRIAL DESIGN FOR ENVIRONMENT 9

Modular Architecture–Types of Modularity–Implications of the Architecture –Establishing the Architecture – Delayed Differentiation – Platform Planning: Differentiation Plan, Commonality Plan–The Industrial Design Process–Assessing the Quality of Industrial Design–Environmental Impacts –The Design for Environment Process.

UNIT IV ROBUST DESIGN FOR MANUFACTURING AND SUPPLY CHAIN 9

Robust design through the design of experiments (DOE)–Design for X (DFX)–Iteration of DFM method–Failure Mode and Effect Analysis (FMEA)–Quality Function Deployment (QFD)–Partial disassembly, folding, or compression– Delayed final packaging.

UNIT V DESIGN THINKING IN COST-CUTTING AND INTELLECTUAL PROPERTY 9

Fundamentals of Cost Calculations–Methods for Estimating Costs–Target Costing–Life Cycle costs–"Design" in Intellectual Property–Utility Patents–Design Patents–Copyrightable Designs – Trademark Rights–Legal Overlap, Trade-Offs, and Strategic Considerations.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1	Apply design concepts for manufacturing, assembly and environment.
CO2	Make economically sound decisions.
CO3	Design methodologies on industrial ecology.
CO4	Analyze the design for its manufacturability using modern quality control concepts and Approaches.
CO5	Learn the value of design and how it impacts society, industry, and the environment.

TEXT BOOKS:

1. MichaelG.Luchs, ScottSwan, Abbie Griffin,“Design Thinking: New Product Development Essentials from the PDMA”,ISBN:978-1-118-97180-2,November2015,Wiley-Blackwell Publishers.
2. Karl Ulrich, Steven Eppinger, Maria C. Yang, “Product Design and Development”,ISBN:9789390113231,Seventh edition,McGraw Hill Publishers.
3. Gerhard Pahl, Wolfgang Beitz, Jörg Feldhusen, Karl-Heinrich Grote, “Engineering Design:ASystematicApproach”,ISBN:978-1-84628-319-2,2007,SpringerPublishers.

REFERENCES:

1. Idris Mootee,“Design Thinking for Strategic Innovation: What They Can't Teach You at Business or Design School”,ISBN:978-1-118-62012-0,August2013,Wiley Publishers.
2. Vijay Kumar, “101 Design Methods: A Structured Approach for Driving Innovation in Your Organization”,ISBN:978-1-118-08346-8,October 2012,Wiley Publishers.
3. Tim Brown, “Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation”,ISBN: 9780062856623, March2019,Harper Collins Publishers.

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	2	2	-	1	1	1	-	-	-	1	3	3	3
2	3	2	2	2	-	1	1	1	-	-	-	1	3	3	3
3	3	2	2	2	-	1	1	1	-	-	-	1	3	3	3
4	3	2	2	2	3	1	1	1	-	-	-	1	3	3	3
5	3	2	2	2	3	3	3	1	-	-	1	1	3	3	3
Avg	3	2	2	2	3	1.4	1.4	1	-	-	1	1	3	3	3

PTCE3201 FLUID MECHANICS AND MACHINERY L T P C
3 0 0 3

UNIT I FLUID PROPERTIES AND FLOW CHARACTERISTICS 10

Definitions of Fluid - Properties of fluids – Fluid pressure and its Measurements - Buoyancy and floatation - Flow characteristics - Eulerian and Lagrangian Principle of fluid flow– concept of control volume and system – Reynold's transportation theorem - continuity equation, energy equation and momentum equation - Applications.

UNIT II FLOW THROUGH PIPES AND BOUNDARY LAYER 9

Reynold's Experiment - Laminar flow through circular conduits - Darcy Weisbach equation – friction factor - Moody diagram - minor losses - Hydraulic and energy gradient – Pipes in series and parallel - Boundary layer concepts – types of boundary layer thickness.

UNIT III DIMENSIONAL ANALYSIS AND MODEL STUDIES 7

Fundamental dimensions - Dimensional homogeneity - Rayleigh's method and Buckingham Pi theorem - Dimensionless parameters - Similitude and model studies - Distorted and undistorted models.

UNIT IV TURBINES 10

Impact of jets - Velocity triangles - Theory of rotodynamic machines - Classification of turbines – Pelton wheel, Francis turbine (inward and outward) and Kaplan turbine- Working principles - Work done by water on the runner - Efficiencies – Draft tube - Specific speed - Performance curves for turbines.

UNIT V PUMPS 9

Classification of pumps - Centrifugal pumps – NPSH – Minimum speed to start the pump - working principle - Heads and efficiencies– Velocity triangles- Work done by the impeller - performance curves - Reciprocating pump working principle – indicator diagram and it's variations – work saved by fitting air vessels.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to be able to

CO1 Understand the difference between solid and fluid, its properties and behaviour in static conditions along with the conservation laws applicable to fluid flow and its application through fluid kinematics and dynamics.

CO2 Estimate losses in pipelines for both laminar and turbulent conditions and analysis of pipes connected in series and parallel and to understand the concept of boundary layer theory.

CO3 Formulate the relationship among the parameters involved in the given fluid phenomenon and to predict the performances of prototype by model studies.

CO4 Design of Pelton wheel, Francis and Kaplan turbines and explain the working principles of each turbine with draft tube theory for reaction turbines.

CO5 Differentiate pumps and explain the working principle with characteristic curves and design centrifugal and reciprocating pumps.

TEXT BOOKS:

1. Modi P.N. and Seth, S.M. Hydraulics and Fluid Mechanics, Standard Book House, New Delhi, (2017)
2. Jain A. K. Fluid Mechanics including Hydraulic Machines, Khanna Publishers, New Delhi, 2014.

REFERENCES:

1. K.L. Kumar, Engineering Fluid Mechanics, (8th Ed.) S. Chand Publishing (India) Pvt. Ltd., New Delhi, 2016.
2. S K Som; Gautam Biswas and S Chakraborty, Introduction to Fluid Mechanics and Fluid Machines, Tata McGraw Hill Education Pvt. Ltd., 2017.
3. Subramanya, K. Fluid Mechanics and Hydraulic Machines,2nd Ed., Tata McGraw- Hill Pub. Co., New Delhi, 2018.
4. Yunus A. Cengel ; John M. Cimbala, Fluid Mechanics, 4th Ed., McGraw Hill Education Pvt. Ltd.,2019.
5. Streeter, V. L. and Wylie E. B., Fluid Mechanics, McGraw Hill Publishing Co.,1998.

MAPPING OF CO'S WITH PO'S

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	1	1	1	1	1	2	1	2	1	2	3	2	2
2	3	3	3	1	1	1	1	2	1	2	1	2	3	3	2
3	3	3	3	2	1	1	1	2	1	2	1	2	3	3	2
4	3	3	3	2	1	1	1	3	1	2	1	2	3	3	2
5	3	3	3	2	1	1	1	3	1	2	1	2	3	3	3

PTCY3251 ENVIRONMENTAL SCIENCE AND SUSTAINABILITY L T P C
2 0 0 2

UNIT I ENVIRONMENT AND BIODIVERSITY 6

Definition, scope and importance of environment – need for public awareness. Eco-system and Energy flow– ecological succession. Types of biodiversity: genetic, species and ecosystem diversity– values of biodiversity, India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ.

UNIT II ENVIRONMENTAL POLLUTION 6

Causes, Effects and Preventive measures of Water, Soil, Air and Noise Pollutions. Solid, Hazardous and E-Waste management. Case studies on Occupational Health and Safety Management system (OHASMS). Environmental protection, Environmental protection acts.

UNIT III RENEWABLE SOURCES OF ENERGY 6

Energy management and conservation, New Energy Sources: Need of new sources. Different types new energy sources. Applications of- Hydrogen energy, Ocean energy resources, Tidal energy conversion. Concept, origin and power plants of geothermal energy.

UNIT IV SUSTAINABILITY AND MANAGEMENT 6

Development , GDP ,Sustainability- concept, needs and challenges-economic, social and aspects of sustainability-from unsustainability to sustainability-millennium development goals, and protocols Sustainable Development Goals-targets, indicators and intervention areas Climate change- Global, Regional and local environmental issues and possible solutions-case studies. Concept of Carbon Credit, Carbon Footprint. Environmental management in industry-A case study.

UNIT V SUSTAINABILITY PRACTICES 6

Zero waste and R concept, Circular economy, ISO 14000 Series, Material Life cycle assessment, Environmental Impact Assessment. Sustainable habitat: Green buildings, Green materials, Energy efficiency, Sustainable transports. Sustainable energy: Non-conventional Sources, Energy Cyclescarbon cycle, emission and sequestration, Green Engineering: Sustainable urbanization-Socioeconomical and technological change.

TOTAL : 30 PERIODS

COURSE OUTCOMES:

CO1 To recognize and understand the functions of environment, ecosystems and biodiversity and their conservation.

CO2 To identify the causes, effects of environmental pollution and natural disasters and contribute to the preventive measures in the society.

CO3 To identify and apply the understanding of renewable and non-renewable resources and contribute to the sustainable measures to preserve them for future generations.

CO4 To recognize the different goals of sustainable development and apply them for suitable technological advancement and societal development.

CO5 To demonstrate the knowledge of sustainability practices and identify green materials, energy cycles and the role of sustainable urbanization.

TEXT BOOKS:

1. Anubha Kaushik and C. P. Kaushik's "Perspectives in Environmental Studies", 6th Edition, New Age International Publishers , 2018.
2. Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, 2016.
3. Gilbert M.Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education, 2004.
4. Allen, D. T. and Shonnard, D. R., Sustainability Engineering: Concepts, Design and Case Studies, Pearson; 1st edition, 2011.

5. Bradley. A.S; Adebayo, A.O., Maria, P. Engineering applications in sustainable design and development, CL Engineering; International edition, 2015.
6. Environment Impact Assessment Guidelines, Notification of Government of India, 2006.
7. Mackenthun, K.M., Basic Concepts in Environmental Management, Lewis Publication, London, 1998.

REFERENCES :

1. Daniel J. Sherman, David R. Montgomery, '' Environmental Science and Sustainability'', W. W. Norton, Incorporated, 2nd edition, 2023.
2. R.K. Trivedi, 'Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards', B.S Publications, 2010.
3. Cunningham, W.P. Cooper, T.H. Gorhani, 'Environmental Encyclopedia', Jaico Publications, Mumbai, 2001.
4. Dharmendra S. Sengar, 'Environmental law', Prentice hall of India PVT. LTD, New Delhi, 2007.
5. Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press, 3rd edition, 2015.
6. Erach Bharucha "Textbook of Environmental Studies for Undergraduate Courses" Orient Blackswan Pvt. Ltd. 2013.

CO - PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1							**3**					
CO2		**2**	**3**									
CO3			**2**				**3**					
CO4							**3**	**3**				
CO5			**3**				**2**	**2**				
Avg	**-**	**2**	**3**	**-**	**-**	**-**	**3**	**3**	**-**	**-**	**-**	-

1' = Low; '2' = Medium; '3' = High

PTME3301 **MECHANICS OF MATERIALS** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

1. To develop the understanding of the principle concepts of stress, strain and deformation of solids for various engineering applications.
2. To analyse the flexural and shear stresses induced in beams due to different loading conditions
3. To analyse the effect of torsion on shafts and springs.
4. To understand and analyse the deflection of beams for different support and loading conditions
5. To examine the stresses induced in thin and thick shells.

UNIT I STRESS, STRAIN AND DEFORMATION OF SOLIDS 9

Rigid bodies and deformable solids –Stresses and strains: Tension, Compression and Shear - Elastic constants – Relationships – Compound bars – Thermal stresses –Volumetric strains – Stress on inclined planes – Principal stresses and principal planes – Mohr's circle of stress.

UNIT II TRANSVERSE LOADING ON BEAMS AND STRESSES IN BEAM 9

Beams – Types - Transverse loading on beams – Shear force and bending moment in beams – Cantilevers – Simply supported beams and over hanging beams - Theory of simple bending – Bending stress distribution - Load carrying capacity - Proportioning of sections –Flitched beams – Carriage springs – Shear stress distribution- Shear Centre.

UNIT III TORSION 9

Theory of Pure Torsion- Stresses and deformation in circular and hollows shafts – Transmission of power through hollow & solid shafts – Stepped shafts –Shafts fixed at the both ends – Stresses in helical springs – Deflection of helical springs.

UNIT IV DEFLECTION OF BEAMS 9

Double Integration method – Macaulay's method – Area moment method - Conjugate beam method - Strain energy method - computation of slopes and deflections in beams- Maxwell's reciprocal theorem.

UNIT V THIN &THICK SHELLS, THEORIES OF FAILURE 9

Stresses and deformations in thin cylindrical shells and spherical shells subjected to internal pressure – Stresses in thick cylinders – Lame's theory – Application of theories of failure- Euler's buckling theory.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

CO1 Have thorough understanding of the fundamental concepts of stress and strains.
CO2 Understand the bending and shear stress distribution in beams.
CO3 Have sufficient knowledge on designing shafts to transmit power.
CO4 Have the ability to determine the deflection of beams.
CO5 Have the knowledge of behaviour of cylindrical and spherical shells.

TEXT BOOKS:

1. Bansal, R.K., Strength of Materials, Laxmi Publications (P) Ltd., 2018
2. Rajput, R.K., Strength of Materials, S Chand And Company Ltd., New Delhi, 2018

REFERENCES:

1. Egor. P.Popov “Engineering Mechanics of Solids” Prentice Hall of India, New Delhi, 2015.
2. Ferdinand P. Beer, Russell Johnson, Jr. and John J. Dewole Mechanics of Materials, 7th Edition, Tata McGraw Hill publishing ‘co. Ltd., New Delhi, 2014.
3. Hibbeler, R.C., Mechanics of Materials, Pearson Education, 10th Edition, 2022.
4. Subramanian R., Strength of Materials, Oxford University Press, Oxford Higher Education Series, 2007.

CO-PO-PSO MAPPING: MECHANICS OF MATERIALS

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	2	3	2	2	2	3	1	1	1	2	3	3	2
2	3	3	3	3	2	3	2	3	1	1	1	2	3	2	2
3	3	3	3	3	2	3	2	3	1	1	1	2	3	3	2
4	3	3	3	3	2	2	2	2	1	1	1	2	3	2	2
5	3	3	3	3	2	3	2	3	1	1	1	2	3	3	2
Avg.	**3**	**3**	**3**	**3**	**2**	**3**	**2**	**3**	**1**	**1**	**1**	**2**	**3**	**3**	**2**

PTME3302	KINEMATICS OF MACHINERY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

Students will understand and acquire knowledge on the fundamentals of the theory of kinematics.

UNIT I MECHANISMS 9

Elements or Links – Classification – Rigid Link, flexible and fluid link – Types of kinematic pairs – sliding, turning, rolling, screw and spherical pairs – lower and higher pairs – closed and open pairs – constrained motion – completely, partially, or successfully constrained and incompletely constrained. Grashoff's law, Degrees of freedom, Kutzbach criterion for planar mechanisms, Mechanism, and machines – classification of machines – kinematic chain – inversion of mechanism – inversions of quadric cycle chain – single and double slider crank chains.

UNIT II KINEMATICS & PLANE MOTION OF BODY 9

Velocity and acceleration – Motion of a link in machine – Determination of Velocity and acceleration diagrams – Graphical method – Application of relative velocity method four bar chain. Velocity and acceleration analysis of for a given mechanism, determination of Coriolis component of acceleration. determination of instantaneous centre, diagrams for simple mechanisms and determination of angular velocity of points and links.

UNIT III FRICTION IN MACHINE ELEMENTS 9

Introduction, Screw friction, Belt drives, types of belt drives, materials used for belt, velocity ratio of belt drives, slip of belt, creep of belt, tensions for flat belt drive, angle of contact, centrifugal tension, maximum tension of belt, Friction aspects in clutches.

UNIT IV CAMS 9

Definitions of cam and followers – their uses – Types of followers and cams – Terminology –Types of follower motion: Uniform velocity, Simple harmonic motion, cycloidal and uniform acceleration and retardation. Maximum velocity and maximum acceleration during outward and return strokes - Construction of cam profile using different follower – Cam with specific contours.

UNIT V GEARS & GEAR TRAINS 9

Higher pairs, friction wheels and toothed gears–types – law of gearing, condition for constant velocity ratio for transmission of motion, Form of teeth: cycloidal and involute profiles. Velocity of sliding – phenomena of interferences – Methods of interference-expressions for arc of contact and path of contact – Introduction to gear Trains, Train value, Types – Simple, compound and reverted wheel train – Epicyclic gear Train. Methods of finding train value or velocity ratio – Epicyclic gear trains - Differential gear for an automobile.

TOTAL :45 PERIODS

COURSE OUTCOMES:

Upon successful completion of this course, the students would be able to:

CO1 Interpret the mechanisms from the basic concepts for kinematic pairs, joints and mechanisms

CO2 Evaluate velocity and acceleration for various mechanisms

CO3 Analyze the effects of friction in machine elements.

CO4 Design cams for producing a desired motion.

CO5 Evaluate gear parameters and gear ratios for different types of gear trains for automobile and machine tools

TEXT BOOKS:

1. Theory of Machines by Thomas Bevan/ CBS Publishers.
2. Theory of Machines – S. S Rattan- TMH Publishers
3. Theory of machines and Machinery /Vickers / Oxford

REFERENCES:

1. Theory of Machines & Mechanisms - P.L Ballaney- Khanna Publishers
2. Theory of Mechanisms and machines – A.Ghosh & A.K.Malik – East West Press Pvt. Ltd
3. Kinematics and dynamics of Machinery by R.L Norton; TATA McGraw-Hill

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2	-	-	-	-	1	-	-	-	2	3	-	-
2	3	3	2	-	2	-	-	1	2	2	-	2	3	2	2
3	3	3	2	-	-	-	-	1	-	-	-	2	3	-	2
4	3	3	2	-	2	-	-	1	2	2	-	2	3	2	2
5	3	3	2	-	2	-	-	1	-	-	-	2	3	2	2
Avg	3	3	2	-	2	-	-	1	2	2	-	2	3	2	2

PTME3303	MANUFACTURING TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

To impart knowledge on metal casting, joining, and forming processes

UNIT I METAL CASTING PROCESSES 9

Sand Casting – Sand Mould – Type of patterns - Pattern Materials – Pattern allowances – Types of sand- sand properties and testing – Cores –Types and applications Basics of gating system – Molding machines – Melting furnaces – Principle of special casting processes- Shell, investment – Ceramic mould–Pressure die casting–Centrifugal Casting-CO_2 casting process Defects in Sand casting process Stir casting– Squeeze casting –Full Moulding –magnetic Moulding- Micro casting -Casting techniques for single crystal components -Casting defects.

UNIT II METAL JOINING PROCESSES 9

Fusion welding processes–Type of Gas welding–Flame characteristics–Filler and Flux materials Arc welding, Electrodes, Coating and specifications–Principles and types of Resistance welding– Gas Tungsten arc welding- Gas metal arc welding –Cold metal Transfer-Wire arc additive Manufacturing–Thermal spraying- Submerged arc welding – Electro slag welding – Plasma arc welding – Thermit Welding –Electron beam welding -Laser beam welding-Ultrasonic Welding –Friction welding–Friction stir welding–Diffusion bonding Weld defects - Brazing and soldering — Adhesive bonding..

UNIT III BULK DEFORMATION PROCESSES 9

Hot working and cold working of metals – Forging processes – Open, impression and closed die forging–Characteristics of the processes–Typical forging operations–rolling of metals– Types of Rolling – Flat strip rolling –contour roll forming- shape rolling operations – Defects in rolled parts – Principle of rod and wire drawing–Tube drawing–Principles of Extrusion–Types– Hot and Cold extrusion.

UNIT IV SHEET METAL PROCESSES 9

Sheet metal characteristics–Typical shearing bending and drawing operations–Stretch forming operations – Formability of sheet metal – Test methods –special forming processes – Working principle and applications–Hydro forming–Rubber pad forming– Multi-point Die Forming– Warm/Hot Forming – Solid Granular Medium Forming –Metals pinning-Introduction of Explosive forming magnetic pulse forming, peen-forming, Super plastic-forming –Micro-forming–Incremental forming.

UNIT V MANUFACTUREOFPLASTICCOMPONENTS 9

Types and characteristics of plastics – Molding of thermoplastics – working principles and typical applications – injection molding – Plunger and screw machines – Compression molding transfer molding –Typical industrial applications–introduction to blow-molding–Rotational-molding–Film-blowing– Extrusion–Vacuum bag Forming- Thermo-forming–Bonding of Thermo-plastics.

TOTAL:45 PERIODS

COURSE OUTCOMS:

Upon completion of this course the students will be able to:

1. Explain the working principles of various metal casting processes.
2. Categorize and select the appropriate metal joining process.
3. Compare the working principles of bulk deformation of metals.
4. Suggest suitable sheet metal forming processes for production of Engineering Components.
5. Explain the manufacturing of plastic components.

TEXT BOOKS:

1. Kalpakjian.S,"Manufacturing Engineering and Technology", Pearson Education India Edition,8th edition 2020.
2. Rao.P.N., Manufacturing Technology Foundry, Forming and Welding, 5thEdition. Tata McGraw Hill, 2018.

REFERENCES:

1. Gowri.S,P.Hariharan,A.SureshBabu,Manufacturing Technology, Pearson Education,2008.
2. R.K.Jain Production Technology Manufacturing Systems Vol –I K.hanna Publishers
3. PaulDegarmaE.,BlackJ.T.and Ronald A.Kosher, Materials and Processes, in Manufacturing, Edition, Prentice Hall of India,1997.
4. Sharma,P.C.,A Textbook of Production Technology, S.ChandandCo.Ltd.,2006.
5. Roy.A.Lindberg, Processes and materials of manufacture, PHI / Pearson Education,2006.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2	2	-	-	2	1	-	-	-	1	3	2	3
2	3	3	2	2	-	-	2	1	-	-	-	1	3	2	3
3	3	3	2	2	-	-	2	1	-	-	-	1	3	2	3
4	3	3	2	2	-	-	2	1	-	-	-	1	3	2	3
5	3	3	2	2	-	-	2	1	-	-	-	1	3	2	3
Avg	3	3	2	2	-	-	2	1	-	-	-	1	3	2	3

PTME3304 ENGINEERING MATERIALS AND METALLURGY L T P C

3 0 0 3

COURSE OBJECTIVE:

To impart knowledge on phase diagram constructions, Heat treatments of metals and alloys, and selection of ferrous & non-ferrous materials for suitable engineering applications

UNIT I CONSTITUTION OF ALLOYS AND PHASE DIAGRAMS 9

Constitution of alloys – Solid solutions, substitutional and interstitial – phase diagrams, Isomorphous, eutectic, eutectoid, peritectic, and peritectoid reactions, application of lever rule for phase calculation; Iron – Iron carbide equilibrium diagram. Classification of steel and cast Iron microstructure, properties and application.

UNIT II HEAT TREATMENT 9

Phase transformation- Pearlite, bainite and martensite formation mechanism; Diffusion-Fick's first and second Law-Homogenous and heterogeneous nucleation-critical radius of Nucleation-Full annealing, stress relief, spheroidising –normalizing, hardening and tempering of steel. TTT diagram – continuous cooling Transformation (CCT) diagram – Austempering, Martempering – Hardenability, Jominy end quench test –recrystallisation.

Case hardening, carburizing, Nitriding, cyaniding, carbonitriding – Flame and Induction hardening – Vacuum and Plasma hardening – Thermo-mechanical treatments

UNIT III FERROUS AND NON-FERROUS ALLOYS 9

Effect of alloying additions on steel (Mn, Si, Cr, Mo, V Ti & W) – stainless and tool steels – HSLA - Maraging steels-TRIP steel, PH steels – Grey, white, malleable, spheroidal – alloy cast irons, Copper and its alloys – Brass, Bronze and Cupronickel – Aluminium and its alloys; Al-Cu – precipitation strengthening treatment – Titanium alloys, Mg-alloys, Ni-based super alloys – shape memory alloys- Properties and Applications

UNIT IV POWDER METALLRGY 9

PM process- Powder preparation, powder characterization, powder compaction, sintering-stages of sintering-mechanism of sintering, different sintering techniques-case studies on cemented carbide and cermet tool making.

UNIT V MECHANICAL BEHAVIOUR OF MATERIALS 9

Mechanisms of plastic deformation, slip and twinning – Types of fracture – fracture mechanics- Griffith's theory- Testing of materials under tension, compression, and shear loads – Hardness tests (Brinell, Vickers and Rockwell), Micro and nano-hardness tests, Impact test- lzod and charpy, fatigue and creep failure mechanisms, fatigue-creep interaction-case studies on different failures.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

CO1 Construct the iron-iron carbide phase diagram and estimate the phases present in the micro-structure.

CO2 Design a suitable heat treatment process for ferrous alloys based on the requirements

CO3 Suggest suitable ferrous and non-ferrous alloys for specific engineering applications

CO4 Use the PM techniques to produce Engineering components

CO5 Describe testing procedures and failure mechanisms

TEXT BOOKS

1. Williams D Callister, “Material Science and Engineering” Wiley India Pvt Ltd, Revised Ir edition 2007.
2. Sydney H.Avner, “Introduction to Physical Metallurgy”, McGraw Hill Book Company, 1994

REFERENCES:

1. G.S. Upadhyay and Anish Upadhyay, “Materials Science and Engineering”, Viva Books Pv New Delhi, 2006.
2. Raghavan.V, “Materials Science and Engineering”, Prentice Hall of India Pvt.Ltd. 1999.
3. Kenneth G.Budinski and Michael K. Budinski, “Engineering Materials”, Prentice Hall of Private Limited, 4th Indian Reprint 2002.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2	2	-	1	-	-	-	-	-	1	2	1	2
2	3	2	3	2	-	-	2	-	-	-	-	2	2	1	2
3	3	-	2		-	1	-	-	-	-	-	2	2	1	2
4	3	-	2	2	-	1	-	-	-	-	-	3	2	1	2
5	3	3	2	1	-	-	-	-	-	-	-	2	2	1	2
AVG	3	2.7	2.2	1.8		1	2	-	-	-	-	2	2	1	2

PTME3305 **THERMODYNAMICS** **L T P C**
3 0 0 3

COURSE OBJECTIVE:
To impart knowledge on various forms of energy, energy transfer and energy interactions.

UNIT I FIRST LAW OF THERMODYNAMICS 9
Thermodynamic systems, Properties and processes Thermodynamic Equilibrium - Displacement work - P-V diagram. Thermal equilibrium - Zeroth law – Concept of temperature and Temperature Scales. First law – application to closed and open systems – steady and unsteady flow processes. Properties of Ideal gas, real gas - comparison. Equations of state for ideal gas.

UNIT II SECOND LAW AND CONCEPT OF ENTROPY 9
Heat Engine – Refrigerator - Heat pump. Statements of second law and their equivalence & corollaries. Carnot cycle - Reversed Carnot cycle - Performance - Clausius inequality. Concept of entropy - T-s diagram - Tds Equations - Entropy change for a pure substance, Principle of increase in entropy.

UNIT III EXERGY ANALYSIS 9
High and low grade energy, Exergy and Anergy, Availability and Irreversibility for open and closed system processes - I and II law Efficiency, Applications of II Law.

UNIT IV PROPERIES OF PURE SUBSTANCES AND REAL GASES 9
Steam - formation and its thermodynamic properties - p-v, p-T, T-v, T-s, h-s diagrams. PVT surface. Determination of dryness fraction of wet and very wet steam. Calculation of work done and heat transfer in non-flow and flow processes using Steam Table and Mollier Chart.

Real Gas, Vander Waal's relation - Reduced properties - Compressibility factor - Principle of Corresponding states - Generalized Compressibility Chart.

UNIT V GAS MIXTURES AND THERMODYNAMIC RELATIONS 9
Gas mixtures, Maxwell relations - Tds Equations - heat capacities relations - Energy equation, Joule-Thomson experiment - Clausius- Clapeyron equation.

TOTAL : 45 PERIODS

COURSE OUTCOMES:
At the end of the course the students would be able to
CO1: Understand and carry out various thermodynamic system analysis
CO2: Apply the second law of thermodynamics to various thermal systems
CO3: Determine the availability and perform the exergy analysis of thermal systems
CO4: Evaluate the properties of pure substance and real gases.
CO5: Explain the thermodynamic relations and compute properties of gas mixtures

TEXT BOOKS:

1. Nag.P.K., “Engineering Thermodynamics”, 6th Edition, Tata McGraw Hill (2017), New Delhi
2. Cengel, Y and M. Boles, Thermodynamics - An Engineering Approach, Tata McGraw Hill,8th Edition, 2015

REFERENCES:

1. Rathakrishnan, E., “Fundamentals of Engineering Thermodynamics”, 2nd Edition, Prentice Hall of India Pvt. Ltd, 2006.
2. E. Natarajan, Engineering Thermodynamics-Fundamentals and Applications, First Edition 20212, ISBN: 93-1568-61-3, Anuragam Publication.
3. Chattopadhyay, P, “Engineering Thermodynamics”, 2nd Edition Oxford University Press, 2016
4. Claus Borgnakke and Richard E. Sonntag, “Fundamentals of Thermodynamics”, 7th Edition,

Wiley Eastern, 2009.
5. Venkatesh. A, “Basic Engineering Thermodynamics”, Universities Press (India) Limited, 2007
6. Moran & Shapiro, “Principles of Engineering Thermodynamics”, 8th Edition, Wiley Eastern,

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	3	2	1	-	-	1	-	-	-	-	1	2	1	2
2	2	3	2	1	-	-	1	-	-	-	-	1	3	1	2
3	2	3	2	1	1	-	1	-	-	-	-	1	3	2	2
4	2	3	2	1	-	1		-	-	-	-	1	2	2	2
5	2	3	2	1	-	1		-	-	-	-	1	2	1	2
Avg	2	3	2	1	1	1	1	-	-	-	-	1	2.4	1.4	2

PTME3401	DYNAMICS OF MACHINES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

Students will acquire knowledge on force analysis of machine components, control mechanisms, the significance of unbalanced forces and its consequences in terms of vibrations.

UNIT I PRECESSION AND GOVERNERS 9

Gyroscopes, effect of precession motion on the stability of moving vehicles such as motor car, motor cycle, aero planes and ships. Watt, Porter and Proell governors, spring loaded governors – Hartnell and Hartung with auxiliary springs. sensitiveness, isochronism and hunting.

UNIT II STATIC AND INERTIA FORCE ANALYSIS 9

static force analysis of planar mechanisms, Dynamic force analysis of slider crank mechanism, inertia torque, angular velocity and acceleration of connecting rod, crank effort and turning moment diagrams – fluctuation of energy – fly wheels and their design

UNIT III BALANCING 9

Balancing of rotating masses single and multiple – single and different planes, use analytical and graphical methods. Primary, secondary, and higher balancing of reciprocating masses. analytical and graphical methods, unbalanced forces and couples – Balancing of Multi-cylinder inline engines, V-engines – Partial balancing in engines

UNIT IV FREE VIBRATION 9

Basics of vibratory systems – Degrees of freedom – Natural frequency -Spring mass system Equations of motion — Viscously damped free vibration- Logarithmic decrement- Transverse vibration – Dunkerley's method- Critical speed of shafts -Two and three rotor torsional vibration.

UNIT V FORCED VIBRATION 9

Response of one-degree freedom system to Harmonic excitation force – Vibration Isolation - rotating unbalance - support motion – Transmissibility - Energy dissipated by damping- Vibration measuring instruments. .

TOTAL:45 PERIODS

COURSE OUTCOMES:

Upon successful completion of this course the student should be able to:

CO1: Implement the stabilization knowledge in sea vehicles, aircrafts and automobile vehicles

CO2: Assess the force-motion relationship in components subjected to external forces in standard mechanisms and to design flywheel

CO3: Determine the undesirable effects of unbalances resulting from prescribed motions in mechanism

CO4: Calculate the natural frequencies, and amplitudes of mechanical systems subjected to free vibration.

CO5: Estimate the effect of dynamics of undesirable forced vibrations.

TEXT BOOKS:

1. Uicker, J.J., Pennock G.R and Shigley, J.E., “Theory of Machines and Mechanisms”,3rd Edition, Oxford University Press, 2009.
2. Rattan, S.S, “Theory of Machines”, 3rd Edition, Tata McGraw-Hill, 2009.

REFERENCES:

1. Homas Bevan, “Theory of Machines”, 3 rd Edition, CBS Publishers and Distributors, 2005.
2. Robert L. Norton, “Kinematics and Dynamics of Machinery”, Tata McGraw-Hill, 2009.
3. Ghosh. A andMallick, A.K., “Theory of Mechanisms and Machines”, Affiliated East-West Pvt. Ltd., New Delhi, 1988.
4. Rao.J.S. and Dukkipati.R.V. “Mechanisms and Machine Theory”, Wiley-Eastern Ltd., New Delhi, 1992.
5. Grover. G.T., “Mechanical Vibrations”, Nem Chand and Bros., 1996
6. V.Ramamurthi, “Mechanics of Machines”, Narosa Publishing House, 2002.
7. Khurmi, R.S.,”Theory of Machines”,14th Edition, S Chand Publications 2015

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	2	1	-	-	-	1	-	-	-	2	3	-	-
2	3	2	2	1	-	-	-	1	-	2	-	2	3	-	-
3	3	2	3	1	-	-	1	1	-	2	-	2	3	-	2
4	3	2	3	1	-	-	1	1	-	-	-	2	3	-	2
5	3	2	3	1	-	-	1	1	-	-	-	2	3	-	2
Avg	3	2	3	1	-	-	1	1	-	2	-	2	3	-	2

PTME3402	APPLIED THERMODYNAMICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

To impart knowledge on application of thermodynamic concepts on work producing and consuming thermal systems.

UNIT I AIR STANDARD CYCLES 9

Air Standard Cycles – Carnot, Otto, Diesel, Dual, Brayton – Cycle Analysis, Performance and Comparison, Gas turbine cycle analysis – open and closed cycle. Performance and its improvement - Regenerative, Intercooled, Reheat cycles and their combination.

UNIT II VAPOUR POWER CYCLES 9

Rankine Cycle, modified reheat and regenerative cycles, Binary Vapour cycle, comparison.

UNIT III STEAM NOZZLES AND STEAM TURBINES 9

Types and Shapes of nozzles, Flow of steam through nozzles, Critical pressure ratio, Variation of mass flow rate with pressure ratio. Effect of friction. Metastable flow. Steam Turbines - Impulse and reaction principles, Velocity diagrams, Work done and efficiency – optimal operating conditions. Multi-staging, compounding and governing.

UNIT IV INTERNAL COMBUSTION ENGINES – FEATURES AND COMBUSTION 9

IC engine – Classification, working, components and their functions. Ideal and actual: Valve timing, port timing and p-v diagrams, two stroke & four stroke engines – comparison. Fuel requirements for IC engines, stoichiometric air-fuel ratio calculation for different fuels. Fuel Injection and Ignition systems, Charging, lubrication and cooling systems of IC engines, Normal and abnormal combustion in SI & CI Engines. Performance and emission testing of IC Engines.

UNIT V REFRIGERATION AND AIR CONDITIONING 9

Carnot Cycles on Refrigerator, Heat Pump and Heat Transformers - Refrigerants and their properties - Compression based Refrigeration Cycles & Systems

Air-Water Properties, Psychometric Charts & Process, Thermal Comfort in Built environment, Types of Air Conditioning Systems, Indoor Air Quality

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

CO1 Analyze the different thermodynamic cycles and deduce their maximum thermodynamic efficiency

CO2 Assess the performance of Steam power cycle

CO3 Evaluate the performance of steam nozzles and steam turbines

CO4 Identify and understand the function of each IC engine components

CO5 Understand and apply refrigeration cycles and air-conditioning systems for variou applications

TEXT BOOKS:

1. Mahesh. M. Rathore, “Thermal Engineering”, 1st Edition, Tata McGraw Hill, 2010.
2. Ganesan.V , " Internal Combustion Engines" 4th Edition, Tata McGraw Hill, 2012.

REFERENCES:

1. Ballaney. P, “Thermal Engineering”, 25th Edition, Khanna Publishers, 2017.
2. Domkundwar, Kothandaraman, &Domkundwar, “A Course in Thermal Engineering”, 6th Edition, DhanpatRai& Sons, 2011.
3. Gupta H.N, “Fundamentals of Internal Combustion Engines”, 2nd Edition Prentice Hall of India, 2013.
4. Mathur M.L and Mehta F.S., “Thermal Science and Engineering”, 3rd Edition, Jain Brothers Pvt. Ltd, 2017.
5. Soman. K, “Thermal Engineering”, 2nd Edition, Prentice Hall of India, 2011.

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	2	1	-	-	-	-	-	-	1	3	2	**2**
2	3	3	3	2	1	-	-	-	-	-	-	1	3	2	**2**
3	3	3	3	2	1	-	-	-	-	-	-	1	3	2	**2**
4	3	3	3	2	1	-	-	-	-	-	-	1	3	2	**2**
5	3	3	3	2	1	-	-	-	-	-	-	1	3	2	**2**
Avg	3	3	3	2	1	-	-	-	-	-	-	1	3	2	**2**

PTME3403	METAL CUTTING AND MACHINE TOOLS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

To Impart Knowledge on science of metal cutting through the application of mechanics of machining, material properties, and other relevant engineering knowledge.

UNIT I THEORY OF METAL CUTTING 9

Need for metal cutting, Classification of metal cutting processes, Mechanics of orthogonal and oblique cutting, forces in machining, Shear stress and shear strain in metal cutting, Types of chip, Nomenclature of single point cutting tool, Material factors – work piece materials and cutting tool materials, Tribological aspects in metal cutting - friction at the tool-chip interface, cutting fluids, thermal aspects - cutting temperatures, their measurement and heat transfer models, effect of process parameters, tool wear and mechanisms, tool life, surface integrity - surface roughness, machining induced microstructural changes, Machinability

UNIT II TURNING MACHINES 9

Centre lathe, constructional features, specification, Specification of cutting tool inserts and tool holders as per ISO standard, operations – taper turning methods, thread cutting methods, special attachments, machining time and power estimation. Capstan and turret lathes - tool layout – automatic lathes: semi-automatic – single spindle: Swiss type, automatic screw type – multi spindle.

UNIT III ROTATING CUTTING TOOLS, GEAR CUTTING AND BROACHING 9

Drilling - geometry of helical drills, special modifications to improve drill performance, Allied operations - reaming, boring, tapping, Milling - Classification - Horizontal vs Vertical and Conventional vs Climb milling - types of milling cutters - Surface finish in milling – machining time calculations - Gear cutting, gear hobbing and gear shaping – gear finishing methods; broaching machines: broach construction – push, pull, surface broaching.

UNIT IV ABRASIVE PROCESSES 9

Grinding - Mechanics of grinding and specific energy in grinding, grinding wheel – specifications and selection, types of grinding process – cylindrical grinding, surface grinding, centreless grinding, internal grinding; Surface integrity in grinding - Traditional micro-/nano-finishing methods - Honing, Lapping, Superfinishing - Typical applications, Hybrid mass finishing of AM parts.

UNIT V COMPUTER NUMERICAL CONTROL MACHINE TOOLS 9

Computer Numerical Control (NC) machine tools – Need, types, constructional details, special features - ball screws, ATC, sensors, machining centre, part programming fundamentals – G-codes and M-codes, manual part programming and computer assisted part programming.

TOTAL 45 PERIODS

COURSE OUTCOMES:

CO1 Analyze the variables governing metal cutting process and the mechanics behind metal cutting.

CO2 Determine the machining parameters of turning process and select appropriate automates.

CO3 Explain the need for milling & hole making processes and various gear cutting methods.

CO4 Analyze the process parameters and the physics of grinding, and explain the commonly used abrasive finishing processes

CO5 Develop CNC part programs for machining and turning centers.

TEXT BOOKS:

1. Kalpakjian. S, “Manufacturing Engineering and Technology”, Pearson Education India Edition, 2009.
2. Roy. A. Lindberg, Processes and materials of manufacture, PHI / Pearson education, 2006.

REFERENCES:

1. Geofrey Boothroyd, “Fundamentals of Metal Machining and Machine Tools”, McGraw Hill, 1984.
2. HMT – “Production Technology”, Tata McGraw Hill, 1998.
3. Richerd R Kibbe, John E. Neely, Roland O.Merges and Warren J.White “Machine Tool Practices”, Prentice Hall of India, 1998.
4. Rao. P.N “Manufacturing Technology,” Metal Cutting and Machine Tools, Tata McGraw- Hill, New Delhi, 2003.
5. Stephen Malkin, Grinding Technology: Theory and Applications of Machining with Abrasives, Industrial Press, 2nd Edition, 2008
6. Michael Fitzpatrick, Machining and CNC Technology, McGraw-Hill Education; 3rd edition, 2013.

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2	3	3	2	2	2	-	-	-	2	3	3	1
2	3	3	2	3	-	-	-	-	-	-	-	-	3	2	-
3	3	3	2	3	-	-	-	-	-	-	-	-	3	1	-
4	3	3	2	3	2	-	-	-	-	-	-	-	3	3	-
5	3	3	3	3	3	-	-	-	-	-	-	2	3	3	1
Avg	3	3	2.2	3	2.7	2	2	2	-	-	-	2	3	2.4	1

PTME3404	POWER GENERATION TECHNOLOGIES	L	T	P	C
		3	0	0	3

OBJECTIVE:
To understand the working of different power plants, analyse their performance and compute/compare their respective cost of power generation.

UNIT I HYDRO POWER PLANTS 9
Energy scenario – Global and National. Hydro Power Plants - Essential elements and classification - Layout - Selection of turbines – SHP - Pumped storage plants.

UNIT II COAL, OIL AND GAS TURBINE POWER PLANTS 9
Cycle analysis - Layout of modern coal based power plant. Super Critical Boilers - FBC Boilers. Subsystems – Water and Steam, Fuel and ash handling, Air and Gas, Draught system.

Diesel and Gas Turbine power plants- Layout and Functioning.

UNIT III NUCLEAR POWER PLANTS 9
Layout and subsystems. Fuels and Nuclear reactions. Boiling Water Reactor, Pressurized Water Reactor, Fast Breeder Reactor, Gas Cooled and Liquid Metal Cooled Reactors – working and Comparison. Safety measures

UNIT IV RENEWABLE ENERGY POWER PLANTS 9
Solar power plants – Photovoltaic and Thermal. Wind power plants – Vertical and Horizontal axis. Biomass power plants – Gasification and Combustion. Tidal, OTEC and Wave Power plants. Geothermal plants. Fuel cell – Types. Hybrid Power Plants – Wind and Solar.

UNIT V ECONOMICS OF POWER GENERATION 9
Load and load duration curves. Electricity billing – Tariff structures. Wheeling and Banking. Economics of power plant – Fixed and variable cost – computation of per unit cost of electricity.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon completion of this course the students will be able to:
1. Describe the working of a hydro-electric power plant and select appropriate turbine
2. Compare the pro's and con's of coal, diesel and gas turbine power plants
3. Enumerate components associated with the nuclear power plants
4. Apply suitable technologies for harnessing renewable energy
5. Understand the cost of power generation from different fuel sources

TEXT BOOKS:
1. P.K. Nag, "Power Plant Engineering", Tata McGraw Hill, 5th Edn. 2021.
2. Paul Breeze, "Power Generation Technologies", Elsevier Ltd., 2019.

REFERENCES:
1. Black and Veatch, "Power Plant Engineering", Indian edition, CBS Publishers and Distributors, Delhi, 2005.
2. M.M.El. Wakil, "Power Plant Technology", Tata McGraw Hill, 2010.
3. K. Rajput, "Power Plant Engineering", Laxmi Publications, 2016.
4. Janet Wood, "Nuclear Power", The Institution of Engineering and Technology, 2007.
5. B H Khan, Non-Conventional Energy Resources, 3rd Edition, McGraw Hill, 2017

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	3			2	1				1	2		2
2	2	2	2	2			2					2	2	1	
3	3	3	3	3	2	3	3	3		3		2	3	1	2
4	3	3	3	3	3	2	3	2				1	2	1	3
5	1	1	1	1	1						3	1			2
Avg	2.4	2.4	2.4	2.4	2	2.5	2.5	2		3	3	1.4	2.25	1	2.25

PTME3411 THERMAL ENGINEERING LABORATORY L T P C

0 0 3 1.5

COURSE OBJECTIVES:

To impart and give exposure to performance testing of various engine categories, components and fuel characterization

PART I IC ENGINE LABORATORY 30

LIST OF EXPERIMENTS

1. Valve Timing and Port Timing diagrams.
2. Actual p-v diagrams of IC engines.
3. Performance Test on four – stroke Diesel Engine.
4. Heat Balance Test on 4 – stroke Diesel Engine.
5. Morse Test on Multi-Cylinder Petrol Engine.
6. Retardation Test on a Diesel Engine.
7. Determination of p-θ diagram and heat release characteristics of an IC engine.
8. Determination of Flash Point and Fire Point of various fuels / lubricants
9. Performance test on a two stage Reciprocating Air compressor

PART II STEAM LABORATORY 15

List of Experiments:

1. Study of Steam Generators and Turbines.
2. Performance and Energy Balance Test on a Steam Generator.
3. Performance and Energy Balance Test on Steam Turbine.

TOTAL: 45

PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

1. Examine the performance of IC engines
2. Determine the valve overlap and scavenging periods
3. Evaluate the performance of boilers and steam turbines
4. Performance prediction of air compressors
5. Quantify the flash and fire point of any given fuel/lubricant

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	1	-	-	-	1	-	-	1	-	2	3	2	2
2	3	2	1	-	-	-	1	-	-	1	-	2	3	2	2
3	3	2	1	-	-	-	1	-	-	1	-	2	3	2	2
Avg	3	2	1	-	-	-	1	-	-	1	-	2	3	2	2

PTME3501	OPERATIONS RESEARCH	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

To impart the knowledge on Linear programming, Transportation, Inventory control, Queuing system, Project and Maintenance Management.

UNIT – I LINEAR PROGRAMMING PROBLEMS 9

OR-Definition - Phases - models, LP problem formulation – Graphical solution, GLPP, Standard and Canonical forms of LPP- simplex methods- Big M, Two phase methods, Alternate optimal solutions, Duality in LP and Revised Simplex method

UNIT – II TRANSPORTATION 9

Transportation problems- Basic feasible solution, Optimal solution By MODI method, Balanced and Unbalanced TP, Degeneracy, Production problems. Assignment problems – Hungarian method - Traveling salesman problems - Sheduling and Sequencing models- Johnson algorithm, n job 2 machines, n job 3 machines and n job m machines.

UNIT – III INVENTORY CONTROL 9

Types of inventory- Inventory cost - EOQ - Deterministic inventory problems – Purchase and Production models with and without shortages-EOQ with price breaks - Stochastic inventory problems - Multi product problems - Systems of inventory control (P and Q Systems)-Determination of buffer stock and re-order levels -Selective inventory control techniques (ABC, VED, SDE, etc.)

UNIT – IV QUEUING THEORY 9

Queuing system - Characteristics - symbols - Poisson process and exponential distribution –Single server queuing models - Multiserver queuing models, Simulation Monte Carlo technique- Inventory & Queuing problems.

UNIT – V PROJECT MANAGEMENT AND REPLACEMENT MODELS 9

Project management: Network logic – Ford-Fulkerson's rule - AON diagram - CPM and PERT techniques, Critical path and float calculations. Replacement models -types of failures – Gradual failures:- replacement of items: with and without change in money values, sudden failures- individual and group replacement policies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon the completion of this course the student will be able to

CO1 Select the constraints on the availability of resources, develop a model and render an optimal solution during the given circumstances

CO2 Analyze the challenges in the transportation and production problems and furnish a rational solution to maximize the benefits

CO3 Determine the purchase/ manufacturing policies to manage the safety stocks and meet the customer demands.

CO4 Categorize the different queue discipline and explore the avenues for better customer service

CO5 Evaluate the nature of the project/ failure and offer methodical assistance towards decision making.

TEXT BOOKS:

1. Wayne.L.Winston, “Operations research applications and algorithms”,4th edition,2004,Cengage learning
2. Hamdy A Taha, “Operations research an introduction”, 10th edition 2017, PHI/Pearson education.

REFERENCES:

1. Srinivasan G, “Operations research principles and applications”, 3rd edition EEE 2017, PHI.
2. Pannerselvam R, “Operations research”, 2nd edition 2009, PHI
3. Ravindran, Phillips and Solberg, “Operations research principles and practice”, 2nd edition 2007, Wiley India.
4. Sharma J K, “Operations research theory and applications”,5Th edition 2013, Macmillan India.
5. Prem kumar Gupta and D.S.Hira, “Problems in Operations research”,2009 S.Chand

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	3	3	-	-	-	-	-	3	-	3	3	3
2	3	3	3	3	3	-	-	-	-	-	3	-	3	3	3
3	3	3	3	3	3	-	-	-	-	-	3	-	3	3	3
4	3	3	3	3	3	-	-	-	-	-	2	-	3	2	3
5	3	3	3	3	3	-	-	-	-	-	3	-	3		3
Avg	3	3	3	3	3	-	-	-	-	-	2.6	-	3	2.2	3

PTME3502	COMPUTER AIDED DESIGN AND MANUFACTURE	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

The main learning objectives of this course is to provide knowledge on Geometric modelling and CNC part programming.

UNIT I COMPUTER AIDED DESIGN 9

Product cycle- Design process- sequential and concurrent engineering- Computer aided design – CAD system architecture- Computer graphics – co-ordinate systems- 2D and 3D transformations- homogeneous coordinates-Line drawing -Clipping- viewing transformation-visual realism.

UNIT II GEOMETRIC MODELLING 9

Representation of curves- Hermite curve- Bezier curve- B-spline curves-rational curves- Techniques for surface modeling – surface patch- Coons and bicubic patches- Bezier and B spline surfaces. Solid modeling techniques- CSG and B-rep – Introduction to model storage –Data structures for interactive modeling- integration of design analysis and CAD-customization and design automation.

UNIT III CAD STANDARDS and CAD CAM INTERFACE 9

Graphics and computing standards- Data exchange standards- IGES-STEP – communication standards- current trends in manufacturing engineering- Group technology-design for manufacture and assembly – process planning techniques – Total approach to product development – techniques of quality engineering – QFD and FMEA – Taguchi methods –Additive Manufacturing.

UNIT IV COMPUTER NUMERICAL CONTROL 9

Fundamentals of Numerical control – CNC technology – CNC hardware basics- CNC Tooling and machine tools- Control systems – CNC Programming – Manual programming – Machining and Turning Centre Programming - Computer assisted part programming – APT language structure and commands.

UNIT V INFORMATION AND INTEGRATION OF MANUFACTURING SYSTEMS 9

Information Requirements of Manufacturing - Group Technology and Computer Aided Process Planning- production planning and control- Integration of Manufacturing Systems: Communications - Material-Handling Systems- Flexible Manufacturing Systems - Computer Aided Quality Control - introduction to Computer Integrated Manufacturing- Future of CAD/CAM

TOTAL : 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

CO1 Apply the fundamental concepts of computer graphics and its tools in a generic framework.

CO2 Create and manipulating geometric models using curves, surfaces and solids.

CO3 Apply standard CAD practices in engineering design and to understand the need for integration of CAD and CAM

CO4 Apply CNC manual and computer assisted part programming for various manufacturing process

CO5 Discriminate the problems in Production Planning and Control.

TEXT BOOKS:

1. Groover, M. P., CAD/CAM: Computer-Aided Design and Manufacturing, Pearson Education, 2008.

REFERENCES:

1. P.N.Rao “CAD/CAM Principles and Applications” Tata McGraw-Hill Publication Co. New Delhi – 2006.
2. Ibrahim Zeid “Mastering CAD CAM” Tata McGraw-Hill Publishing Co.2007.
3. Chris McMahon and Jimmie Browne “CAD/CAM Principles, practice and manufacturing management “Pearson Education Asia – 2001
4. Donald Hearn and M. Pauline Baker “Computer Graphics”’. Prentice Hall, Inc, 1992.

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	1	3	1	2	-	-	1	-	2	-	2	3	1	-
2	3	1	2	1	2	-	-	1	-	2	-	2	3	1	-
3	3	1	3	1	2	-	-	1	-	2	-	2	3	1	-
4	3	2	2	1	2	-	-	1	-	-	-	2	3	1	-
5	3	3	2	2	2	-	-	1	-	-	-	2	3	1	-
Avg	3	1.6	2.4	1.2	2	-	-	1	-	2	-	2	3	2	-

PTME3503	DESIGN OF MACHINE ELEMENTS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for familiarizing the various steps involved in the design process using standard practices and standard data, evaluating the design parameters of a component to satisfy functional and strength requirements.

UNIT I FUNDAMENTAL CONCEPTS IN DESIGN 9

Introduction to the design process - factors influencing machine design, selection of materials based on mechanical properties - Preferred numbers- Direct, Bending, and torsional loading- Modes of failure - Factor of safety – Combined loads – Principal stresses curved beams – crane hook and 'C' frame- theories of failure – Design based on strength and stiffness – stress concentration – Fluctuating stresses – Endurance limit –Design for finite and infinite life under variable loading - Exposure to standards.

UNIT II DESIGN OF SHAFTS AND COUPLINGS 9

Shafts and Axles - Design of solid and hollow shafts based on strength, rigidity, and critical speed – Keys and splines – Rigid and flexible couplings.

UNIT III DESIGN OF JOINTSAND POWER SCREWS 9

Threaded fasteners - Bolted joints – Simple and eccentrically loaded bolted joints- Welded joints – Butt, Fillet and parallel transverse fillet welds – welded joints subjected to bending, torsional Terminology of Power Screw- Torque Requirement- Self-Locking screw- Efficiency of Screws-Collar Friction Torque.

UNIT IV DESIGN OF SPRINGSAND PIPE JOINTS 9

Types of springs, design of helical and concentric springs–Surge in springs, Design of laminated springs Introduction to pipe joints and fittings- soldered fittings-screwed connections - pipe connections- oval type flanged pipe joint

UNIT V DESIGN OF BEARINGS 9

Sliding contact and rolling contact bearings - Hydrodynamic journal bearings, Sommerfeld Number, Raimondi & Boyd graphs - Selection of Rolling Contact bearings - Seals and Gaskets.

TO 45 PERIODS

Note: Use of approved design data book is permitted.

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

CO1 Design machine members subjected to static and variable loads.
CO2 Design shafts and couplings for various applications.
CO3 Design bolted, welded joints and power screws for various kinds of loads.
CO4 Design helical, leaf springs, and pipe joints for various applications.
CO5 Design sliding and rolling contact bearings

TEXT BOOKS:

1. Bhandari V B, "Design of Machine Elements", 4th Edition, Tata McGraw-Hill Book Co, 2016
2. Joseph Shigley, Richard G. Budynas and J. Keith Nisbett "Mechanical Engineering Design" 10th Edition, Tata McGraw-Hill, 2015.

REFERENCES:

1. Ansel C Ugural, "Mechanical Design – An Integral Approach", 1st Edition, Tata McGraw-Hill Book Co, 2004.
2. Design Data Hand Book", PSG College of Technology, Coimbatore, 2013.

3. Merhyle Franklin Spotts, Terry E. Shoup, and Lee EmreyHornberger, “Design of Machine Elements” 8th Edition, Printice Hall, 2004.
4. Robert C. Juvinall and Kurt M. Marshek, “Fundamentals of Machine Component Design”,6th Edition, Wiley, 2017.
5. Sundararajamoorthy T. V. and Shanmugam. N, “Machine Design”, Anuradha Publications, Chennai, 2003.

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	2	-	-	-	1	1	1	-	2	3	2	2
2	3	3	3	2	-	-	-	1	1	1	-	2	3	2	2
3	3	3	3	2	-	-	-	1	1	1	-	2	3	2	2
4	3	3	3	2	-	-	-	1	1	1	-	2	3	2	2
5	3	3	3	2	-	-	-	1	1	1	-	2	3	2	2
Avg	3	3	3	2	-	-	-	1	1	1	-	2	3	2	2

PTME3504	FINITE ELEMENT ANALYSIS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

To apply the concepts of the finite element analysis to solve multi-dimensional problems in engineering.

UNIT I INTRODUCTION 9

Historical Background – Mathematical Modeling of field problems in Engineering – Governing Equations – Discrete and continuous models – Boundary, Initial and Eigen Value problems– Weighted Residual Methods – Variational Formulation of Boundary Value Problems – Ritz Technique – Basic concepts of the Finite Element Method.

UNIT II ONE-DIMENSIONAL PROBLEMS 9

One Dimensional Second Order Equations – Discretization – Element types- Linear and Higher order Elements – Derivation of Shape functions and Stiffness matrices and force vectors-Assembly of Matrices - Solution of problems from solid mechanics including thermal stresses-heat transfer. Natural frequencies of longitudinal vibration and mode shapes. Fourth Order Beam Equation – Transverse deflections and Transverse Natural frequencies of beams.

UNIT III TWO DIMENSIONAL SCALAR VARIABLE PROBLEMS 9

Second Order 2D Equations involving Scalar Variable Functions – Variational formulation – Finite Element formulation – Triangular elements and Quadrilateral elements- Shape functions and element matrices and vectors. Application to Field Problems - Thermal problems – Torsion of Non-circular shafts.

UNIT IV TWO DIMENSIONAL VECTOR VARIABLE PROBLEMS 9

Equations of elasticity – Plane stress, plane strain and axisymmetric problems – Constitutive matrices and Strain displacement matrices – Stiffness matrix – Stress calculations - Plate and shell elements.

UNIT V ISOPARAMETRIC FORMULATION AND ADVANCED TOPICS 9

Natural co-ordinate systems – Isoparametric elements – Shape functions for isoparametric elements– One and two dimensions – Serendipity elements – Numerical integration - Meshing techniques - Introduction to Analysis Software-Introduction to Non Linearity.

TOTAL:45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

CO1 Develop mathematical models for Boundary Value Problems and their numerical solution

CO2 Formulate the Finite Element methodology to solve the one-dimensional problems

CO3 Estimate field variables for two-dimensional scalar variable problems

CO4 Determine field variables for two-dimensional vector variable problems

CO5 Apply the Iso-parametric transformation and use the numerical integration techniqu engineering problems.

TEXT BOOKS:

1. Rao, S.S., “The Finite Element Method in Engineering”, 6th Edition, Butterw Heinemann,2018.

REFERENCES:

1. David Hutton, “Fundamentals of Finite Element Analysis”, Tata McGrawHill, 2005
2. Dhanaraj. R and Prabhakaran Nair. K, “Finite Element Analysis”, Oxford Publications, 20
3. Robert D. Cook, David S. Malkus, Michael E. Plesha, Robert J. Witt, “Concepts Applications of Finite Element Analysis”, 4th Edition, Wiley Student Edition, 2004.
4. Seshu.P, “Text Book of Finite Element Analysis”, PHI Learning Pvt. Ltd., NewDelhi, 201
5. TirupathiR.Chandrupatla and Ashok D. Belegundu, “Introduction to Finite Elemen Engineering”, International Edition, Pearson Education Limited, 2014.

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2	2	2	-	-	1	-	-	2	1	3	2	2
2	3	3	3	3	2	-	-	1	-	-	1	2	3	2	2
3	3	3	3	2	3	-	-	1	-	-	2	2	3	2	2
4	3	3	3	3	2	-	-	1	-	-	1	2	3	2	2
5	3	3	2	2	3	-	-	1	-	-	2	1	3	2	2
Avg	3	3	2.6	2.4	2.4	-	-		-	-	1.6	1.6	3	2	2

PTME3505	HYDRAULICS AND PNEUMATICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To make students conversant with the fluid power principles, and different types of hydraulic pumps.
2. To impart knowledge about the various types of hydraulic actuators and control components.
3. To inculcate the skills to design and develop hydraulic circuits and systems.
4. To familiarize the students with the design of pneumatic circuits.
5. To provide the knowledge of trouble shooting methods in fluid power systems.

UNIT – I FLUID POWER PRINICIPLES AND HYDRAULIC PUMPS 9

Introduction to Fluid power – Advantages and Applications – Fluid power systems – Types of fluids – Properties of fluids and selection – Basics of Hydraulics – Pascal's Law – Principles of flow – Friction loss – Work, Power and Torque- Problems, Sources of Hydraulic power : Pumping Theory – Pump Classification – Construction, Working, Design, Advantages, Disadvantages, Performance, Selection criteria of pumps – Fixed and Variable displacement pumps – Problems.

UNIT – II HYDRAULIC ACTUATORS AND CONTROL COMPONENTS 9

Hydraulic Actuators: Cylinders – Types and construction, Application, Hydraulic cushioning – Rotary Actuators – Hydraulic motors - Control components: Direction Control, Flow control and pressure control valves – Types, Construction and Operation – Accessories: Reservoirs, Pressure Switches – Filters –types and selection- Applications – Fluid Power ANSI Symbols – Problems.

UNIT – III HYDRAULIC CIRCUITS AND SYSTEMS 9

Accumulators, Pressure Intensifiers, Industrial hydraulic circuits – Regenerative, Pump Unloading, Double Pump, Air-over oil, Sequence, Reciprocation, Synchronization, Fail-Safe, Speed Control, Deceleration circuits, Sizing of hydraulic systems, Hydrostatic transmission, Electro hydraulic circuits – Servo and Proportional valves – Applications – Mechanical, hydraulic servo systems, Case Studies.

UNIT – IV PNEUMATIC AND ELECTRO PNEUMATIC SYSTEMS 9

Properties of air – Air preparation and distribution – Filters, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust Valves, Pneumatic actuators, Design of Pneumatic circuit –classification single cylinder and multi cylinder circuits – Cascade method –Integration of fringe circuits, Electro Pneumatic System – Elements – Relay ladder diagram – timer circuits – Problems, PLC – Logic ladder diagram – Controlling Fluid power actuators, Case Studies.

UNIT – V TROUBLE SHOOTING AND APPLICATIONS 9

Installation, Selection, Maintenance, Trouble Shooting and Remedies in Hydraulic and Pneumatic systems, Conditioning of hydraulic fluids Design of hydraulic circuits for Drilling, Planning, Shaping, Surface grinding, Press and Forklift applications. Design of Pneumatic circuits for metal working, handling, clamping counter and timer circuits – Low cost Automation – Hydraulic and Pneumatic power packs, Case Studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

1. Apply the principles of fluid power systems, and select relevant hydraulic pumps for the fluid power applications.
2. Select necessary control components and hydraulic actuators for the fluid power applications.
3. Design and develop hydraulic circuits and systems.
4. Design and develop pneumatic circuits and systems.
5. Solve problems and troubles in fluid power systems.

TEXT BOOKS:

1. Anthony Esposito, “Fluid Power with Applications”, Prentice Hall, 2009
2. James A. Sullivan, “Fluid Power Theory and Applications”, Prentice Hall, 1997

REFERENCES:

1. Shanmugasundaram.K., “Hydraulic and Pneumatic Controls”. Chand & Co, 2006.
2. Jagadeesha. T., “Pneumatics Concepts, Design and Applications “, Universities Press, 2015.
3. Joshi.P., Pneumatic Control”, Wiley India, 2008.
4. Srinivasan.R., “Hydraulic and Pneumatic Controls”, Vijay Nicole Imprints, 2008.
5. Majumdar, S.R., “Oil Hydraulics Systems – Principles and Maintenance”, Tata McGraw Hill, 2001.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	1	1	1	-	-	-	-	-	-	-	1	3	1	3
2	3	1	1	1	-	-	-	-	-	-	-	1	3	1	3
3	3	3	3	3	-	-	-	-	-	-	-	1	3	1	3
4	3	3	3	3	-	-	-	-	-	-	-	1	3	1	3
5	3	3	3	2	-	-	-	-	-	-	-	1	3	1	3
Avg	3	2.2	2.2	2	-	-	-	-	-	-	-	1	3	1	3

		L	T	P	C
PTME3601	**DESIGN OF TRANSMISSION SYSTEMS**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for designing mechanical power transmission elements.

UNIT I DESIGN OF FLEXIBLE ELEMENTS 9

Motor power capacity for various applications - Design of Flat belts and pulleys - Selection of V belts and sheaves – Selection of wire ropes and pulleys – Design of Transmission Chains and Sprocket.

UNIT II SPUR ANDHELICAL GEARS 9

Gear materials - Design of straight tooth spur & helical gears based on speed ratios, number of teeth, Fatigue strength, Factor of safety, strength, and wear considerations. Force analysis –Tooth stresses - Dynamic effects - Helical gears – Module - normal and transverse, Equivalent number of teeth – forces.

UNIT III BEVEL ANDWORMGEARS 9

Straight bevel gear: Gear materials - Tooth terminology, tooth forces, and stresses, equivalent number of teeth, estimation of dimensions of straight bevel gears. Worm Gear: Gear materials - Tooth terminology, Thermal capacity, forces and stresses, efficiency, estimation of dimensions of worm gear pair.

UNIT IV GEARBOXES 9

Need - Design of sliding and constant mesh gearboxes: Speed selection - Geometric progression - Standard step ratio - Ray diagram, kinematic layout – Determination of a number of teeth. Design of multi-speed gearbox for machine tool applications, Variable speed gearbox, Fluid Couplings, and Torque Converters for automotive applications.

UNIT V CLUTCHES AND BRAKES 9

Design of single and multi-plate clutches, cone clutches, internal expanding rim clutches, and Electromagnetic clutches. Design of brakes: External shoe brakes - Single and Double Shoe, Internal expanding shoe brakes, and Band brakes.

TOTAL : 45 PERIODS

Note: Use of approved design data book is permitted.

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

CO1 Design flexible elements like belts, ropes, and chain drives for engineering applications.

CO2 Design spur and helical gear drives for power transmission.

CO3 Design bevel and worm drives for power transmission.

CO4 Design multi-speed gearbox for machine tools and automotive applications.

CO5 Design clutch and brake systems for engineering applications.

TEXT BOOKS:

1. Shigley. J., Mischke. C., Budynas, R., and Nisbett. K., “Mechanical Engineering Design”, 10th Edition, Tata McGraw-Hill,2014.
2. Sundararajamoorthy. T. V. and Shanmugam. N., “Machine Design”, 9th Edition, Anuradha Publications, Chennai,2003
3. Bhandari V, “Design of Machine Elements”, 15th Reprint, Tata McGraw-Hill Book Co,2014

REFERENCES:

1. Bernard Hamrock, Steven Schmid, Bo Jacobson, “Fundamentals of Machine Elements”,2nd Edition, Tata McGraw Hill,2006
2. Sen and Bhattacharya, “Principles of Machine Tools”, New Central Book Agencies,1975.
3. C.S.Sharma, KamleshPurohit, “Design of Machine Elements”, Prentice Hall of India,Pvt. Ltd., 2003
4. Design Data Hand Book, PSG College of Technology, 2013-Coimbatore
5. GitinMaitra,L. Prasad “Handbook of Mechanical Design”, 2nd Edition, Tata McGraw- Hill,2001
6. Md. Jalaludeen , Machine Design, Volume II, Design of Transmission Systems, 4th edition, Anuradha Publications,2014
7. Prabhu. T.J., “Design of Transmission Elements”, Mani Offset, Chennai,2003
8. Robert C. Juvinall and Kurt M. Marshek, “Fundamentals of Machine component Design”,5th Edition, Wiley, 2011.

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	2	-	-	-	1	-	-	-	2	3	1	2
2	3	3	3	2	-	-	-	1	-	-	-	2	3	1	2
3	3	3	3	2	-	-	-	1	-	-	-	2	3	1	2
4	3	3	3	2	-	-	-	1	-	-	-	2	3	1	2
5	3	3	3	2	-	-	-	1	-	-	-	2	3	1	2
Avg	3	3	3	2	-	-	-	1	-	-	-	2	3	1	2

PTME3602	METROLOGY AND MEASUREMENTS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

To impart knowledge on dimensional, form and surface finish measurement in manufacturing

UNIT I BASICS OF METROLOGY 9

Measurement – Need, Process, Role in quality control; Factors affecting measurement - SWIPE; Errors in Measurements – Types – Control – Measurement uncertainty – Types, Estimation using GUM approach and Monte Carlo method, Problems on Estimation of Uncertainty, Statistical analysis of measurement data, Measurement system analysis, Estimation of Gage R&R using Range and average method and ANOVA, Calibration of measuring instruments, ISO standards, Metrological requirements for accredited laboratories.

UNIT II MEASUREMENT OF LINEAR AND ANGULAR DIMENSIONS 9

Linear Measuring Instruments – Vernier caliper, Micrometer, Vernier height gauge, Depth Micrometer, Bore gauge, Telescoping gauge; Gauge blocks – Use and precautions, Comparators – Working and advantages; Optical measurements - measuring microscope and profile projector for dimensional measurements, Displacement measurement sensors for inline quality control - laser displacement sensor, chromatic confocal distance sensor and laser optical micrometer - Angular measuring instruments – Bevel protractor, Clinometer, Angle gauges, Precision level, Electronic level, Sine bar, Autocollimator, Angle dekkor, Alignment telescope.

UNIT III TOLERANCE ANALYSIS 9

Sources of Variation, Tolerancing – Interchangeability, Selective assembly, Tolerance representation, Terminology, Limits and Fits, Design of Limit gauges. Tolerance analysis in manufacturing, Process capability, tolerance stackup analysis – Worst case analysis and root sum of squares analysis, tolerance charting.

UNIT IV METROLOGY OF SURFACES 9

Fundamentals of GD & T - Conventional vs Geometric tolerance, Interpretation of GD&T Symbols in engineering drawings, Datums, Inspection of geometric parameters like straightness, flatness, roundness, perpendicularity, parallelism, symmetry, runout. Material conditions - concept of bonus tolerance, Simple problems. Measurement of Surface finish – Functionality of surfaces, Parameters, Surface roughness representation in engineering drawings, Comparative, Stylus based and Optical Measurement techniques, Filters – Selection of cut-off length, Introduction to 3D surface metrology- Parameters.

UNIT V ADVANCES IN METROLOGY 9

Lasers in metrology - Advantages of lasers – Laser interferometers – Applications – Straightness, Alignment; Ball bar tests, Computer Aided Metrology - Basic concept of CMM – Types of CMM – Constructional features – Probes – Accessories – Software – Applications – Multi-sensor CMMs – Articulated CMMs. Machine Vision - Basic concepts of Machine Vision System – Elements – Applications - On-line and in-process monitoring in production; Digital Metrology solutions – X ray Computed tomography; White light Scanners / Structured light scanners; Metrology for e-mobility; Role of Metrology in I4.0 / Smart Manufacturing, Requirements for Metrology for I4.0.

TOTAL:45 PERIODS

COURSE OUTCOMES:

CO1 To describe the importance of measurements in engineering and the factors affecting measurements and to estimate measurement uncertainty.

CO2 To describe the working principle and applications of various linear and angular contact and non-contact measuring instruments.

CO3 To analyse the effect of tolerance in manufacturing, interpret the various tolerance symbols given in engineering drawings to choose the appropriate manufacturing process.

CO4 To describe the principles and methods of form and surface metrology.

CO5 To describe the advances in measurements for quality control in manufacturing Industries.

TEXT BOOKS:

1. Dotson Connie, "Fundamentals of Dimensional Metrology", Cengage Learning, Sixth edition, 2016.
2. Mark Curtis, Francis T. Farago, "Handbook of Dimensional Measurement", Industrial Press, Fifth edition, 2013

REFERENCES:

1. Ammar Grous, J "Applied Metrology for Manufacturing Engineering", Wiley-ISTE, 2011.
2. Galyer, J.F.W. Charles Reginald Shotbolt, "Metrology for Engineers", Cengage Learning EMEA; 5th revised edition, 1990.
3. Raghavendra N.V. and Krishnamurthy, L., Engineering Metrology and Measurements, Oxford University Press, 2013.
4. Venkateshan, S. P. "Mechanical Measurements", Second edition, John Wiley & Sons, 2015.
5. NPL Measurement good practice guides relevant to the syllabus – No. 40, No. 41, No. 42, No. 43, No. 80, No. 118, No. 130, No. 131.

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2		2	-	3	3	2	2	-	-	1	3	2	1
2	2		3	2	-	-	-	-	2	2	-	-	3	3	-
3	2	2	2	2	-	-	2	2	-	-	-	-	3	2	-
4		3	-	3	2	-	-	-	-	-	-	-	3	3	-
5	-	-	-	3	3	-	-	-	-	-	-	-	3	3	-
Avg	2.3	2.3	2.5	2.4	2.5	3	2.5	2	2	2	-	1	3	2.6	1

PTGE3851 HUMAN VALUES AND ETHICS L T P C
2 0 0 2

COURSE DESCRIPTION

This course aims to provide a broad understanding about the modern values and ethical principles that have evolved and are enshrined in the Constitution of India with regard to the democratic, secular and scientific aspects. The course is designed for undergraduate students so that they could study, understand and apply these values in their day to day life.

COURSE OBJECTIVES:

- To create awareness about values and ethics enshrined in the Constitution of India
- To sensitize students about the democratic values to be upheld in the modern society.
- To inculcate respect for all people irrespective of their religion or other affiliations.
- To instill the scientific temper in the students' minds and develop their critical thinking.
- To promote sense of responsibility and understanding of the duties of citizen.

UNIT I DEMOCRATIC VALUES 6

Understanding Democratic values: Equality, Liberty, Fraternity, Freedom, Justice, Pluralism, Tolerance, Respect for All, Freedom of Expression, Citizen Participation in Governance – World Democracies: French Revolution, American Independence, Indian Freedom Movement.
Reading Text: Excerpts from John Stuart Mills' *On Liberty*

UNIT II SECULAR VALUES 6

Understanding Secular values – Interpretation of secularism in Indian context - Disassociation of state from religion – Acceptance of all faiths – Encouraging non-discriminatory practices.

Reading Text: Excerpt from *Secularism in India: Concept and Practice* by Ram Puniyani

UNIT III SCIENTIFIC VALUES 6

Scientific thinking and method: Inductive and Deductive thinking, Proposing and testing Hypothesis, Validating facts using evidence based approach – Skepticism and Empiricism – Rationalism and Scientific Temper.

Reading Text: Excerpt from *The Scientific Temper* by Antony Michaelis R

UNIT IV SOCIAL ETHICS 6

Application of ethical reasoning to social problems – Gender bias and issues – Gender violence – Social discrimination – Constitutional protection and policies – Inclusive practices.

Reading Text: Excerpt from *21 Lessons for the 21st Century* by Yuval Noah Harari

UNIT V SCIENTIFIC ETHICS 6

Transparency and Fairness in scientific pursuits – Scientific inventions for the betterment of society - Unfair application of scientific inventions – Role and Responsibility of Scientist in the modern society.

Reading Text: Excerpt from *American Prometheus: The Triumph and Tragedy of J.Robert Oppenheimer* by Kai Bird and Martin J. Sherwin.

TOTAL: 30 PERIODS

COURSE OUTCOMES

Students will be able to

CO1 :Identify the importance of democratic, secular and scientific values in harmonious functioning of social life

CO2 : Practice democratic and scientific values in both their personal and professional life.

CO3 : Find rational solutions to social problems.

CO4 : Behave in an ethical manner in society

CO5 : Practice critical thinking and the pursuit of truth.

REFERENCES:

1. The Nonreligious: Understanding Secular People and Societies, Luke W. Galen Oxford University Press, 2016.
2. Secularism: A Dictionary of Atheism, Bullivant, Stephen; Lee, Lois, Oxford University Press, 2016.
3. The Oxford Handbook of Secularism, John R. Shook, Oxford University Press, 2017.
4. The Civic Culture: Political Attitudes and Democracy in Five Nations by Gabriel A. Almond and Sidney Verba, Princeton University Press,
5. Research Methodology for Natural Sciences by Soumitro Banerjee, IISc Press, January 2022

PTME3611	SIMULATION AND ANALYSIS LABORATORY	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVE:

The main objective of this course is to prepare the students for learning the basics of simulation and analysis tools.

SIMULATION

1. Introduction to MATLAB, MATLAB basics, Dealing with matrices, Graphing-Functions of one variable and two variables
2. Simulation of Spring-mass system using MATLAB
3. Solving the simple problems in vibration
4. Simulation of the working principle of air conditioning system
5. Simulation of the working principle of hydraulic and pneumatic cylinder
6. Simulation of the working principle of cam and follower mechanism
7. Simulation of quick return mechanism

ANALYSIS

LIST OF EXPERIMENTS

Use of any finite element analysis software for following problems:

1. Force and Stress analysis using link elements in Trusses, cables and bars.
2. Stress and deflection analysis in beams with different support conditions.
3. Stress analysis of flat plates and simple shells.
4. Stress analysis of axi – symmetric components.
5. Thermal stress and heat transfer analysis of fins, plates and cylinders.
6. Vibration analysis of spring-mass systems.
7. Modal analysis of Beams.
8. Harmonic, transient and spectrum analysis of simple systems

TOTAL:45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

CO1 Simulate and analyze the response of mechanical systems.
CO2 Analyze structural and thermal problems.
CO3 Perform dynamic analysis of mechanical components

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	3	3	-	-	1	3	2	-	3	3	3	3
2	3	3	3	3	3	-	-	1	3	2	-	3	3	3	3
3	3	3	3	3	3	1	1	1	3	2	-	3	3	3	3
Avg	3	3	3	3	3	1	1	1	3	2	-	3	3	3	3

PTME3701	MECHATRONICS AND IoT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

To impart knowledge on the principles of sensors, actuators, micro-controllers, Programmable Logic control, Arduino and Raspberry Pi and IOT.

UNIT – I SENSORS AND ACTUATORS 9

Introduction to Mechatronics - Modular Approach, Sensors and Transducers: Static and Dynamic Characteristics, Transducers - Resistive, Capacitive, Inductive and Resonant, Optical Sensors – Photodetectors - Vision Systems – Laser - Fibre optic - Non-fibre Optic, Solid State Sensors, Piezoelectric and Ultrasonic Sensors. Actuators – Brushless Permanent Magnet DC Motor – PM, VR and Hybrid Stepper motors – DC and AC Servo Motors.

UNIT – II SIGNAL CONDITIONING CIRCUITS AND PLC 9

Operational Amplifiers – Inverting and Non-Inverting Amplifier – Wheatstone bridge – Instrumentation Amplifier – PID Controller, Protection Circuits, Filtering Circuits, Multiplexer, Data Logger and Data Acquisition System, Switching Loads by Power Semiconductor Devices Circuits – Thyristors – TRIAC – Darlington Pair – MOSFET and Relays. PLC – Architecture – Input / Output Processing – Logic Ladder Programming – Functional Block Programming using Timers and Counters – Applications.

UNIT – III FUNDAMENTALS OF IoT AND EMBEDDED SYSTEMS 9

The Internet of Things (IoT) - Introduction to the IoT Framework – IoT Enabling Technologies- The Effective Implementation of IoT: The Detailed Procedure. Embedded Systems: An Introduction - Single-Chip Microcontroller Systems - Single-Board Microcontroller Systems - Single-Board Computer Systems - Embedded Systems: Peripherals - Software Considerations

UNIT – IV ARDUINO AND RASPBERRY Pi 9

Arduino: The Arduino Boards - Arduino Peripherals- Arduino IDE – ESP8266 Wi-Fi module. Raspberry Pi: The Raspberry Pi Boards - The Raspberry Pi Peripherals - The Raspberry Pi Operating System. Interfacing and Controlling I/O devices by Arduino and Raspberry Pi: LEDs - Push buttons - Light intensity sensor - Ultrasonic distance sensor – Temperature sensor- Humidity sensor - Sensor and Actuator interactions

UNIT – V MECHATRONICS AND IoT CASE STUDIES 9

Mechatronics systems: Aerial drone actuation and Control - Autonomous Robot with Vision System, Automotive Mechatronics: Electronic Ignition System - ABS - EBD - Adaptive Cruise Control. IoT case studies: Remote Monitoring Systems- Remotely Operated Autonomous Systems - Centralized Water Management System - IoT Enabled Robotic Camera Dolly - Portable, Wireless, Interactive IoT Sensors for Agriculture - IoT Vehicle Management System with Network Selection.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

1. Select suitable sensors and actuators to develop mechatronics systems
2. Devise proper signal conditioning circuit for mechatronics systems, and also able to implement PLC as a controller for an automated system.
3. Elucidate the fundamentals of IoT and Embedded Systems.
4. Implement Arduino and Raspberry Pi as controllers for automated systems.
5. Design and develop an apt mechatronics/IoT based system for the given real-time application.

Textbooks:

1. Bradley D.A., Burd N.C., Dawson D., Loader A.J., “Mechatronics: Electronics in Products and Processes”, Routledge, 2017.
2. Sami S.H and Kisheen Rao G, “The Internet of Mechanical Things: The IoT Framework for Mechanical Engineers”, CRC Press, 2022.

References:

1. John Billingsley, “Essentials of Mechatronics”, Wiley, 2006.
2. David H., Gonzalo S., Patrick G.,Rob B. and Jerome H.,“IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things”, Pearson Education, 2018.
3. Nitin G and Sharad S, “Internet of Things: Robotic and Drone Technology”, CRC Press, 2022.
4. Newton C. Braga, “Mechatronics For The Evil Genius”, McGraw Hill, 2005.
5. Bell C., “Beginning Sensor Networks with Arduino and Raspberry Pi”, Apress, 2013.
6. Bolton W., “Mechatronics”, Pearson Education, 2019.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	1	1	1	-	-	-	-	-	-	2	1	2	3
2	3	3	3	1	2	-	-	-	-	-	-	2	1	2	3
3	3	1	2	1	2	-	-	-	-	-	-	2	1	2	3
4	3	3	3	3	3	2	-	-	-	-	-	2	1	2	3
5	3	3	3	3	3	2	-	-	-	-	2	2	1	2	3
Avg	3	2.4	2.4	1.8	2.2	2	-	-	-	-	2	2	1	2	3

PTME3702 COMPUTER INTEGRATED MANUFACTURING

L	T	P	C
3	0	0	3

COURSE OBJECTIVE:

To impart knowledge on production planning & control, cellular manufacturing, flexible manufacturing system and role of robots in industrial automation**.**

UNIT – I FUNDAMENTALS OF CIM **9**

Various phases in Product Design and CAD, CAM, Concepts of CAD/CAM – Concurrent Engineering – CIM concepts and elements – Types of production – Manufacturing Metrics and Economics – Production Performance Metrics – Manufacturing Cost - Problems – Lean Production and Just-In-Time Production.

UNIT – II PRODUCTION PLANNING & CONTROL AND COMPUTER AIDED PROCESS PLANNING **9**

Production planning and Control System - Aggregate Production Planning and Master Production Schedule – Material Requirement Planning (MRP I) – Simple Problems – Capacity Planning – Shop Floor Control – Inventory Control – EOQ, WIP costs & Inventory Holding Costs - Simple Problems –Introduction to Manufacturing Resource Planning (MRP II) & Enterprise Resource Planning (ERP) –Process planning – Manual Process Planning and case studies Computer Aided Process Planning (CAPP).

UNIT – III AUTOMATION IN MANUFACTURING SYSTEMS **9**

Automation principles and strategies – Automation migration strategies – Basic Elements of an Automated system – Advanced Automation Functions – Levels of Automation. CNC – DNC – Automated assembly lines – Line balancing – Automated production lines – Automatic identification and data capture.

UNIT – IV CELLULAR MANUFACTURING AND FMS **9**

Group Technology(GT) - Part Families – Parts Classification and coding – Simple Problems in OPITZ Part Coding system – Production flow Analysis – Cellular Manufacturing – Composite part concept – Machine cell design and layout – Quantitative analysis in Cellular Manufacturing –Rank Order Clustering Method - Arranging Machines in a GT cell – Hollier Method – Performance Metrics in Cell Operation. FMS: Types of FMS & Flexibility – FMS Components – FMS Application & Benefits – FMS Planning and Implementation Issues – Quantitative analysis of Bottleneck Model in FMS.

UNIT – V INDUSTRIAL ROBOTICS AND AGVs **9**

Robot Anatomy and Related Attributes – Classification - Control systems – End Effectors –Sensors – Applications – Basics of Robot Part Programming – Robot Accuracy and Repeatability – Simple Problems. sensor - Sensor and Actuator interactions. Automated Guided Vehicle System (AGVS) –Types of AGVS - Applications – Vehicle Guidance technologies –Vehicle Management & Safety.

TOTAL :45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to:

1. Explain the fundamentals of CIM.
2. Identify and solve the problems in Production Planning and Control.
3. Apply the automation techniques in manufacturing systems.
4. Implement Cellular Manufacturing Processes and FMS.
5. Select and apply the suitable Robots and AGVs for industrial applications.

TEXT BOOKS:

1. Mikell .P. Groover, “Automation, Production Systems and Computer Integrated Manufacturing”, Pearson Education, 2018
2. Kant Vajpayee S, “Principles of Computer Integrated Manufacturing”, Prentice Hall India, 2003.

REFERENCES:

1. Gideon Halevi and Roland Weill, “Principles of Process Planning – A Logical Approach” Chapman & Hall, London, 1995.
2. Peter Scallan, “Process Planning: The design/manufacture interface,” Elsevier Science & Technology Books, 2003.
3. Radhakrishnan P., Subramanyan S. and Raju V., “CAD/CAM/CIM”, New Age International (P) Ltd, New Delhi, 2018.
4. Rao. P. N., Tewari. N. and Kundra. T.K., “Computer Aided Manufacturing”, Tata McGraw Hill Publishing Company, 2000.

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2	1	-	-	-	-	-	-	-	1	2	1	3
2	3	3	3	2	-	-	-	-	-	-	-	1	2	1	3
3	3	3	3	3	-	-	-	-	-	-	-	1	2	1	3
4	3	3	3	3	-	-	-	-	-	-	-	1	2	1	3
5	3	3	2	1	-	-	-	-	-	-	-	1	2	1	3
Avg	3	3	2.4	2	-	-	-	-	-	-	-	1	2	1	3

PTME3703	REFRIGERATION AND AIR CONDITIONING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:
To impart knowledge on principles of operations in different Refrigeration & Air conditioning systems and components.

UNIT – I INTRODUCTION 9
Introduction to Refrigeration - Unit of Refrigeration and C.O.P.– Ideal cycles- Refrigerants Desirable properties – Classification - Nomenclature - ODP & GWP.

UNIT – II VAPOUR COMPRESSION REFRIGERATION SYSTEM 9
Vapor compression cycle: p-h and T-s diagrams - deviations from theoretical cycle – subcooling and super heating- effects of condenser and evaporator pressure on COP- multipressure system –low temperature refrigeration - Cascade systems – problems. Equipments: Type of Compressors, Condensers, Expansion devices, Evaporators.

UNIT – III OTHER REFRIGERATION SYSTEMS 9
Working principles of Vapour absorption systems and adsorption cooling systems – Steam jet refrigeration- Ejector refrigeration systems- Thermoelectric refrigeration- Air refrigeration - MagneticVortex and Pulse tube refrigeration systems.

UNIT – IV PSYCHROMETRIC PROPERTIES AND PROCESSES 9
Properties of moist Air-Gibbs Dalton law, Specific humidity, Dew point temperature, Degree of saturation, Relative humidity, Enthalpy, Humid specific heat, Wet bulb temperature Thermodynamic wet bulb temperature, Psychrometric chart; Psychrometric of air-conditioning processes, mixing of air streams.

UNIT – V AIR CONDITIONING SYSTEMS AND LOAD ESTIMATION 9
Air conditioning loads: Outside and inside design conditions; Heat transfer through structure, Solar radiation, Electrical appliances, Infiltration and ventilation, internal heat load; Apparatus selection; fresh air load, human comfort & IAQ principles, effective temperature & chart, calculation of summer & winter air conditioning load; Classifications, Layout of plants; Air distribution system.

TOTAL:45 PERIODS

OUTCOMES:
At the end of the course the students would be able to:
1. Understand the basic concepts of Refrigeration
2. Analyse the performance of Vapor compression Refrigeration systems
3. Demonstrate the various types of Refrigeration systems
4. Predict the Psychrometric properties and its use in psychrometric processes
5. Know the concepts of Air conditioning and to able solve problems

TEXT BOOKS:

1. Arora, C.P., "Refrigeration and Air Conditioning", 3rd edition, McGraw Hill, New Delhi, 2010
2. R.S. Khurmi , J.K. Gupta Textbook of Refrigeration And Air-Conditioning., Fifth edition, S Chand and Company, 2022

REFERENCES:

1. ASHRAE Hand book, Fundamentals, 2010
2. JonesW.P., "Air conditioning engineering", 5th edition, Elsevier Butterworth-Heinemann, 2007
3. Roy J. Dossat, "Principles of Refrigeration", 4th edition, Pearson Education Asia, 2009.
4. Stoecker,W.F. and Jones J.W., "Refrigeration and Air Conditioning", McGraw Hill, New Delhi,1986.
5. A Textbook of Refrigeration and Air-Conditioning by R.K. Rajput | 1 January 2013

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	-	-	3	-	1	-	-	1	3	-	1
2	3	3	2	-	1	-	1	-	-	-	2	1	3	-	1
3	3	2	1	-	-	-	3	-	1	-	2	1	3	-	1
4	3	2	1	-	1	-	1	-	-	-	-	1	3	-	1
5	3	3	2	-	2	1	2	-	2	-	2	1	3	-	1
Avg	2.6	2.2	1.5	-	1.3	1	2	-	1.3	-	2	1	3	-	1

PTME3704	ADVANCED VEHICLE ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE

To impart knowledge on the recent advancement in vehicle engineering technologies

UNIT – I ELECTRIC VEHICLES **9**

EV architectures, advantages and disadvantages, Electrical and mechanical energy storage technologies, battery management. Performance of Electric Vehicles, Tractive effort, and Transmission requirement, Vehicle performance, Tractive effort in normal driving.

UNIT – II ELECTRIC VEHICLE MOTORS **9**

Electric Propulsion basics, motor capacity determination, Induction motor, DC motor, Permanent Magnet Motor, Switch Reluctance Motor, Configuration, Characteristics, Performance, and control of Drives.

UNIT – III AUTONOMOUS AND CONNECTED VEHICLES **9**

Vehicle-to-Vehicle Technology, Vehicle to Road and Vehicle to Vehicle Infrastructure, Basic Control System, Surroundings Sensing Systems, Role of Wireless Data Networks, Advanced Driver Assistance Systems, Basics of Radar System, Ultrasonic Sonar Systems, Lidar System, Camera Technology, Basics of Wireless Technology, Receiver System.

UNIT – IV AUTOMOTIVE NETWORKING **9**

Bus Systems – Classification, Applications in the vehicle, Coupling of networks, networked vehicles, Buses - CAN Bus, LIN Bus, MOST Bus, Bluetooth, Flex Ray, Diagnostic Interfaces.

UNIT – V ON-BOARD TESTING **9**

Integration of Sensor Data to On-Board Control Systems (OBD), OBD requirements, certification, enforcement, systems, testing, Catalytic converter and Exhaust Gas Recirculation system monitoring, Introduction to Cyber-physical system.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course the students would be able to

1. Acquire an overview of electric vehicles and their importance in automotive.
2. Discuss the characteristics and the selection of traction motor.
3. Comprehend the vehicle-to-vehicle and autonomous technology.
4. Explain the networking of various modules in automotive systems, communication protocols and diagnostics of the sub systems.
5. Be familiar with on-board diagnostics systems.

TEXT BOOKS:

1 John G Hayes and G AbaasGoodarzi, Electric Powertrain -, 1st Edition, John Wiley & Sons Ltd., 2018

2 Hussain T Mouftah, Melike Erol-kantarci and Samesh Sorour, Connected and Autonomous Vehicles in Smart Cities,CRC Press, 1st Edition, 2020.

REFERENCES:

1 Dominique Paret, Multiplexed Networks for Embedded Systems, John Wiley & Sons Ltd., 2007.

2 Hong Cheng, —Autonomous Intelligent Vehicles: Theory, Algorithms & Implementation‖, Springer, 2011

3 Advanced Technology Vehicles Manufacturing (ATVM) Loan Program (Energy Science, Engineering and Technology: Congressional Policies, Practices and Procedures)by Andrew M Wright and Harrison R Scott | 5 September 2012

4 Advanced Vehicle Technology by Heinz Heisler MSc BSc FIMI MIRTE MCIT | 17 July 2002

5 Advanced Motorsport Engineering: Units for Study at Level 3by Andrew Livesey | 1 September 2011

COs	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	2	1	1	-	-	-	-	-	-	1	3	2	2
2	3	2	2	1	1	-	-	-	-	-	-	1	3	2	2
3	3	2	2	1	1	-	-	-	-	-	-	1	3	2	2
4	3	2	2	1	1	-	-	-	-	-	-	1	3	2	2
5	3	2	2	1	1	-	-	-	-	-	-	1	3	2	2
Avg	3	2	2	1	1	-	-	-	-	-	-	1	3	2	2

PTME3801 **HEAT AND MASS TRANSFER** **L T P C**
4 0 0 4

COURSE OBJECTIVE:
To impart knowledge on fundamentals of heat and mass transfer and develop problem solving skills in its applications.

UNIT I CONDUCTION **12**
Heat Conduction Equation — Cartesian, Cylindrical and Spherical Coordinates with and without heat generation, Boundary Conditions, Thermal Contact Resistance, Critical radius of insulation.
Transient Heat Conduction – Plane wall, cylinder, sphere, Lumped systems, Semi-infinite solids, Heisler-Grobber charts.

UNIT II CONVECTION **12**
Classification of fluid flows, Energy & Momentum equations, Velocity & ThermalBoundary layers Free convection – Vertical, Horizontal, Inclined plates, Cylinders and Spheres.
Forced Convection – Entry region, heat transfer and pressure drop for fluid flow in tubes.Drag and heat transfer in External flow – flat plate, cylinders, spheres and tube banks.

UNIT III HEAT TRANSFER APPLICATIONS **12**
Fin Design – Uniform and non-uniform cross sectional area, fin performance, overall surface efficiency.
Heat Exchangers – Overall heat transfer coefficient, LMTD, ε-NTU method, TEMAclassification.
Boiling and Condensation — Physical mechanisms, Regimes and heat transfer calculations.

UNIT IV RADIATION **12**
Fundamental concepts — Radiation intensity, Black body radiation, View factor, Surface emission. Kirchhoff's law, Radiation heat transfer between two surfaces. Radiation shields, Thermal radiation network

UNIT V SIMULTANEOUS HEAT & MASS TRANSFER **12**
Machine Learning in Heat Transfer — Introduction, Linear regression and Neural networks. Boundary conditions, Fick's law of diffusion, Rate equations, Convective Mass Transfer, Analogy between Friction, Heat and Mass transfer coefficients.

TOTAL :60 PERIODS

COURSE OUTCOMES:
At the end of the course, the students will be able to
CO1 Apply the conduction equations for steady and transient conditions.
CO2 Solve problems involving free and forced convection heat transfer.
CO3 Estimate heat transfer in systems involving radiation heat transfer.
CO4 Analyse the heat transfer problems in real systems.
CO5 Relate heat and mass transfer processes.

TEXT BOOKS:

1. Yunus A. Çengel, Afshin J. Ghajar, Mehmet Kanoğlu, Heat and Mass Transfer:Fundamentals & Applications, McGraw Hill, 2019.
2. J. P. Holman, Heat Transfer, McGraw Hill, 2011.

REFERENCES:

1. Theodore L. Bergman, Adrienne S. Lavine, Frank P. Incropera, David P. DeWitt,Fundamentals of Heat and Mass Transfer, Wiley, 2020.
2. YVC Rao, Heat Transfer, Universities Press, 2001.
3. Frank Kreith, Raj M. Manglik, Principles of Heat Transfer, Cengage Learning, 2016.
4. C. Balaji, Balaji Srinivasan, Sateesh Gedupudi, Heat Transfer Engineering:Fundamentals and Techniques, Elsevier, 2020.
5. Charles H. Forsberg, Heat Transfer Principles and Applications, Elsevier, 2020.

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	1	-	-	-		-	1	-		1	3		2
2	3	2	1	-	-	-		-	1	-		1	3		2
3	2	3	2	-	1	-	2	-	2	-	2	1	3	1	2
4	3	2	1	-	-	-	1	-	1	-		1	3		2
5	2	2	2	-	2	-	2	-	1	-	1	1	3	1	2
Avg	2.6	2.2	1.2	-	1.2	-	1.6	-	1.2	-	1.2	1	3	1	2

PTME3811	PROJECT WORK	L	T	P	C
		0	0	6	3

COURSE OBJECTIVE:

To test the acquired engineering knowledge of students through design, fabrication, and computational skills

A project topic must be selected by the students in consultation with their guides. The ultimate aim of the project work is to deepen comprehension of mechanical principles by applying them to a new problem which may be the simulation, analysis, design and fabrication of mechanical systems for a specific application. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The project work is evaluated jointly by external and internal examiners constituted by the Head of the Department based on oral presentation and the project report.

If the student opts for semester long internship, the student shall undergo the internship in the Government Organizations/Reputed Industries with the due approval of Centre for Academic Course, Anna University. The student should submit the report after the report according the guidelines given by CAC.

TOTAL 90 PERIODS

COURSE OUTCOMES:

CO1 Manage the selection and initiation of individual projects and of portfolios of sustainable projects in the enterprise

CO2 Identify the concepts to relevant research problems and societal practical applications

CO3 Demonstrate a strong working knowledge of ethics and professional responsibility

CO4 Implement processes for successful resource, communication, and risk and change management.

CO5 Demonstrate effective organizational leadership and change management skills for projects and project teams.

PTME3001	ADDITIVE MANUFACTURING	L	T	P	C
		2	0	2	3

COURSE OBJECTIVES:

- To introduce the development of Additive Manufacturing (AM), various software tools, processes, and techniques to create physical objects that satisfy product development/prototyping requirements.

UNIT I INTRODUCTION 6

Overview - Need - Development of Additive Manufacturing (AM) Technology: Rapid Prototyping- Rapid Tooling - Rapid Manufacturing - Additive Manufacturing. AM Process Chain- ASTM/ISO 52900 Classification - Benefits. Applications: Building Printing - Bio Printing - Food Printing-Electronics Printing. Business Opportunities and Future Directions – Case studies: Automobile, Aerospace, Healthcare.

UNIT II DESIGN FOR ADDITIVE MANUFACTURING (DfAM) 6

Concepts and Objectives - AM Unique Capabilities - Part Consolidation – Topology Optimization- Generative design - Lattice Structures - Multi-Material Parts and Graded Materials - Data Processing: CAD Model Preparation - AM File formats: STL-Problems with STL- AMF Design for Part Quality Improvement: Part Orientation - Support Structure - Slicing - Tool Path Generation – Design rules for Extrusion based AM.

UNIT III VAT POLYMERIZATION AND DIRECTED ENERGY DEPOSITION 6

Photo polymerization: Stereolithography Apparatus (SLA)- Materials -Process – top down and bottom up approach - Advantages - Limitations - Applications. Digital Light Processing (DLP) - Process - Advantages - Applications. Continuous Liquid Interface Production (CLIP)Technology. Directed Energy Deposition: Laser Engineered Net Shaping (LENS)- Process - Material Delivery -Materials -Benefits -Applications.

.

UNIT IV POWDER BED FUSION AND MATERIAL EXTRUSION 6

Powder Bed Fusion: Selective Laser Sintering (SLS): Process - Powder Fusion Mechanism - Materials and Application. Selective Laser Melting (SLM), Electron Beam Melting (EBM): Materials - Process - Advantages and Applications. Material Extrusion: Fused Deposition Modeling (FDM)- Process-Materials -Applications and Limitations.

UNIT V OTHER ADDITIVE MANUFACTURING PROCESSES 6

Binder Jetting: Three-Dimensional Printing - Materials - Process - Benefits- Limitations - Applications.

Material Jetting: Multijet Modeling- Materials - Process - Benefits - Applications.

Sheet Lamination: Laminated Object Manufacturing (LOM)- Basic Principle- Mechanism: Gluing or Adhesive Bonding - Thermal Bonding- Materials-Application and Limitation.

30

ADDITIVE MANUFACTURING LABORATORY

Experiments

1. Modelling and converting CAD models into STL file.
2. Manipulation and error fixing of STL file.
3. Design and fabrication of parts by varying part orientation and support structures.
4. Fabrication of parts with material extrusion AM process.
5. Fabrication of parts with vat polymerization AM process.

Design and fabrication of topology optimized parts.

Equipment required - lab

1. Extrusion based AM machine
2. Resin based AM machine
3. Mechanical design software
4. Open-source AM software for STL editing manipulation and slicing.

30

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of this course students shall be able to:

CO1: Recognize the development of AM technology and how AM technology propagated into various businesses and developing opportunities.

CO2: Acquire knowledge on process of transforming a concept into the final product in AM technology.

CO3: Elaborate the vat polymerization and direct energy deposition processes and its applications.

CO4: Acquire knowledge on process and applications of powder bed fusion and material extrusion.

CO5: Evaluate the advantages, limitations, applications of binder jetting, material jetting and sheet lamination processes.

TEXT BOOKS:

1. Ian Gibson, David Rosen, Brent Stucker, MahyarKhorasani “Additive manufacturing technologies”. 3rd edition Springer Cham, Switzerland. (2021). ISBN: 978-3-030-56126-0
2. Andreas Gebhardt and Jan-Steffen Hötter “Additive Manufacturing: 3D Printing for Prototyping and Manufacturing”, Hanser publications, United States, 2015, ISBN: 978-1-56990-582-1.

REFERENCES:

1. Andreas Gebhardt, “Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing”, Hanser Gardner Publication, Cincinnati., Ohio, 2011, ISBN :9783446425521.
2. Milan Brandt, “Laser Additive Manufacturing: Materials, Design, Technologies, and Applications”, Woodhead Publishing., United Kingdom, 2016, ISBN: 9780081004333.
3. Amit Bandyopadhyay and Susmita Bose, “Additive Manufacturing”, 1st Edition, CRC Press., United States, 2015, ISBN-13: 978-1482223590.
4. Kamrani A.K. and Nasr E.A., “Rapid Prototyping: Theory and practice”, Springer., United States ,2006, ISBN: 978-1-4614-9842-1.
5. Liou, L.W. and Liou, F.W., “Rapid Prototyping and Engineering applications: A tool box for prototype development”, CRC Press., United States, 2011, ISBN: 9780849334092.

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	1	3	1	2	-	-	1	-	2	-	2	3	1	-
2	3	1	2	1	2	-	-	1	-	2	-	2	3	1	-
3	3	1	3	1	2	-	-	1	-	2	-	2	3	1	-
4	3	2	2	1	2	-	-	1	-	-	-	2	3	1	-
5	3	3	2	2	2	-	-	1	-	-	-	2	3	1	-
Avg	3	1.6	2.4	1.2	2	-	-	1		-	-	2	3	1	-

PTME3002	CONVENTIONAL AND FUTURISTIC VEHICLE TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE

To impart knowledge on both conventional and futuristic vehicle technologies.

UNIT – I ADVANCED ENGINE TECHNOLOGY 9

Gasoline Direct Injection, Common Rail Direct Injection, Variable Compression Ratio Turbocharged Engines, Electric Turbochargers, VVT, Intelligent Cylinder De-activation, After Treatment Technologies, Electric EGR, Current EMS architecture.

UNIT – II COMBUSTION TECHNOLOGY 9

Spark Ignition combustion, Compression Ignition Combustion, Conventional Dual Fuel Combustion, Low-Temperature Combustion Concepts– Controlled Auto Ignition, Homogeneous Charge Compression Ignition, Premixed Charge Compression Ignition, Partially Premixed Compression Ignition, Reactivity Controlled Compression Ignition, Gasoline Direct Injection Compression Ignition.

UNIT – III LOW CARBON FUEL TECHNOLOGY 9

Alcohol Fuels, Ammonia Fuel and Combustion, Methane Technology, Dimethyl Ether, Hydrogen Fuel Technology, Challenges, and way forward

UNIT – IV HYBRID AND ELECTRIC VEHICLE (BATTERY POWERED) 9

Conventional Hybrids (Conventional ICE + Battery), Modern Hybrids (RCCI/GDCI Engine + Battery), Pure Electric Vehicle Technology – Challenges and Way forward

UNIT – V FUEL CELL TECHNOLOGY 9

Fuel cells for automotive applications - Technology advances in fuel cell vehicle systems - Onboard hydrogen storage - Liquid hydrogen and compressed hydrogen - Metal hydrides, Fuel cell control system - Alkaline fuel cell - Road map to market.

TOTAL :45 PERIODS

OUTCOMES:

At the end of the course the students would be able to

1. Understand the latest trends in engine technology
2. Explain the need for advanced combustion technologies and their impact on reducing carbon footprint on the environment.
3. Analyze the basic characteristics of low carbon fuels, their impact over conventional fuels, and in achieving sustainable development goals.
4. Understand the working and energy flow in various hybrid and electric configurations.
5. Analyze the need for fuel cell technology in automotive applications.

TEXT BOOKS:

1. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
2. Rakesh Kumar Maurya, Characteristics and Control of Low-Temperature Combustion Engines. ISBN 978-3-319-68507-6 , SPRINGER

REFERENCES:

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
2. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003
3. Rand D.A.J, Woods, R & Dell RM Batteries for Electric vehicles, John Wiley & Sons, 1998
4. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
5. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	2	2	2	-	-	-	1	-	-	1	3	2	2
2	3	2	2	2	2	-	-	-	1	-	-	1	3	2	2
3	3	2	2	2	2	-	-	-	1	-	-	1	3	2	2
4	3	2	2	2	2	-	-	-	1	-	-	1	3	2	2
5	3	2	2	2	2	-	-	-	1	-	-	1	3	2	2
Avg	3	3	3	2	2	-	-	-	1	-	-	1	3	2	2

PTME3003	DIGITAL MANUFACTURING	L	T	P	C
		2	0	2	3

COURSE OBJECTIVES:

To study the various aspects of digital manufacturing, importance of DM in Product Life-cycle Management and Supply Chain Management in the digital work environment.

UNIT – I INTRODUCTION 6

Introduction – Need – Overview of Digital Manufacturing and the Past – Aspects of Digital Manufacturing: Product life cycle, Smart factory, and value chain management – Practical Benefits of Digital Manufacturing – The Future of Digital Manufacturing.

UNIT – II DIGITAL LIFE CYCLE & SUPPLY CHAIN MANAGEMENT 6

Collaborative Product Development, Mapping Requirements to specifications – Part Numbering, Engineering Vaulting, and Product reuse – Engineering Change Management, Bill of Material and Process Consistency – Digital Mock up and Prototype development – Virtual testing and collateral. Overview of Digital Supply Chain - Scope& Challenges in Digital SC - Effective Digital Transformation - Future Practices in SCM

UNIT – III SMART FACTORY 6

Smart Factory – Levels of Smart Factories – Benefits – Technologies used in Smart Factory – Smart Factory in IoT- Key Principles of a Smart Factory – Creating a Smart Factory – Smart Factories and Cybersecurity

UNIT – IV INDUSTRY 4.0 6

Introduction – Industry 4.0 –Internet of Things – Industrial Internet of Things – Framework: Connectivity devices and services – Intelligent networks of manufacturing – Cloud computing – Data analytics –Cyber physical systems –Machine to Machine communication – Case Studies.

UNIT – V STUDY OF DIGITAL TWIN 6

Basic Concepts – Features and Implementation – Digital Twin: Digital Thread and Digital Shadow- Building Blocks – Types – Characteristics of a Good Digital Twin Platform – Benefits, Impact & Challenges – Future of Digital Twins.

30

DIGITAL MANUFACTURING AND IoT LABORATORY

Experiments

1. Measure the Distance Using Ultrasonic Sensor and Make Led Blink Using Arduino
2. Detect the Vibration of an Object Using Arduino
3. Sense a Finger When it is Placed on Board Using Arduino
4. Temperature Notification Using Arduino
5. Switch Light On and Off Based on the Input of User Using Raspberry Pi
6. Connect with the Available Wi-Fi Using Arduino

30

OUTCOMES:

At the end of the course the students would be able to

1. Impart knowledge to use various elements in the digital manufacturing.

2. Differentiate the concepts involved in digital product development life cycle process and supply chain management in digital environment.

3. Select the proper procedure of validating practical work through digital validation in Factories.
4. Implementation the concepts of IoT and its role in digital manufacturing.
5. Analyse and optimize various practical manufacturing process through digital twin.

TEXTBOOKS:

1. Zude Zhou, Shane (Shengquan) Xie and Dejun Chen, Fundamentals of Digital Manufacturing Science, Springer-Verlag London Limited, 2012.
2. Alasdair Gilchrist, “Industry 4.0: The Industrial Internet of Things”, A press, 2016.

REFERENCES:

1. Lihui Wang and Andrew YehChing Nee, Collaborative Design and Planning for Digital Manufacturing, Springer-Verlag London Limited, 2009.
2. Andrew Yeh Chris Nee, Fei Tao, and Meng Zhang, “Digital Twin Driven Smart Manufacturing”, Elsevier Science., United States, 2019.
3. Alp Ustundag and EmreCevikcan, “Industry 4.0: Managing The Digital Transformation”, Springer Series in Advanced Manufacturing., Switzerland, 2017
4. Ronald R. Yager and Jordan PascualEspada, “New Advances in the Internet of Things”, Springer., Switzerland, 2018.
5. Ronald R. Yager and Jordan PascualEspada, “New Advances in the Internet of Things”, Springer., Switzerland, 2018.

CO	**PO**												**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	-	1	1	3	3	-	1	2	2	-	2	3	2	1
2	3	2	3	1	3	3	2	2	2	2	-	2	3	2	3
3	3	-	3	1	3	3	2	-	3	2	-	2	3	2	3
4	3	2	2	2	3	3	2	2	2	2	2	2	3	2	3
5	3	-	2	-	1	3	-	2	2	2	-	2	3	2	2
Avg	3	2	2.2	1.2	2.6	3	3	1.7	2.2	2	2	2	3	2	2.4

PTME3004	LEAN MANUFACTURING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

To introduce the basics of 6 SIGMA, methodologies of lean manufacturing & its tools

UNIT – I BASICS OF 6 SIGMA 9

Introduction to 6 Sigma, basic tools of six sigma like problem solving approach, standard deviation, normal distribution, various sigma levels with some examples, value for the enterprise, Variation, and sources of variation, Mean and moving the mean, Various quality costs, cost of poor quality.

UNIT – II INTRODUCTION TO LEAN MANUFACTURING TOOLS 9

Process Capability Indices, Cause and Effect diagram, Control Charts, Introduction to FMEA, APQP, PPAP. 3 foundational 6 Sigma methodologies: DMAIC, DMEDI, and Process Management DMEDI for process creation, DMAIC for process improvement and PDCA for sustaining improvements.

UNIT – III DEEPER UNDERSTADING METHODOLOGIES 9

What is a process, Why Process management, Keys to process management, Difference between process management and 6 Sigma, Introduction to Deming cycle, PDCA, DMAIC and continuous improvement, DMEDI for creation process, DMAIC Vs DMEDI with examples, Introduction to Toyota Production System, Six Sigma and Production System integration.

UNIT – IV LEAN ELEMENTS 9

Introduction to Lean Concepts like In-Built Quality, Concept of Right Part at the Right Time, Lead Time reduction, Optimum utilization of Capital, Optimum utilization of People. Understanding the Zero-defect concept and Metrics, Focus on Human Resources, Quality, Delivery, Cost. Building Zero defect capabilities, Cultural and Organizational aspects

UNIT – V IMPLEMENTATION AND CHALLENGES 9

Implementing Checks and Balances in the process, Robust Information Systems, Dashboard, follow up and robust corrective and preventive mechanism. Concept of Audits, and continuous improvement from gap analysis, risk assessments etc.

TOTAL :45 PERIODS

OUTCOMES:

At the end of the course the students would be able to:

1. Discuss the basics of 6 SIGMA
2. Elaborate the lean manufacturing tools.
3. Illustrate about the deeper understanding methodologies of Lean manufacturing.
4. Discuss lean concepts and its elements.
5. Describe the implementation and challenges of lean manufacturing.

TEXT BOOKS:

1 Quality Planning and Analysis- JM Juran& FM Gryna. Tata Mc Graw Hill
2 Lean Manufacturing: Principles to Practice by Akhilesh N. Singh, Bibliophile SouthAsia
3 The Toyota Way: 14 Management Principles
4 Gemba Kaizen: A Commonsense Approach to a Continuous Improvement Strategy,Masaki Imai

REFERENCES:

1. Quality Council of India https://qcin.org/ & its library. https://qcin.org/nbqp/knowledge_bank/
2. International Society of Six Sigma Professionals: https://isssp.org/about-us/
3. NPTEL / SWAYAM: https://nptel.ac.in/courses/110105123 : Six Sigma, Prof.Jitesh J Thakkar, IIT Kharagpur, Certification course. (Self- Learning).
4. Older / Previous editions of AIAG manuals on APQP, FMEA and PPAP. These are great sources of information on Quality Planning and has basics of Project Management and required skills.
5. Quality Management for Organizations Using Lean Six Sigma Techniques- Erick C Jones

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	1	2	1	1	-	-	-	1	-	3	1	1	2	1
2	1	1	2	1	1	-	-	-	1	-	3	1	1	2	1
3	1	1	2	1	1	-	-	-	1	-	3	1	1	2	1
4	1	1	2	1	1	-	-	-	1	-	3	1	1	2	1
5	1	1	2	1	1	-	-	-	1	-	3	1	1	2	1
Avg	1	1	2	1	1	-	-	-	1	-	3	1	1	2	1

PTME3005	MODERN ROBOTICS	L	T	P	C
		2	0	2	3

COURSE OBJECTIVE:

To impart knowledge on anatomy of robots, kinematics, different end effector, mobile robots and its societal applications

UNIT – I INTRODUCTION 9

Robot: Definition, History of Robotics, Robot Anatomy, Co-ordinate systems, types and classification, Configuration space and degrees of freedom of rigid bodies and robots, Configuration space topology and representation; configuration and velocity constraints; task space and workspace, Rigid-body motions, rotation matrices, angular velocities, and exponential coordinates of rotation, Homogeneous transformation matrices.

UNIT – II SIMULATION OF ROBOT KINEMATICS 9

Robot kinematics, Forward and inverse kinematics (two three four degrees of freedom), Forward and inverse kinematics of velocity, Homogeneous transformation matrices, translation, and rotation matrices Dennavit and Hartenberg (D-H) transformation, Dynamics of Open Chains, Trajectory Generation, motion planning, robot control: First- and second-order linear error dynamics, stability of a feedback control system.

UNIT – III GRASPING AND MANIPULATION OF ROBOTS 9

Kinematics of contact, contact types (rolling, sliding, and breaking), graphical methods for representing kinematic constraints in the plane, and form-closure grasping, Coulomb friction, friction cones, graphical methods for representing forces and torques in the plane, End effectors, grippers, types of gripper, gripper force analysis, and examples of manipulation and grasping.

UNIT – IV MOBILE ROBOTS 9

Mobile robot, Wheeled Mobile Robots: Kinematic models of omnidirectional and non-holonomic wheeled mobile robots, Controllability, motion planning, feedback control of non-holonomic wheeled mobile robots; odometry for wheeled mobile robots; and mobile manipulation. Reference Trajectory generation, feed forward control

UNIT – V APPLICATIONS OF ROBOTS 9

Application of robotic: industrial robots, Service robots, domestic and household robots, medical robots, defence robots, agricultural robots, space robots, Aerial robotics Role of robots in inspection, assembly, material handling, underwater, space and healthcare

TOTAL :45

OUTCOMES:

At the end of the course the students would be able to

1. Explain the definition, history of robotics and robot anatomy.
2. Develop the solutions for robot kinematics
3. Describe the grasping and manipulation of robots.
4. Explain mobile robot and manipulation.
5. Summarise the applications of robots in industry, Defence, domestic & household and medical field.

TEXT BOOKS:

1. Modern Robotics: Mechanics, Planning, and Control, by Kevin M. Lynch , Frank C. Park , Cambridge University Press; 1st edition (25 May 2017), ISBN-10 : 110715
2. Modern Robotics: Mechanics, Systems and Control, by Julian Evans, Larsen and Keller Education (27 June 2019), ISBN-10 : 1641720751

REFERENCES:

1. Modern Robotics: Designs, Systems and Control, by Jared Kroff, Willford Press (18 June 2019)ISBN-10 : 1682856763
2. Advanced Technologies in Modern Robotic Applications, by ChenguangYang , Hongbin Ma , Mengyin Fu, Springer; Softcover reprint of the original 1st ed. 2016 edition (30 May 2018), ISBN-10 : 981109263X
3. Modern Robotics: Building Versatile Machines, by Harry Henderson, Facts On File Inc; Illustrated edition (1 August 2006), ISBN-10 : 0816057451
4. Artificial Intelligence for Robotics, by Francis X. Govers, Packt Publishing Limited; Standard Edition (30 August 2018), ISBN-10 : 1788835441
5. Modern Robotics Hardcover by Lauren Barrett (Editor), Murphy & Moore Publishing (1 March 2022), ISBN-10 : 1639873732

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	3	3	-	-	-	-	-	-	2	1	2	3
2	3	3	3	3	3	-	-	-	-	-	-	2	1	2	3
3	3	3	3	3	3	-	-	-	-	-	-	2	1	2	3
4	3	3	1	-	3	-	-	-	-	-	-	2	1	2	3
5	3	1	1	-	-	3	3	-	-	-	-	2	1	2	3
Avg	3	2.6	2.2	3	3	3	3	-	-	-	-	2	1	1	3

PTME3006	GREEN MANUFACTURING DESIGN AND PRACTICES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

To familiarize the students with the environment for Green Manufacturing, concept of green manufacturing, green supply chain and green concepts in industries.

UNIT I ENVIRONMENT FOR GREEN MANUFACTURING AND LIFE CYCLE ASSESSMENT 9

Introduction - Principles of Green Manufacturing - Social Environment - Business Environment - Policy Environment - Environment Performance Index Score - Environmental effects of design -selection of natural friendly material - ECO design - Environmental Damage Material flow and cycles – Material recycling – Emission less manufacturing- Industrial Ecology – Pollution prevention – Reduction of toxic emission – Design for recycle.

UNIT II GREEN MANUFACTURING SUPPLY 9

Green Supply Chain (GSC) Issues in GSC - Techniques/Methods of Green Supply Chain – Monitoring Performance – Future Sustainable Supply Chains – Market Strategies Cases – Structure and Planning Cases.

UNIT III GREEN MANUFACTURING IN INDUSTRIES 9

Smart Factories and Electric Vehicles - Semiconductor - Manufacturing - Nano - Manufacturing - Future Industries - Competency and Performance - Understanding Green Consumers Behavior - Green Manufacturing in Agriculture

UNIT IV DESIGN FOR SUSTAINABILITY 9

Introduction to Sustainability, Principles and its effect on Design and Manufacturing – Green Design Methods and Tools – Industrial Ecology and Sustainability – Economics of Sustainable Engineering

UNIT V ANALYSIS AND DEVELOPMENT TECHNIQUES AND GREEN CO-RATING 9

Reliability and Factor Analysis of Preliminary Data - Qualitative Analysis - Life -Cycle Management - Fuzzy Techniques - Model Development Techniques – Interpretive Structural Modelling – Structural Equation Modelling – Ecological Footprint – Intent –

System Approach – Assessment Process – Types of Rating – Green CO – Benefits

TOTAL : 45 PERIODS

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

CO1 Perceive the Concept of a Green Manufacturing Environment
CO2 Conceptualize Green Supply Chain
CO3 Understand the current green trends in industries
CO4 Make sustainable choices for industrial production
CO5 To describe techniques of modelling and analysis of green manufacturing

TEXTBOOKS:

1. David A.Dornfeld – "Green Manufacturing: Fundamentals and Applications" – 1st Edition – USA – 2012. Springer Publications.
2. Balkan Cetinkaya, Richard Cuthbertson, Graham Ewer, Thorsten Klaas-Wissing, WojciechPiotrowicz, Christoph Tyssen, "Sustainable Supply Chain Management: Practical Ideas for Moving Towards Best Practice", 2011, Springer Science & Business Media.

REFERENCES:

1. Vikram Bali, RajniMohana, Ahmed A Elngar, Sunil Kumar Chawla, Gurpreet Singh –"Handbook of Sustainable Development Through Green Engineering and Technology" - 1st Edition – USA – 2022. CRC Press.
2. Chandan Deep Singh, Harleen Kaur –"Sustainable Green Development and Manufacturing Performance through Modern Production Techniques" – 1st Edition – USA – 2021. CRC Press.
3. Mrityunjay Singh, TatsukiOhji, Rajiv Asthana – " Green and Sustainable Manufacturing of Advanced Material" - 1st Edition – USA – 2015. Elsevier Publications.
4. J. Paulo Davim, "Green Manufacturing Processes and Systems" – 1st Edition – Heidelberg – 2014. Elsevier Publications.
5. Nand K. Jha – "Green Design and Manufacturing for sustainability" – 1st Edition – USA – 2016, CRC Press, Taylor & Francis Group.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	2	-	-	1	-	-	-	-	1	2	-	-
2	3	2	1	2	-	-	1	-	-	-	-	1	2	-	-
3	3	2	1	2	-	-	1	-	-	-	-	1	2	-	-
4	3	2	1	2	-	-	1	-	-	-	-	1	2	-	-
5	3	2	1	2	-	-	1	-	-	-	-	1	2	-	-
Avg	3	2	1	2	-	-	1	-	-	-	-	1	2	-	-

PTME3007	ENVIRONMENTAL SUSTAINABILITY AND IMPACT ASSESSMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

To make students understand the concepts of environmental impact Assessment and life cycle assessment

UNIT I CONCEPTS OF ENVIRONMENTAL IMPACT ASSESSMENT 9

Environment-Environmental Impacts-Impact Analysis-Impact Assessment and Impact Statement- EIA- As an Integral Part of the Planning Process-Conceptual frame works for EIA Legislative development- Indian directive, Principles of Indian Constitution for protection of environment- Global.

UNIT II DETAILED CONTENTS OF EIA 9

Introduction-Project Description-Description of The Environment-Anticipated Environmental Impacts and Mitigation Measures-Analysis of Alternatives-Environmental Monitoring Programme-Additional studies-Project Benefits-Environmental Cost Benefit Analysis.

UNIT III SUSTAINABILITY ASSESSMENT 9

Plan for mitigation of adverse impact on the environment – options for mitigation of impact on water, air and land, flora and fauna; Addressing the issues related to the Project Affected People – ISO 14000-Sustainability assessment-concept models and various approaches-product sustainability and risk assessment-corporate social responsibility- Carbon credits-carbon trading and carbon footprint-legal provisions for environmental protection.

UNIT IV LIFE CYCLE ASSESSMENT 9

Fundamentals of Life Cycle Assessment- Scope and goal of Life Cycle Analysis (LCA)- Circular economy-Future of LCA- Triple bottom line approach-Bio-mimicking-Environment Impact Assessment (EIA)- Industrial ecology and industrial symbiosis-Environmental Life Cycle Costing.

UNIT V ENVIRONMENTAL IMPACT ASSESSMENT AMENDMENTS 9

Spatial economics- EIA notification September 2006 and amendments-Categorization of projects-Procedure for getting environmental clearance-Public participation in environmental decision-making process-Case studies on EIA for Industries and Infrastructure projects.

TOTAL : 45 PERIODS

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

CO1 Explain the concepts of Environmental Impact analysis
CO2 Examine different environmental attributes and select the environmental parameters affecting the project

CO3 Apply various methods to Predict the Environmental impacts of the project after deciding various environmental attributes
CO4 Perform life cycle assessment and assess environmental impacts of manufacturing processes
CO5 Understand the EIA report for getting Environmental Clearance

TEXTBOOKS:

1. Atkinson G, Dietz S, Neumayer E, “Handbook of sustainable manufacturing” Edward Elgar Publishing limited, 2014
2. Rodick, D, “Industrial Development for the 21 st century: Sustainable development perspectives” UN New York, 2007

REFERENCES:

1. Christian N. Madu,”Handbook of Environmentally Conscious Manufacturing” Springer Cham, Aug 2022
2. Lawn.P, “Sustainable development indicators in ecological economics”, Edward Elgar Publishing limited, 2006
3. Asefa, “The economics of sustainable development”, WE Upjohn institute for employment research, 2005
4. Dornfeld, David (Ed), “Green manufacturing: fundamentals and applications”, Springer Science & Business Media,2012
5. Klemes J, “Sustainability in the process industry”, McGraw Hill, 2011

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	1	1	2	-	-	-	2	-	1	-	3	1	1	2	2
2	1	1	2	-	-	-	2	-	1	-	3	1	1	2	2
3	1	1	2	-	-	-	2	-	1	-	3	1	1	2	2
4	1	1	2	-	-	-	2	-	1	-	3	1	1	2	2
5	1	1	2	-	-	-	2	-	1	-	3	1	1	2	2
Avg	1	1	2	-	-	-	2	-	1	-	3	1	1	2	2

PTME3008 GREEN SUPPLY CHAIN MANAGEMENT

L	T	P	C
3	0	0	3

COURSE OBJECTIVE:

To familiar with the modern lead free electronic manufacturing processes, recycling of electronics, and reliability assessment.

UNIT – I INTRODUCTION TO GREEN ELECTRONICS **9**

Environmental concerns of the modern society- Overview of electronics industry and their relevant regulations in China, European Union and other key countries- global and regional strategy and policy on green electronics industry. Restriction of Hazardous substances (RoHS) - Waste Electrical and electronic equipment (WEEE - Energy using Product (EuP) and Registration - Evaluation, Authorization and Restriction of Chemical substances (REACH).

UNIT – II GREEN ELECTRONICS MATERIALS AND PRODUCTS **9**

Basics of IC manufacturing and its process – Electronics with Lead (Pb) -free solder pastes, conductive adhesives, Introduction to green electronic materials and products - halogen-free substrates and components. Substitution of non-recyclable thermosetting polymer based composites with recyclable materials X-Ray Fluorescence (XRF) for identifying hazardous substances in electronic products

UNIT – III GREEN ELECTRONICS ASSEMBLY AND RECYCLING **9**

Various processes in assembling electronics components - the life-cycle environmental impacts of the materials used in the processes - substrate interconnects. Components and process equipments - Technology and management on e-waste recycle system construction, global collaboration, and product disassembles technology.

UNIT – IV PRODUCT DESIGN AND SUSTAINABLE ECO-DESIGN **9**

Stages of product development process in green design: Materials- Manufacturing - Packaging and use - End of Life and disposal - Design for recycling - Life Cycle Assessment (LCA), and Eco-design tools - Environmental management systems, and International standards - Eco-design in electronics industry.

UNIT – V CASE STUDIES **9**

Reliability of green electronics systems , Reuse and recycle of End-of-Life(EOL) electrical and electronic equipment for effective waste management – Introduction of Green Supply Chain, and Modeling green products from Supply Chain point of view - A life-cycle assessment for eco-design of Cathode Ray Tube Recycling.

TOTAL:45 PERIODS

OUTCOMES:

At the end of the course the students would be able to:

1. Get concise awareness of standards and legislation of modern electronic manufacturing for green environment.
2. Explain the conventional electronic processing and lead free electronic manufacturing techniques.
3. Realize the assembly process and the need of recycle of electronics
4. Use reliability and product life cycle estimation tools for electronic manufacturing.
5. Validate the green electronic manufacturing procedures in applications.

TEXT BOOKS:

1. Green Supply Chain Management, by CharisiosAchillas , Dionysis D. Bochtis , DimitriosAidonis, Routledge; 1st edition (16 November 2018), ISBN-10 : 1138644617
2. Sammy G. Shina, Green Electronics Design and Manufacturing, McGraw Hill., 2008.

REFERENCES:

1. David Austen, Green Electronic Morning, Ingleby Gallery, 2006.
2. John Hu. Mohammed Ismail, CMOS High Efficiency on – Chip Power Management, Springer Publications 4th edition, 2011.
3. Yuhang yang and Maode Ma, Green Communications and Networks, Springer Publication., 2014.
4. SankaGanesan, Michael Pecht, Lead free Electronics, John Wiley & Sons, 2006.
5. Charles A. Harper, Electronic Materials and Processes Hand book, McGraw-Hill, 2010.
6. Sammy G. Shina, Green Electronics Design and Manufacturing, McGraw Hill., 2008.

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	1	1	2	-	-	-	2	-	1	-	3	1	1	2	2
2	1	1	2	-	-	-	2	-	1	-	3	1	1	2	2
3	1	1	2	-	-	-	2	-	1	-	3	1	1	2	2
4	1	1	2	-	-	-	2	-	1	-	3	1	1	2	2
5	1	1	2	-	-	-	2	-	1	-	3	1	1	2	2
Avg	1	1	2	-	-	-	2	-	1	-	3	1	1	2	2

PTME3009	CASTING AND WELDING PROCESSES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

To study the casting of ferrous and non-ferrous alloys casting and their metallurgy and its applications.

UNIT – I FERROUS CAST ALLOYS 9

Solidification of pure metals and alloys and eutectics -Nucleation - Growth Process, Critical nucleus size- Super cooling- Niyama Criterion -G/R ratio- Cell- Dendritic - Random dendritic structure-Segregation and Coring- Eutectics-Compositions and alloys in Cast Irons, FG-CGI- SG structures, Metallic Glass- Mold dilation, Mold metal reactions- Structure and Section sensitivity Cast irons- family & microstructures-Alloying effects- Malleable Iron, ADI, Charge calculations- Effect of normal elements and alloying elements in steels- Compositional aspects and properties of alloy steels-melting procedure and composition control for carbon steels- low alloy steels - stainless steels- composition control- slag-metal reactions-desulphurization-dephosphorization, specifications for carbon steels- low alloy steels and stainless steels

UNIT – II NON-FERROUS CAST ALLOYS 9

Copper- Aluminium- Magnesium- zinc - Nickel base alloys- melting practices - Al alloys, Mg alloys, Nickel alloys, Zinc alloys and copper alloys-modification and grain refinement of Al alloys- problems in composition control- degassing techniques -Heat Treatment of Aluminium alloys – Basics of Solution and Precipitation process. - Applications of Aluminium Alloy castings in various fields. Residual Stresses- defects in castings

UNIT – III PHYSICAL METALLURGY OF WELDING 9

Welding of ferrous materials: Iron- Iron carbide diagram, TTT and CCT diagrams, effects of steel composition, formation of different microstructural zones in welded plain-carbon steels. Welding of C-Mn and low-alloy steels, phase transformations in weld and heat - affected zones, cold cracking, role of hydrogen and carbon equivalent, formation of acicular ferrite and effect on weld metal toughness.

UNIT – IV WELDING OF ALLOY STEELS AND NON-FERROUS METALS 9

Welding of stainless steels, types of stainless steels, overview of joining ferritic and martensitic types, welding of austenitic stainless steels, Sensitisation, hot cracking, sigma phase and chromium carbide formation, ways of overcoming these difficulties, welding of cast iron. Welding of non-ferrous materials: Joining of aluminium, copper, nickel and titanium alloys, problems encountered and solutions

UNIT – V DEFECTS, WELDABILITY AND STANDARDS 9

Defects in welded joints: Defects such as arc strike, porosity, undercut, slag entrapment and hot cracking, causes and remedies in each case. Joining of dissimilar materials, weldability and testing of weldments. Introduction to International Standards and Codes

TOTAL:45 PERIODS

OUTCOMES:

At the end of the course the students would be able to:

1. Explain the ferrous casting metallurgy and its applications.
2. Explain the non-ferrous casting metallurgy and its applications.
3. Explain the ferrous welding metallurgy and its applications.
4. Explain the welding metallurgy of alloy steels and non ferrous metals and its applications.
5. Identify the causes and remedies of various welding defects; apply welding

standards and codes.

TEXTBOOKS:

1. Heine R W, Loper C R and Rosenthal P C, "Principles of Metal Castings", Tata McGraw Hill, 2017.
2. A.K.Chakrabarthi, ‘Casting Technology and Cast Alloys,Prentice Hall, 2005.

REFERENCES:

1. ASM International. Handbook Committee, ASM Handbook: Casting. Volume 15, ASM International, 2008.
2. Baldev Raj, Shankar V, Bhaduri A K, “Welding Technology for Engineers”, Narosa Publications, 2009.
3. Beeley P, “Foundry Technology" Butterworth-Heinemann, 2001.
4. R.S.Parmar, ‘Welding Engineering and Technology’, Khanna Publishers, 2010
5. John Campbell, “Casting", Butterworth-Heinemann, 2003.

COs	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	1	1	2	2	-	-	-	-	1	-	-	1	2	1	1
2	1	1	2	2	-	-	-	-	1	-	-	1	2	1	1
3	1	1	2	2	-	-	-	-	1	-	-	1	2	1	1
4	1	1	2	2	-	-	-	-	1	-	-	1	2	1	1
5	1	1	2	2	-	-	-	-	1	-	-	1	2	1	1
Avg	1	1	2	2	-	-	-	-	1	-	-	1	2	1	1

PTME3010	COMPOSITE MATERIALS AND MECHANICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

To study the processing of different types of composite material and mechanics approach to design a laminate

UNIT – I INTRODUCTION, LAMINA CONSTITUTIVE EQUATIONS & MANUFACTURING 9

Definition –Need – General Characteristics, Applications. Fibers – Glass, Carbon, Ceramicand Aramid fibers. Matrices – Polymer, Graphite, Ceramic and Metal Matrices – Characteristics of fibers and matrices. Lamina Constitutive Equations: Lamina Assumptions – Macroscopic Viewpoint. Generalized Hooke's Law. Reduction to Homogeneous Orthotropic Lamina – Isotropic limit case, Orthotropic Stiffness matrix (Qij), Typical Commercial material properties, Rule of Mixtures. Generally Orthotropic Lamina – Transformation Matrix, Transformed Stiffness. Manufacturing:Bag Moulding Compression Moulding – Pultrusion – Filament Winding – Other Manufacturing Processes

UNIT – II FLAT PLATE LAMINATE CONSTITUTE EQUATIONS 9

Definition of stress and Moment Resultants. Strain Displacement relations. Basic Assumptions of Laminated anisotropic plates. Laminate Constitutive Equations – Coupling Interactions, Balanced Laminates, Symmetric Laminates, Angle Ply Laminates, Cross Ply Laminates. Laminate Structural Moduli. Evaluation of Lamina Properties from Laminate Tests. Quasi-Isotropic Laminates. Determination of Lamina stresses within Laminates.

UNIT – III LAMINA STRENGTH ANALYSIS 9

Introduction - Maximum Stress and Strain Criteria. Von-Misses Yield criterion for Isotropic Materials. Generalized Hill's Criterion for Anisotropic materials. Tsai-Hill's Failure Criterion for Composites. Tensor Polynomial (Tsai-Wu) Failure criterion. Prediction of laminate Failure

UNIT – IV THERMAL ANALYSIS 9

Assumption of Constant C.T. E's. Modification of Hooke's Law. Modification of Laminate Constitutive Equations. Orthotropic Lamina C.T. E's. C.T. E's for special Laminate Configurations –Unidirectional, Off-axis, Symmetric Balanced Laminates, Zero C.T.E laminates, Thermally Quasi-Isotropic Laminates

UNIT – V ANALYSIS OF LAMINATED FLAT PLATES 9

Equilibrium Equations of Motion. Energy Formulations. Static Bending Analysis. Buckling Analysis.
Free Vibrations – Natural Frequencies

TOTAL :45 PERIODS

OUTCOMES:

At the end of the course the students would be able to:

1. Summarize the various types of Fibers, Equations and manufacturing methods
2. Derive Flat plate Laminate equations
3. Analyze Lamina strength
4. Analyze the thermal behavior of Composite laminates
5. Analyze Laminate flat plates

TEXT BOOKS:

1. Gibson, R.F., "Principles of Composite Material Mechanics", Second Edition, McGraw-Hill, CRC press in progress, 1994, -.

2. Hyer, M.W., “Stress Analysis of Fiber – Reinforced Composite Materials”, McGraw Hill, 1998

REFERENCES:

1. Agarwal, B.D., and Broutman L.J., “Analysis and Performance of Fiber Composites”, John Wiley and Sons, New York, 1990.
2. Halpin, J.C., “Primer on Composite Materials, Analysis”, Technomic Publishing Co., 1984.
3. Issac M. Daniel and Ori Ishai, “Engineering Mechanics of Composite Materials”, Oxford University Press-2006, First Indian Edition - 2007
4. Mallick, P.K., Fiber,” Reinforced Composites: Materials, Manufacturing and Design”, Maneel Dekker Inc, 1993.
5. Mallick, P.K. and Newman, S., (edition), “Composite Materials Technology: Processes and Properties”, Hansen Publisher, Munish, 1990.

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	2	3	3	-	2	2	-	-	-	-	2	3	-	-
2	2	2	2	2	-	2	2	-	-	-	-	2	3	-	-
3	2	2	2	2	-	2	2	-	-	-	-	2	3	-	-
4	2	2	2	2	-	2	2	-	-	-	-	2	3	-	-
5	2	2	2	2	-	2	2	-	-	-	-	2	3	-	-
Avg	2	2	2.2	2.2	-	2	2	-	-	-	-	2	3	-	-

PTME3011	COMPUTATIONAL FLUID DYNAMICS AND HEAT TRANSFER	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To impart the knowledge on the basics of CFD and its significance of solving capability of the industrial oriented problems.
2. To understand the use of FDM and FVM discretization techniques for solving steady and transient diffusion problems.
3. To study the concept of use of FVM for solving convection diffusion problems
4. To provide insights of CFD concept for incompressible flow analysis
5. To understand the significance of various types of turbulence modelling

UNIT I GOVERNING EQUATIONS AND BOUNDARY CONDITIONS 9

Introduction and application of Computational Fluid Dynamics – Governing equations for Transport Phenomena– Continuity, Momentum and Energy equations – Types of boundary conditions – Types of discretization techniques - Types of Partial Differential Equations - Initial and Boundary value problems.

UNIT II FINITE DIFFERENCE AND FINITE VOLUME METHODS FOR DIFFUSION PROBLEMS 9

Finite difference formulations - Taylor series of expansion – Numerical error and order of accuracy – Finite volume formulation – Solving of steady and transient diffusion problems using Finite Difference and Finite Volume methods.

UNIT III FINITE VOLUME METHOD FOR CONVECTION DIFFUSION PROBLEMS 9

Introduction to convection diffusion problems - Central, upwind differencing schemes,
Hybrid and Power-law schemes - Analysis of properties of discretization schemes - Conservativeness, Boundedness, Transportiveness.

UNIT IV INCOMPRESSIBLE FLOW ANALYSIS 9

Momentum equation - Equivalent Formulations for the Navier Stokes Equations - Primitive and Non-Primitive Variables method - Collocated and Staggered grid – SIMPLE algorithm and its variants – PISO Algorithms.

UNIT V TURBULENCE MODELS AND MESH GENERATION 9

Reynolds Averaging – RANS - Turbulence models, mixing length model, Two equation (k-Є) models – High and low Reynolds number models, Mesh Generation and refinement Techniques – Introduction to use of simulation software tools.

TOTAL : 45

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

CO1 Understand the need of CFD for solving industrial problems
CO2 Apply the concept of FDM and FVM for diffusion problems
CO3 Analytical skills to solve convection diffusion problems by using various discretization schemes
CO4 Familiarize the role of various algorithm used for incompressible flow analysis.
CO5 Assess the different turbulence models as well as the simulation software tools.

TEXT BOOKS:

1. 1. Versteeg and Malalasekera, N, “An Introduction to Computational Fluid Dynamics - The Finite Volume Method,” Pearson Education, Ltd., Second Edition, 2014.
2. Ghoshdastidar P S, “Computer Simulation of fluid Flow and Heat Transfer”, 1998, Tata McGraw-Hill.

REFERENCES:

1. Subas, V.Patankar, “Numerical heat transfer fluid flow”, Hemisphere Publishing Corporation, 1980.
2. Muralidhar, K., and Sundararajan, T., “Computational Fluid Flow and Heat Transfer”, Narosa Publishing House, 2nd edition 2003..
3. Anderson, D.A., Tannehill, J.I., and Pletcher, R.H., “Computational fluid Mechanics and Heat Transfer “ Hemisphere Publishing Corporation, New York, USA,1984.
4. Pradip Niyogi, Chakrabartty S K, Laha M K, “Introduction to Computational Fluid Dynamics”, 9th Edition, Pearson., 2005.

**Each course must contain only five units with equal distribution of hours.*

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	3	2	-	-	1	-	1	-	-	1	2	1	-
2	3	2	3	2	-	-	-	-	1	-	-	1	2	1	-
3	3	2	3	2	-	-	-	-	1	-	-	1	2	1	-
4	3	2	2	-	-	-	-	-	-	-	-	1	2	1	-
5	3	2	2	-	3	-	-	-	-	-	-	1	2	1	3

PTME3012	FAILURE ANALYSIS AND NDT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

The main learning objective of this course is to

1. Understating the importance of failure analysis and causes of failures, principles of NDT methods, its applications and limitations.

UNIT I INTRODUCTION TO FAILURE ANALYSIS 9

Need and scope of failure analysis. Engineering Disasters in history and their failure analysis. Sources of failures. Description & origin of Processing defects. Types of failures-Ductile & Brittle, Fracture Analysis, FMEA.Application of fracture mechanics concepts to design for safety. NDT for failure analysis- an overview.

UNIT II DYE PENETRANT & MAGNETIC PARTICLE INSPECTION 9

Importance of NDT, Visual Inspection: Tools, applications and limitations,

Liquid Penetrant Inspection (LPI): Principles, Requisites of a good penetrant anddeveloper, Types of penetrants and developers, Techniques, procedures, interpretation and evaluation of penetranttest indications, advantages and limitations, case study.

Magnetic Particle Inspection (MPI): Principles, Magnetization- Methods, techniques. Continuous & Residual testing of MPI,System sensitivity, Interpretation of MPI indications, Advantage and limitations, case study.

UNIT III ULTRASONIC TESTING 9

Principle, type of Ultrasonic waves, mode conversion in ultrasonics, Principle, UT testing methods: Contact testing andimmersion testing, normal beam and straight beam testing, angle beam testing, dualcrystal probe, Ultrasonic Testing Techniques: Resonance testing, Through transmissiontechnique, Pulse echo testing technique, Instruments used in UT, Transducer types,Reference blocks with artificially created defects, Calibration of equipment, A-Scan, B-scan & C-scan, case study.

UNIT IV EDDY CURRENT TESTING & THERMOGRAPHY 9

Eddy current Testing: Principles, Physics aspects of ECT- conductivity, permeability, resistivity,inductance, inductive reactance, impedance, Filed factor and lift off effect, edge effect, endeffect, Depth of penetration of ECT, Instrumentation, application of ECT, advantages,limitations, case study.

Thermography: Principles, Contact and non-contactinspection methods, Heat sensitive paints and papers, thermally quenched phosphors,Liquid crystals, techniques for applying liquid crystals, advantage and limitations, Infrared radiation and infrared detectors, applications, case study.

UNIT V RADIOGRAPHY TESTING 9

Principle, electromagnetic radiation sources, X-ray sources, Production of X-rays, High energy X-ray source, Gama ray source, Properties of X-rays and gamma rays, Inspection techniques, Exposure, Real time radiography, Films andscreens used in radiography, Quality of radiographic film processing, interpretation,evaluation of test results, Computed Tomography, Safety aspects required in radiography, Applications, advantages and limitations, case study.

TOTAL :45 PERIODS

COURSE OUTCOMES:

Upon completion of the Course, the students will be able to:

CO1 Discuss on the various failures, their analysis and their importance

CO2 Adapt the Penetrant testing procedures for evaluating the surface defects.

CO3 Interpret the images and the results obtained from the Thermographic technique and the Eddy current testing

CO4 Describe the testing procedure and analyze the results obtained in the Ultrasonic inspection

CO5 Explain the techniques involved in the Radiographic testing and the various advancements inRadiography.

TEXT BOOKS:

1. Paul E Mix, “Introduction to Non-destructive testing: a training guide”, Wiley, 2nd edition New Jersey, 2005.
2. ASM Metals Handbook, “Non-Destructive Evaluation and Quality Control”, American Society of Metals, Metals Park, Ohio, USA, 200, Volume-17.

REFERENCES:

1.Vito J. Colangelo, Francis A. Heiser,Analysis of Metallurgical Failures, Wiley Publications,1987.

2. ASNT, American Society for Non Destructive Testing, Columbus, Ohio, NDT Handbook, Vol. 1, Leak Testing, Vol. 2, Liquid Penetrant Testing, Vol. 3, Infrared and Thermal Testing Vol. 4, Radiographic Testing, Vol. 5, Electromagnetic Testing, Vol. 6, Acoustic Emission Testing, Vol. 7, Ultrasonic Testing.

3. Baldev Raj, T.Jayakumar, M.Thavasimuthu “Practical Non-Destructive Testing”, Narosa Publishing House, 2009.

4. Charles, J. Hellier,“ Handbook of Non-destructive evaluation”, McGraw Hill, New York 2001.

5. Ravi Prakash, “Non-Destructive Testing Techniques”, New Age International Publishers, 1st revised edition, 2010.

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	3	1	3	3	3	2	-	-	-	2	3	2	1
2	3	2	1	3	2	2	2	1	-	-	-	2	3	1	1
3	3	2	1	2	2	2	2	1	-	-	-	2	3	1	1
4	3	2	1	3	2	2	2	1	-	-	-	2	3	1	1
5	3	2	1	3	2	2	2	1	-	-	-	2	3	1	1
Avg	3	2	1.4	2.4	2.2	2.2	2.2	1.2	-	-	-	2	2	1.2	1

PTME3013	DESIGN CODES AND STANDARDS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

To study the Codes and Standards used in different industries and government norms and regulations

UNIT – I INTRODUCTION 9

Introduction to Codes and Standards. What is code? What is Standard Need for codes and standards. Objective of Codes and Standards. Codes, Standards and Good Engineering Practices.

UNIT – II CODES 9

Codes and Standards used in Different Industry. Material, Design, Inspection and Construction Codes. Process Industry Codes. Machinery Design codes. Codes used in Oil and Gas Industry. Welding Codes. Machine Design. Automotive. HVAC. Performance Test Codes. Other Discipline codes

UNIT – III STANDARDS 9

Sources of Codes and Standards. Who publishes Codes and Standards? International Societies and Professional Bodies. Process of Standardisation and Code publishing in Professional Bodies and Companies. Interdisciplinary Codes.

UNIT – IV REGULATIONS 9

Government and Federal Regulations. Need for them. Indian and International Regulations. Standards organisations. Weather and Climatic codes. IS, ISO, IBR, OISD. Certification Bodies. Authorities and Engineers to certify. PE, Chartered Engineers

UNIT – V DESIGN CODES 9

Codes and Standards applicable in Process Industry Equipment Design. Pressure Vessel Design Codes. Heat Exchanger Design Codes. Wind and Seismic Codes. Machinery Codes. Package Equipment Design Codes. Performance Test Codes. ASTM, ASME, API, AWS, ANSI, ISO, ASHRAE.

TOTAL :45 PERIODS

OUTCOMES:

At the end of the course the students would be able to:

1. Explain the need for codes and Standards in Industry.
2. Discuss the different codes and standards used in different industry.
3. Discuss the sources of different codes and standards and the societies that publish them and how these are evolved
4. Explain need for Government regulations and Certification authorities and familiar with common regulations in India and International
5. Discuss knowledge of codes and standards used in Process equipment design for Oil and Gas Industry.

TEXTBOOKS:

1. Mechanical Engg. Handbook. ASME. ASTM.API
2. Perrys Chemical Engg Handbook

REFERENCES:

1. ASME
2. API
3. ISO, IBR, OISD
4. AWS
5. ISHRAE

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	3	-	-	-	-	-	1	-	-	1	1	2	2
2	2	1	3	-	-	-	-	-	1	-	-	1	1	2	2
3	2	1	3	-	-	-	-	-	1	-	-	1	1	2	2
4	2	1	3	-	-	-	-	-	1	-	-	1	1	2	2
5	2	1	3	-	-	-	-	-	1	-	-	1	1	2	2
Avg	2	1	3	-	-	-	-	-	1	-	-	1	1	2	2

PTME3014	DESIGN FOR X	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

The main learning objective of this course is to prepare the students for designing the components with the considerations of quality, reliability, safety, cost, environment, manufacturing and assembly.

UNIT I DESIGN FOR QUALITY 9

Quality Function Deployment **-**House of Quality-Objectives and Functions-Targets-Stakeholders- Measures and Matrices-Design of Experiments –design Process-Identification of control factors, noise factors, and performance metrics - developing the experimental plan- experimental design – testing noise factors- Running the experiments –Conducting the Analysis-Selecting and conforming factor-Set points-reflecting and repeating

UNIT II DESIGN FOR RELIABILITY AND SAFETY 9

Reliability – Definitions – Constant failure Rate – Weibull Frequency distribution – Reliability with variable failure rate – System reliability - Design strategy – Causes of unreliability – Minimizing Failure – Sources of reliability data – Cost of reliability – Failure Mode Effect Analysis – Defects and Failure Modes – Importance of Failure – Safety – Safe product – Design aspects of safety – Fail safe design – Potential dangers and safety hazards – Guidelines for design for safety – Warning Labels

UNIT III DESIGN FOR MANUFACTURE AND ASSEMBLY 9

Role of Manufacturing in design – Manufacturing functions - types of manufacturing process, process systems- Manufacturing process selection - Design for Manufacturability (DFM) – Design for Assembly (DFA) - Role of standardization in DFMA – Mistake Proofing.

UNIT IV DESIGN FOR ENVIRONMENT AND SERVICEABILITY 9

Design for Environment – Life cycle design – DFE Approach – DFE scoring methods. Human factors in design, ergonomics, user friendly design- Serviceability – Preventive Maintenance – Breakdown Maintenance – Testability – Role of reliability in maintenance and repair.

UNIT V DESIGN FOR COSTING 9

Categories of costing – Overhead cost – methods of developing cost estimates – Manufacturing cost – Product profit model – refinements to cost analysis methods – Design to cost – Value Analysis in costing – Life cycle costing

TOTAL : 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

CO1 Apply the quality concepts to develop a robust product.

CO2 Enforce methods to improve the reliability of a product and to ensure the safety of the product by use of standards and guidelines

CO3 Apply the principles of process selection and to design the components by considering the manufacturing and assembly guidelines.
CO4 Design the product for its environment and to improve its re-pairability.
CO5 Predict the product cost using strategies and to refine the cost by performing cost analysis.

TEXTBOOKS:

1. Dieter. G. N., Linda C. Schmidt, “Engineering Design”, McGraw Hill, 2013.
2. Horenstein, M. N., Design Concepts for Engineers, Prentice Hall, 2015.

REFERENCES:

1. Dhillon, B. S., Advanced Design Concepts for Engineers, Technomic Publishing Co., 1998.
2. Edward B. Magrab, Satyandra K. Gupta, F. Patrick McCluskey and Peter A. Sandborn, “Integrated Product and Process Design and Development”, CRC Press, 2009.
3. James Garratt, “Design and Technology”, Cambridge University Press, 1996.
4. Joseph E. Shigley, Charles R.Mische, and Richard G. Budynas, “Mechanical Engineering Design”, McGraw Hill Professional, 2003.
5. Sumesh Krishnan and MukulSukla, Concepts in Engineering Design, Notion Press, 2016.

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	2	1	2	2	1	-	-	-	2	3	2	2
2	3	3	3	2	1	2	3	1	-	-	-	2	3	2	2
3	3	3	3	2	1	2	2	1	-	-	-	2	3	2	2
4	3	3	3	2	1	2	3	1	-	-	-	2	3	2	2
5	3	3	3	2	1	2	2	1	-	-	-	2	3	2	2
Avg	3	3	3	2	1	2	2.4	1	-	-	-	2	3	2	2

PTME3015 DESIGN OF PRESSURE VESSELS

L	T	P	C
3	0	0	3

COURSE OBJECTIVE:

To acquire the Mathematical knowledge to design and analysis of pressure vessels and piping

UNIT – I INTRODUCTION **9**

Methods for determining stresses – Terminology and Ligament Efficiency – Applications

UNIT – II STRESSES IN PRESSURE VESSELS **9**

Introduction – Stresses in a circular ring, cylinder –Dilation of pressure vessels, Membrane stress Analysis of Vessel – Cylindrical, spherical and conical heads – Thermal Stresses – Discontinuity stresses in pressure vessels.

UNIT – III DESIGN OF VESSELS **9**

Design of Tall cylindrical self-supporting process columns – Supports for short vertical vessels – Stress concentration at a variable Thickness transition section in a cylindrical vessel, about a circular hole, elliptical openings. Theory of Reinforcement – Pressure Vessel Design.

UNIT – IV BUCKLING AND FRACTURE ANALYSIS IN VESSELS **9**

Buckling phenomenon – Elastic Buckling of circular ring and cylinders under external pressure –collapse of thick walled cylinders or tubes under external pressure – Effect of supports on Elastic Buckling of Cylinders – Buckling under combined External pressure and axial loading.

UNIT – V PIPING **9**

Introduction – Flow diagram – piping layout and piping stress Analysis.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course the students would be able to:

1. Understand the working principle and applications of pressure vessels.
2. Determine the stresses in pressure vessels.
3. Design and analyse the pressure vessels.
4. Perform buckling and fracture analysis in vessels
5. Design and analyse piping layout.

TEXT BOOKS:

1. John F. Harvey, "Theory and Design of Pressure Vessels", CBS Publishers and Distributors,1987.
2. Theory And Design Of Pressure Vessels (Pb 2001) by HARVEY J.F. | 1 January 2001

REFERENCES:

1. Henry H. Bedner, “Pressure Vessels, Design Hand Book", CBS publishers and Distributors,1987.

2. Stanley, M. Wales, “Chemical process equipment, selection and Design". Buterworths series in Chemical Engineering, 1988.
3. William. J., Bees, “Approximate Methods in the Design and Analysis of Pressure Vessels and Piping”, Pre ASME Pressure Vessels and Piping Conference, 1997.
4. Sam Kannapan, “Introduction to Pipe Stress Analysis”. John Wiley and Sons, 1985.
5. Theory and design of Pressure Vessels (Pb 2001)by HARVEY J.F. | 1 January 2001

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	2	-	1	1	1	-	-	-	1	2	-	2
2	3	3	3	2	-	1	1	1	-	-	-	1	2	-	2
3	3	3	3	2	-	1	1	1	-	-	-	1	2	-	2
4	3	3	3	2	-	1	1	1	-	-	-	1	2	-	2
5	3	3	3	2	-	1	1	1	-	-	-	1	2	-	2
Avg	3	3	3	2	-	1	1	1	-	-	-	1	2	-	2

PTME3016 BIOENERGY CONVERSION TECHNIQUES

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

To elucidate on biomass, types, availability, and characteristics

UNIT – I INTRODUCTION **9**

Biomass: types – advantages and drawbacks – typical characteristics – proximate & ultimate analysis – comparison with coal - Indian scenario - carbon neutrality – biomass assessment studies – typical conversion mechanisms - densification technologies

UNIT – II BIOMETHANATION **9**

Biomethenation process – influencing parameters – typical feed stocks – Biogas plants: types and design, Biogas appliances – burner, luminaries and power generation systems – Industrial effluent based biogas plants.

UNIT – III COMBUSTION **9**

Perfect, complete and incomplete combustion – stoichiometric air requirement for biofuels - equivalence ratio – fixed Bed and fluid Bed combustion

UNIT – IV GASIFICATION, PYROLYSIS AND CARBONISATION **9**

Chemistry of gasification - types – comparison – typical application – performance evaluation –economics. Pyrolysis - Classification - process governing parameters – Typical yield rates. Carbonization – merits of carbonized fuels – techniques adopted for carbonisation

UNIT – V LIQUIFIED BIOFUELS **9**

Straight Vegetable Oil (SVO) as fuel - Biodiesel production from oil seeds, waste oils and algae - Process and chemistry - Biodiesel Vs. Diesel – comparison on emission and performance fronts. Production of alcoholic fuels (methanol and ethanol) from biomass – engine modifications

TOTAL :45 PERIODS

OUTCOMES:

At the end of the course the students would be able to:

1. Estimate the surplus biomass availability of any given area.
2. Design a biogas plant for a variety of biofuels.
3. Determine and compare the cost of steam generation from biofuels with that of coal and petroleum fuels.
4. Analyse the influence of process governing parameters in thermochemical conversion of biomass.
5. Synthesize liquid biofuels for power generation from biomass.

TEXTBOOKS:

1. Biomass for Bioenergy and Biomaterials, by Nidhi Adlakha, Rakesh Bhatnagar , Syed Shams Yazdani, CRC Press; 1st edition (22 October 2021), ISBN-10 : 0367745550
2. Bioenergy and Biochemical Processing Technologies, by Augustine O. Ayeni, Samuel EshorameSanni , Solomon U. Oranusi, Springer (30 June 2022).

REFERENCES:

1. David Boyles, Bio Energy Technology Thermodynamics and costs, Ellis Hoknood Chichester,1984.
2. Iyer PVR et al, Thermochemical Characterization of Biomass, M N E S
3. Khandelwal KC, Mahdi SS, Biogas Technology – A Practical Handbook, Tata McGraw Hill, 1986
4. Mahaeswari, R.C. Bio Energy for Rural Energisation, Concepts Publication,1997
5. Tom B Reed, Biomass Gasification – Principles and Technology, Noyce Data Corporation, 1981

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	2	3	2	2	-	3	-	1	-	2	2	3	-	-
2	2	2	3	2	-	2	2	-	-	-	2	2	3	-	-
3	2	2	3	2	-	-	1	-	-	-	2	2	3	2	-
4	2	2	3	2	-	-	1	-	-	-	2	2	3	1	-
5	2	2	3	2	-	-	1	-	-	-	2	2	3	1	-
Avg	2	2	3	2	2	2	1.6	-	-	-		-		1.3	-

PTME3017 ENERGY CONSERVATION IN INDUSTRIES

L	T	P	C
3	0	0	3

COURSE OBJECTIVE:

To learn quantifying the energy demand and energy supply scenario of nation and explaining the need for energy auditing for becoming environmentally benign

UNIT – I INTRODUCTION 9

Energy scenario of World, India and TN - Environmental aspects of Energy Generation – Material and Energy balancing - Energy Auditing: Need, Types, Methodology and Barriers. Role of Energy Managers. Basic instruments for Energy Auditing.

UNIT – II ELECTRICAL SUPPLY SYSTEMS 9

Electricity Tariff structures – Typical Billing - Demand Side Management - HT and LT supply - Power Factor – Energy conservation in Transformers – Harmonics

UNIT – III ENERGY CONSERVATION IN MAJOR THERMAL UTILITIES 9

Stoichiometry - Combustion principles. Energy conservation in: Boilers - Steam Distribution Systems - Furnaces - Thermic Fluid Heaters – Cooling Towers – D.G. sets. Insulation and Refractories - Waste Heat Recovery Devices.

UNIT – IV ENERGY CONSERVATION IN MAJOR ELECTRICAL UTILITIES 9

Energy conservation in: Motors - Pumps – Fans – Blowers - Compressed Air Systems - Refrigeration and Air Conditioning Systems - Illumination systems

UNIT – V ENERGY MONITORING, TARGETING, LABELLING AND ECONOMICS 9

Elements of Monitoring & Targeting System – CUSUM - Energy / Cost index diagram – Energy Labelling - Energy Economics – Cost of production and Life Cycle Costing - Economic evaluation techniques – Discounting and Non-Discounting - ESCO concept – PAT scheme

TOTAL :45 PERIODS

OUTCOMES:

At the end of the course the students would be able to:

1. Discuss Quantify the energy demand and energy supply scenario of nation and appreciate the need for energy auditing for becoming environmentally benign
2. Analyse factors behind energy billing and apply the concept of demand side management for lowering energy costs
3. Compute the stoichiometric air requirement for any given fuel and quantify the energy losses associated with thermal utilities of industries
4. Diagnose the causes for under performance of various electrical utilities and suggest remedies for improving their efficiency
5. Apply CUSUM and other financial evaluation techniques to estimate the accruable energy savings/monetary benefits for any energy efficiency project

TEXT BOOKS:

1. Guide book for National Certification Examination for “Energy Managers and Energy Auditors” (4 Volumes). Available at http://www.em-ea.org/gbook1.asp. This website is administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India.
2. K. Nagabhushan Raju, Industrial Energy Conservation Techniques: (concepts, Applications and Case Studies), Atlantic Publishers &Dist, 2007.

REFERENCES:

1. Abbi Y P, Shashank Jain., Handbook on Energy Audit and Environment Management, TERI Press, 2006.
2. Albert Thumann and Paul Mehta D, “Handbook of Energy Engineering”, 7thEdition, The Fairmont Press, 2013.
3. Murphy.W.R. and McKay.G, “Energy Management”, Butterworth, London 1982.
4. Paul W.O'Callaghan, Design and management for energy conservation: A handbook for energy managers, plant engineers, and designers, Pergamon Press, 1981.
5. Steve Doty, Wayne Turner C, Energy Management Handbook 7th Edition, The Fairmont Press, 2009.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	2	1	-	-	-	3	-	1	-	-	1	2	2	2
2	2	2	1	-	-	-	3	-	1	-	-	1	2	2	2
3	2	2	1	-	-	-	3	-	1	-	-	1	2	2	2
4	2	2	1	-	-	-	3	-	1	-	-	1	2	2	2
5	2	2	1	-	-	-	3	-	1	-	-	1	2	2	2

PTME3018	ERGONOMICS IN DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

To introduce to industrial design with considerations of ergonomics, aesthetics and environmental aspects.

UNIT – I INTRODUCTION 9

An approach to industrial design, Elements of design structure for industrial design in engineering application in modern manufacturing systems- Ergonomics and Industrial Design: Introduction to Ergonomics, Communication system, general approach to the man-machine relationship, Human component of work system, Machine component of work system, Local environment-light, Heat, Sound.

UNIT – II ERGONOMICS AND PRODUCTION 9

Introduction, Anthropometric data and its applications in ergonomic, working postures, Body Movements, Work Station Design, Chair Design. Visual Effects of Line and Form: The mechanics of seeing, Psychology of seeing, Figure on ground effect, Gestalt's perceptions - Simplicity, Regularity, Proximity, Wholeness. Optical illusions, Influences of line and form.

UNIT – III DESIGN PRINCIPLES FOR DISPLAY AND CONTROLS 9

Displays: Design Principles of visual Displays, Classification, Quantitative displays, Qualitative displays, check readings, Situational awareness, Representative displays, Design of pointers, Signal and warning lights, colour coding of displays, Design of multiple displays Controls: Design considerations, Controls with little efforts – Push button, Switches, rotating Knobs. Controls with muscular effort – Hand wheel, Crank, Heavy lever, Pedals. Design of controls in automobiles, Machine Tools

UNIT – IV VISUAL ASPECTS 9

Colour: Colour and light, Colour and objects, Colour and the eye – after Image, Colour blindness, Colour constancy, Colour terms – Colour circles, Munsel colour notation, reactions to colour and colour combination – colour on engineering equipment, Colour coding, Psychological effects, colour and machine form, colour and style

UNIT – V AESTHETIC CONCEPTS 9

Concept of unity, Concept of order with variety, Concept of purpose, Style and environment, Aesthetic expressions - Symmetry, Balance, Contrast, Continuity, Proportion. Style - The components of style, House style, Style in capital good. Introduction to Ergonomic and plant layout software's, total layout design.

TOTAL: 45 periods

COURSE OUTCOMES:

At the end of the course the students would be able to

1 Appreciate ergonomics need in the industrial design.
2 Apply ergonomics in creation of manufacturing system
3 Discuss on design of controls and display.
4 Consider environmental factors in ergonomics design.
5 Report on importance of aesthetics to manufacturing system and product

TEXT BOOKS:

1. Benjamin W.Niebel, Motion and Time Study, Richard, D. Irwin Inc., 7thEdition, 2002
2. Brain Shakel,"Applied Ergonomics Hand Book", Butterworth Scientific London 1988.

REFERENCES:

1. Bridger, R.C., Introduction to Ergonomics, 2ndEdition, 2003, McGraw Hill Publications.
2. Martin Helander, A Guide to human factors and Ergonomics, Taylor and Francis, 2006
3. Mayall W.H. “Industrial design for Engineers”, London Hiffee books Ltd., 1988.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	1	3	-	2	2	3	1	-	-	-	1	2	--	2
2	3	1	3	-	2	2	3	1	-	-	-	1	2	-	2
3	3	1	3	-	2	2	3	1	-	-	-	1	2	-	2
4	3	1	3	-	2	2	3	1	-	-	-	1	2	-	2
5	3	1	3	-	2	2	3	1	-	-	-	1	2	-	2
Avg	3	1	3	-	2	2	3	1	-	-	-	1	2	-	2

PTME3019	NEW PRODUCT DEVELOPMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE: The main objective of this course is to prepare the students on generic development processes and new product development.

UNIT I INTRODUCTION TO PRODUCT DEVELOPMENT 9

Introduction – Characteristics of Successful Product Development – Product Development Team – Challenges of Product Development – Duration and Cost of Product Development – Product Development Process – Concept Development: The Front-End Process – Adapting the Generic Product Development Process – Product Development Process Flows – Product Development Organizations – Tournament Structure of Opportunity Identification – Opportunity Identification Process.

UNIT II PRODUCT PLANNING, CUSTOMER NEEDS IDENTIFICATION & PRODUCT SPECIFICATION 9

Product Planning Process – Identifying Customer Needs – Importance of Latent Needs – Process of Identifying Customer Needs – Definition of Specifications – Time to Establish Specification – Establishing Target Specifications – Setting the Final Specifications.

UNIT III PRODUCT CONCEPT GENERATION, SELECTION & TESTING 9

Activity of Concept Generation – Concept Selection – Concept Screening – Concept Scoring – Caveats – Concept Testing.

UNIT IV PRODUCT ARCHITECTURE & INDUSTRIAL DESIGN, 9

Product Architecture – Definition – Implications – Establishing the Architecture – Delayed Differentiation – Platform Planning – Related System-Level Design Issues – Industrial Design – Assessing the Need for Industrial Design – Impact of Industrial Design – Industrial Design Process – Management of the Industrial Design Process – Assessing the Quality of Industrial Design.

UNIT V DESIGN FOR MANUFACTURING & PROTOTYPING 9

Design for Manufacturing – DFM Process: Estimate the Manufacturing Costs – Reduce the Costs of Components – Reduce the Costs of Assembly – Reduce the Costs of Supporting Production – Consider the Impact of DFM Decisions on Other Factors – Prototyping – Principles of Prototyping – Prototyping Technologies – Planning for Prototypes.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

CO1 Apply the principles of generic development process; and understanding the organization structure for new product development. identify the opportunity and planning for new product development.

CO2 Conduct customer need analysis; and to design and set product specification for new product development.

CO3 Generate, select, and test the concepts for new product development

CO4 Apply principles of product architecture and industrial design for new product development.

CO5 Apply the principles in design for manufacturing and prototyping for new product development.

TEXT BOOK:

1. Ulrich K.T., Eppinger S. D. and Anita Goyal, “Product Design and Development “McGraw-HillEducation; 7edition,2020.

REFERNCES:

1. Belz A., 36-Hour Course: “Product Development” McGraw-Hill, 2010.
2. Rosenthal S.,“Effective Product Design and Development”, Business One Orwin, Homewood,1992,ISBN1-55623-603-4.
3. Pugh.S,“Total Design Integrated Methods for Successful Product Engineering”, Addison Wesley Publishing,1991,ISBN0-202-41639-5.
4. Chitale, A. K. and Gupta, R. C., Product Design and Manufacturing, PHI Learning, 2013.
5. Jamnia, A., Introduction to Product Design and Development for Engineers, CRC Press, 2018.

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2
2	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2
3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2
4	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2
5	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2
Avg	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2

PTME3020	PRODUCT LIFE CYCLE MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

The main objective of the course is to prepare the students for understanding and applying the fundamental concepts and principles behind PLM in Product Design & Development.

UNIT I INTRODUCTION TO PLM 9

Definition of PLM; PLM Initiative; PLM Paradigm – P, L and M of PLM – Scope of PLM – PLM Paradigm – Benefits of PLM – Spread of PLM – Overcoming Problems& Enabling Opportunities –PLM Environment – Issues in the Traditional Environment – Product Data Issues – A Complex, Changing Environment – Example from "Before PLM" – Product Pains: Aerospace Products; Power Plants; Automotive Products – Product Opportunities.

UNIT II PLM ENVIRONMENT: BUSINESS PROCESS 9

Business Processes in the PLM Environment – Relevance of Business Processes in PLM – Definitions & Introductions for Business Process – Business Process Reality in a Typical Company – Business Process Activities in the PLM Initiative – Learning from Experience with Business Process.

UNIT III PLM ENVIRONMENT: PRODUCT DATA 9

Product Data in the PLM Environment – Relevance of Product Data in PLM – Product Data Reality in a Typical Company – Product Data Activities in the PLM Initiative – Learning from Experience with Product Data.

UNIT IV PLM ENVIRONMENT: INFORMATION SYSTEMS 9

Information Systems in the PLM Environment – Relevance of Information Systems Applications in PLM – PLM Applications in the Product Lifecycle – Generic and Specific PLM Applications – PDM System: A Special Application – Importance of the PDM System in PLM – Reality in a Typical Company – Application Activities in the PLM Initiative – Best Practice PDM System Selection – Learning from Experience with Information Systems.

UNIT V PLM ENVIRONMENT: PROJECT MANAGEMENT 9

Project/Program Management in the PLM Environment – Skills and Relevance – Definitions and Introduction with Project Management – Project Management Reality in a Typical Company – Project Management Activities in the PLM Initiative – Learning from Experience with Project Management.

TOTAL:45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

CO1	Apply the fundamental concepts and principles behind PLM in Product Design & Development.
CO2	Apply the business process concept of PLM in Product Design & Development.
CO3	Apply the product data concept of PLM in Product Design & Development.
CO4	Apply the information systems concept of PLM in Product Design & Development.
CO5	Apply the project management concept of PLM in Product Design & Development.

TEXT BOOKS:

1. John Stark, “Product Lifecycle Management: 21st Century Paradigm for Product Realisation”, Springer Publisher, 2011 (2nd Edition).
2. Michael Grieves, “Product Life Cycle Management”, Tata McGraw Hill, 2006.

REFERNCE BOOKS:

1. UthayanElangovan, Product Lifecycle Management (PLM): A Digital Journey Using Industrial Internet of Things (IIoT), CRC Press, 2020.
2. EudesCanuto, Bernd Daum and Michael Rodel, Product Development with SAP PLM, SAP Press, 2017.
3. John Stark, “Global Product: Strategy, Product Lifecycle Management and the Billion Customer Question”, Springer Publisher, 2007.
4. AnttiSaaksvuori and AnselmiImmonen, “Product Lifecycle Management, Springer Publisher, 3rd Ed., 2008.
5. IvicaCrnkovic, Ulf Asklund and AnnitaPerssonDahlqvist, “Implementing and Integrating Product Data Management and Software Configuration Management”, Artech House Publishers, 2003.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	2	3	2	2	2	2	1	1	2	2	2	3	3	2
2	2	2	3	2	2	2	2	1	1	2	2	2	3	3	2
3	2	2	3	2	2	2	2	1	1	2	2	2	3	3	2
4	2	2	3	2	2	2	2	1	1	2	2	2	3	3	2
5	2	2	3	2	2	2	2	1	1	2	2	2	3	3	2
Avg	2	2	3	2	2	2	2	1	1	2	2	2	3	3	2

PTME3021 ENERGY EFFICIENT BUILDINGS

L	T	P	C
3	0	0	3

COURSE OBJECTIVE:

1 To learn energy saving concepts in buildings through incorporation of renewable energy systems

UNIT – I INTRODUCTION 9

Climate and Building, Historical perspective, Aspects of Net Zero building design – Sustainable Site, Water, Energy, Materials and IGBC, LEED, GRIHA, IEQ and ECBC Standards

UNIT – II LANDSCAPE AND BUILDING ENVELOPES 9

Energy efficient landscape design – Micro climates – various methods – Shading, water bodies – Building envelope: Building materials, Envelope heat loss and heat gain and its evaluation, paints, insulation, Design methods and tools

UNIT – III THERMAL COMFORT, PASSIVE HEATING AND COOLING 9

Thermal comfort, Psychrometry, Comfort indices – ASHRAE / ISHRAE Standards on thermal Comfort – Passive heating and cooling systems - HVAC Systems for build environment – Heat Pumps, Evaporative Cooling and Radiant Cooling.

UNIT – IV ENERGY CONSERVATION IN BUILDING UTILITIES 9

Energy conservation in Hot water generator – Boiler, Heat Pumps, DG Sets, Motors , Pumps, Illumination Systems, Electrical distribution systems, Cooling Towers,Refrigeration and Air Conditioning Systems, Water and Waste Management systems

UNIT – V RENEWABLE ENERGY IN BUILDINGS 9

Introduction of Renewable sources in buildings, , Stand-alone PV systems, BIPV, Solar water heating, Solar Air Conditioning in Buildings, Small wind turbines, Poly-generation systems in Buildings

TOTAL:45 PERIODS

OUTCOMES:

At the end of the course the students would be able to:

1. Familiar with climate responsive building design and basic concepts
2. Explain the basic terminologies related to buildings
3. Discuss the energy efficient air conditioning techniques
4. Evaluate the performance of buildings
5. Gets acquainted with Renewable energy systems in buildings

TEXTBOOKS:

1. Advanced Decision Making for HVAC Engineers, by JavadKhazaii, Springer; Softcover reprint of the original 1st ed. 2016 edition (23 June 2018),ISBN-10 : 3319814869
2. Thermal Comfort and Energy-Efficient Cooling of Non-residential Buildings, by Doreen E. Kalz, Jens Pfafferott, Springer; 2014th edition (8 April 2014), ISBN-10 : 9783319045818.

REFERENCES:

1. ASHRAE Handbook – Fundamentals / Equipment's/ Applications – ASHRAE 2021,2020, 2019 Editions

2. Baruch Givoni: Climate considerations in building and Urban Design, John Wiley & Sons, 1998
3. Baruch Givoni: Passive Low Energy Cooling of Buildings by, John Wiley & Sons, 15-Jul-1994
4. JA Duffie and WA Beckman: Solar Engineering of Thermal Processes, Third Edition, John Wiley & Sons, 2006.
5. Jan F. Kreider, Peter S. Curtiss, Ari Rabl, Heating and Cooling of buildings: Design for Efficiency, Revised Second Edition, CRC Press, 28-Dec-2009.

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	2	1	-	-	-	3	-	1	-	-	1	2	1	1
2	2	2	1	-	-	-	3	-	1	-	-	1	2	1	1
3	2	2	1	-	-	-	3	-	1	-	-	1	2	1	1
4	2	2	1	-	-	-	3	-	1	-	-	1	2	1	1
5	2	2	1	-	-	-	3	-	1	-	-	1	2	1	1
Avg	2	2	1	-	-	-	3	-	1	-	-	1	2	1	1

PTME3022	RENEWABLE ENERGY TECHNOLOGIES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

To learn the various renewable energy technologies and its applications.

UNIT – I ENERGY SCENARIO 9

Indian energy scenario in various sectors – domestic, industrial, commercial, agriculture, transportation and others – Present conventional energy status – Present renewable energy status-Potential of various renewable energy sources-Global energy status-Per capita energy consumption - Future energy plans

UNIT – II SOLAR ENERGY 9

Solar radiation – Measurements of solar radiation and sunshine – Solar spectrum - Solar thermal collectors – Flat plate and concentrating collectors – Solar thermal applications – Solar thermal energy storage – Fundamentals of solar photo voltaic conversion – Solar cells – Solar PV Systems – Solar PV applications.

UNIT – III WIND ENERGY 9

Wind data and energy estimation – Betz limit - Site selection for windfarms – characteristics - Wind resource assessment - Horizontal axis wind turbine – components - Vertical axis wind turbine – Wind turbine generators and its performance – Hybrid systems – Environmental issues - Applications.

UNIT – IV BIO-ENERGY 9

Bio resources – Biomass direct combustion – thermochemical conversion - biochemical conversion-mechanical conversion - Biomass gasifier - Types of biomass gasifiers - Cogeneration –- Carbonisation – Pyrolysis - Biogas plants – Digesters –Biodiesel production – Ethanol production - Applications.

UNIT – V OCEAN AND GEOTHERMAL ENERGY 9

Small hydro - Tidal energy – Wave energy – Open and closed OTEC Cycles – Limitations – Geothermal energy – Geothermal energy sources - Types of geothermal power plants – Applications - Environmental impact.

TOTAL:45 PERIODS

OUTCOMES: At the end of the course the students would be able to

1. Discuss the Indian and global energy scenario.
2. Describe the various solar energy technologies and its applications.
3. Explain the various wind energy technologies.
4. Explore the various bio-energy technologies.
5. Discuss the ocean and geothermal technologies.

TEXT BOOKS:

1 Fundamentals and Applications of Renewable Energy | Indian Edition, by Mehmet Kanoglu, Yunus A. Cengel, John M. Cimbala, cGraw Hill; First edition (10 December 2020), ISBN-10 : 9390385636

2 Renewable Energy Sources and Emerging Technologies, by Kothari, Prentice Hall India Learning Private Limited; 2nd edition (1 January 2011), ISBN-10 : 8120344707

REFERENCES:

1 Godfrey Boyle, “Renewable Energy, Power for a Sustainable Future”, Oxford University Press, U.K., 2012.

2 Rai.G.D., “Non-Conventional Energy Sources”, Khanna Publishers, New Delhi, 2014.

3 Sukhatme.S.P., “Solar Energy: Principles of Thermal Collection and Storage”, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2009.
4 Tiwari G.N., “Solar Energy – Fundamentals Design, Modelling and applications”, Alpha Science Intl Ltd, 2015.
5 Twidell, J.W. & Weir A., “Renewable Energy Resources”, EFNSpon Ltd., UK, 2015.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	1	1	1	1	1	2	3	2	2	1	1	3	2	1	2
2	3	2	2	1	1	1	3	1	1	1	2	3	2	1	2
3	3	2	3	1	2	1	3	1	1	1	1	3	1	1	2
4	2	2	2	1	2	1	3	1	1	1	2	3	2	2	2
5	2	1	2	1	2	1	3	1	1	1	1	3	2	1	2
Avg	2.2	1.6	2	1	1.6	1.2	3	1.2	1.2	1	1.4	3	1.8	1.2	2

PTME3023	ENERGY STORAGE DEVICES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

To study the various types of energy storage devices, their performance and its technological applications

UNIT – I INTRODUCTION TO ENERGY STORAGE 9

Need for Energy Storage – Types of Energy Storage – Various forms of Energy Storage – Mechanical– Thermal - Chemical– Electrochemical – Electrical - Other alternative energy storage technologies –Efficiency and Comparison.

UNIT – II ENERGY STORAGE SYSTEMS 9

Pumped Air Energy Storage – Compressed Air Energy Storage – Flywheel – Sensible and Latent Heat Storage – Storage Materials – Performance Evaluation - Thermochemical systems – Batteries – Types- Charging and Discharging – Battery testing and performance.

UNIT – III MOBILE AND HYBRID ENERGY STORAGE SYSTEMS 9

Batteries for electric vehicles - Battery specifications for cars, heart pacemakers, computer standby supplies – V2G and G2V technologies – HESS.

UNIT – IV RENEWABLE ENERGY STORAGE AND ENERGY MANAGEMENT 9

Storage of Renewable Energy Systems –Solar Energy – Wind Energy – Energy Storage in Micro grid– Smart Grid – Energy Conversion Efficiency - Battery Management Systems – EVBMS – Energy Audit and Management

UNIT – V OTHER ENERGY DEVICES 9

Superconducting Magnetic Energy Storage (SMES), Supercapacitors – MHD Power generation –Hydrogen Storage - Fuel Cells – Basic principle and classifications – PEMFC, AMFC, DMFC, SOFC,MCFC and Biofuel Cells – Biogas Storage.

TOTAL :45

OUTCOMES:

At the end of the course the students would be able to:

1. Discuss the need and identify the suitable energy storage devices for applications.
2. Explain the working of various energy storage devices and their importance.
3. Explain the basic characteristics of batteries for mobile and hybrid systems.
4. Discuss the storage of renewable energies and management systems.
5. Explain the need for other energy devices and their scope for applications.

TEXT BOOKS:

1. Rober Huggins, “Energy Storage: Fundamentals, Materials and Applications”, 2 nd Edition, Springer, 2015.
2. Dell, Ronald M Rand, David A J, “Understanding Batteries”, Royal Society of Chemistry, 2001

REFERENCES:

1. Francisco Díaz-González, Andreas Sumper, OriolGomis-Bellmunt,” Energy Storage in Power Systems” Wiley Publication, 2016.
2. Ibrahim Dincer and Mark A Rosen, “Thermal Energy Storage Systems and

Applications", John Wiley & amp; Sons, 2002.
3. Lindon David, "Handbook of Batteries", McGraw Hill, 2002.
4. AuliceScibioh M. and Viswanathan B, "Fuel Cells – principles and applications', University Press(India), 2006
5. Ru-Shiliu, Leizhang, Sueliang Sun, "Electrochemical Technologies for Energy Storage and Conversion", Wiley Publications, 2012.

COs	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	1	-	2	-	-	-	-	-	1	2	3
2	3	2	1	1	1	-	2	-	-	-	-	-	1	2	3
3	3	2	1	1	1	-	2	-	-	-	-	-	1	2	3
4	3	2	1	1	1	-	2	-	-	-	-	-	1	2	3
5	3	2	1	1	1	-	2	-	-	-	-	-	1	2	3
Avg	3	2	1	1	1	-	2	-	-	-	-	-	1	2	3

PTME3024	SURFACE ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students to understand metallurgical changes that occur during surface modification.

UNIT I SURFACES & FRICTION 9

Basics of surfaces features – Roughness parameters – surface measurement - Cause of frictionLaws of friction – Static friction – Rolling Friction – Stick-slip Phenomenon - Friction properties ofmetal and nonmetals – Friction in extreme conditions – Thermal considerations in sliding contact.Contact mechanics.

UNIT II WEAR & CORROSION 9

Types of Wear, Adhesive, Abrasive, Oxidative, Corrosive, Erosive and Fretting Wear, Roles of Friction and Lubrication, Wear-debris analysis, Theoretical wear models, Standards,
Expressions for Corrosion Rate. Pourbaix Diagram, Forms of Corrosion – Uniform, Pitting, Intergranular, Stress Corrosion. Corrosion Fatigue. Dezincification. Erosion Corrosion, Crevice Corrosion – Cause and Remedial Measures – Pilling Bed-worth Ratio – High Temperature Oxidation-Hydrogen Embrittlement – Remedial Measures. Standards.

UNIT III CORROSION OF INDUSTRIAL COMPONENTS& TESTING 9

Corrosion in Fossil Fuel Power Plants, Automotive Industry, Chemical Processing Industries, Corrosion in Petroleum Production Operations and Refining, Corrosion of Pipelines, Wear of Industrial Components.
Purpose of Corrosion Testing – Classification – Susceptibility Tests for Intergranular CorrosionStress Corrosion Test. Salt Spray Test Humidity and Porosity Tests, Accelerated Weathering Tests. ASTM Standards for Corrosion Testing and Tests For Assessment of Wear

UNIT IV PLATING & THIN FILM COATINGS 9

Surface properties – Hydrophobic – Super hydrophobic – Hydrophilic - surface metallurgy, Fundamentals of electroplating, Electrodeposition from plating baths,Electroless plating, Metalliding, Selective plating, CLC, Hard anodizing. Thermal evaporation, PVD and CVD, Sputter coating, Ion plating, Thinfilm for wear application, Coating specifications.

UNIT V HARD FACING PROCESSES AND APPLICATIONS 9

Thermal spray processes and their applications, Hardfacing transformation, Fusion alloys, Non -fusion materials. Hardfacing for repairs, Hardfacing with fusion processes, Non-fusion deposits, WeldabilityConsiderations, Finishing considerations.

TOTAL : 45

COURSE OUTCOMES:

Upon completion of the course, the students will be able to:

CO1 Explain the different failures that occur on the surface of the engineering components.
CO2 Discuss on the kinetic aspects and the effect of various parameters on the rate of corrosion.
CO3 Interpret the corrosion failures that occur in different industrial components and articulate the results obtained from the corrosion testing.
CO4 Discuss on the various plating techniques and thin film coatings
CO5 Implement suitable corrosion protection methods in critical engineering components.

TEXT BOOKS:

1. Mars Guy Fontana ,Corrosion Engineering, Tata McGraw-Hill, 2005.
2. Dheerendra Kumar Dwivedi , Surface Engineering -Enhancing Life of Tribological Component, Springer India, 2018.

REFERENCES:

1. Gabe. D.R., “Principles Of Metal Surface Treatment And Protection”, Pergamon, 1990
2. P. K. Dutta & I. S. Gray, Surface Engineering, Vol. I - III, Royal Society of Chemistry, 1993
3. Kenneth G. Budinsk, Surface Engineering for wear resistance, Prentice Hall, NJ 1988
4. Stand Grainger Engineering Coatings – Design and Application Jaico Publishing House,
5. 1994.Parthasarathy. N.V., Electroplating Handbooks, Prentice Hall, 1992

COs	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	3	1	3	3	3	2	-	-	-	2	3	1	1
2	3	1	1	3	2	2	2	1	-	-	-	2	3	1	1
3	3	1	1	2	2	2	2	1	-	-	-	2	3	1	1
4	3	2	1	3	2	2	2	1	-	-	-	2	3	1	1
5	3	2	1	3	2	2	2	1	-	-	-	2	3	1	1
Avg	3	1.8	1.4	2.4	2.2	2.2	2.2	1.2	-	-	-	2	2	1	1

PTME3025 HYBRID AND ELECTRIC VEHICLE TECHNOLOGY

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

To provide knowledge on the various hybrid electric powertrain configurations, electric vehicle controls, drives, and energy storage technologies.

UNIT – I INTRODUCTION 9

Basics of vehicle performance, vehicle power source characterization, transmission characteristics, History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, the impact of modern drive-trains on energy supplies.

UNIT – II HYBRID ELECTRIC DRIVE TRAINS 9

Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis. Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis.

UNIT – III CONTROL OF AC & DC DRIVES 9

Introduction to electric components used in hybrid and electric vehicles, Configuration, and control -DC Motor drives, Induction Motor drives, Permanent Magnet Motor drives, and Switch Reluctance Motor drives, drive system efficiency.

UNIT – IV ENERGY STORAGE 9

Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Energy Storage and its analysis - Battery based, Fuel Cell-based, and Super Capacitor based, Hybridization of different energy storage devices.

UNIT – V DRIVE SIZING AND ENERGY MANAGEMENT STRATEGIES 9

Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting of appropriate energy storage technology, Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification, and comparison of energy management strategies, Implementation issues.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

1. Discuss Characterize and configure hybrid drivetrains requirement for a vehicle
2. Design and apply appropriate hybrid and electric drive trains in a vehicle
3. Design and install suitable AC and DC drives for electric vehicles.
4. Discuss arrive at a suitable energy storage system for a hybrid / electric vehicle
5. Apply energy management strategies to ensure better economy and efficiency

TEXT BOOKS:

1 Iqbal Husain, ―Electric and Hybrid Vehicles: Design Fundamentals‖, Third Edition, 2021

2 James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003

REFERENCES:

1 Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.

2 Rand D.A.J, Woods, R & Dell RM Batteries for Electric vehicles, John Wiley & Sons, 1998

3 Hybrid, Electric and Fuel-Cell Vehicles, International Edition by Jack Erjavec | 6 June 2012

4 Energy Management in Hybrid Electric Vehicles using Co-Simulation by Christian Paar | 11 February 2011

5 Hybrid Electric Vehicle Design and Control: Intelligent Omnidirectional Hybrids (MECHANICAL ENGINEERING) by Yangsheng Xu , Jingyu Yan, et al. | 16 December 2013

COs	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	1	-	2	-	-	-	-	-	1	2	3
2	3	2	1	1	1	-	2	-	-	-	-	-	1	2	3
3	3	2	1	1	1	-	2	-	-	-	-	-	1	2	3
4	3	2	1	1	1	-	2	-	-	-	-	-	1	2	3
5	3	2	1	1	1	-	2	-	-	-	-	-	1	2	3
Avg	3	2	1	1	1	-	2	-	-	-	-	-	1	2	2

PTME3026	THERMAL MANAGEMENT OF BATTERIES AND FUEL CELLS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

To impart knowledge on the significance of battery thermal management and its impact on performance and safety

UNIT – I ADVANCED BATTERIES 9

Li-ion Batteries- chemistry, different formats, operating areas, efficiency, aging. Battery Management System- Configuration, Characteristics. Tesla Model S- 18650 Cell specifications, P85 Battery Pack mechanical structure, Texas Instruments BMS. Supercapacitors Vs batteries. Diamond battery concepts.

UNIT – II THERMAL MANAGEMENT IN BATTERIES 9

Thermal Management Systems- impact, Types- Air, Liquid, Direct refrigerant, Heat pipe, Thermo-Electric, Phase Change Material Cooling methods. Solid-liquid PCM Types- Organic, Inorganic, Eutectics. PCM Thermal Properties and applications. Tesla Model-S Battery Module- bonding techniques, thermal management.

UNIT – III BATTERY THERMAL MANAGEMENT CASE STUDIES 9

EV Battery Cooling- challenges and solutions. Heat Exchanger Design and Optimization Model for EV Batteries using PCMs- system set up, selection of PCMs. Chevrolet Volt Model Battery Thermal Management System- Case study. Modelling Liquid Cooling of a Li-Ion Battery Pack with COMSOL Multiphysics- simulation concepts.

UNIT – IV THERMAL MANAGEMENT IN FUEL CELLS 9

Fuel Cells- operating principle, hydrogen-air fuel cell system characteristics, other fuel cell technologies, polarization curves, applications. Fuel cell thermal management-basic model, energy balance, governing equations, characteristic curve, sizing, cooling methods, advantages, restrictions.

UNIT – V FUEL CELL THERMAL MANAGEMENT CASE STUDIES 9

Fuel cell system- balance of plant- components required. Fuel cell power plant sizing problems- Fuel Cell Electric Vehicle Fuel economy calculations-Battery EVs Vs Fuel Cell EVs. Toyota Mirai FCV- Operating principle, High pressure hydrogen tank, Boost convertor, NiMH Battery, Internal circulation system, Hydrogen refueling- Case studies.

TOTAL: 45PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

1 Discuss the different Li-ion Batteries and Fuel Cell performances.
2 Design a Battery Pack with appropriate PCM.
3 Apply Cooling Models using Simulation
4 Estimate fuel economy.
5 Utilize different Thermal Management System approaches during real world usage.

TEXTBOOKS:

1 Ibrahim Dinçer, Halil S. Hamut, and Nader Javani, “Thermal Management of Electric Vehicle Battery Systems’’, Wiley, 2017.

2 Jiuchun Jiang and Caiping Zhang, “Fundamentals and applications of Lithium-Ion batteriesin Electric Drive Vehicles’’, Wiley, 2015.
3 Mehrdad Ehsani, Yimin Gao, Sebastien E. Gay and Ali Emadi, “Modern Electric, Hybrid Electric, and Fuel Cell Vehicles-Fundamentals, Theory, and Design’’, CRC Press, 2005.
4 John G. Hayes and G. Abas Goodarzi, “Electric Powertrain”, Wiley, 2018 Davide Andrea, “Battery Management Systems for Large Lithium-Ion Battery Packs” ARTECH House, 2010.

REFERENCES:

1 Nag.P.K, “Engineering Thermodynamics”, 5th Edition, Tata McGraw Hill Education, New Delhi, 2013.
2 “Vehicle thermal Management Systems Conference Proceedings”, 1st Edition; 2013, Coventry Techno centre, UK
3 Younes Shabany,” Heat Transfer: Thermal Management of Electronics Hardcover” 2010, CRC Press.
4 T. Yomi Obidi, “Thermal Management in Automotive applications”, 2015, SAE International.
5 Jerry Sergent, Al Krum, “Thermal Management Handbook: For Electronic Assemblies Hardcover”, 1998, Mc Graw- Hill.

COs	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	2	1	1	-	-	-	-	-	-	1	3	2	2
2	3	2	2	1	1	-	-	-	-	-	-	1	3	2	2
3	3	2	2	1	1	-	-	-	-	-	-	1	3	2	2
4	3	2	2	1	1	-	-	-	-	-	-	1	3	2	2
5	3	2	2	1	1	-	-	-	-	-	-	1	3	2	2
Avg	3	2	2	1	1	-	-	-	-	-	-	1	3	2	2

PTME3027	DRONE TECHNOLOGIES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

To understand the basics of drone concepts, fundamentals of design, fabrication and programming of drone

UNIT – I INTRODUCTION TO DRONE TECHNOLOGY 9

Drone Concept - Vocabulary Terminology- History of drone - Types of current generation of drones based on their method of propulsion- Drone technology impact on the businesses- Drone business through entrepreneurship- Opportunities/applications for entrepreneurship and employability

UNIT – II DRONE DESIGN, FABRICATION AND PROGRAMMING 9

Classifications of the UAV -Overview of the main drone parts- Technical characteristics of the parts -Function of the component parts -Assembling a drone- The energy sources- Level of autonomy- Drones configurations -The methods of programming drone- Download program - Install program on computer- Running Programs- Multi rotor stabilization- Flight modes -Wi-Fi connection.

UNIT – III DRONE FLYING AND OPERATION 9

Concept of operation for drone -Flight modes- Operate a small drone in a controlled environment- Drone Controls Flight operations –management tool –Sensors-Onboard storage capacity -Removable storage devices- Linked mobile devices and applications

UNIT – IV DRONE COMMERCIAL APPLICATIONS 9

Choosing a drone based on the application -Drones in the insurance sector- Drones in delivering mail, parcels and other cargo- Drones in agriculture- Drones in inspection of transmission lines and power distribution -Drones in filming and panoramic picturing

UNIT – V FUTURE DRONES AND SAFETY 9

The safety risks- Guidelines to fly safely -Specific aviation regulation and standardization- Drone license- Miniaturization of drones- Increasing autonomy of drones -The use of drones in swarms

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:

CO1: Know about a various type of drone technology, drone fabrication and programming.
CO2: Execute the suitable operating procedures for functioning a drone
CO3: Select appropriate sensors and actuators for Drones
CO4: Develop a drone mechanism for specific applications
CO5: Create the programs for various drones

TEXT BOOKS:

1. Daniel Tal and John Altschuld, “Drone Technology in Architecture, Engineering and Construction: A Strategic Guide to Unmanned Aerial Vehicle Operation and Implementation”, 2021 John Wiley & Sons, Inc.
2. Terry Kilby and Belinda Kilby, “Make:Getting Started with Drones “,Maker Media, Inc, 2016

REFERENCES

1. John Baichtal, “Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs”, Que Publishing, 2016

2. Zavrsnik, “Drones and Unmanned Aerial Systems: Legal and Social Implications for Security and Surveillance”, Springer, 2018.

COs	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	1	2	3	1	3	2	-	-	-	-	-	1	2	1	3
CO2	1	2	3	1	3	2	-	-	-	-	-	1	2	1	3
CO3	1	2	3	1	3	2	-	-	-	-	-	1	2	1	3
CO4	1	2	3	1	3	2	-	-	-	-	-	1	2	1	3
CO5	1	2	3	1	3	2	-	-	-	-	-	1	2	1	3
Ave	1	2	3	1	3	2	-	-	-	-	-	1	2	1	3

PTME3028	INTEGRATED PRODUCT DESIGN AND MANUFACTURING USING GD&T	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

To impart the knowledge on GD&T to interpret engineering drawings from the manufacturing perspective, and for cost effective manufacturing of products.

UNIT I Need for GD&T and basic concepts 9

Engineering drawings and tolerancing - Dimensioning, dimensioning standards and rules, Geometric properties of a surface - Coordinate tolerancing system and its shortcomings, Geometric dimensioning and tolerancing system - benefits, Symbols & terms as per ASME Y14.5M, rules and concepts, virtual condition and bonus tolerance

UNIT II Form, Datums, and Orientation controls 9

Flatness, Straightness, Circularity and Cylindricity control; Datums - Implied datums, Planar datums, datum targets, FOS datum features, FOS datum features applications RFS, at MMC and LMC, Orientation controls - Perpendicularity, Angularity and parallelism control of axis / midplane;

UNIT III Position, Concentricity, Symmetry, Runout and Profile controls 9

Tolerance of position - Position vs Coordinate conversion, Tolerance of position RFS, at MMC and LMC, TOP calculations, fixed and floating fastener calculations; Runout control - circular, total and runout calculations, Profile control - surface, line, Profile modifiers, Derived element controls - Straightness derived median line, Flatness derived median plane, Concentricity control, Symmetry control.

UNIT IV GD&T for Integrated product design and manufacturing - 1 9

Concurrent engineering in Y14.5M, Datum reference frames, Foundation of geometric control: interrelated features, the boundary concept, Taylor's principle, and refinement of controls; Application considerations, Product and process design - The six step methodology, Developing the tooling and gaging designs needed to create a producible product

UNIT V GD&T for Integrated product design and manufacturing - 2 9

Producibility design cycle, datum - specification, selection, qualification, and identification; Phantom gage dimensioning, Dimensional measurements, Inspection and verification, functional gaging, functional gage tolerancing, functional inspection techniques, functional workholding and fixturing, Implementation and process improvement.

TOTAL : 45

COURSE OUTCOMES:

CO1 Explain why geometric tolerancing is superior to coordinate tolerancing
CO2 Interpret the symbols and material modifiers used in GD&T
CO3 Define the key terms used in GD&T
CO4 Interpret applications of datum targets, size datum features, and size datum

features

CO5 Interpret the various types of tolerance (flatness, circularity, cylindricity, straightness, perpendicularity, parallelism, angularity, position, runout, and profile)

TEXTBOOKS:

3. Alex Krulikowski, "Fundamentals of Geometric Dimensioning and Tolerancing" 3rd Edition, 2013, Cengage Learning, ISBN: 9781111129828.
4. Bob Campbell, "Integrated Product Design and Manufacturing Using Geometric Dimensioning and Tolerancing", 2003, Marcel Dekker.

REFERENCES:

5. Georg Henzold, "Geometrical Dimensioning and Tolerancing for Design, Manufacturing and Inspection A Handbook for Geometrical Product Specification Using ISO and ASME Standards", Butterworth-Heinemann, 3rd edition, 2021, ISBN: 978-0-12-824061-8.
6. ASME Y14.5-2018, "Dimensioning and Tolerancing - Engineering Product Definition and Related Documentation Practices, ASME, 2018.
7. James D. Meadows, "Geometrical Dimensioning and Tolerancing - Application, Analysis and Measurement", ASME Press, 2009.
8. David A. Madsen and David P. Madsen, "Geometrical Dimensioning and Tolerancing", 9th Edition, The Goodheart-Willcox Company, Inc., 2013.
9. Gene R. Cogorno, "Geometrical Dimensioning and Tolerancing for Mechanical Design", McGraw-Hill, 2006.

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2	3									3	3	
2	3	3	2	3									3	3	
3	3	3	2	3									3	3	
4	3	3	3	3									3	3	
5	3	3	3	3									3	3	

PTME3029 NON-TRADITIONAL MACHINING PROCESSES L T P C

3 0 0 3

COURSE OBJECTIVE:

To impart knowledge on working principles, process characteristics and applications of various nontraditional machining processes

UNIT I INTRODUCTION AND MECHANICAL ENERGY BASED PROCESSES 9

Need for non-traditional machining processes - Classification of non-traditional machining processes - Applications, advantages and limitations of non-traditional machining processes - Mechanical energy based non-traditional machining processes - Abrasive jet machining, Abrasive water jet machining, Ultrasonic machining - working principle, equipment, effect of process parameters, applications, advantages and limitations.

UNIT II CHEMICAL AND ELECTRO CHEMICAL ENERGY BASED PROCESSES 9

Principles, equipment, effect of process parameters, applications, advantages and limitations of Chemical machining, Electro-chemical machining, Electro-chemical honing, Electro-chemical grinding, Electro chemical deburring

UNIT III THERMO-ELECTRIC ENERGY BASED PROCESSES 9

Electric discharge machining - Principle, equipment, effect of process parameters, workpiece and electrode materials, applications, advantages and limitations, Improvements - Powder mixed EDM, cryogenic assisted EDM, magnetic field assisted EDM, Wire electric discharge machining, Electro-discharge grinding, Laser beam machining, Plasma arc machining, Electron beam machining, Ion beam machining.

UNIT IV NANO FINISHING PROCESSES 9

Abrasive flow machining - Principle, equipment, effect of process parameters, applications, advantages and limitations – Chemo-mechanical polishing, Drag finishing of cutting tools and biomedical implants, Magnetic field assisted nanofinishing processes - Magnetic abrasive finishing, Magnetorheological finishing, Magnetorheological abrasive flow finishing

UNIT V HYBRID NON-TRADITIONAL MACHINING PROCESSES 9

Assisted hybrid machining processes their working principles, equipment, effect of process parameters, applications, advantages and limitations - Vibration assisted conventional processes - turning, drilling, milling and grinding, Vibration assisted non-traditional processes - ECM, EDM; Thermal assisted machining - Laser assisted conventional machining, Plasma assisted conventional machining, Laser assisted ECM, EDM

TOTAL :45 PERIODS

COURSE OUTCOMES:

At the end of the course the students will be able to

CO1 Classify different types of non-traditional machining processes and evaluate mechanical energy based non-traditional machining processes.

CO2 Explain the principle and applications of chemical and electro chemical energy based processes.

CO3 Explain the principle of thermo-electric energy based processes and analyse the effect of process parameters on EDM.
CO4 Select a suitable nano-finishing process for the given application.
CO5 Explain the need and principle of assisted / hybrid conventional and non-traditional machining processes.

TEXT BOOKS:

1. Helmi Youssef and Hassan El-Hofy, "Non-Traditional and Advanced Machining Technologies", CRC Press, Boca Raton, Florida, 2nd Edition, 2021. ISBN 13: 978-0-367-43134-1
2. Anand Pandey, "Modern Machining Processes", Ane Books Pvt. Ltd., New Delhi, India, 2019..

REFERENCES:

1. Benedict, G.F., "Non-traditional Manufacturing Processes", Marcel Dekker Inc., New York 1987. ISBN-13: 978-0824773526.
2. Carl Sommer, "Non-Traditional Machining Handbook", Advance Publishing., United States, 2000, ISBN-13: 978-1575373256.
3. Golam Kibria, Bhattacharyya B. and Paulo Davim J., "Non-traditional Micromachining Processes: Fundamentals and Applications", Springer International Publishing., Switzerland, 2017, ISBN:978-3-319-52008-7.
4. Jain V.K., "Nanofinishing science and Technology- Basic and Advanced Finishing and Polishing Processes", CRC Press, Boca Raton, Florida, 2017, ISBN-13: 9781498745949.
5. Kapil Gupta, Neelesh K. Jain and Laubscher R.F., "Hybrid Machining Processes: Perspectives on Machining and Finishing", 1st edition, Springer International Publishing., Switzerland, 2016, ISBN-13: 978-3319259208.

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	3	-	-	2	-	-	-	-	-	3	3	-
2	3	3	3	3	-	-	2	-	-	-	-	-	3	3	-
3	3	3	3	3	3	-	3	-	-	-	-	-	3	3	-
4	3	-	3	-	3	-	2	-	-	-	-	-	3	2	-
5	3	-	3	-	3	-	2	-	-	-	-	-	3	3	-
Avg	3	3	3	3	3	-	1.4	-	-	-	-	-	3	2.6	-

PTME3030 SENSORS AND INSTRUMENTATION

L	T	P	C
3	0	0	3

COURSE OBJECTIVE:

To Impart knowledge on the measurement of various physical parameters using Data Acquisition system

UNIT – I INTRODUCTION 9

Basics of Measurement – Classification of errors – Error analysis – Static and dynamic characteristics of transducers – Performance measures of sensors – Classification of sensors – Sensor calibration techniques – Sensor Output Signal Types.

UNIT – II MOTION, PROXIMITY AND RANGING SENSORS 9

Motion Sensors – Potentiometers, Resolver, Encoders – Optical, Magnetic, Inductive, Capacitive, LVDT – RVDT – Synchro – Microsyn, Accelerometer – GPS, Bluetooth, Range Sensors – RF beacons, Ultrasonic Ranging, Reflective beacons, Laser Range Sensor (LIDAR).

UNIT – III FORCE, MAGNETIC AND HEADING SENSORS 9

Strain Gage, Load Cell, Magnetic Sensors –types, principle, requirement and advantages: Magneto resistive – Hall Effect – Current sensor Heading Sensors – Compass, Gyroscope, Inclinometers.

UNIT – IV OPTICAL, PRESSURE AND TEMPERATURE SENSORS 9

Photo conductive cell, photo voltaic, Photo resistive, LDR – Fiber optic sensors – Pressure – Diaphragm, Bellows, Piezoelectric – Tactile sensors, Temperature – IC, Thermistor, RTD, Thermocouple. Acoustic Sensors – flow and level measurement, Radiation Sensors - Smart Sensors - Film sensor, MEMS & Nano Sensors, LASER sensors.

UNIT – V SIGNAL CONDITIONING AND DAQ SYSTEMS 9

Amplification – Filtering – Sample and Hold circuits – Data Acquisition: Single channel and multichannel data acquisition – Data logging - applications - Automobile, Aerospace, Home appliances, Manufacturing, Environmental monitoring.

TOTAL :45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

1. Recognize with various calibration techniques and signal types for sensors.
2. Explain the working principle and characteristics of force, magnetic, heading, pressure and temperature, smart and other sensors and transducers.
3. Apply the various sensors and transducers in various applications
4. Select the appropriate sensor for different applications.
5. Acquire the signals from different sensors using Data acquisition systems.

TEXT BOOKS:

1. Ernest O Doebelin, “Measurement Systems – Applications and Design”, Tata McGraw-Hill, 2009.
2. Sawney A K and PuneetSawney, “A Course in Mechanical Measurements and Instrumentation and Control”, Dhanpat Rai & Co, 12th edition New Delhi, 2013.

REFERENCES:

1. C. Sujatha ... Dyer, S.A., Survey of Instrumentation and Measurement, John Wiley & Sons, Canada, 2001.

2. Hans Kurt Tönshoff (Editor), Ichiro, “Sensors in Manufacturing” Volume 1, Wiley-VCH April
2001.
3. John Turner and Martyn Hill, “Instrumentation for Engineers and Scientists”, Oxford Science
Publications, 1999.
4. Patranabis D, “Sensors and Transducers”, 2nd Edition, PHI, New Delhi, 2011.
5. Richard Zurawski, “Industrial Communication Technology Handbook” 2nd edition, CRC Press, 2015.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	3	3	-	-	-	-	-	-	1	3		3
2	3	3	3	3	3	-	-	-	-	-	-	1	3	2	3
3	3	3	3	3	3	-	-	-	-	-	-	1	3	2	3
4	3	3	3	3	3	-	-	-	-	-	-	1	3	2	3
5	3	3	3	3	3	-	-	-	-	-	-	1	3	2	3
Avg	3	3	3	3	3	-	-	-	-	-	-	1	3	2	3

PTME3031 PROCESS PLANNING AND COST ESTIMATION L T P C
3 0 0 3

COURSE OBJECTIVE:

To impart knowledge on creation of process plan and estimation of cost for various manufacturing operations.

UNIT – I INTRODUCTION TO PROCESS PLANNING 9

Introduction – Process layouts – Drawing Interpretation – Material evaluation – Steps in process selection – Production equipment and tooling selection – Work study and Ergonomics – Value analysis – Value Engineering – Business process Re-Engineering (BPR).

UNIT – II PROCESS PLANNING STEPS 9

Design of a process plan – Selection of production processes, tools and process parameters- Positioning and work holding devices, Selection of inspection devices and tools, Documenting the process plan, Computer-Aided Process Planning (CAPP) – Benefits, Architecture and approaches.

UNIT – III INTRODUCTION TO COST ESTIMATION 9

Importance of costing and estimation – methods of costing-elements of cost estimation – Types of estimates – Estimating procedure – Estimation labor cost, material cost-Classification of costs – Cost elements, Overhead expenses, Break-even analysis, Calculation of depreciation cost.

UNIT – IV PRODUCTION COST ESTIMATION 9

Estimation of production cost for - Casting processes, Welding processes, and Forging processes.

UNIT – V ESTIMATION OF MACHINING TIME AND COST 9

Estimation of Machining time – Lathe operations, Drilling, Milling, Shaping and Planning, and Grinding, Cost estimation for machining processes.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

1. Explain the process flow for a given Product.
2. Create a process plan for manufacturing a component.
3. Estimate the overhead cost and breakeven associated with manufacturing.
4. Evaluate the total cost for the Cast, welded and Forged products.
5. Analyze the machining time and estimate the cost of machined product.

TEXT BOOKS:

1. Gideon Halevi, “Process and operation planning”, Kluwer academic publishers (Printed ebook), 2003.
2. M. Adithan,” Process Planning and Cost Estimation”, New Age International Publishers, 2007.

REFERENCES:

1. Peter Scallan, “Process planning, The Design/Manufacture interface”, Butterworth-Heinemann, 2003.
2. Robert Creese, M. Adithan, B.S Pabla, “Estimating and Costing for the Metal Manufacturing Industries”, Marcel Dekker, 1992.
3. Phillip F. Ostwald, Jairo Munoz, “Manufacturing Processes And Systems”, 9th Edition, Wiley student edition, 2002.

4. Chitale, A, K., and Gupta, R. C,, “Product Design and manufacturing”, Prentice Hall of India, New Delhi , 1997.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2	1	-	-	-	-	-	-	-	1	2	1	1
2	3	3	3	1	-	-	-	-	-	-	-	1	2	1	3
3	3	3	3	1	-	-	-	-	-	-	-	1	2	1	3
4	3	3	3	1	-	-	-	-	-	-	-	1	2	1	3
5	3	3	3	1	-	-	-	-	-	-	-	1	2	1	3
Avg	3	3	3	1	-	-	-	-	-	-	-	1	2	1	3

PTME3032	ELECTRICAL DRIVES AND CONTROL	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

To learn the basic concepts of different types of electrical machines and their performance.

UNIT – I INTRODUCTION 9

Basic Elements – Types of Electric Drives – factors influencing the choice of electrical drives– heating and cooling curves – Loading conditions and classes of duty – Selection of power rating for drive motors with regard to thermal overloading and Load variation factors

UNIT – II DRIVE MOTOR CHARACTERISTICS 9

Mechanical characteristics – Speed-Torque characteristics of various types of load and drive motors– Braking of Electrical motors – DC motors: Shunt, series, and compound - single phase and three phase induction motors.

UNIT – III STARTING METHODS 9

Types of D.C Motor starters – Typical control circuits for shunt and series motors – Three phases quirrel cage and slip ring induction motors.

UNIT – IV CONVENTIONAL AND SOLID-STATE SPEED CONTROL OF D.C. DRIVES 9

Speed control of DC series and shunt motors – Armature and field control, Ward-Leonard control system - Using controlled rectifiers and DC choppers –applications.

UNIT – V CONVENTIONAL AND SOLID-STATE SPEED CONTROL OF A.C. DRIVES 9

Speed control of three phase induction motor – Voltage control, voltage / frequency control, slip power recovery scheme – Using inverters and AC voltage regulators – applications.

TOTAL:45 PERIODS

OUTCOMES:

At the end of the course the students would be able to:

1. Discuss the basic concepts of different types of electrical machines and their performance.
2. Explain the different methods of starting D.C motors and induction motors
3. Discuss the conventional and solid-state drives
4. Describe the conventional and solid-state speed control of D.C. drives
5. Explain the conventional and solid-state speed control of A.C. drives

TEXT BOOKS:

1. Nagrath .I.J. & Kothari .D.P, “Electrical Machines”, Tata McGraw-Hill, 2006
2. VedamSubrahmaniam, “Electric Drives (Concepts and Applications)”, Tata McGraw-Hill, 2010

REFERENCES:

1. Partab. H., “Art and Science and Utilisation of Electrical Energy”, Dhanpat Rai and Sons, 2017

2. Pillai.S.K “A First Course on Electric Drives”, Wiley Eastern Limited, 2012

3. Singh. M.D., K.B.Khanchandani, “Power Electronics”, Tata McGraw-Hill, 2006.
4. Fundamentals Of Electric Drives And Controlby B.R. Gupta and V. Singhal | 1 January 2013
5. Advanced Electrical Drives - Analysis ModelingControlbyRik De Doncker, Andre Veltman, et al. | 1 January 2014

COs	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	1	-	-	-	-	-	1	-	-	1	2	1	1
2	2	1	1	-	-	-	-	-	1	-	-	1	2	1	1
3	2	1	1	-	-	-	-	-	1	-	-	1	2	1	1
4	2	1	1	-	-	-	-	-	1	-	-	1	2	1	1
5	2	1	1	-	-	-	-	-	1	-	-	1	2	1	1
Avg	2	1	1	-	-	-	-	-	1	-	-	1	2	1	1

PTME3033 DESIGN CONCEPTS IN ENGINEERING L T P C

3 0 0 3

COURSE OBJECTIVE:

The main learning objective of this course is to prepare the students foranalyzing the various design requirements and get acquainted with the processes involved in product development.

UNIT I DESIGN TERMINOLOGY 9

Definition-various methods and forms of design-importance of product design-static and dynamic products-various design projects-morphology of design-requirements of a good design-concurrent engineering-computer aided engineering-codes and standards-product and process cycles-bench marking.

UNIT II DESIGN PROCESSES AND DESIGN FOR QUALITY 9

Basic modules in design process-scientific method and design method-Need identification, importance of problem definition-structured problem, real life problem-information gathering - customer requirements- Quality Function Deployment (QFD)-product design specifications-generation of alternative solutions- Analysis and selection-Detail design and drawings-Prototype, modeling, simulation, testing and evaluation - Design of Experiments

UNIT III CREATIVITY IN DESIGN AND RELIABILITY 9

Creativity and problem solving-vertical and lateral thinking-invention-psychological view, mental blocks-Creativity methods-brainstorming, synectics, force fitting methods, mind map, concept map- Theory of innovative problem solving (TRIZ) - conceptual decomposition creating design concepts.

Reliability-Survival and Failure-Series and parallel systems-Mean time between failure-Weibull distribution

UNIT IV HUMAN AND SOCIETAL ASPECTS IN PRODUCT DEVELOPMENT 9

Human factors in design, ergonomics, user friendly design-Aesthetics and visual aspects environmental aspects-marketing aspects-team aspects-legal aspects-presentation aspects

UNIT V MATERIAL AND PROCESSES IN DESIGN 9

Material selection for performance characteristics of materials-selection for new design substitution for existing design-economics of materials-selection methods-recycling and material selection-types of manufacturing process, process systems- Design for Manufacturability (DFM) - Design for Assembly (DFA).

TOTAL :45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

CO1 Articulate the various design requirements and get acquainted with the processes involved in product development.

CO2 Design the processes to develop a successful and a quality product.

CO3 Implement the scientific approaches to provide reliable design solutions.

CO4 Integrate human and societal aspects in design.

CO5: Select materials and manufacturing processes in design.

TEXT BOOKS:

1. Dieter. G. N., Linda C. Schmidt, “Engineering Design”, McGraw Hill, 2013.
2. Horenstein, M. N., Design Concepts for Engineers, Prentice Hall, 2015.

REFERENCES:

1. Dhillon, B. S., Advanced Design Concepts for Engineers, Technomic Publishing Co., 1998.
2. Edward B. Magrab, Satyandra K. Gupta, F. Patrick McCluskey and Peter A. Sandborn, “Integrated Product and Process Design and Development”, CRC Press, 2009.
3. James Garratt, “Design and Technology”, Cambridge University Press, 1996.
4. Joseph E. Shigley, Charles R.Mische, and Richard G. Budynas, “Mechanical Engineering Design”, McGraw Hill Professional, 2003.
5. Sumesh Krishnan and MukulSukla, Concepts in Engineering Design, Notion Press, 2016.

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	2	2	2	2	1	1	1	2	2	2	2	2
2	3	3	3	2	2	2	2	1	1	1	2	2	2	2	2
3	3	3	3	2	2	2	1	1	1	1	2	2	2	2	2
4	3	3	3	2	1	2	2	1	1	1	2	2	2	2	2
5	3	3	3	2	1	2	2	1	1	1	2	2	2	2	2
Avg	3	3	3	2	1.6	2	1.8	1	1	1	2	2	2	2	2

PTME3034	TURBO MACHINES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

To study the energy transfer in rotor and stator parts of the turbo machines, centrifugal fans, blowers, compressors and turbines.

UNIT – I WORKING PRINCIPLES 9

Classification of Turbomachines. Energy transfer between fluid and rotor - Euler equation and its interpretation. Velocity triangles. Efficiencies in Compressor and Turbine stages. Degree of reaction. Dimensionless parameters for Turbomachines.

UNIT – II CENTRIFUGAL FANS AND BLOWERS 9

Types – components – working. Flow analysis in impeller blades-volute and diffusers. Velocity triangles - h-s diagram. Stage parameters in fans and blowers. Performance characteristic curves – various losses. Fan – bearings, drives and noise.

UNIT – III CENTRIFUGAL COMPRESSOR 9

Components - blade types. Velocity triangles - h-s diagram, stage work. Slip factor and Degree of Reaction. Performance characteristics and various losses. Geometry and performance calculation.

UNIT – IV AXIAL FLOW COMPRESSOR 9

Construction details. Work done factor. Velocity triangles - h-s diagram, stage work. Work done factor. Performance characteristics, efficiency and stage losses – Stalling and Surging. Free and Forced vortex flow.

UNIT – V AXIAL AND RADIAL FLOW TURBINES 9

Axial flow turbines - Types – Elements - Stage velocity diagrams - h-s diagram, stage work - impulse and reaction stages. Compounding of turbines. Performance coefficients and losses. Radial flow turbines: Types – Elements - Stage velocity diagrams - h-s diagram, stage work Performance coefficients and losses.

TOTAL : 45 PERIODS

OUTCOMES:

At the end of the course the students would be able to:

1. Explain the energy transfer in rotor and stator parts of the turbo machines.
2. Explain the function of various elements of centrifugal fans and blowers
3. Evaluate the working and performance of centrifugal compressor.
4. Analyze flow behavior and flow losses in axial flow compressor.
5. Explain the types and working of axial and radial flow turbines

TEXTBOOKS:

1. Ganesan, V., “Gas Turbines”, 3rd Edition, Tata McGraw Hill, 2011..
2. Yahya, S.M., “Turbines, Compressor and Fans”, 4th Edition, Tata McGraw Hill, 2011.

REFERENCES:

1. Dixon, S.L., “Fluid Mechanics and Thermodynamics of Turbomachinery”, 7th Edition, Butterworth-Heinemann, 2014.
2. Gopalakrishnan. G and Prithvi Raj. D,” A Treatise on Turbomachines”, Scitech Publications (India) Pvt. Ltd., 2nd Edition, 2008.
3. Lewis, R.I., “Turbomachinery Performance Analysis” 1st Edition, Arnold Publisher, 1996.
4. Saravanamutto, Rogers, Cohen, Straznicky., “Gas Turbine Theory” 6th Edition, Pearson Education Ltd, 2009.
5. Venkanna, B.K., “Fundamentals of Turbomachinery”, PHI Learning Pvt. Ltd., 2009.

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	1	1	1	-	-	-	-	1	-	-	1	3	2	1
2	2	1	1	1	-	-	-	-	1	-	-	1	3	2	1
3	2	1	1	1	-	-	-	-	1	-	-	1	3	2	1
4	2	1	1	1	-	-	-	-	1	-	-	1	3	2	1
5	2	1	1	1	-	-	-	-	1	-	-	1	3	2	1
Avg	2	1	1	1	-	-	-	-	1	-	-	1	3	2	1