DHANALAKSHMI SRINIVASAN UNIVERSITY

SAMAYAPURAM (NEAR SAMAYAPURAM TOLL PLAZA),

TIRUCHIRAPALLI – 621 112 TAMIL NADU, INDIA

SCHOOL OF ENGINEERING AND TECHNOLOGY

B.TECH- MECHANICAL ENGINEERINGSYLLABUS

REGULATIONS-2021

DHANALAKSHMI SRINIVASAN UNIVERSITY

SAMAYAPURAM (NEAR SAMAYAPURAM TOLL PLAZA),

TIRUCHIRAPALLI – 621 112 TAMIL NADU, INDIA

SCHOOL OF ENGINEERING AND TECHNOLOGY

MECHANICAL ENGINEERING

FULL SEMESTER WISE CURRICULUM

Semester I								
S. No	Subject Code	Subject Name	Subject Category	Contact Hours	L	T		C
	21ENG01	Basics in Communication	HS	4	3	0		3
	21MAT01	Algebra and Calculus	BS	4	3	1		4
	21PHY01 / 21CHY01	Engineering Physics/Engineering Chemistry	BS	5	3	0		3
	21GEN01/221GEN05	Engineering Graphics & Design/ Workshop Practices	ES	5	1	0		3
	21GEN02	Programming for Problem Solving	ES	5	3	0		3
	21PHYP1	Engineering Physics Laboratory	BS	2	0	0		1
	21GENP2	Programming for Problem Solving Laboratory	ES	2	0	0		1
	21NCP01	Yoga	NC	2	0	0		0
			Total		13	1		18
Semester II								
S. No	Subject Code	Subject Name	Subject Category	Contact Hours	L	T		C
	21ENG02	Technical Communication	HS	2	2	0		2
	21MAT02	Advanced calculus and ODE	BS	4	3	1		4
	21PHY01 / 21CHY01	Engineering Physics/Engineering Chemistry	BS	5	3	0		3
	21GEN03	Basic Electrical & Electronics Engineering	ES	3	3	0		3
	21MEC01	Engineering Mechanics	PC	4	3	1		4
	21GEN01/221GEN05	Engineering Graphics & Design/ Workshop Practices	ES	4	0	0		2
	21CHYP1	Engineering Chemistry	BS	2	0	0		1
	21ENGP2	Communication Skills Laboratory	HS	2	0	0		1
	21NCP02	NSS	NC	3	0	0		0
			Total		15	2		20
Semester III								
S. No	Subject Code	Subject Name	Subject Category	Contact Hours	L	T		C
	21MAT03	Numerical Methods	BS	4	3	1		3
	[illegible]	Applied Thermodynamics	PC	4	3	1		3
	21MEC03	Fluid Mechanics & Machineries	ES	3	3	0		3
	21EEC04	Electrical Drives and Control	PC	4	4	0		3
	21MEC05	Manufacturing Technology	PC	3	3	0		3
	21MEC06	Engineering Metallurgy	ES	3	3	0		3
	21MECP1	Manufacturing Technology Lab	PC	3	0	0		2
	21MECP2	Fluid Mechanics and machinery Lab	ES	3	0	0		2

			Total		19	2		22
Semester IV								
S. No	Subject Code	Subject Name	Subject Category	Contact Hours	L	T		C
	21MEC09	Theory of Machines	PC	3	2	1		3
	21MEC10	Strength of Materials	PC	3	3	0		3
		Open Elective – I	OE	3	3	0		3
	21MEC11	Design of Machine Elements	PC	3	2	1		3
	21MEC12	Thermal Engineering	PC	3	3	0		3
	21HSC02	Universal Human Values II	HS	3	2	1		3
	21MECP3	Thermal Engineering Lab	PC	4	0	0		1
	21MECP4	Theory of Machines Lab	PC	4	0	0		2
			Total		13	2		21
Semester V								
S. No	Subject Code	Subject Name	Subject Category	Contact Hours	L	T		C
	21MEC16	Design of Transmission Elements	PC	3	3	0		3
	21MEC17	Metrology & Measurements	PC	3	3	0		3
	21MEC18	CAD/CAM	PC	3	3	0		3
	21MEC19	Energy conversion systems	PC	3	3	0		3
	21MEC20	Open Elective – II	OE	3	3	0		3
		Professional Elective – I	PE	3	3	0		3
	21MECP5	Metrology & Measurements Lab	PC	3	0	0		2
	21MECP6	CAD/CAM Lab	PC	3	0	0		2
	21GENP7	Business English/Career development Program	PC	3	0	0		1
			Total		15	0		23
Semester VI								
S. No	Subject Code	Subject Name	Subject Category	Contact Hours	L	T		C
	21MEC22	Finite Element Analysis	PC	4	3	1		3
	21MEC23	Heat and Mass Transfer	PC	4	3	1		3
		Professional Elective – II	PE	3	3	0		3
		Professional Elective – III	PE	3	3	0		3
		Open Elective – III	OE	3	3	0		3
	21MEC24	Management Science and Productivity	PE	3	3	0		3
	21MEC25	Mini Project	EEC	4	0	0		2
	21GENP9	Heat Transfer and R & AC Lab	PC	3	0	0		2
			Total		15	2		22
Semester VII								
S. No	Subject Code	Subject Name	Subject Category	Contact Hours	L	T		C
	21MEC26	Power Plant Engineering	PC	3	3	0		3
	21MEC27	Automobile Technology	PC	3	3	0		3
		Professional Elective – IV	PE	3	2	1		3
		Professional Elective – V	PE	3	3	0		3
		Open Elective – IV	OE	3	3	0		3
	21GEN09	Comprehensive Viva Voce	EEC	4	10	0		1

			Total		17	1		16

Semester VIII

S. No	Subject Code	Subject Name	Subject Category	Contact Hours	L	T		C
	21MEC30	Project Management	OE	3	3	0		3
		Professional Elective - VI	PE	3	2	0		3
	21MEC31	Project Work	EEC		0	0		12
			Total		6	0		18

List of Professional Electives

(Students should choose any five out of the following 25 subjects)

S. No	Subject Code	Subject Name	Subject Category	Contact Hours	L	T	P	C
1	21MEC32	Composite Materials and Mechanics	PE	3	3	0	0	3
2	21MEC33	Fuels & Combustion	PE	3	3	0	0	3
3	21MEC34	Non Destructive Testing and Evaluation	PE	3	3	0	0	3
4	21MEC35	Metal Forming Technology	PE	3	3	0	0	3
5	21MEC36	Renewable Energy Resources	PE	3	3	0	0	3
6	21MEC37	Robot Dynamics and Applications	PE	3	3	0	0	3
7	21MEC38	Gas Dynamics and Jet Propulsion	PE	3	3	0	0	3
8	21MEC39	Turbo Machines	PE	3	3	0	0	3
9	21MEC40	Composite Materials and Mechanics	PE	3	3	0	0	3
10	21MEC41	Welding Technology	PE	3	3	0	0	3
11	21MEC42	Refrigeration & Air conditioning	PE	3	3	0	0	3
12	21MEC43	Bio Fuels & Bio Energy	PE	3	3	0	0	3
13	21MEC44	Mechanical Vibrations and Noise Control	PE	3	3	0	0	3
14	21MEC45	Design of Jig & Fixtures	PE	3	3	0	0	3
15	21MEC46	Micro Electro Mechanical Systems	PE	3	3	0	0	3
16	21MEC47	Industrial Safety	PE	3	3	0	0	3
17	21MEC48	Industrial Engineering and Management	PE	3	3	0	0	3
18	21MEC49	Production Planning & Control	PE	3	3	0	0	3
19	21MEC50	Fundamentals of HVAC Systems	PE	3	3	0	0	3
20	21MEC51	Industrial Noise and Vibration Control	PE	3	3	0	0	3
21	21MEC52	Additive Manufacturing	PE	3	3	0	0	3
22	21MEC53	Electric Vehicle Technology	PE	3	3	0	0	3
23	21MEC54	Energy Engineering	PE	3	3	0	0	3
24	21MEC55	Computational Fluid Dynamics	PE	3	3	0	0	3
25	21MEC56	Optimization Techniques	PE	3	3	0	0	3

List of Open Electives								
(Students should choose any two out of the following 5 subjects)								
S. No	Subject Code	Subject Name	Subject Category	Contact Hours	L	T	P	C
1	21UOE61	Introduction to Robotics	OE	3	3	0	0	3
2	21UOE62	Machine Learning in Refrigeration and Air conditioning	OE	3	3	0	0	3
3	21UOE63	Sustainable Manufacturing and Green Engineering	OE	3	3	0	0	3
4	21UOE64	Artificial Intelligence (AI) in Industry 4.0	OE	3	3	0	0	3
5	21UOE65	Renewable Energy	OE	3	3	0	0	3

21MAT03	NUMERICAL METHODS	L	T	P	C
		4	1	0	4

Course Objectives

- To understand the knowledge of various techniques and methods of solving various types of partial differential equations.
- To introduce the numerical techniques of interpolation in various intervals in real life situations.
- To acquaint the student with understanding of numerical techniques of differentiation and integration which plays an important role in engineering and technology disciplines.
- To acquaint the knowledge of various techniques and methods of solving ordinary differential equations.

UNIT I	SOLUTION OF EQUATIONS AND EIGEN VALUE PROBLEMS	12 Hours

Solution of algebraic and transcendental equations - Fixed point iteration method - Newton Raphson method - Solution of linear system of equations - Gauss elimination method - Pivoting . Gauss Jordan method - Iterative methods of Gauss Jacobi and Gauss Seidel - Eigen values of a matrix by Power method and Jacobi‟s method for symmetric matrices.

UNIT II	INTERPOLATION AND APPROXIMATION	12 Hours

Interpolation with unequal intervals - Lagrange's interpolation - Newton‟s divided difference interpolation - Cubic Splines - Difference operators and relations Interpolation with equal intervals - Newton‟s forward and backward difference formulae.

UNIT III	NUMERICAL DIFFERENTIATION AND INTEGRATION	12 Hours

Approximation of derivatives using interpolation polynomials - Numerical integration using Trapezoidal, Simpson‟s 1/3 rule - Romberg‟s Method - Two point and three point Gaussian quadrature formulae - Evaluation of double integrals by Trapezoidal and Simpson‟s 1/3 rules.

UNIT IV	INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS	12 Hours

Single step methods - Taylor‟s series method - Euler‟s method Modified Euler‟s method - Fourth order Runge Kutta method for solving first order equations Multi step methods - Milne‟s and Adams - Bash forth predictor corrector methods for solving first order equations.

UNIT V	BOUNDARY VALUE PROBLEMS IN ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS	12 Hours

Finite difference methods for solving second order two point linear boundary value problems - Finite difference techniques for the solution of two dimensional Laplace‟s and Poisson‟s equations on rectangular domain - One dimensional heat flow equation by explicit and implicit (Crank Nicholson) methods - One dimensional wave equation by explicit method.

Course Outcomes:

- Understand the basic concepts and techniques of solving algebraic equation.
- Apply the numerical techniques of differentiation and integration for engineering problems.

- Understand the knowledge of various techniques and methods for solving first and second order ordinary differential equations.
- Solve the partial and ordinary differential equations with initial and boundary conditions by using certain techniques with engineering applications.

Text books:

1. Burden, R.L and Faires, J.D, "Numerical Analysis", 9th Edition, Cengage Learning, 2016.
2. Grewal, B.S., and Grewal, J.S., "Numerical Methods in Engineering and Science", Khanna Publishers, 10th Edition, New Delhi, 2015.
3. Dr.P.Kandasamy, Dr.K.Thilagavathy & Dr.K.Gunavathi "Numerical Methods " S.Chand. Publications.

Reference Books:

1. Brian Bradie, "A Friendly Introduction to Numerical Analysis", Pearson Education, Asia, New Delhi, 2007.
2. Gerald. C. F. and Wheatley. P. O., "Applied Numerical Analysis", Pearson Education, Asia, 6th Edition, New Delhi, 2006.
3. Mathews, J.H. "Numerical Methods for Mathematics, Science and Engineering", 2nd Edition, Prentice Hall, 1992.
4. Sankara Rao. K., "Numerical Methods for Scientists and Engineers", Prentice Hall of India Pvt. Ltd, 3rd Edition, New Delhi, 2007.
5. Sastry, S.S, "Introductory Methods of Numerical Analysis", PHI Learning Pvt. Ltd, 5th Edition, 2015.

21MEC02	APPLIED THERMODYNAMICS	L	T	P	C
		3	1	0	3

Course Objectives:

- Impart knowledge on the basics and application of zeroth and first law of thermodynamics.
- Impart knowledge on the second law of thermodynamics in analysing the performance of thermal devices.
- Impart knowledge on availability and applications of second law of thermodynamics.
- Teach the various properties of steam through steam tables and Mollier chart.

Unit I	BASICS, ZEROTH AND FIRST LAW	9 hours

Review of Basics – 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.

Unit II	SECOND LAW AND ENTROPY	9 hours
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.		
Unit III	**AVAILABILITY AND APPLICATIONS OF II LAW**	**9 hours**
Ideal gases undergoing different processes - principle of increase in entropy. Applications of II Law. High and low-grade energy. Availability and Irreversibility for open and closed system processes - I and II law Efficiency.		
Unit IV	**PROPERTIES OF PURE SUBSTANCES**	**9 hours**
Steam - formation and its thermodynamic properties - p-v, p-T, T-v, T-s, h-s diagrams. PVT surface. Determination of dryness fraction. Calculation of work done and heat transfer in non-flow and flow processes using Steam Table and Mollier Chart..		
Unit V	**POSITIVE DISPLACEMENT COMPRESSORS**	**9 hours**
Reciprocating compressors - Construction - Working - Effect of clearance volume – Multi-staging - Volumetric efficiency - Isothermal efficiency		

Course outcomes:

- Identify thermodynamics systems, point functions and path functions.
- Solve engineering problems using zeroth and first laws of thermodynamics.
- Analyse the heat and work interactions by applying the concepts of entropy principles and exergy.
- Analyse thermodynamic systems involving pure substances and mixtures.
- Calculate thermodynamics properties based on thermodynamics relations.
- Analyse basic thermodynamic cycles of various systems.

Text Books:

- Yunus A. Cengel, Thermodynamics: An Engineering Approach, 8th Edition, McGraw - Hill Education, 2017.

Reference Books:

- P. K. Nag, Engineering Thermodynamics, 6th Edition, McGraw - Hill Education, 2017.
- Michael Moran and Howard Shapiro, Principles of Engineering Thermodynamics, 8th Edition, Wiley, 2015.

21MEC03	FLUID MECHANICS AND	L	T	P	C

	MACHINERIES	3	0	0	3

Course Objectives:

1. To introduce the students about property of the fluids, behaviour of fluids under static conditions.
2. To impart basic knowledge of the dynamics of fluids and boundary layer concept.
3. To expose to the applications of the conservation laws to a) flow measurements b) flow through pipes (both laminar and turbulent) and c) forces on pipe bends.
4. To exposure to the significance of boundary layer theory and its thicknesses.
5. To expose the students to basic principles of working of hydraulic machineries and to design Pelton wheel, Francis and Kaplan turbine, centrifugal and reciprocating pumps.

Unit I	**FLUID PROPERTIES AND FLOW CHARACTERISTICS**	**9 hours**

Properties of fluids – Fluid statics - Pressure Measurements - Buoyancy and floatation - Flow characteristics - Eulerian and Lagrangian approach - Concept of control volume and system - Reynold‟s transportation theorem - Continuity equation, energy equation and momentum equation - Applications

Unit II	**FLUID PROPERTIES AND FLOW CHARACTERISTICS**	**9 hours**

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

Unit III	**DIMENSIONAL ANALYSIS AND MODEL STUDIES**	**9 hours**

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

Unit IV	**TURBINES**	**9 hours**

Impact of jets - Velocity triangles - Theory of rotodynamic machines - Classification of turbines - Working principles - Pelton wheel - Modern Francis turbine - Kaplan turbine - Work done - Efficiencies - Draft tube - Specific speed - Performance curves for turbines - Governing of turbines

Unit V	**PUMPS**	**9 hours**

Classification of pumps - Centrifugal pumps - Working principle - Heads and efficiencies– Velocity triangles - Work done by the impeller - Performance curves - Reciprocating pump working principle - Indicator diagram and variations - Work saved by fitting air vessels - Rotary pumps.

Course outcomes:

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

1. Understand the properties and behaviour in static conditions. Also, to understand the conservation laws applicable to fluids and its application through fluid kinematics and dynamics
2. Estimate losses in pipelines for both laminar and turbulent conditions and analysis of pipes connected in series and parallel. Also, to understand the concept of boundary layer and its thickness on the flat solid surface.
3. Formulate the relationship among the parameters involved in the given fluid phenomenon and to predict the performances of prototype by model studies
4. Explain the working principles of various turbines and design the various types of turbines.
5. Explain the working principles of centrifugal, reciprocating and rotary pumps and design the centrifugal and reciprocating pumps

Text Books:

1. Modi P.N. and Seth, S.M. Hydraulics and Fluid Mechanics, Standard Book House, New Delhi, 22nd edition (2019)
2. Jain A. K. Fluid Mechanics including Hydraulic Machines, Khanna Publishers, New Delhi, 2014.
3. Kumar K. L., Engineering Fluid Mechanics, Eurasia Publishing House(p) Ltd. New Delhi, 2016.

Reference Books:

1. Fox W.R. and McDonald A.T., Introduction to Fluid Mechanics John-Wiley and Sons, Singapore, 2011.
2. Pani B S, Fluid Mechanics: A Concise Introduction, Prentice Hall of India Private Ltd, 2016.
3. Cengel Y A and Cimbala J M, Fluid Mechanics, McGraw Hill Education Pvt. Ltd., 2014.
4. S K Som; Gautam Biswas and S Chakraborty, Introduction to Fluid Mechanics and Fluid Machines, Tata McGraw Hill Education Pvt. Ltd., 2012.
5. Streeter, V. L. and Wylie E. B., Fluid Mechanics, McGraw Hill Publishing Co., 2010.

21EEC04	ELECTRIC DRIVES AND CONTROLS	L	T	P	C
		3	0	0	3

Course Objectives

- To understand the basic concepts of different types of electrical machines and their Performance.
- To study the different methods of starting D.C motors and induction motors.
- To study the conventional and solid-state drives

Unit 1 – Introduction 9 Hours

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 2 - Characteristics of Motor Drive 9 Hours

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 andthree phase induction motors.

Unit 3 - Starting Methods 9 Hours

Types of D.C Motor starters – Typical control circuits for shunt and series motors – Three phase
squirrel cage and slip ring induction motors.

Unit 4 - Speed Control of D.C. Drives 9 Hours

Speed control of DC series and shunt motors – Armature and field control, Ward-Leonard controlsystem - Using controlled rectifiers and DC choppers –applications.

Unit 5 - Speed Control of A.C. Drives 9 Hours

Speed control of three phase induction motor – Voltage control, voltage / frequency control, slippower recovery scheme – Using inverters and AC voltage regulators – applications.

Total: 45

Course Outcome

- Ability to explain different types of electrical machines and their performance

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
3. Krishnan R., “Electric Motor Drives”, 1st edition, Pearson Education India, 2015.

References

1. Dubey G.K.., “Fundamentals of Electrical Drives”, 2nd edition, Alpha Science International Ltd, 2001
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.

21MEC05	MANUFACTURING TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To identify and explain manufacturing concepts.
2. To impart students, knowledge on fundamentals concepts in metal casting, welding, and forming processes.
3. To enable students, understand basics of digital printing, powder metallurgy process and fabrication methods for polymer products and glass products.

Unit I	Manufacturing and Metal forming processes	10 hours

Manufacturing – Role of Manufacturing in the development of a country – classification of manufacturing processes.Cold and hot working of metals – Bulk metal forming- Sheet metal forming- High Energy RateForming processes: Explosive forming- Electro hydraulic forming – Electromagnetic forming

Unit II	Casting and Joining Processes	10 hours

Casting: Fundamentals of metal casting – Types of patterns – sand mold making –different castingtechniques – types of furnaces – Defects in castings – Testing and inspection of castings. Fusion welding processes – solid state welding processes – other welding techniques – Weldingdefects – Testing of welded joints.

Unit III	Processing parts made of metal powders, ceramics, polymer and glass	10 hours

Powder metallurgy-production of metal powders-stages in powder metallurgy – production ofceramic parts-production of glass parts.Injection molding-Blow molding – compression molding-thermoforming.Systematic process selection for given parameters – Process selection charts-economic quantityselection

Unit IV	Theory of Metal Cutting	10 hours

Single point cutting tool, forces in machining, Types of chip, cuttingtools– nomenclature, orthogonal metal cutting, thermal and aspects, cutting tool materials, tool wear,tool life, surface finish, cutting fluids and Machinability, Shaper - Drilling,reaming, boring, Tapping. Milling operations- Gear cutting – forming and generation principle and construction of gear milling, hobblingand gear shaping processes –finishing of gears

Unit V	CNC Machining	10 hours

Numerical Control (NC) machine tools – CNC types, constructional details, special features,
machining centre, part programming fundamentals CNC – manual part programming – micromachining – wafer machining.

Course outcomes:

Upon successful completion of the course the students will be able to

1. Develop suitable casting processes for various materials and components

2. Identify a suitable welding process & Process Parameters for an application
3. Design a suitable metal forming system for making an industrial product
4. Analyse the influence of Process Parameters on the powder metallurgy process
5. Select fabrication method for glass and polymer products
6. Identify suitable manufacturing process for product realisation
7. Fabricate simple components by various manufacturing processes

Text Books:

1. Rao. P.N "Manufacturing Technology - Metal Cutting and Machine Tools", 3rd Edition, TataMcGraw-Hill, New Delhi, 2013.

Reference Books:

1. Richerd R Kibbe, John E. Neely, Roland O. Merges and Warren J.White "Machine ToolPractices", Prentice Hall of India, 1998
2. Geofrey Boothroyd, "Fundamentals of Metal Machining and Machine Tools", Mc Graw Hill, 1984
3. HMT, "Production Technology", Tata McGraw Hill, 1998. 4. Roy. A.Lindberg, "Process and Materials of Manufacture," Fourth Edition, PHI/PearsonEducation

21MEC06	ENGINEERING METALLURGY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To impart knowledge on the structure, properties, treatment, testing and applications ofmetals and non-metallic materials so as to identify and select suitable materials forvarious engineering applications.

Unit I	ALLOYS AND PHASE DIAGRAMS	10 hours

Constitution of alloys – Solid solutions, substitutional and interstitial – phase diagrams, Isomorphous, eutectic, eutectoid, peritectic, and peritectoid reactions, Iron – carbon equilibriumdiagram. Classification of steel and cast Iron microstructure, properties and application.

Unit II	HEAT TREATMENT	10 hours

Definition – Full annealing, stress relief, recrystallisation and spheroidising – normalising, hardeningand Tempering of steel. Isothermal transformation diagrams – cooling curves superimposed onI.T. diagram CCR – Hardenability, Jominy end quench test - Austempering, martempering – casehardening, carburizing, Nitriding, cyaniding, carbonitriding – Flame and Induction hardening – Vacuum and Plasma hardening. .

Unit III	FERROUS AND NON-FERROUS METALS	10 hours

Effect of alloying additions on steel- α and β stabilisers– stainless and tool steels – HSLA, Maragingsteels – Cast Iron - Grey, white, malleable, spheroidal – alloy cast irons, Copper and copper alloys – Brass, Bronze and Cupronickel – Aluminium and Al-Cu – precipitation strengthening treatment – Bearing alloys, Mg-alloys, Ni-based super alloys and Titanium alloys.

Unit IV	NON-METALLIC MATERIALS	10 hours
Polymers – types of polymer, commodity and engineering polymers – Properties and applications ofvarious thermosetting and thermoplastic polymers (PP, PS, PVC, PMMA, PET,PC, PA, ABS, PI, PAI, PPO, PPS, PEEK, PTFE, Polymers – Urea and Phenol formaldehydes)- EngineeringCeramics – Properties and applications of Al2O3, SiC, Si3N4, PSZ and SIALON –Composites- Classifications- Metal Matrix and FRP - Applications of Composites.		
Unit V	**MECHANICAL PROPERTIES AND DEFORMATION MECHANISMS**	**10 hours**
Mechanisms of plastic deformation, slip and twinning – Types of fracture – Testing of materialsunder tension, compression and shear loads – Hardness tests (Brinell, Vickers and Rockwell),hardness tests, Impact test lzod and charpy, fatigue and creep failure mechanisms		

Course outcomes:

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

1. Explain alloys and phase diagram, Iron-Iron carbon diagram and steel classification.
2. Explain isothermal transformation, continuous cooling diagrams and different heat
3. treatment processes.
4. Clarify the effect of alloying elements on ferrous and non-ferrous metals
5. Summarize the properties and applications of non metallic materials. CO5 Explain the testing of mechanical properties.

Text Books:

1. Williams D Callister, “Material Science and Engineering” Wiley India Pvt Ltd, Revised IndianEdition 2014

Reference Books:

1. Kenneth G.Budinski and Michael K. Budinski, “Engineering Materials”, Prentice Hall of IndiaPrivate Limited, 2010.
2. Raghavan.V, “Materials Science and Engineering”, Prentice Hall of India Pvt. Ltd., 2015.
3. U.C.Jindal : Material Science and Metallurgy, "Engineering Materials and Metallurgy", FirstEdition, Dorling Kindersley, 2012
4. Upadhyay. G.S. and Anish Upadhyay, “Materials Science and Engineering”, Viva Books Pvt. Ltd., New Delhi, 2006.

21MECP1	MANUFACTURING TECHNOLOGY LAB	L	T	P	C
		0	0	2	1

Course Objectives:

The main learning objective of this course is to provide hands on training to the students in:

1. Selecting appropriate tools, equipments and machines to complete a given job
2. Performing various welding process using GMAW
3. Performing various machining process such as rolling, drawing, turning, shaping, drilling, milling
4. Fabricating gears using gear making machines
5. Analyzing the defects in the cast and machined components

List of Experiments:

1. Fabricating simple structural shapes using 4G7as Metal Arc Welding machine
2. Preparing green sand moulds with cast patterns
3. Casting aluminum parts using stir casting machine.
4. Reducing the thickness of the plates using rolling machine.
5. Reducing the diameter of on circular parts using wire drawing process machine.
6. Taper Turning and Eccentric Turning on circular parts using lathe machine.
7. Knurling, external and internal thread cutting on circular parts using lathe machine.
8. Shaping – Square and Hexagonal Heads on circular parts using shaper machine.
9. Drilling and Reaming using vertical drilling machine.
10. Milling contours on plates using vertical milling machine.

11. Cutting spur and helical gear using milling machine.
12. Generating gears using gear hobbing machine.
13. Generating gears using gear shaping machine.
14. Grinding components using cylindrical, surface and centerless grinding machine.
15. Broaching components using broaching machine.

Course outcomes:

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

1. Select appropriate tools, equipments and machines to complete a given job.
2. Perform various welding process using GMAW.
3. Perform various machining process such as rolling, drawing, turning, shaping, drilling, milling.
4. Fabricate gears using gear making machines.
5. Analyze the defects in the cast and machined components

21MECP2	FLUID MECHANICS AND MACHINERIES LAB	L	T	P	C
		0	0	3	2

Course Objectives:

1. Calibrate various flow measuring devices.
2. Evaluate various losses in flow through a piping system.
3. Evaluate the performance of fluid machines.

Measurement of metacentric height and radius of gyration of a floating body; calibration of flow measuring devices: venturi-meter, orifice meter, notches and weirs, nozzle meters; determination of major and minor losses in piping system; verification of Bernoulli,,s theorem; determination of lift and drag coefficients of cylinder and air-foil; demonstration of laminar and turbulent flow in pipes; Osborne Reynolds experiment; study of jet forces; experiments on turbines: performance and operating characteristics; experiments on pumps: centrifugal pumps, reciprocating pumps, gear pumps; experiment on torque converter; study and visualization of vortices.

PART I	FLUID MECHANICS	30 hours

1. Calibration of flow meters such as nozzle meter, orifice meter and orifice meter.
2. Calibration of notches such as rectangular notch and triangular notch.
3. Determination of major and minor losses in piping system.
4. Determination of meta-centric height of a floating body.
5. Flow past a small orifice to determine the various coefficients of it.
6. Measurement of a drag on a given specimen in an air flow.
7. Determination of impact of jet.

PART II	FLUID MACHINERY	30 hours

8. Determination of performance characteristics of Francis turbine.
9. Determination of performance characteristics of gear pump.
10. Determination of performance characteristics of single and multi-stage centrifugal pump.

11. Determination of performance characteristics of Pelton turbine
12. Determination of performance characteristics of reciprocating pump.
13. Determination of performance characteristics of torque converter.

Course outcomes:

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

1. Apply the conservation laws to determine the coefficient of discharge of a venturi-meter and finding the friction factor of given pipe
2. Apply the fluid static and momentum principles to determine the metacentric height and forces due to impact of jet
3. Determine the performance characteristics of turbine, rotodynamic pump and positive displacement pump.

Reference Books:

1. Fox W.R. and McDonald A.T., Introduction to Fluid Mechanics John-Wiley and Sons, Singapore, 2011.
2. Pani B S, Fluid Mechanics: A Concise Introduction, Prentice Hall of India Private Ltd, 2016.
3. Cengel Y A and Cimbala J M, Fluid Mechanics, McGraw Hill Education Pvt. Ltd., 2014.
4. S K Som; Gautam Biswas and S Chakraborty, Introduction to Fluid Mechanics and Fluid Machines, Tata McGraw Hill Education Pvt. Ltd., 2012.
5. Streeter, V. L. and Wylie E. B., Fluid Mechanics, McGraw Hill Publishing Co., 2010.

21MEC09	Theory of Machines	L	T	P	C
		3	0	0	3

Course Objectives:

- To impart students‟ knowledge about forces acting on machine parts.
- To enable students to understand the fundamental concepts of machines.
- To facilitate students to understand the functions of cams, gears and fly wheels.
- To make students to get an insight into balancing of rotations and reciprocating masses and the concepts of vibration.

Unit I	Basics of Mechanisms	9 hours

Introduction - Terminologies, Degree of Freedom - Study of planar mechanisms and their inversions - Velocity and accelerations in planar mechanisms, Coriolis component of acceleration

Unit II	Kinematics of Cams, Gears and Gear Trains	9 hours

Cams with different Follower Motion, Gear terminologies - Law of gearing - Interference and undercutting - Epicyclic gear train - Two position and Three position synthesis of planar mechanism - Graphical and analytical methods - Freudenstein equation

Unit III	Dynamic Force Analysis	9 hours

D‟Alembert‟s Principle, Dynamic Analysis of planar Mechanism. Turning Moment Diagrams - Fly Wheels - Applications.

Unit IV	Balancing and Vibration	9 hours

Static and Dynamic Balancing of Rotating Masses, Balancing of Reciprocating Masses, Introduction to vibration - Terminologies - Single degree of freedom- damped and undamped- free and forced vibration.

Unit V	Mechanisms for Control & Gyroscope	9 hours

Governors- types and its characteristics, Gyroscopic Effects on the Movement of Air Planes and Ships – Gyroscope Stabilization.

Course outcomes:

- Apply different mechanisms for designing machines.
- Compute velocity and acceleration of various plan mechanisms.
- Apply the principles for analyzing cams, gears and gear trains.
- Synthesize mechanisms for doing useful work.
- Analyze dynamic forces acting on mechanism.
- Balance rotating and reciprocating masses and reduce vibrations.
- Analyze gyroscopic effects on aeroplanes, ships and automobiles.
- Measure and analyze free, forced and damped vibrations of mechanical systems.

Text Books:

- S. S. Rattan, “Theory of Machines”, Tata McGraw Hill, 2015.

Reference Books:

- Joseph Edward Shigley and John Jospeh Uicker JR, Theory of Machines and Mechanisms SI Edition, Oxford University Press, 2014
- R L Norton, Kinematics and Dynamics of Machinery, McGraw-Hill Education, 2017
- R L Norton, Design of Machinery: An Introduction to the Synthesis and Analysis of Mechanisms and Machines, McGraw-Hill Higher Education, 2011

21MEC10	STRENGTH OF MATERIALS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To understand the concepts of stress, strain, principal stresses and principal planes.
2. To study the concept of shearing force and bending moment due to external loads in determinate beams and their effect on stresses.
3. To determine stresses and deformation in circular shafts and helical spring due to torsion.
4. To compute slopes and deflections in determinate beams by various methods.
5. To study the stresses and deformations induced in thin and thick shells.

Unit I	STRESS, STRAIN AND DEFORMATION OF SOLIDS	9 hours

Rigid bodies and deformable solids – Tension, Compression and Shear Stresses - Deformation of simple and compound bars – Thermal stresses – Elastic constants - Volumertric strains – Stresses on inclined planes – Principal stresses and principal planes – Mohr‟s circle of stress.

Unit II	TRANSVERSE LOADING ON BEAMS AND STRESSES IN BEAM	9 hours

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

Unit III	TORSION	9 hours

Theory of Torsion – Stresses and Deformations in Solid and Hollow Circular Shafts – Combined bending moment and torsion of shafts - Power transmitted to shaft – Shaft in series and parallel – Closed and Open Coiled helical springs – springs in series and parallel.

Unit IV	DEFLECTION OF BEAMS	9 hours

Elastic curve – Governing differential equation - Double integration method - Macaulay's method - Area moment method - Conjugate beam method for computation of slope and deflection of determinant beams

Unit V	THIN CYLINDERS, SPHERES AND THICK CYLINDERS	9 hours

Stresses in thin cylindrical shell due to internal pressure - circumferential and longitudinal stresses - Deformation in thin cylinders – Spherical shells subjected to

internal pressure – Deformation in spherical shells – Thick cylinders - Lame‟s theory.

Course outcomes:

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

1. Understand the concepts of stress and strain in simple and compound bars, the importance of principal stresses and principal planes.
2. Understand the load transferring mechanism in beams and stress distribution due to shearing force and bending moment.
3. Apply basic equation of torsion in designing of shafts and helical springs
4. Calculate slope and deflection in beams using different methods.
5. Analyze thin and thick shells for applied pressures.

Text Books:

1. Rajput R.K. “Strength of Materials (Mechanics of Solids)", S.Chand & company Ltd., New Delhi, 7th edition, 2018.
2. Rattan S.S., “Strength of Materials", Tata McGraw Hill Education Pvt .Ltd., New Delhi, 2017.

Reference Books:

1. Singh. D.K., “Strength of Materials”, Ane Books Pvt Ltd., New Delhi, 2021.
2. Egor P Popov, “Engineering Mechanics of Solids”, 2nd edition, PHI Learning Pvt. Ltd., New Delhi, 2015.
3. Beer. F.P. & Johnston. E.R. “Mechanics of Materials”, Tata McGraw Hill, 8th Edition, New Delhi 2019.
4. Vazirani. V.N, Ratwani. M.M, Duggal .S.K “Analysis of Structures: Analysis, Design and Detailing of Structures-Vol.1”, Khanna Publishers, New Delhi 2014.

21MEC11	Design of Machine Elements	L	T	P	C
		3	0	0	3

Course Objectives:

- Develop an ability to apply knowledge of mechanics and materials
- Develop an ability to design a system / component to meet desired needs within realistic
- constraints using suitable design methodology.
- Utilize various standards and methods of standardization.
- Apply the concept of design and validation by strength analysis.

Unit I	Introduction to Design Process	9 hours

Introduction to Design process – Factors – Materials selection - direct - Bending and Torsional stress equation - Impact and Shock loading - Factor of safety - Design stress - Theories of failures – Problems.

Unit II	Fatigue strength	9 hours

Stress concentration - theoretical stress concentration factor - Size factor - Surface limits factor - fatigue stress concentration factor - notch sensitivity - Variable and cyclic loads – Fatigue strength – S-N curve – Continued cyclic stress – Soderberg and Goodman equations.

Unit III	Design of Mechanical Springs	9 hours

Stresses and deflections of helical springs – extension -compression springs – springs for fatigue loading, energy storage capacity – helical torsion springs – Flat Spiral Springs - leaf springs. Computer aided design of springs.

Unit IV	**Design of Joints, Keys and cotters**	**9 hours**

Riveted, Welded and Bolted Joints, Computer aided design of joints – Design of keys-stresses in keys-cotter joints-spigot and socket, sleeve and cotter, jib and cotter joints-knuckle joints.

Unit V	**Design of Shafts, Couplings and Engine Components**	**9 hours**

Design of solid and hollow shafts for strength and rigidity – design of shafts for combined bending and axial loads – shaft sizes. Computer aided design of shafts and analysis- Design of couplings – Rigid – Muff, Split muff and Flange couplings - Flexible – Oldham, Universal couplings. Computer aided design of Couplings – Design of Piston – Connecting rod – Crankshaft – Flywheel.

Course outcomes:

- Analyse machine components using theories of failure
- Design machine parts against fatigue failures of components subjected to variable and cyclic loads
- Design springs for withstanding static and fatigue loads
- Design welded, riveted and bolted joints
- Design keys, cotter and knuckle joints
- Design shafts and different types of couplings using computers
- Design engine components like piston, connecting rod, crankshaft and flywheel

Text Books:

- Keith J Nisbett and Richard G Budynas, Shigley's Mechanical Engineering Design, McGraw-Hill Education, 10th Edition, 2014.

Reference Books:

- V.B. Bhandari, Design of Machine elements, Tata Mc Graw Hill, 3rd Edition, 2010.
- P.C.Sharma & D.K.Aggarwal, A Text Book of Machine Design, S.K.Kataria & Sons, New Delhi,12th edition, 2012.
- Jack A.Collins, Henry Busby, George Staab, Mechanical Design of Machine Elements and Machines, 2nd Edition, Wiley India Pvt. Limited, 2011.
- Steven R. Schmid, Bernard J. Hamrock, Bo. O. Jacobson, Fundamentals of Machine Elements, CRC Press, Third Edition, 2014.
- Juvinal, R.C and Kurt M.Marshek, Machine component design, John Wiley, 2012.
- Design Data – PSG College of Technology, DPV Printers, Coimbatore, 2012.

21MEC12	**THERMAL ENGINEERING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:

- To guide the students to apply the laws of thermodynamics in applications of

thermal systems.

- To help students gain essential and basic knowledge of various types of internal and external
- Combustion engines, so as to equip them with knowledge required for the design of engines and power plants.
- To train the students with the procedures for the testing of engines and fuels.
- To equip the students to analyse various components of thermal power plant.

Unit I	**IC Engines**	**9 hours**
Working principle of 2 stroke and 4 stroke SI and CI engines with PV and Valve Timing Diagrams, Combustion process - Knocking and detonation, Cetane number and Octane number, Comparison of fuel system of diesel and petrol engines, Cooling system, Lubrication system, Ignition system - Battery, Magneto and Electronic systems		
Unit II	**IC Engines Performance**	**9 hours**
Performance test - Measurement of Brake power, Indicated power, Fuel consumption, Air consumption; Heat balance test, Morse test and Retardation test on IC engine.		
Unit III	**STEAM BOILERS**	**9 hours**
Types of boilers, Reheating - Regeneration - Modern features of high-pressure boilers - Heat Recovery Boilers - Mountings and Accessories. Steam Nozzles – One-dimensional steady flow of steam through a convergent and divergent nozzle.		
Unit IV	**STEAM TURBINE AND GAS TURBINE**	**9 hours**
Steam Turbine – Impulse and Reaction principle. Gas Turbine – Open and Closed cycle gas turbine, Reheating, Regeneration and Intercooling		
Unit V	**REFRIGERATION & AIR-CONDITIONING**	**9 hours**
Vapour compression system - Components - Working - P-H and T-S diagrams - Calculation of COP - Effect of sub-cooling and super-heating - Vapour absorption system. Air-conditioning Types, Working Principles - Psychrometry, Psychrometric chart, cooling load calculations.		

Course outcomes:

- Apply the laws of thermodynamics to the working of I.C engines.
- Conduct engine tests and analyze different performance parameters.
- Design a steam nozzles for thermal power plant
- Analyze different subsystems of thermal power plants and performance of reciprocating compressors.
- Analyze various refrigeration systems and suggest for better modifications.
- Evaluate the cooling load requirements for conditioned space.
- Experimentally determine the performance indicators of IC Engines, R&AC systems and compressors

Text Books:

- Rajput R.K, Thermal Engineering, 10th Edition, Laxmi Publications (P) Ltd, 2017.

Reference Books:

- Ganesan V, Internal Combustion Engines, 4th Edition, McGraw Hill Education, 2012.
- Manohar Prasad, Refrigeration and Air Conditioning, 3rd Edition, New Age International, 2015.
- Soman.K, Thermal Engineering, PHI Learning Private Ltd, 2011

21MECP3	THERMAL ENGINEERING Lab	L	T	P	C
		0	0	2	1

Course Objectives:

- Analyzing the performance characteristics of various engines
- Applying for proper valve and port timing in IC engines
- Conducting boiler operation and performance test on a boiler and steam turbine List of Experiments
- Valve Timing and Port Timing diagrams.
- Actual p-v diagrams of IC engines.
- Performance Test on four – stroke Diesel Engine.
- Heat Balance Test on 4 – stroke Diesel Engine.
- Morse Test on Multi-Cylinder Petrol Engine.

LIST OF EXPERIMENTS

1. Analyzing the performance characteristics of various engines
2. Applying for proper valve and port timing in IC engines
3. Conducting boiler operation and performance test on a boiler and steam turbine
4. Valve Timing and Port Timing diagrams.
5. Actual p-v diagrams of IC engines.
6. Performance Test on four – stroke Diesel Engine.
7. Heat Balance Test on 4 – stroke Diesel Engine.
8. Morse Test on Multi-Cylinder Petrol Engine.

Course outcomes:

1. Analyze the performance characteristics of various engines
2. Apply for proper valve and port timing in IC engines
3. Conduct boiler operation and performance test on a boiler and steam turbine

Reference Book:

- Ganesan V, Internal Combustion Engines, 4th Edition, McGraw Hill Education, 2012.

21MECP4	Theory of Machines Lab	L	T	P	C
		3	0	0	3

Course Objectives:

- To supplements the principles learnt in dynamics of machinery.
- To understand how certain measuring devices are used for dynamic testing.
- Demonstrate experiments on single and two degrees of freedom translational and rotational vibration systems.
- Familiarize students with measurement of moment of inertia and center of gravity of complex objects Provide an exposure to governors and gyroscope.
- Demonstrate balancing of rotating and reciprocating masses.

List of Experiments:

1. Study of gear parameters.
2. Epicycle gear Train.
3. Determination of moment of inertia of flywheel and axle system.
4. Determination of mass moment of inertia of a body about its axis of symmetry.
5. Undamped free vibrations of a single degree freedom spring-mass system.
6. Torsional Vibration (Undamped) of single rotor shaft system.
7. Dynamic analysis of cam mechanism.
8. Experiment on Watts Governor.
9. Experiment on Porter Governor.
10. Experiment on Proell Governor.
11. Experiment on motorized gyroscope.
12. Determination of critical speed of shafts.

Course outcomes:

- Interpret the concepts of natural frequency, damping, critical speeds in translational and rotating vibrational systems
- Determine moment of inertia and center of gravity of complex objects
- Construct the characteristic plots for different types of governors
- Evaluate the working of a gyroscope and measure the gyroscopic couple
- Analyze and implement the balancing of rotating and reciprocating masses.

21MEC16	Design of Transmission Elements	L	T	P	C
		3	0	0	3

Course Objectives:

1 To gain knowledge on the principles and procedure for the design of Mechanical power Transmission components.
2 To understand the standard procedure available for Design of Transmission of Mechanical elements spur gears and parallel axis helical gears.
3 To learn the design bevel, worm and cross helical gears of Transmission system.
4 To learn the concepts of design multi and variable speed gear box for machine tool applications.
5 To learn the concepts of design to cams, brakes and clutches

Unit I	**Design of Flexible Elements**	**9 hours**

Design of Flat belts and pulleys - Selection of V belts and pulleys – Selection of hoisting wire ropes and pulleys – Design of Transmission chains and Sprockets.

Unit II	**Spur Gears and Parallel Axis Helical Gears**	**9 hours**

Speed ratios and number of teeth-Force analysis -Tooth stresses - Dynamic effects – Fatigue strength - Factor of safety - Gear materials – Design of straight tooth spur & helical gears based on strength and wear considerations – Pressure angle in the normal and transverse plane- Equivalent number of teeth-forces for helical gears.

Unit III	**Bevel, Worm and Cross Helical Gears**	**9 hours**

Straight bevel gear: Tooth terminology, tooth forces and stresses, equivalent number of teeth. Estimating the dimensions of pair of straight bevel gears. Worm Gear: Merits and demerits terminology. Thermal capacity, materials-forces and stresses, efficiency, estimating the size of the worm gear pair. Cross helical: Terminology-helix angles-Estimating the size of the pair of cross helical gears.

Unit IV	**Gear Boxes**	**9 hours**

Geometric progression - Standard step ratio - Ray diagram, kinematics layout -Design of sliding mesh gear box - Design of multi speed gear box for machine tool applications - Constant mesh gear box - Speed reducer unit. – Variable speed gear box, Fluid Couplings, Torque Converters for automotive applications.

Unit V	**Cams, Clutches and Brakes**	**9 hours**

Cam Design: Types-pressure angle and under cutting base circle determination-forces and surface stresses. Design of plate clutches –axial clutches-cone clutches-internal expanding rim clutches-Electromagnetic clutches. Band and Block brakes - external shoe brakes – Internal expanding shoe brake.

Course outcomes:

- Apply the concepts of design to belts, chains and rope drives.
- Apply the concepts of design to spur, helical gears.
- Apply the concepts of design to worm and bevel gears.
- Apply the concepts of design to gear boxes.
- Apply the concepts of design to cams, brakes and clutch.

Text Books:

- 1. Bha ndari V, “Design of Machine Elements”, 4th Edition, Tata McGraw-Hill Book Co, 2016.
- 2. Jose ph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett “Mechanical Engineering Design”, 8th Edition, Tata McGraw-Hill, 2008.

Reference Books:

- Merhyle F. Spotts, Terry E. Shoup and Lee E. Hornberger, "Design of Machine Elements" 8th Edition, Printice Hall, 2003.
- Orthwein W, "Machine Component Design", Jaico Publishing Co, 2003.
- Pra bhu. T.J., "Design of Transmission Elements", Mani Offset, Chennai, 2000.
- Robert C. Juvinall and Kurt M. Marshek, "Fundamentals of Machine Design", 4th Edition, Wiley,2005
- Sundararajamoorthy T. V, Shanmugam .N, "Machine Design", Anuradha Publications,Chennai, 2003.

21MEC17	METROLOGY AND MEASUREMENTS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To learn basic concepts of the metrology and importance of measurements.
2. To teach measurement of linear and angular dimensions assembly and transmission elements.
3. To study the tolerance analysis in manufacturing.
4. To develop the fundamentals of GD & T and surface metrology.
5. To provide the knowledge of the advanced measurements for quality control in manufacturing industries.

Unit I	BASICS OF METROLOGY	9 hours

Measurement – Need, Process, Role in quality control; Factors affecting measurement - SWIPE; Errors in Measurements – Types – Control – Measurement uncertainty – Types, Estimation, Problems on Estimation of Uncertainty, Statistical analysis of measurement data, Measurement system analysis, Calibration of measuring instruments, Principle of air gauging- ISO standards.

Unit II	MEASUREMENT OF LINEAR, ANGULAR DIMENSIONS, ASSEMBLY AND TRANSMISSION ELEMENTS	9 hours

Linear Measuring Instruments – Vernier caliper, Micrometer, Vernier height gauge, Depth Micrometer, Bore gauge, Telescoping gauge; Gauge blocks – Use and precautions, Comparators – Working and advantages; Opto-mechanical measurements using measuring microscope and Profile projector - Angular measuring instruments – Bevel protractor, Clinometer, Angle gauges, Precision level, Sine bar, Autocollimator, Angle dekkor, Alignment telescope. Measurement of Screw threads - Single element measurements – Pitch Diameter, Lead, Pitch. Measurement of Gears – purpose – Analytical measurement – Runout, Pitch variation, Tooth profile, Tooth thickness, Lead – Functional checking – Rolling gear test.

Unit III	TOLERANCE ANALYSIS	9 hours

Tolerancing– Interchangeability, Selective assembly, Tolerance representation, Terminology, Limits and Fits, Problems (using tables IS919); Design of Limit gauges, Problems. Tolerance analysis in manufacturing, Process capability, tolerance stackup, tolerance charting

Unit IV	METROLOGY OF SURFACES	9 hours
Fundamentals of GD & T- Conventional vs Geometric tolerance, Datums, Inspection of geometric deviations like straightness, flatness, roundness deviations; Simple problems – Measurement of Surface finish – Functionality of surfaces, Parameters, Comparative, Stylus based and Optical Measurement techniques, Filters, Introduction to 3D surface metrology- Parameters.		
Unit V	**ADVANCES IN METROLOGY**	**9 hours**
Lasers in metrology - Advantages of lasers – Laser scan micrometers; Laser interferometers – Applications – Straightness, Alignment; Ball bar tests, Computer Aided Metrology - Basic concept of CMM – Types of CMM – Constructional features – Probes – Accessories – Software – Applications – Multisensor CMMs. Machine Vision - Basic concepts of Machine Vision System – Elements – Applications - On-line and in-process monitoring in production - Computed tomography – White light Scanner		

Course outcomes:

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

1. Discuss the concepts of measurements to apply in various metrological instruments.
2. Apply the principle and applications of linear and angular measuring instruments, assembly and transmission elements.
3. Apply the tolerance symbols and tolerance analysis for industrial applications.
4. Apply the principles and methods of form and surface metrology.
5. Apply the advances in measurements for quality control in manufacturing Industries.

Text Books:

1. Dotson Connie, "Dimensional Metrology", Cengage Learning, First edition, 2012.
2. Mark Curtis, Francis T. Farago, "Handbook of Dimensional Measurement", Industrial Press, Fifth edition, 2013.

Reference Books:

1. AmmarGrous, 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. National Physical Laboratory Guide No. 40, No. 41, No. 42, No. 43, No. 80, No. 118, No. 130, No. 131. http://www.npl.co.uk.
4. Raghavendra N.V. and Krishnamurthy. L., Engineering Metrology and Measurements, Oxford University Press, 2013.
5. Venkateshan, S. P., "Mechanical Measurements", Second edition, John Wiley &Sons, 2015.

21MEC18	CAD/CAM	L	T	P	C
		3	0	0	3

Course Objectives:

1. To provide an overview of how computers are being used in mechanical component design
2. To understand the application of computers in various aspects of Manufacturing viz., Design, Proper planning, Manufacturing cost, Layout & Material Handling system

Unit I	INTRODUCTION	10 hours

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-Brief introduction to CAD and CAM – Manufacturing Planning, Manufacturing control- Introduction to CAD/CAM – CAD/CAM concepts —Types of production - Manufacturing models and Metrics – Mathematical models of Production Performance

Unit II	GEOMETRIC MODELING	10 hours

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 andB-rep

Unit III	CAD STANDARDS	10 hours

Standards for computer graphics- Graphical Kernel System (GKS) - standards for exchange imagesOpen Graphics Library (OpenGL) - Data exchange standards - IGES, STEP, CALS etc. - communication standards

Unit IV	FUNDAMENTAL OF CNC AND PART PROGRAMING	10 hours

Introduction to NC systems and CNC - Machine axis and Co-ordinate system- CNC machine tools Principle of operation CNC- Construction features including structure- Drives and CNC controllers-2D and 3D machining on CNC- Introduction of Part Programming, types - Detailed Manual part programming on Lathe & Milling machines using G codes and M codes- Cutting Cycles, Loops, Sub program and Macros- Introduction of CAM package

Unit V	CNC Machining	10 hours

Group Technology(GT),Part Families–Parts Classification and coding–Simple Problems in Opitz Part Coding system–Production flow Analysis–Cellular Manufacturing–Composite part concept–Types of Flexibility - FMS – FMS Components – FMS Application & Benefits – FMS Planning and Control–Quantitative analysis in FMS

Course outcomes:

Upon successful completion of the course the students will be able to

1. Explain the 2D and 3D transformations, clipping algorithm, Manufacturing models and Metrics
2. Explain the fundamentals of parametric curves, surfaces and Solids
3. Summarize the different types of Standard systems used in CAD
4. Apply NC & CNC programming concepts to develop part programme for Lathe &
5. Milling Machines
6. Summarize the different types of techniques used in Cellular Manufacturing and FMS

Text Books:

2. Radhakrishnan P, Subramanyan S. and Raju V., "CAD/CAM/CIM", 2nd Edition, New Age International (P) Ltd, New Delhi, 2000..

Reference Books:

4. Chris McMahon and Jimmie Browne "CAD/CAM Principles", "Practice and Manufacturing management " Second Edition, Pearson Education, 1999.
5. 2. Donald Hearn and M. Pauline Baker "Computer Graphics"". Prentice Hall, Inc,1992.
6. 3. Foley, Wan Dam, Feiner and Hughes - "Computer graphics principles & practice" Pearson Education -2003
7. 4. William M Neumann and Robert F.Sproul "Principles of Computer Graphics", McGraw Hill Book Co. Singapore, 1989.

21MEC19	ENERGY CONVERSION SYSTEM	L	T	P	C
		3	0	0	3

Course Objectives:

- Analyze the thermodynamic cycles used in power generation.
- Evaluate the merits of direct thermal energy conversion systems compared to conventional techniques
- Analyze the performance of fuel cells
- Select the best energy storage mechanism for any given application
- Developing a mechanism for total energy recovery from a system adopting CHCP concept

Unit I	ENERGY CONVERSION CYCLES	9 hours

Bell Coleman, Scuderi, Stirling, Ericsson, Lenoir, Atkinson, Stoddard and Kalina cycle – Comparison with Rankine and Brayton cycles

Unit II	DIRECT CONVERSION OF THERMAL TO ELECTRICAL ENERGY	9 hours

MHD - Thermoelectric Converters – Thermoelectric refrigerator – Thermoelectric Generator – Thermionic converters – Ferro electric converter – Nernst Effect Generator – Thermo Magnetic Converter.

Unit III	DIRECT CONVERSION OF CHEMICAL TO ELECTRICAL ENERGY	9 hours

Fuel Cell : Basics – working advantages and drawbacks – types – comparative analysis – thermodynamics and kinetics of fuel cell process – performance of fuel cell – applications

Unit IV	ENERGY STORAGE SYSTEMS	9 hours

Batteries – types – working – performance governing parameters – hydrogen energy – solar cells. Energy storage devices for Mechanical Energy, Electrical Energy, Chemical Energy, Thermal Energy.

Unit V	COMBINED HEAT AND POWER PRODUCTION	9 hours

Cogeneration - types - Configuration and thermodynamic performance of steam turbine cogeneration systems – gas turbine cogeneration systems – reciprocating IC engines cogeneration systems – concept of Polygeneration

Course outcomes:

- Analyze the thermodynamic cycles used in power generation
- Evaluate the merits of direct thermal energy conversion systems compared to conventional techniques
- Analyze the performance of fuel cells
- Select the best energy storage mechanism for any given application
- Develop a mechanism for total energy recovery from a system adopting CHCP concept relations.
- Analyse basic thermodynamic cycles of various systems.

Text Books:

- Archie.W.Culp, Principles of Energy Conversion, 2nd Edition, McGraw-Hill Inc., 1991, New York.
- Kordesch Karl, and Günter R. Simader, Fuel Cell and Their Applications, Wiley 2006.

Reference Books:

- Hart A.B. and Womack, G.J., Fuel Cells: Theory and Application, Prentice Hall, 1989.
- Kettari, M.A., Direct Energy Conversion, Addison-Wesley, 1997.
- Yogi Goswami, D. and Frank Kreith, Energy Conversion, Second Edition, Science, 2017.

21MECP5	METROLOGY AND MEASUREMENTS LAB	L	T	P	C
		0	0	0	2

Course Objectives:

1. Plan and conduct experiments involving a single factor.
2. Use common measuring instruments.
3. Determine the measurement uncertainty after carrying out the measurement
4. Explain the principle and working of specialized measuring instruments.

List of Suggested experiments	30 hours

1. Measure various screw thread parameters using instruments like thread plug and ring gauges, universal measuring microscope, three wire sets, thread pitch micrometer and thread pitch gauge
2. Study the straightness error using autocollimator and spirit level
3. Psychrometric studies using sling psychrometer
4. Calibration of pressure gauge using dead weight pressure gauge tester.
5. Measurements using LVDT, slip gauges, three-pin micrometer and bore dial gauge.
6. Determine stress-strain relationship using strain gauges and load cell.
7. Studies using the ultrasonic flaw detecting equipment

8. Measurements using the profile projector
9. Measurements using disc micrometer
10. Measurement of the tool angles using tool maker‟s microscope and digital dial gauge.
11. Use of optical flat for determining parallelism error and combination set for determining angle.
12. Measure the speed of a rotating object using stroboscope.
13. Thermocouple-based experiments
14. R&R study between observers
15. Studies using gear tooth vernier
16. Studies using the Feeler gauge and sine bar
17. Studies on the surface profilometer
18. Measurement of area using planimeter
19. Determining the class of fits between given shafts and hole
20. Studies on coordinate measuring machine
21. Studies on cylindricity testing machine, laser scan micrometer and coating thickness gauge

Course outcomes:

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

1. Discuss the concepts of measurements to apply in various metrological instruments.
2. Apply the principle and applications of linear and angular measuring instruments, assembly and transmission elements.
3. Apply the tolerance symbols and tolerance analysis for industrial applications.
4. Apply the principles and methods of form and surface metrology.

Reference Books:

1. K. J. Hume and G. H. Sharpe, Practical Metrology. Macdonald & Co, 1953.
2. C. Dotson, Fundamentals of Dimensional Metrology, 5th ed. Delmar Cengage Learning, 2006.
3. J. P. Holman, Experimental Methods for Engineers, 7th ed. McGraw-Hill, 2000

21MECP6	CAD / CAM LABORATORY	L	T	P	C
		0	0	2	1

Course Objectives:

1. To gain practical experience in handling 2D drafting and 3D modelling software systems.
2. To study the features of CNC Machine Tool.
3. To expose students to modern control systems (Fanuc, Siemens etc.,)
4. To know the application of various CNC machines like CNC lathe, CNC Vertical Machining centre, CNC EDM and CNC wire-cut and studying of Rapid prototyping

I	3D GEOMETRIC MODELLING	30 hours

1. Introduction of 3D Modelling software

Creation of 3D assembly model of following machine elements using 3D Modelling software

2. Flange Coupling
3. Plummer Block
4. Screw Jack
5. Lathe Tailstock
6. Universal Joint
7. Machine Vice
8. Stuffing box
9. Crosshead10. Safety Valves
11. Non-return valves
12. Connecting rod
13. Piston
14. Crankshaft

* Students may also be trained in manual drawing of some of the above components

II	Manual Part Programming.	30 hours

(i) Part Programming - CNC Machining Centre a) Linear Cutting.
b) Circular cutting.
c) Cutter Radius Compensation. d) Canned Cycle Operations.
(ii) Part Programming - CNC Turning Centre a) Straight, Taper and Radius Turning.
b) Thread Cutting. c) Rough and Finish Turning Cycle. d) Drilling and TappingCycle.

III	Computer Aided Part Programming	10 hours

CL Data and Post process generation using CAM packages.
Application of CAPP in Machining and Turning Centre

Course outcomes:

Upon successful completion of the course the students will be able to

1. Draw 3D and Assembly drawing using CAD software
2. Demonstrate manual part programming with G and M codes using CAM

Reference:

Radhakrishnan P, Subramanyan S. and Raju V., "CAD/CAM/CIM", 2nd Edition, New Age International (P) Ltd, New Delhi,2000..

21MEC22	FINITE ELEMENT ANALYSIS	L	T	P	C
		3	1	0	3

Course Objectives:

1. Understand the basics and significance of finite element method.
2. Develop formulations for various problems using finite element method.
3. Solve field problems using finite element method by writing programs or using commercial software

Unit I	**INTRODUCTION**	**9 hours**

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 hours**

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 and heat transfer. Longitudinal vibration frequencies and mode shapes. Fourth Order Beam Equation –Transverse deflections and Natural frequencies of beams.

Unit III	**TWO DIMENSIONAL SCALAR VARIABLE PROBLEMS**	**9 hours**

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

Unit IV	**TWO DIMENSIONAL VECTOR VARIABLE PROBLEMS**	**9 hours**

Equations of elasticity – Plane stress, plane strain and axisymmetric problems – Body forces and temperature effects – Stress calculations - Plate and shell elements.

Unit V	**ISOPARAMETRIC FORMULATION**	**9 hours**

Natural co-ordinate systems – Isoparametric elements – Shape functions for iso parametric elements – One and two dimensions – Serendipity elements – Numerical integration and application to plane stress problems - Matrix solution techniques – Solutions Techniques to Dynamic problems – Introduction to Analysis Software

Course outcomes:

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

1. Summarize the basics of finite element formulation.
2. Apply finite element formulations to solve one dimensional Problems.
3. Apply finite element formulations to solve two dimensional scalar Problems.
4. Apply finite element method to solve two dimensional Vector problems.
5. Apply finite element method to solve problems on iso parametric element and dynamic Problems.

Text Books:

1. Reddy. J.N., "An Introduction to the Finite Element Method", 3rd Edition, Tata McGraw-Hill, 2005

2. Seshu, P, "Text Book of Finite Element Analysis", Prentice-Hall of India Pvt. Ltd., New Delhi, 2007

Reference Books:

1. Bhatti Asghar M, "Fundamental Finite Element Analysis and Applications", John Wiley & Sons, 2005 (Indian Reprint 2013)*
2. Chandrupatla&Belagundu, "Introduction to Finite Elements in Engineering", 3rd Edition, Prentice Hall College Div, 1990
3. Logan, D.L., "A first course in Finite Element Method", Thomson Asia Pvt. Ltd., 2002
4. Rao, S.S., "The Finite Element Method in Engineering", 3rd Edition, Butterworth Heinemann, 2004
5. Robert D. Cook, David S. Malkus, Michael E. Plesha, Robert J. Witt, "Concepts and Applications of Finite Element Analysis", 4th Edition, Wiley Student Edition, 2002.

21MEC23	HEAT and MASS TRANSFER	L	T	P	C
		3	1	0	3

Course Objectives:

- To Learn the principal mechanism of heat transfer under steady state and transient conditions.
- To learn the fundamental concept and principles in convective heat transfer.
- To learn the theory of phase change heat transfer and design of heat exchangers.
- To study the fundamental concept and principles in radiation heat transfer.
- To develop the basic concept and diffusion, convective mass transfer

Unit I	CONDUCTION	9 hours

General Differential equation – Cartesian, Cylindrical and Spherical Coordinates – One Dimensional Steady State Heat Conduction — plane and Composite Systems – Conduction with Internal Heat Generation – Extended Surfaces – Unsteady Heat Conduction – Lumped Analysis – Semi Infinite and Infinite Solids –Use of Heisler‟s charts – Methods of enhanced thermal conduction

Unit II	CONVECTION	9 hours

Conservation Equations, Boundary Layer Concept – Forced Convection: External Flow – Flow over Plates, Cylinders Spheres and Bank of tubes. Internal Flow – Entrance effects. Free Convection – Flow over Vertical Plate, Horizontal Plate, Inclined Plate, Cylinders and Spheres. Mixed Convection

Unit III	PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGERS	9 hours

Regimes of Pool boiling and Flow boiling - Correlations in boiling and condensation. Heat Exchanger Types - Overall Heat Transfer Coefficient – Fouling Factors. LMTD and NTU methods.

Unit IV	RADIATION	9 hours

Introduction to Thermal Radiation - Radiation laws and Radiative properties - Black Body and Gray body Radiation - Radiosity - View Factor Relations. Electrical Analogy. Radiation Shields.

Unit V	MASS TRANSFER	9 hours

Basic Concepts – Diffusion Mass Transfer – Fick‟s Law of Diffusion – Steady state and Transient Diffusion - Stefan flow –Convective Mass Transfer – Momentum, Heat and Mass Transfer Analogy – Convective Mass Transfer Correlations

Course outcomes:

- Apply heat conduction equations to different surface configurations under steady state and transient conditions and solve problems.
- Apply free and forced convective heat transfer correlations to internal and external flows through/over various surface configurations and solve problems.
- Explain the phenomena of boiling and condensation, apply LMTD and NTU methods of thermal analysis to different types of heat exchanger configurations and solve problems.
- Explain basic laws for Radiation and apply these principles to radiative heat transfer between different types of surfaces to solve problems.
- Apply diffusive and convective mass transfer equations and correlations to solve problems for different applications.

Text Books:

- R.C. Sachdeva, "Fundamentals of Engineering Heat & Mass transfer", New Age International Publishers, 2009 2.
- Yunus A. Cengel, "Heat Transfer A Practical Approach" – Tata McGraw Hill, 5thEdition – 2013

Reference Books:

- Frank P. Incropera and David P. Dewitt, "Fundamentals of Heat and Mass Transfer", John Wiley & Sons, 7th Edition, 2014. 2. Holman, J.P., "Heat and Mass Transfer", Tata McGraw Hill, 2010 3.
- Kothandaraman, C.P., "Fundamentals of Heat and Mass Transfer", New Age International, New Delhi, 2012 4. Ozisik, M.N., "Heat Transfer", McGraw Hill Book Co., 1994. 5.
- S.P. Venkateshan, "Heat Transfer", Ane Books, New Delhi, 2014

21MEC24	Management Science and Productivity	L	T	P	C
		3	0	0	3

Course Objectives:

- To analyze different planning activities needed during the operations stage of a manufacturing or a service industry.
- To apply productivity techniques for achieving continuous improvement.

Unit I	Introduction to macro and micro economics	9 hours

Macro-economic measures – micro economics – Demand and supply – Determinants of demand and supply – Elasticity of demand – Demand forecasting techniques (short term & long term) – Problems.		
Unit II	**Elements of cost**	**9 hours**
Determination of Material cost - Labour cost – Expenses - Types of cost – Cost of production – Over-head expenses–break even analysis - Problems.		
Unit III	**Productivity and Cellular Manufacturing**	**9 hours**
Definition – Factors affecting- Increasing productivity of resources - Kinds of productivity measures - Case study - Group Technology – Cellular layout – Machine-Part Cell Formation (MPCF) – Heuristic approaches – Hierarchical clustering for MPCF.		
Unit IV	**Work study, Plant location and layout**	**9 hours**
Method study – Time study – stopwatch time study – Work measurement - performance rating- allowances – Ergonomics. Plant location –need - Factors – comparison – quantitative methods for evaluation Plant layout: objectives-principles – factors influencing – tools and techniques including computer based layout design – CRAFT, ALDEP, CORELAP.		
Unit V	**Material requirement Planning (MRP)**	**9 hours**
Objectives – functions – MRP system – MRP logic – Management information from MRP – lot sizing consideration – Manufacturing resource planning – capacity requirement planning (CRP) –Bill of material.		

Course outcomes:

- Analyze the way price of a product affects the demand for a product for consequent actions and predict demand for a product by making use of different demand forecasting techniques.
- Explain Break even analysis to determine safe production levels and costing of industrial products.
- Apply productivity techniques for continuous improvement in different functionalities of an industry.
- Analyze the existing operations that happen in factories for establishing time standards for different activities.
- Demonstrate the knowledge of selection of location for the new plant & optimizing the layout within the plant for smooth production.
- Apply cellular manufacturing concepts in industry.
- Compute material requirement needed to satisfy the Master Production Schedule of a factory by having thorough understanding of MRP logic.

Text Books:

- R Dan Reid, and Nada R. Sanders, Operations Management, John wiley& Sons, 5th Edition, 2012.

Reference Books:

- William J Stevenson, Operations Management, McGrawHill, 12th Edition, India, 2017.
- R Panneerselavam, Production and Operations Management, PHI publications 3rd Edition, 2012.

21GENP9	HEAT TRANSFER AND R&AC LAB	L	T	P	C

		0	**0**	**3**	**2**

Course Objectives:

- To gain experimental knowledge of Predicting the thermal conductivity of solids and liquids.
- To gain experimental knowledge of Estimating the heat transfer coefficient values of various fluids.
- To gain experimental knowledge of Testing the performance of tubes in tube heat exchangers

LIST OF EXPERIMENTS

1. Thermal conductivity measurement of pipe insulation using lagged pipe apparatus.
2. Determination of thermal conductivity of a composite wall, insulating powder, oils, and water.
3. Determination of heat transfer coefficient of air under natural convection and forced convection.
4. Heat transfer from pin-fin under natural and forced convection.
5. Determination of heat flux under pool boiling and flow boiling in various regimes.
6. Determination of heat transfer coefficient in film-wise and drop-wise condensation.
7. Determination of friction factor, heat transfer coefficient of cold/hot fluid and effectiveness of a tube-in-tubeheat exchanger.
8. Determination of Stefan – Boltzmann constant.
9. Determination of emissivity of a grey surface.
10. Calibration of thermocouples / RTDs at standard reference temperatures.

Course outcomes:

- Conduct experiment on Predict the thermal conductivity of solids and liquids
- Conduct experiment on Estimate the heat transfer coefficient values of various fluids.
- Conduct experiment on Test the performance of tubes in tube heat exchangers

Reference Books:

- Frank P. Incropera and David P. Dewitt, "Fundamentals of Heat and Mass Transfer", John Wiley & Sons, 7th Edition, 2014. 2. Holman, J.P., "Heat and Mass Transfer", Tata McGraw Hill, 2010 3.
- Kothandaraman, C.P., "Fundamentals of Heat and Mass Transfer", New Age International, New Delhi, 2012 4. Ozisik, M.N., "Heat Transfer", McGraw Hill Book Co., 1994. 5.

21MEC26	**Power Plant Engineering**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:

- To study the coal based thermal power plants.
- To study the diesel, gas turbine and combined cycle power plants.
- To learn the basic of nuclear engineering and power plants.
- To learn the power from renewable energy
- To study energy, economic and environmental issues of power plants

Unit I	**Coal Based Thermal Power Plants**	**9 hours**

Rankine cycle - improvisations, Layout of modern coal power plant, Super Critical Boilers, FBC Boilers, Turbines, Condensers, Steam & Heat rate, Subsystems of thermal power plants – Fuel and ash handling, Draught system, Feed water treatment. Binary Cycles and Cogeneration systems.

Unit II	**Diesel, Gas Turbine and Combined Cycle Power Plants**	**9 hours**

Otto, Diesel, Dual & Brayton Cycle - Analysis & Optimisation. Components of Diesel and Gas Turbine power plants. Combined Cycle Power Plants. Integrated Gasifier based Combined Cycle systems.

Unit III	**Nuclear Power Plants**	**9 hours**

Basics of Nuclear Engineering, Layout and subsystems of Nuclear Power Plants, Working of Nuclear Reactors : Boiling Water Reactor (BWR), Pressurized Water Reactor (PWR), CANada Deuterium- Uranium reactor (CANDU), Breeder, Gas Cooled and Liquid Metal Cooled Reactors. Safety measures for Nuclear Power plants.

Unit IV	**Power from Renewable Energy**	**9 hours**

Hydro Electric Power Plants – Classification, Typical Layout and associated components including Turbines. Principle, Construction and working of Wind, Tidal, Solar Photo Voltaic (SPV), Solar Thermal, Geo Thermal, Biogas and Fuel Cell power systems.

Unit V	**Energy, Economic and Environmental Issues of Power Plants**	**9 hours**

Power tariff types, Load distribution parameters, load curve, Comparison of site selection criteria, relative merits & demerits, Capital & Operating Cost of different power plants. Pollution control technologies including Waste Disposal Options for Coal and Nuclear Power Plants.

Course outcomes:

- Explain the layout, construction and working of the components inside a thermal power plant.
- Explain the layout, construction and working of the components inside a Diesel, Gas and Combined cycle power plants.
- Explain the layout, construction and working of the components inside nuclear power plants.
- Explain the layout, construction and working of the components inside Renewable energy power plants
- Explain the applications of power plants while extend their knowledge to power plant economics and environmental hazards and estimate the costs of electrical energy production.

Text Books:

- Nag. P.K., "Power Plant Engineering", Third Edition, Tata McGraw – Hill Publishing Company Ltd., 2008.

- A Textbook of Power Plant Engineering by R.K. Rajput | 1 January 2016.

Reference Books:

- El-Wakil. M.M., "Power Plant Technology", Tata McGraw – Hill Publishing Company Ltd., 2010.
- Godfrey Boyle, "Renewable energy", Open University, Oxford University Press in association with the Open University, 2004.
- Thomas C. Elliott, Kao Chen and Robert C. Swanekamp, "Power Plant Engineering", Second Edition, Standard Handbook of McGraw – Hill, 1998.
- Power Plant Engineering by B. Vijaya Ramnath C. Elanchezhian, L. Saravanakumar | 1 November 2019.
- Power Plant Engineering, As per AICTE: Theory and Practice by Dipak Kumar Mandal, Somnath Chakrabarti, et al. | 1 January 2019

21NCP06	RENEWABLE ENERGY SOURCES	L	T	P	C
		3	0	0	0

Course Objectives:

1. To enable the students to understand the principle of working and the components of differentnon-conventional sources of energy and their utilization.
2. To get an exposure to the wind energy, Biomass, tidal energy, fuel cells andenergy conversion technologies.

Unit I	RENEWABLE ENERGY SOURCES	9 hours

Environmental consequences of fossil fuel use, Importance of renewable sources of energy, Types of RE sources, Limitations of RE sources, Present Indian and international energy scenario of conventional and RE sources.

Unit II	SOLAR ENERGY	9 hours

Present renewable energy status in India - Solar radiation – Measurements of solarradiation and sunshine – Solar thermal collectors – Flat plate and concentrating collectors – Solarthermal applications – Solar thermal energy storage – Fundamentals of solar photo voltaic conversion.

Unit III	WIND ENERGY	9 hours

Types of Wind Power Plants (WPPs)–Components of WPPs-Working of WPPs – Horizontalaxis wind turbine – Vertical axis wind turbine – Wind turbine generators, Environmental issues - Applications.

Unit IV	BIO &OTHER ENERGY SOURCES	9 hours

Bio resources – Biomass direct combustion – Biomass gasifier –- Geothermal Energy: Basics, Direct Use, Geothermal Electricity. Tidal Energy - Wave Energy: Energy from waves, wave power devices.

Unit V	NEW ENERGY SOURCES	9 hours

Fuel cell – Principle - Types of fuel cells – Hydrogen energy – Properties –Hydrogen production – Storage – Transport and utilisation - Safety issues. Energy Storage methodsand devices.

Course outcomes:

At the end of the course student will

1. To estimate solar radiation and formulate heat transfer equations and analyze of modern energyconversion technologies
2. To describe various renewable energy resources and techniques to utilize them effectively.
3. Compute wind energy potential and predict the performance of wind turbines.
4. Describe and analyze photovoltaic systems.
5. Explain the energy harvesting methods from various energy sources.

Text Books:

1. Twidell, J.W. & Weir, A., "Renewable Energy Resources", EFN Spon Ltd., UK, 2005.
2. Godfrey Boyle, "Renewable Energy, Power for a Sustainable Future", Oxford University Press,U.K., 2012.
3. S.P. Sukhatme, "Solar Energy: Principles of Thermal Collection and Storage", Tata McGraw HillPublishing Company Ltd., New Delhi, 2009.
4. G.N. Tiwari, "Solar Energy – Fundamentals Design, Modelling and applications", Alpha ScienceIntl Ltd, 2015.
5. B.H. Khan, "Non-Conventional Energy Resources", The McGraw Hill companies, 2009

Reference Books:

1. G.D. Rai, "Non-Conventional Energy Sources", Khanna Publishers, New Delhi, 2014.

21MEC18	WELDING TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

3. To understand the basics of welding and to know about the various types of weldingprocesses

Unit I	GAS AND ARC WELDING PROCESSES	10 hours

Fundamental principles – Air Acetylene welding, Oxyacetylene welding, Carbon arc welding, Shieldedmetal arc welding, Submerged arc welding, TIG & MIG welding, Plasma arc welding and Electroslagwelding processes - advantages, limitations and applications

Unit II	RESISTANCE WELDING PROCESSES	10 hours
Spot welding, Seam welding, Projection welding, Resistance Butt welding, Flash Butt welding,Percussion welding and High frequency resistance welding processes - advantages, limitations andapplications		
Unit III	**SOLID STATE WELDING PROCESSES**	**10 hours**
Cold welding, Diffusion bonding, Explosive welding, Ultrasonic welding, Friction welding, Forgewelding, Roll welding and Hot pressure welding processes - advantages, limitations and applications		
Unit IV	**OTHER WELDING PROCESSES**	**10 hours**
Thermit welding, Atomic hydrogen welding, Electron beam welding, Laser Beam welding, Friction stirwelding, Under Water welding, Welding automation in aerospace, nuclear and surface transportvehicles.		
Unit V	**DESIGN OF WELD JOINTS, WELDABILITY AND TESTING OF WELDMENTS**	**10 hours**
Various weld joint designs – Welding defects – causes and remedies - Weldability of Aluminium, Copper, and Stainless steels. Destructive and non-destructive testing of weldments		

Course outcomes:

Upon successful completion of the course the students will be able to

7. Understand the construction and working principles of gas and arc welding process.
8. Understand the construction and working principles of resistance welding process.
9. Understand the construction and working principles of various solid state welding process.
10. Understand the construction and working principles of various special welding processes.
11. Understand the concepts on weld joint design, weldability and testing of weldments.

Text Books:

3. Parmer R.S., “Welding Engineering and Technology”, 1st Edition, Khanna Publishers, New Delhi,2008.

Reference Books:

8. AWS- Welding Hand Book. 8th Edition. Vol- 2. “Welding Process”
9. Christopher Davis. “Laser Welding- Practical Guide”. Jaico Publishing House.
10. Davis A.C., “The Science and Practice of Welding”, Cambridge University Press, Cambridge,1993
11. Nadkarni S.V. “Modern Arc Welding Technology”, Oxford IBH Publishers, 1st Edition, 2005.
12. Schwartz M.M. “Metals Joining Manual”. McGraw Hill Books, 1979.
13. Tylecote R.F. “The Solid Phase Welding of Metals”. Edward Arnold Publishers Ltd. London

21MEC54	ENERGY ENGINEERING	L	T	P	C
		3	0	0	3

Course Objectives:

- Evaluate the merits of direct thermal energy conversion systems compared to conventional techniques
- Analyze the performance of fuel cells
- Select the best energy storage mechanism for any given application
- Mechanism for total energy recovery from a system adopting CHCP concept

Unit I	PRESENT ENERGY RESOURCES	9 hours

Different type of conventional Power Plant- Energy Demand Scenario in India-Advantage and Disadvantage of conventional Power Plants

Unit II	BASICS OF SOLAR ENERGY	9 hours

Solar Thermal Energy- Solar Photovoltaic- Advantages and Disadvantages-Environmental impacts and safety

Unit III	POWER AND ENERGY FROM WIND TURBINES	9 hours

India‟s wind energy potential- Types of wind turbines- Off shore Wind energy- Environmental benefits and impacts

Unit IV	AIR POLLUTION AND WATER POLLUTION	9 hours

Sources, effects, control, air quality standards, air pollution act, air pollution measurement. Water pollution-Sources and impacts, Soil pollution-Sources and impacts, disposal of solid waste.

Unit V	GREENHOUSE GASES AND NOISE POLLUTION	9 hours

Effect, acid rain. Noise pollution. Pollution aspects of various power plants. Fossil fuels and impacts, Industrial and transport emissions- impacts.

Course outcomes:

- Evaluate the merits of direct thermal energy conversion systems compared to conventional techniques
- Analyze the performance of fuel cells
- Select the best energy storage mechanism for any given application

Text Books:

- Archie.W.Culp, Principles of Energy Conversion, 2nd Edition, McGraw-Hill Inc., 1991, New York.
- Kordesch Karl, and Günter R. Simader, Fuel Cell and Their Applications, Wiley 2006.

Reference Books:

- Hart A.B. and Womack, G.J., Fuel Cells: Theory and Application, Prentice

Hall, 1989.
- Kettari, M.A., Direct Energy Conversion, Addison-Wesley, 1997.
- Yogi Goswami, D. and Frank Kreith, Energy Conversion, Second Edition, Science, 2017.

21MEC31	NON DESTRUCTIVE TESTING AND EVALUATION	L	T	P	C
		3	0	0	3

Course Objectives:

To study and understand the various Non Destructive Evaluation and Testing methods, theory and their industrial applications.

Unit I	OVERVIEW OF NDT	9 hours

NDT Versus Mechanical testing, Overview of the Non Destructive Testing Methods for the detection of manufacturing defects as well as material characterisation. Relative merits and limitations, Various physical characteristics of materials and their applications in NDT., Visual inspection – Unaided and aided.

Unit II	UNIT II SURFACE NDE METHODS	9 hours

Liquid Penetrant Testing - Principles, types and properties of liquid penetrants, developers, advantages and limitations of various methods, Testing Procedure, Interpretation of results. Magnetic Particle Testing- Theory of magnetism, inspection materials Magnetisation methods, Interpretation and evaluation of test indications, Principles and methods of demagnetization, Residual magnetism.

Unit III	THERMOGRAPHY AND EDDY CURRENT TESTING (ET)	9 hours

Thermography- Principles, Contact and non contact inspection methods, Techniques for applying liquid crystals, Advantages and limitation - infrared radiation and infrared detectors, Instrumentations and methods, applications. Eddy Current Testing-Generation of eddy currents, Properties of eddy currents, Eddy current sensing elements, Probes, Instrumentation, Types of arrangement, Applications, advantages, Limitations, Interpretation/Evaluation.

Unit IV	ULTRASONIC TESTING (UT) AND ACOUSTIC EMISSION (AE)	9 hours

Ultrasonic Testing-Principle, Transducers, transmission and pulse-echo method, straight beam and angle beam, instrumentation, data representation, A/Scan, B-scan, C-scan. Phased Array Ultrasound, Time of Flight Diffraction. Acoustic Emission Technique – Principle, AE parameters, Applications

Unit V	RADIOGRAPHY (RT)	9 hours

Principle, interaction of X-Ray with matter, imaging, film and film less techniques, types and use of filters and screens, geometric factors, Inverse square, law, characteristics of films - graininess, density, speed, contrast, characteristic curves, Penetrameters, Exposure charts, Radiographic equivalence. Fluoroscopy- Xero-Radiography, Computed Radiography, Computed Tomography

Course outcomes:

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

- Explain the fundamental concepts of NDT
- Discuss the different methods of NDE
- Explain the concept of Thermography and Eddy current testing
- Explain the concept of Ultrasonic Testing and Acoustic Emission
- Explain the concept of Radiography

Text Books:

4. Baldev Raj, T.Jayakumar, M.Thavasimuthu "Practical Non-Destructive Testing", Narosa Publishing House, 2014.
5. Ravi Prakash, "Non-Destructive Testing Techniques", 1st revised edition, New Age International Publishers, 2010

Reference Books:

14. ASM Metals Handbook, "Non-Destructive Evaluation and Quality Control", American Society of Metals, Metals Park, Ohio, USA, 200, Volume-17.
15. 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.
16. Charles, J. Hellier," Handbook of Nondestructive evaluation", McGraw Hill, New York 2001.
17. Paul E Mix, "Introduction to Non-destructive testing: a training guide", Wiley, 2 nd Edition New Jersey,.

21MEC33	COMPOSITE MATERIALS AND MECHANICS	L	T	P	C
		3	0	0	3

Course Objectives:

- To understand the fundamentals of composite material strength and its mechanical Behaviour.
- Understanding the analysis of fiber reinforced Laminate design for different combinations of plies with different orientations of the fiber.
- Thermo-mechanical behavior and study of residual stresses in Laminates during processing.
- Implementation of Classical Laminate Theory (CLT) to study and analysis for residual stresses in an isotropic layered structure such as electronic chips.

Unit I	INTRODUCTION, LAMINA CONSTITUTIVE EQUATIONS & MANUFACTURING	9 hours

Definition –Need – General Characteristics, Applications. Fibers – Glass, Carbon, Ceramic and 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 hours

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 hours

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 hours

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 QuasiIsotropic Laminates

Unit V	ANALYSIS OF LAMINATED FLAT PLATES	**9 hours**

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

Course outcomes:

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

- Summarize the various types of Fibers, Equations and manufacturing methods for Composite materials.
- Derive Flat plate Laminate equations
- Analyze Lamina strength
- Analyze the thermal behavior of Composite laminates
- Analyze Laminate flat plates

Text Books:

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