Four Year Degree Course in Bachelor of Engineering Branch: **MECHANICAL ENGINEERING**

Semester Pattern (Choice Based Credit Grade System)

SEMESTER : THIRD																
Sr. No.	**Subject Code**	**Subject**	**TEACHING SCHEME**					**EXAMINATION SCHEME**								
			HOURS / WEEK			**Total HOURS/WEEK**	**CREDITS**	**THEORY**					**PRACTICAL**			
			Lecture	**Tutorial**	**P/D**			**Duration Of Paper (Hr.)**	**Max. Marks Theory Paper**	**Internal Marks**	**Total**	**Min. Passing Marks**	**Max. Marks**		**Total**	**Min. Passing Marks**
													Int.	**Ext.**		
THEORY																
01	3ME01	Mathematics-III	3	1	--	4	4	3	80	20	100	40	--	--	--	--
02	3ME02	Manufacturing Processes	3	--	--	3	3	3	80	20	100	40	--	--	--	--
03	3ME03	Mechanics of Materials	3	--	--	3	3	3	80	20	100	40	--	--	--	--
04	3ME04	Engineering Thermodynamics	3	--	--	3	3	3	80	20	100	40	--	--	--	--
05	3ME05	Fluid Mechanics	3	--	--	3	3	3	80	20	100	40	--	--	--	--
06	4ES06	**Environmental Studies	2	--	--	2	--	--	--	--	--	--	-	-	-	-
PRACTICALS / DRAWING / DESIGN																
07	3ME07	Manufacturing Processes- lab.	--	--	2	2	1	--	--	--	--	--	25	25	50	25
08	3ME08	Mechanics of Materials- lab .	--	--	2	2	1	--	--	--	--	--	25	25	50	25
09	3ME09	Fluid Mechanics- lab.	--	--	2	2	1	--	--	--	--	--	25	25	50	25
10	3ME10	Machine Drawing- lab.	--	--	2	2	1	--	--	--	--	--	25	25	50	25
		Total	**17**	**1**	**8**	**26**	**20**	**--**	**--**	**--**	**500**	**--**	**--**	**--**	**200**	**--**
														Grand Total	**700**	

Note: **The Examination of the Subject Environmental Studies shall be conducted in IV Semester.

SEMESTER : FOURTH																	
Sr. No.	Subject Code	Subject	TEACHING SCHEME					EXAMINATION SCHEME									
			HOURS / WEEK			Total HOURS/WEEK	CREDITS	THEORY					PRACTICAL				
			Lecture	Tutorial	P/D			Duration Of Paper (Hr.)	Max. Marks Theory Paper	Internal Marks	Total	Min. Passing Marks	Max. Marks		Total	Min. Passing Marks
													Int.	Ext.		
THEORY																	
01	4ME01	Material Science	3	--	--	3	3	3	80	20	100	40	--	--	--	--
02	4ME02	Energy Conversion - I	3	1	--	4	4	3	80	20	100	40	--	--	--	--
03	4ME03	Manufacturing Technology	3	--	--	3	3	3	80	20	100	40	--	--	--	--
04	4ME04	Basic Electrical Drives & Control	3	--	--	3	3	3	80	20	100	40	--	--	--	--
05	4ME05	Hydraulic & Pneumatic Systems	3	--	--	3	3	3	80	20	100	40	--	--	--	--
06	4ES06	**Environmental Studies	2	--	--	2	2	3	80	20	100	40	-	-	-	-
PRACTICALS / DRAWING / DESIGN																	
07	4ME07	Material Science-lab	--	--	2	2	1	--	--	--	--	--	25	25	50	25
08	4ME08	Manufacturing Technology-lab	--	--	2	2	1	--	--	--	--	--	25	25	50	25
09	4ME09	Basic Electrical Drives & Control -lab	--	--	2	2	1	--	--	--	--	--	25	25	50	25
10	4ME10	Hydraulic & Pneumatic Systems-lab	--	--	2	2	1	--	--	--	--	--	25	25	50	25
Total			**17**	**1**	**8**	**26**	**22**	--	--	--	**500**	--	--	--	**200**	**--**
														Total	**700**		

Note: **The Examination of Mandatory Subject Environmental Science shall be conducted in IV Semester.

SEMESTER : FIFTH																	
Sr. No.	Subject Code	Subject	TEACHING SCHEME					EXAMINATION SCHEME									
			HOURS / WEEK			Total HOURS/WEEK	CREDITS	THEORY					PRACTICAL				
			Lecture	Tutorial	P/D			Duration Of Paper (Hr.)	Max. Marks Theory Paper	Internal Marks	Total	Min. Passing Marks	Max. Marks		Total	Min. Passing Marks
													Int.	Ext.		
THEORY																	
01	5ME01	Heat Transfer	3	--	--	3	3	3	80	20	100	40	--	--	--	--
02	5ME02	Metrology & Quality Control	3	--	--	3	3	3	80	20	100	40	--	--	--	--
03	5ME03	Kinematics of Machines	3	1	--	4	4	3	80	20	100	40	--	--	--	--
04	5ME04	Measurement Systems	3	--	--	3	3	3	80	20	100	40	--	--	--	--
05	5ME05	Open Elective – I (OE-I)	3	--	--	3	3	3	80	20	100	40	--	--	--	--
PRACTICALS / DRAWING / DESIGN																	
06	5ME06	Heat Transfer- lab.	--	--	2	2	1	--	--	--	--	--	25	25	50	25
07	5ME07	Metrology & Quality Control- lab.	--	--	2	2	1	--	--	--	--	--	25	25	50	25
08	5ME08	Kinematics of Machines- lab.	--	--	2	2	1	--	--	--	--	--	25	25	50	25
09	5ME09	Measurement Systems –lab.	--	--	2	2	1	--	--	--	--	--	25	25	50	25
		Total	**15**	**1**	**8**	**24**	**20**	**--**	**--**	**--**	**500**	**--**	**--**	**--**	**200**	**--**
															Grand Total	**700**	

Open Elective – I (For other Disciplines) : (i) Production Management (ii) Manufacturing Techniques

An Orientation Program of 15 Hours duration / MOOCs on Advanced Courses line Machine learning, 3-D Printing, Virtual Reality, Supply Chain Management, Numerical Computation for Mechanical Engineers, Bio-mechanics, Fundamentals of nano-Engineering, Micro-Electro Mechanical Systems, Nano-to-Macro Transport Processes, Fundamentals of Photo Voltaics, Machine Tools etc. be offered during V semester.

Open Elective-I to be opted from the University's faculty of Engineering & Technology offered inter-disciplinary courses or MOOCs courses pertaining to the Engineering Profession.

SEMESTER : SIXTH

Sr. No.	Subject Code	Subject	TEACHING SCHEME					EXAMINATION SCHEME								
			HOURS / WEEK			Total HOURS/WEEK	CREDITS	THEORY					PRACTICAL			
			Lecture	Tutorial	P/D			Duration Of Paper (Hr.)	Max. Marks Theory Paper	Internal Marks	Total	Min. Passing Marks	Max. Marks		Total	Min. Passing Marks
													Int.	Ext.		
THEORY																
01	6ME01	Design of Machine Elements	3	--	--	3	3	3	80	20	100	40	--	--	--	--
02	6ME02	Dynamics of Machines	3	1	--	4	4	3	80	20	100	40	--	--	--	--
03	6ME03	Control System Engineering	3	--	--	3	3	3	80	20	100	40	--	--	--	--
04	6ME04	Prof. Elective - I	3	--	--	3	3	3	80	20	100	40	--	--	--	--
05	6ME05	Open Elective - II	3	--	--	3	3	3	80	20	100	40	--	--	--	--
PRACTICALS / DRAWING / DESIGN																
06	6ME06	Design of Machine Elements- lab.	--	--	2	2	1	--	--	--	--	--	25	25	50	25
07	6ME07	Dynamics of Machines- lab.	--	--	2	2	1	--	--	--	--	--	25	25	50	25
08	6ME08	Prof. Elective - I - lab.	--	--	2	2	1	--	--	--	--	--	25	25	50	25
09	6ME09	Research Skills - lab.	--	--	2	2	1	--	--	--	--	--	25	25	50	25
		Total	**15**	**1**	**8**	**24**	**20**	--	--	--	**500**	--	--	--	**200**	--
														Grand Total	**700**	

An Orientation Program of 15 Hours duration / MOOCs on Entrepreneurship Development to be offered during VI Semester.

6ME04: Prof. Elect. (I) : (i) Tool Engineering (ii) Non- Conventional Energy Sources (iii) Computer Aided Design & Simulation

6ME05: Open Elect. (II) [For other Disciplines] : (i) Non- Conventional Energy Sources (ii) Automobile Engineering

Open Elective-II to be opted from the University's faculty of Engineering & Technology offered inter-disciplinary courses or MOOCs courses pertaining to the Engineering Profession.

SEMESTER : SEVENTH

Sr. No.	Subject Code	Subject	TEACHING SCHEME					EXAMINATION SCHEME								
			HOURS / WEEK			Total HOURS/WEEK	CREDITS	THEORY					PRACTICAL			
			Lecture	Tutorial	P/D			Duration Of Paper (Hr.)	Max. Marks Theory Paper	Internal Marks	Total	Min. Passing Marks	Max. Marks		Total	Min. Passing Marks
													Int.	Ext.		
THEORY																
01	7ME01	Mechatronics	3	--	--	3	3	3	80	20	100	40	--	--	--	--
02	7ME02	Productivity Techniques	3	--	--	3	3	3	80	20	100	40	--	--	--	--
03	7ME03	Industrial Management & Costing	3	--	--	3	3	3	80	20	100	40	--	--	--	--
04	7ME04	Energy Conversion - II	3	--	--	3	3	3	80	20	100	40	--	--	--	--
05	7ME05	Professional Elective- II	3	--	--	3	3	3	80	20	100	40	--	--	--	--
PRACTICALS / DRAWING / DESIGN																
06	7ME06	Mechatronics- lab.	--	--	2	2	1	--	--	--	--	--	25	25	50	25
07	7ME07	Energy Conversion – II- lab.	--	--	2	2	1	--	--	--	--	--	25	25	50	25
08	7ME08	Professional Elective- II – lab.	--	--	2	2	1	--	--	--	--	--	25	25	50	25
09	7ME09	Technical Seminar & Project	--	--	8	8	4	--	--	--	--	--	50	--	50	25
		Total	**15**	**0**	**14**	**29**	**22**	**--**	**--**	**--**	**500**	**--**	**--**	**--**	**200**	**--**
														Grand Total		**700**

7ME05: Prof. Elect.-II : (i) Computer Integrated Manufacturing (ii) Robotics (iii) Artificial Intelligence

SEMESTER : EIGHT

Sr. No.	Subject Code	Subject	TEACHING SCHEME					EXAMINATION SCHEME								
			HOURS / WEEK			Total HOURS/WEEK	CREDITS	THEORY					PRACTICAL			
			Lecture	Tutorial	P/D			Duration Of Paper (Hr.)	Max. Marks Theory Paper	Internal Marks	Total	Min. Passing Marks	Max. Marks		Total	Min. Passing Marks
													Int.	Ext.		
THEORY																
01	8ME01	Operation Research Techniques	3	--		3	3	3	80	20	100	40	--	--	--	--
02	8ME02	I.C. Engines	3	--		3	3	3	80	20	100	40	--	--	--	--
03	8ME03	Professional Elective-III	3	--		3	3	3	80	20	100	40	--	--	--	--
04	8ME04	Professional Elective- IV	3	--		3	3	3	80	20	100	40	--	--	--	--
PRACTICALS / DRAWING / DESIGN																
05	8ME05	I.C. Engines- lab.	--	--	2	2	1	--	--	-- --	--	--	25	25	50	25
06	8ME06	Prof. Elective-IV –lab.	--	--	2	2	1	--	--	-- --	--	--	25	25	50	25
07	8ME07	Project	--	--	12	12	6						75	75	150	75
		Total	**12**	**--**	**16**	**28**	**20**	**--**	**--**	**--**	**400**	**--**	**--**	**--**	**250**	--
														Grand Total	**650**	

8ME03 Prof. Elect. –III : (i) Automobile Engineering (ii) Production Planning & Control (iii) Product Design

8ME04 : Prof. Elect. IV: (i) Design of Transmission Systems (ii) Refrigeration & Air Conditioning (iii) Finite Element Analysis

NOTIFICATION

No. 89/2020 Date : 26/10//2020

Subject : Implementation of new Syllabi of Semester III & IV of B.E. (C.B.C.S.) as per A.I.C.T.E. Model Curriculum…

It is notified for general information of all concerned that the authorities of the University have accepted to implement new Syllabi of Semester III & IV of B.E./B.Text. E./B.Tech. (Chem.Tech.) (Food, Pulp & Paper, Oil & Paint and Petrochemical Tech.) (C.B.C.S.) as per A.I.C.T.E. Model Curriculum to be implemented from the academic session 2020-21 & onwards as per "**Appendix – A**" as given below:

Sd/-
(Dr.T.R.Deshmukh)
Registrar

"**Appendix – A**"

SYLLABI OF B.E. SEM. III & IV (MECHANICAL ENGINEERING) [C.B.C.S.]

Semester-III

3ME01 MATHEMATICS-III

Course Learning Objectives :

1. To provide the knowledge to solve ordinary Linear Differential equations with constant coefficient and its reducible equation using particular integral and complementary function and apply method of variation of parameter to solve ordinary Linear differential equations
2. To understand the Laplace transform and its inverse transform for the basic functions. Locate the Laplace transform of periodic function. Apply the Laplace transform to solve differential equation
3. To provide knowledge to apply False Position, Newton Raphson method to solve nonlinear & polynomial equations, Apply Gauss Elimination method, Gauss Seidal iterative method, Relaxation method to solve system of linear equations, Apply Eulers method, Runge-Kutta method, Picards method to solve differential equations
4. To understand the Gradient, divergent and curl of vector point functions. To find the directional derivatives of scalar point functions. To discuss the Irrotational and solenoidal vector fields. To define line surface and volume integrals.

Course Outcomes :

Students will be able to -

1. Demonstrate the knowledge to solve ordinary Linear Differential equations with constant coefficient and its reducible equation using particular integral and complementary function and apply method of variation of parameter to solve ordinary Linear differential equations
2. Define the Laplace transform and its inverse transform for the basic functions. Locate the Laplace transform of periodic function. Apply the Laplace transform to solve differential equation
3. Apply False Position, Newton Raphson method to solve nonlinear & polynomial equations Apply Gauss Elimination method, Gauss Seidal iterative method, Relaxation method to solve system of linear equations, Apply Eulers method, Runge-Kutta method, Picards method to solve differential equations
4. Define Gradient, divergent and curl of vector point functions. Finds the directional derivatives of scalar point functions. Discuss the Irrotational and solenoidal vector fields. Define line surface and volume integrals

SECTION-A

UNIT-I : Ordinary differential equations:- Complete solution, Operator D, Rules for finding complementary function, the inverse operator, Rules for finding the particular integral, Method of variations of parameters, Cauchy's and Legendre's linear differential equations. (10 Hrs)

UNIT-II: Laplace transforms : Definition, standard forms, properties of Laplace transform, inverse Laplace transform, initial and final value theorem, convolution theorem, Laplace transform of impulse function, Unit step function, Laplace transforms of periodic function. Solution of Linear differential equations. (10 Hrs)

UNIT-III :a) Partial differential equation of first order of following form- (i) f (p,q)=0; (ii) f (p,q,z)=0; (iii)f (x,p)=g(y,q); (iv) Pp+Qq=R (Lagranges form); (v) z=px+qy+f (p,q) (Clairaut form)

b) Statistics : Curve fitting by method of least squares (Straight and parabola only), Correlation, Regression.

c) Probability Distribution:– Binomial distribution, Poisson and normal Distribution. (10 Hrs.)

SECTION-B

UNIT-IV: Complex Analysis :- Functions of complex variables, Analytic function, Cauchy-Reimann conditions, Harmonic function, Harmonic conjugate functions, Milne's method, conformal mappings (translation, rotation, magnification, inversion, bilinear transformation), singular points, expansion of function in Tayler's and Laurent's series. Cauchy's integral theorem and formula, Residue theorem. (12 Hrs.)

UNIT-V: Numerical Analysis : Solution of algebric and transcendental equations by Newton-Raphson method & method of false position. Solution of system of linear equations by Gauss-Seidal method, Relaxation method. Solution of first order ordinary differential equations by Picard's, modified Euler's, Runge-Kutta and Taylor's method. (10 Hrs.)

UNIT-VI: Vector Calculus :- Scalar and vector point functions, Differentiation of vectors, Gradient of a scalar point function, Directional derivatives, Divergence and curl of a vector point function and their physical meaning, line, surface, volume integrals, irrotational and solenoidal vector fields, Stoke's and Divergence theorem (without proof). (10 Hrs.)

Books Recommended :-

Text Books:

1. Text book on Applied Engineering Mathematics, Vol. II, J.N. Wartikar and P.N. Wartikar, Pune Vidyarthi Griha Prakashan, Pune.
2. Higher Engineering Mathematics, B.S Grewal, Himalaya Publishing House.
3. Applied Mathematics, Vol. III, J.N. Wartikar and P.N. Wartikar, Pune Vidyarthi Griha Prakashan, Pune.

Reference Book : Advanced Engineering Mathematics, Erwin Kreyzig, John Wiley.

3ME02 MANUFACTURING PROCESSES

Course Learning Objectives :

1. To study the manufacturing processes in sand casting industries, tooling and equipment
2. To study the metal melting process, melting furnaces and defects in casting
3. To study the various types of casting processes
4. To study the mechanical working of metals and allied processes
5. To study the mechanical joining processes and fastenings
6. To study welding processes and surface treatment processes

Course Outcomes :

Students will understand the :

1. basic concept of foundry process and related activities
2. concept of complete sand casting process with advance casting methods
3. fundamentals of welding processes
4. various processes like electroplating, anodizing etc and their importance in industries

SECTION- A

Unit-I : Introduction to manufacturing processes & classification; Introduction to pattern making Pattern materials, pattern making tools, allowances, Types of patterns, functions of patterns, General properties of moulding sands, Mold hardness. Preparation of sand moulds of different types, Moulding processes, core making, core prints, core boxes. Sand casting Processes - Basic principle and Terminology of sand casting, design of gating and riser system – by numerical approach. (9Hrs)

Unit-II : Technology of melting and casting - Melting furnaces, crucibles, pit, open hearth, gas fired cupola, cupola operation and electric hearth furnaces, Electric furnaces - Direct Arc, Indirect arc and electric induction furnace.

Defects in castings and its types, Causes and remedies of casting defects. Origin and classification of defects, shaping faults, Inclusion and sand defects, Gas defects, shrinkage defects, contraction defects, dimensional errors. Inspection and testing of castings:- Radiography, ultrasonic, Eddy current testing, fluorescent penetrant test. (7 Hrs)

Unit III: Casting processes and their principle of operation and applications permanent mold casting, slush casting, shell molding, Investment or lost wax casting, vacuum process, centrifugal casting, continuous casting, Die casting equipment and processes for Gravity, pressure and vacuum casting methods, cleaning of castings, Modernisation & Mechanisation of Foundries. (8 Hrs)

SECTION – B

Unit IV: Mechanical working of metals: Principle of hot and cold working process and its types, Extrusion, piercing, pipe and tube production, manufacture of seamless pipe and tubing. Shearing operations, tube drawing, wire drawing, spinning, embossing and coining, squeezing and bending operations, rotary swaging, load estimation for bulk forming (forging and drawing), rolling and types of rolling mills. (8 Hrs)

Unit V: Joining processes:- Mechanical joining processes, Mechanical fastening, riveting, soldering, brazing Welding, Types of welding processes-Arc welding: principle and working, Gas welding- principle and working Types and purpose of Electrodes, Electrode coatings(flux). TIG & MIG processes – Working principles and its applications, shielding gases, MIG-Spray transfer and dip transfer processes. (6 Hrs.)

Unit VI: Submerged arc welding & resistance welding :- Heat generation in resistance welding, operational characteristics of resistance welding processes such as spot welding, projection welding, butt welding.
Principle of operation of friction welding, forge welding, plasma arc, thermit welding. Welding defects, Testing and Inspection of welds, Ultrasonic, Electroslag, Electron Beam, laser welding, weldability.
Surface Treatment-Electroplating, electroforming, and iodising, metal spraying, shot peening, polishing, mechanical cleaning. (9 Hrs)

Books Recommended :

Text Books:-

1. Workshop Technology Vol. I by Bawa, Tata Mc-Graw Hill Publication.
2. Workshop Technology Vol I by Hajra Chaudhary, Dhanpat Rai & Sons 2001.

References:-

1. Workshop Technology Vol I by Raghuwanshi.
2. Manufacturing Processes by J.P. Kaushish; PHI
3. Processes and Materials of Manufacture by R.A.Lindberg, PHI Pub 2001.
4. Manufacturing technology Vol. I, by P. N. Rao.

3ME07 MANUFACTURINGPROCESSES - LAB

Practices:-

1. Study of safety precautions in workshop practices.
2. Foundary:- Any two of the following jobs Sand preparation and practice in moulding of various types of patterns:- Pattern making - one job, Moulding - one job Casting - one job.
3. Joining Processes :Two composite jobs involving electric welding, gas welding and resistance welding process.
4. One job on Mechanical Working of Metals like piercing / drawing / bending/ embossing/ spinning/ upsetting, etc.

A journal should be prepared and submitted on above term work.

The practical examination shall consist of a job preparation and college assessment should be based upon the jobs, term work and viva examination.

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3ME03 MECHANICS OF MATERIALS

Course Learning Objectives :

1. To develop theoretical basis for stress, strain concept in various components under study
2. To study mechanical behavior of engineering material
3. To familiarize about finding shear force, bending moment, torsion, slope and deflection of various types of beams with different loading conditions
4. To build the necessary background to apply the knowledge of mechanics of materials on engineering applications

Course Outcomes :

Students will be able to -

1. Determine the stress & strain in the member subjected to axial, bending & torsional load
2. To observe different types of material behavior such as elastic, plastic, ductile and brittle
3. Apply SF and BM diagrams to analyse resistance offered by the beam and able to solve practical problems in real world
4. Apply deflection criteria to check the stability of beam

SECTION-A

Unit-I: 1. Mechanical properties: Concept of direct, bending and shear stresses and strains, stress-strain relations, Biaxial and triaxial loading, elastic constants and their relationship, stress-strain diagrams and their characteristics for mild steel, and other metals, factor of safety, stress and strain of bar due to self weight.

2. Uniaxial stresses and strains: Stresses and strains in compound bars in uniaxial tension and compression, temperature stresses in simple restrained bars and compound bars of two metals only, introduction to theory of elasticity and photoelasticity. (10 Hrs.)

Unit-II: 1. Axial force, shear force & bending moment diagrams : Beams, loading and support conditions, bending moment and shear force for all types of loadings for simply supported beams, cantilevers, relation between shear force, bending moment and loading intensity.

2. Simple or pure bending theory: Theory of simple bending, section modulus, moment of resistance, bending stresses in solid, hollow and built up section, leaf springs. (7 Hrs.)

Unit-III: 1.Torsion: Theory of torsion & assumptions, derivation of torsion equation, polar modulus, stresses in solid & hollow circular shaft, power transmitted by shaft, closed coiled helical spring with axial load.

2. Shear stress distribution on beam rectangular and circular cross sections. (7 Hrs.)

SECTION–B

Unit-IV: Thin and thick cylinders and thin spherical shells subjected to internal pressures. (4 Hrs.)

Unit –V: 1. Strain energy under uniaxial tension and compression impact loads and instantaneous stresses.
2. Principal Stresses : Biaxial stress system, principal stresses, principal planes, Mohr's circle of stresses.
3. Strain energy and resilience : proof resilience, shear resilience, strain energy due to self load (7 Hrs.)

Unit-VI: Deflection in simplysupported beam, cantilever beam subjected to point loads, uniformly distributed loads, moments by Macauley's method. (7 Hrs.)

Books Recommended:

Text Books :

1. Ramamruthm : Strength of Materials, Danpat Rai and Sons, New Delhi.
2. R. S. Khurmi: Strength of Material, S. Chand Publication, Delhi.

Reference Books :

1. E.P.Popov : Mechanics of Materials, Prentice Hall of India, New Delhi.
2. S. Timoshenko and O.H.Young : Elements of Strength of Materials, East West Press Private Ltd., New Delhi.
3. Shames, I. H. : Introduction to Solid Mechanics, Prentice Hall of India, New Delhi
4. Beer and Johston : Mechanics of Materials, McGraw Hill.
5. D. S. Prakash Rao : Strength of Material : APractical Approach, University Press, Hyderabad.

3ME08 MECHANICS OF MATERIALS - LAB

Practicals:

Minimum Six to Eight out of the following:

1. Tension test on metals.
2. Compression test on materials.
3. Shear test on metals.
4. Impact test on metals.
5. Hardness test on metals.
6. Torsion test on metals.
7. Deflection of beams.
8. Modulus of rupture test.
9. Deflection of springs.

Practical examination shall be viva-voce based on above practical and the syllabus of the course.

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3ME04 ENGINEERING THERMODYNAMICS

Course Learning Objectives :

1. To study the basic concepts of thermodynamics, thermodynamic systems, work and heat
2. To study the laws of thermodynamics and their applications
3. To study the properties of steam, work done and concept of heat transfer
4. To study the air standard cycles

Course Outcomes :

Students will be able to

1. Understand the basic concepts of thermodynamics, thermodynamic systems, work and heat
2. Apply first law of thermodynamics and application of first law to flow and non-flow processes
3. Apply second law of thermodynamics and understand concept of entropy
4. Understand the properties of steam, work done and heat transfer during various thermodynamics processes with steam as working fluid
5. Understand the concept of air standard cycles

SECTION–A

Unit-I: Introduction to basic concepts of thermodynamics, Macroscopic and microscopic approaches, properties of system, state, processes and cycle, thermodynamic equilibrium, types of thermodynamic systems, Temperatures and Zeroth law of thermodynamics, Quasi-static process, Gas Laws and Ideal gas equation of states, gas constant and universal gas constant.
Work and Heat: Definition of work, thermodynamic work, displacement work and other forms of work, Definition of Heat, Work and heat transfer as path function, comparison of work and heat, work done during various processes, P-V diagrams (10 hrs)

Unit-II: First law of thermodynamics: Energy of a system, classification of energy, law of conservation of energy law, Joules experiment. Energy a property of system, internal energy-a function of temperature, Enthalpy, specific heat at constant volume and constant pressure. Application of first law to non-flow processes, Change in internal energy, work done and Heat transfer during various non-flow processes. (7 hrs)

Unit-III: First Law applied to flow processes: Steady state, steady flow process, equation for work done in steady flow process and its representation on P-V diagram, mass balance and energy balance in steady flow process, steady flow energy equation and its application to nozzles and diffusers, turbine and compressor pumps, heat exchangers, Throttle valve etc. work done and Heat transfer during steady flow processes. (9 hrs)

SECTION–B

Unit-IV: Second Law of thermodynamics: Limitations of First law, Thermal energy reservoir, heat engines refrigerator and heat pumps, COP and tonne of refrigeration, COP for heat pump and refrigerator, Kelvin-Plank and Clausious statements, their equivalence, reversible and irreversible processes, Carnot cycle, Carnot theorem and its corollary, The thermodynamic temperature scale, Reverse Carnot cycle, Inequality of Clausius.
Introduction to Entropy, availability and irreversibility. Principle of increase of entropy. (8Hrs)
Unit-V: Properties of Steam: Triple point and critical point, Sensible heat, latent heat, superheat and total heat of steam. Wet steam, dryness fraction, Internal energy of steam, External work of evaporation, internal latent hear, Specific volume, enthalpy, internal energy and entropy of steam. T-S diagram Mollier chart, Steam tables and their use. Work done and heat transfer during various thermodynamics processes with steam as working fluid. Throttling of steam, determination of dryness fraction using various calorimeters. (8 Hrs)

Unit VI : Air Standard Cycles: Ottto, diesel, semidiesel, Brayton, Sterling and joule cycles etc., their efficiencies and mean effective pressure, comparison of auto, diesel and duel cycles.
Vapour Cycles:- Rankine and Modified Rankine Cycle. Comparison of Rankine and Carnot cycle, representation on P-V, T-S and H-S diagram. (No numerical on this unit) (numerical on air standard cycle) (8 Hrs)

BOOKSRECOMMENDED:

Text Books :

1. Engineering Thermodynamic - by P. K. Nag.
2. Fundamentals of Engineering Thermodynamics; R. Yadav;
3. Thermodynamics Basics and Applied: by V. Ganeshan
4. Thermal Engineerirng: by Mahesh M. Rathore.

Reference Books :

1. Basic Engineering Thermodynamics - by Reyner Joel
2. Thermodynamics - by C.P. Arora.
3. Fundamentals of Classical Thermodynamics - by G. J. Vanwylen.
4. Engineering Thermodynamics; P. Chattopadhyay; Oxford
5. Engineering Thermodynamics; Gordon Rogers, Yon Mayhew; Pearson.

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3ME05 FLUID MECHANICS

Course Learning Objectives :

1. To introduce and explain the fundamentals of Fluid Mechanics used in applications of Hydraulics, Aerodynamics, Gas dynamics, etc.
2. To give fundamental knowledge of fluid, its properties and behavior under various conditions of internal and external flows.
3. To develop understanding about hydrostatic law, principle of buoyancy and stability of a floating body and application of mass, momentum and energy equation in fluid flow.
4. To imbibe basic laws and equations used for analysis of static and dynamic fluids.
5. To inculcate the importance of boundary layer flow and its applications
6. To determine the losses in a flow system, flow through pipes, impact of jet

Course Outcomes :

The student will be able to:

1. identify importance of various fluid properties at rest and in motion
2. derive and apply general governing equations for various fluid flows
3. understand the concept of boundary layer theory and flow separation.
4. calculate energy losses in pipe flow.
5. evaluate the performance characteristics of hydraulic jets

SECTION – A

UNIT-I : 1. Basic properties of fluid such as Density, Specific weight, Specific Volume, Specific gravity, Viscocity of fluid, Surface Tension, Capilarity, vapour pressure & cavitation.

2. pressure & its measurement: Pascals law, Hydrostatic law of pressure & pressure variation in fluid, measurement of pressure by Manometer. (10 Hours)

UNIT-II : 1. Hydrostatic pressure force on plane & curved surfaces. Measurment of total pressure & centre of pressure.

2. Buoyancy & floatation: Concept of buoyancy, centre of buoyancy. Stability of floating body, Metacentre & metacentric height. Condition of equilibrium of floating & sub-merged body. (08 Hours)

UNIT III : 1. Kinematics of fluid flow, Methods of describing fluid motion, Types of flow, rate of flow, streamline, potential line, flow net, velocity & acceleration, continuity equation in three dimensional flow.

2. Dynamics of fluid flow : Eulers equation of motion, Bernoullis equation measurement of fluid flow with venture meter. (08 Hours)

UNIT-IV : Flow through pipes: Losses in pipe, major losses, Darcy's Weisbach equation, monor losses due to sudden enlargement, contraction, entry, exit & pipe fitting. Hydraulic gradient & total energy line, flow through series & parallel pipes, concept of water hammer in pipes. (08 Hours)

UNIT-V : Motion of viscous fluid: Introduction to Laminar & Turbulent flow, Concept of Boundary layer & its type. Drag & Lift force on object. Boundary layer separation, Reynolds number & its significance. (08 Hours)

UNIT-VI : Principal of fluid machinery : Force exerted by fluid jet on plane, curved, stationary & moving vanes. Velocity diagrams, work done & efficiency. (08 Hours)

Books Recommended :-

Text Books:-

1. Fluid Mechanics & Machinery by Modi & Sheth.
2. Fluid Mechanics and Hydraulic Machines by R. K. Bansal.
3. Engineering fluid Mechanics by R. K. Rajput.
4. Fluid mechanics & Machinery by CRSP. Ojha, R. Berndtsson.
5. Fluid Mechanics by Strecter; Tata Macgraw Hill.

Reference Books:-

1. R.K.Rajput; Engineering Fluid Mechanics; S. Chand publications.
2. Dr. Mody & Seth; Hydraulics and Fluid Mechanics; Standard book house
3. S. Ramamrutham, Hydraulic, Fluid Mechanics & Fluid Machines, Dhanpatrai publishing company.
4. Strecter, Fluid Mechanics, Tata Mc-Graw Hill.

3ME09 FLUID MECHANICS - LAB

Practical Term Work:-

At least six (6) practicals (study/Trials) based on above syllabus, as given below shall be performed and a report there of submitted by the students :

1. Measurement of fluid pressure by manometer.
2. Determination of metacentric height.
3. Verification of Bernoulli's equation.
4. Determination of co-efficient discharge by Venturimeter.
5. Calculation of Reynolds number for Laminar & Turbulent flow.
6. Determination of co-efficient of friction (Major losses in Pipes) through pipe.
7. Determination of head loss due to sudden enlargement.
8. Determination of head loss due to sudden contraction.
9. Determination of loss of head in bends & in elbows.
10. Verification of momentum equation.

Note :- Practical examination shall consist of oral or Experimentation based on above term work.

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3ME10 Machine Drawing - Lab

Course Learning Objectives :

1. To study the techniques of sectioning and visualizing the objects
2. To imagine and develop the missing views of objects
3. To seek the knowledge of development of surfaces
4. To seek the knowledge of intersection of solid objects
5. To know the conventions for materials and parts used in industries
6. To prepare the drawings for machine assembly

Course Outcomes :

Student will be able to -

1. Demonstrate the techniques of sectioning and visualizing the objects
2. Imagine, understand and sketch the missing views
3. Develop surfaces of objects and apply knowledge during their fabrication
4. Understand the concept of intersection of solid objects
5. Understand and apply the conventions for materials and parts used in industries
6. Prepare detail machine assembly drawings

List of Practicals :

1. Conversion of pictorial view into Sectional Orthographic Projection
2. Missing Views
3. Development of surfaces of Cubes / Prisms / Cylinders / Pyramids / Cones & their cut sections
4. Intersections of Solids – Prism & Prism /Cylinder & Cylinder /Cylinder & Prism / Cone & Prism
5. Conventions for various materials & parts
6. Preparation of detail drawings of simple machine assembly
7. Preparation of assembly drawing of simple machines

Books recommended:

Text Books:

1. Engineering drawing by N.D. Bhatt; Charactor Publications.
2. Machine Drawing by A. M. Bisen; New Edge International publication.
3. Machine Drawing by R. K. Dhawan, S. Chand
4. Machine Drawing by Basant Agrawal, McGraw Hill.
5.

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B.E. (MECHANICAL) SEMESTER FOURTH

4ME01 MATERIAL SCIENCE

Course Learning Objectives:

1. To study the basic concepts of metallurgy and classification of materials
2. To study the process of formation of microstructures of metal materials and composites
3. To study the alloying elements, their effects and applications
4. To study the ferrous and non-ferrous metals and respective alloys
5. To study the various heat treatment processes and their industrial applications
6. To study the mechanical working of metals and process of powder metallurgy

Course Outcomes:

Students will understand the -

1. Basic concepts of metallurgy and types of materials.
2. Iron-Carbon Equilibrium Diagram, critical temperatures, formation of microstructures and they will get the knowledge of alloys.
3. Uses and practical applications of ferrous & non ferrous materials
4. Various heat treatment processes, powder metallurgy and industrial applications.

SECTION - A

UNIT-I: Introduction to metallurgy: Basic concept of process metallurgy, physical metallurgy, and mechanical metallurgy, Classification of materials & their application, Structure of metals and alloys, formation of Alloys, Solid solutions, types and their formation, lever rule for phase mixtures. Solidification of pure metals, nucleation and growth, ingot structure, dendritic solidification. (8 Hrs)

UNIT II: Study of binary equilibrium diagram and invariant reactions, Construction and study of Iron-carbon Equilibrium Diagram, Critical temperatures, Microstructure of slowly cooled steel, Estimation of carbon from microstructure, structure property relation, Introduction to composite materials, advantages and applications. (8 Hrs)

UNIT III: **Alloy Steels:** Purpose of alloying, Classification of alloy steels, classification of alloying elements, Effect of alloying elements on eutectoid composition, Eutectoid temperature, and on the S curve, , alloying elements and their effect on properties of steels, OHNS steels, Hadfield'S Manganese steels, High speed steels, their heat treatments and applications, Ferritic, Austenitic and Martensitic stainless steels, their properties and applications, weld decay in stainless steel. (8 Hrs)

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SECTION - B

UNIT IV: Cast irons **:** Factors governing condition of carbon in cast iron, Maurer's diagram, Solidification of grey and white cast iron, Malleabalizing, Constitution and properties of white, gray, Nodular and Malleable cast irons, their applications, Alloy cast irons.

Non Ferrous Metals and Alloys : Types, Properties and uses of Brasses and Bronzes. Important alloys of Aluminium, Lead, Tin and Zinc, their applications. Bearing materials, Season cracking, precipitation hardening. (8 Hrs)

UNIT V: Principles of Heat Treatment: - Annealing, Normalizing, Tempering Iso-thermal transformation diagrams(S-curve), super imposition of continuous cooling curves on 's' Curve, pearlite, bainite and martenste transformation, Quenching media, severity of quench, Austempering, Martempering and patenting, Retained austenite and sub-zero treatment. Hardenability. (8 Hrs)

UNIT VI: Methods of surface hardening: Carburizing, Nitriding, Cyaniding, Flame and Induction Hardening. Mechanical working of Metals: - Hot and cold working, Relative advantages and disadvantages, study of stress strain curve, Luder's bands, Work hardening, strain Ageing; Recovery, Recrystallization and grain growth. Metallurgical factors affecting various Mechanical working processes, preferred orientation, Deformation mechanisms-Slip& twining, critical resolved shear stress.

Powder Metallurgy: Concept, Methods of Manufacture of metal powders, compaction Process- Single die and double die, sintering, stages of sintering, Manufacture of porous bearings & cemented carbide tip tools by P.M.T. Advantages, limitations and applications of powder metallurgy. (8 Hrs)

BOOK RECOMMENDED :-

Text Books :-

1. Introduction to physical metallurgy ;Sidney H Avner, TATA Mc-Grawhill
2. Engineering materials & metallurgy R.K.Rajput, S chand publication.
3. Material nScience & Mettalurgy, by V.D. Kodgire. Everest Publication House.

Reference Books:

1. Mechanical Metallurgy, G. E. Dieter, Mc- Graw Hill International, London 3rd Edn. 1999
2. Physical metallurgy for engineers, Clarke and Varney, second Edn.,1987.
3. Power metallurgy, A.K Sinha First Edn. 1991.
4. Material Science and Metallurgy; V.D. Kodgire; Everest Publishing House
5. Engineering physical Metallugrgy, Y Lakhtin, Mir Publications. Second Ed. 1999
6. Material Science and Meallurgy- C Daniel Yesudian, Scitech Publication.

4ME07 MATERIAL SCIENCE - LAB

List of Practicals: - (At least eight (8) practicals out of the following list.)

1. Study of metallurgical microscope.
2. Preparation of specimen for micro-examination.
3. Moulding of specimen for micro-examination.
4. Study of micro structures of Annealed and normalized plain carbon steels.
5. Study of micro structures of alloy steels and H.S.S.
6. Study of micro structures of various cast irons.
7. Study of micro structures of non ferrous metals.(brasses, bronzes)
8. Study of micro structures of hardened and tempered steels.
9. Study of Iron carbon Equilibrium diagram & Allotropic forms of iron.

10. Study different Heat Treatment Process for steel.
11. Study of different surface Hardening processes for steels.
12. Study of effect of alloying elements on the properties of steels.
13. Measurement of hardenability by Jominy end quench test apparatus.
14. Study of hardness tester and conversion of Hardness number
15. Industrial visit to study heat treatment plant.
16. Measurement of particle size, grain size, nodularity, coating thickness etc. by using some software like Metzer Microcam 4.0

Practical Examination:

Note : Practical examination shall consist of viva voce/performance based on the above syllabus and practical work.

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4ME02 ENERGY CONVERSION - I

Course Learning Objectives:

1. To study the properties of steam and its behavior for different thermodynamic process.
2. To study different types of boilers, their mountings, accessories, performance of boilers and different efficiencies.
3. To study the various fuel handling and ash handling system in power plant.
4. To study various types of condensers and cooling towers.
5. To study various thermodynamic aspects of flow of steam through nozzle and diffuser.
6. To study flow of steam through steam turbine and concept of compounding.

Course Outcomes:

1. Students will study the concept steam and steam power plant, mounting and accessories.
2. Students will demonstrate the calculation of various efficiency & related parameters.
3. Student will show the adequate knowledge of fuel & ash handling systems.
4. Students will demonstrate the knowledge of condenser & application.
5. Students will understand the concepts of steam nozzles & steam turbine.

SECTION – A

Unit I : Flow diagram for steam power plant with basic units such as steam generator, turbine, condenser and pump. Steam power plant layout, site selection. Boilers: Introduction to water tube and fire tube boilers used in thermal power plants, packaged Boilers, High pressure boilers; Loeffler, Benson, Lamont Boilers, Boiler mountings and accessories—devices for improving Boiler efficiency. Principle of fluidized bed combustion. Concept of co-generation. (7 Hrs.)

Unit II : Boiler draught; Types of draught, expression for diameter & height of chimney, condition for maximum discharge, efficiency of chimney, reasons for draught loss. Boiler performance:- Boiler rating, boiler power, equivalent evaporation, efficiency. Effect of accessories on boiler efficiency and heat balance. (7 Hrs)

Unit III : CONDENSERS : Need, Types of condensers, quantity of cooling water required. Dalton's law of partial pressure, condenser and vacuum efficiency. Sources of air in condensers and its effect on performance. cooling towers: Natural and mechanical wet type cooling tower.

Steam nozzles : Flow of steam through nozzles & diffusers, Maximum discharge, critical pressure ratio, chocking in nozzles, Effect of friction. Determination of throat & exit areas, Nozzle efficiency, no numerical on concept of super saturated flow & Wilson line. (7 Hrs.)

SECTION – B

UNIT IV : Steam Turbines:- Principle of working, Types of steam turbines such as impulse, reaction, axial & radial flow, back pressure & condensing turbines. Compounding. Reheat, regenerative cycles, bleeding. Analysis limited to two stages only. Analysis of steam Turbines : Flow of steam through impulse & impulse reaction turbine blades, Velocity diagrams. Graphical & analytical methods for work & power developed, axial thrust and efficiency. Height of turbine blades. losses in steam turbines:- blade friction, partial admission, disc friction, gland leakage losses and velocity losses. Governing of steam turbines. (7Hrs)

UNIT V : NUCLEAR POWER:- Fusion, fission, Chain reaction, conversion and breeding in nuclear fission. Components of Nuclear Power Plant such as Reactor, Steam generator, turbine, Moderator, Control Rods etc., Types of nuclear reactors like BWR, PWR, CANDU and liquidized metal cooled thermal reactors. (7 Hrs.)

UNIT VI : Introduction to renewable energy, Wind Energy, solar, fuel cell, bio-gas, MHD, Geothermal, OTEC, tidal power plants, Applications of Non conventional energy. (7 Hours)

RECOMMENDED BOOKS:

Text books :

1. Thermal engineering; Mahesh M Rathore; Tata McGraw-Hill
2. Thermal Engineering R.Yadav; Central publication
3. Non-conventional Energy Sources B. H. Khan Tata McGraw-Hill
4. Non-conventional Energy Sources G. D. Rai.

Reference books:

1. Steam Turbine; Kearton; Oscar Publications.
2. Thermal Power Engineering; Mathur Mehta; Tata McGraw-Hill
3. Power Plant Engineeirng. P. K. Nag
4. Power Plant Engineeirng; R. K. Rajput ; Laxmi Publications
5. Thermal Engineering, P.L.Ballaney; Laxmi Publications.

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4ME03 MANUFACTURING TECHNOLOGY

Course Learning Objectives :

1. To study the mechanics of metal cutting, tool characteristics and cutting forces
2. To study the turning operations using lathe and CNC machines
3. To study the working of drilling and boring machines
4. To study the working of milling and gear cutting machines
5. To study the machining operations using grinding, shaper, planer and slotter machines
6. To study the unconventional machining processes

Course Outcomes :

Students will be able to -

1. Apply the knowledge of theory of metal cutting, tool selection & calculate cutting forces
2. Demonstrate the knowledge of basics of turning operations
3. Understand the drilling and boring operations and working of drilling & boring machines
4. Understand the milling and gear cutting operations and working of respective machines
5. Understand the working of grinding, shaper, planer and slotter machines
6. Understand the knowledge of unconventional machining processes

SECTION – A

UNIT I : Theory of Metal cutting: Mechanics of Metal cutting, Tool material, Tool Geometry, Cutting tool classification, Tool life, Tool wear, Calculation of Cutting forces, Machinability, Cutting fluids, Chip thickness ratio, Merchant circle. (8 Hrs)

UNIT II : Construction, Operations and accessories of centre lathe, introduction of capstan & turret lathe, indexing mechanism, bar feeding mechanism, Machine tool classification. Numerical approach. Taper turning & Screw cutting & basic concept of CNC. Introduction, working principal & CNC turning operation. (10 Hrs)

UNIT III : a) Drilling operation : Drilling M/cs general purpose, Mass production and special purpose drilling M/cs.
b) Introduction & types of Boring. Boring M/c :- Horizontal, Vertical and jig Boring M/c. Introduction to Broaching and its types, broach terminologies, etc. (8 Hrs)

SECTION - B

UNIT IV : (a) Calculation of machining time for Milling.
(b)Milling M/c :- Types, Types of Milling Cutters, Dividing head, Compound and differential idexing.
c) Gear producing M/cs. (6 Hrs)

UNIT V : a)Grinding Machines: Bench grinders, surface grinders, centreles grinders, types of bonds & Abrasive modification of grinding wheels.
b) Study of various part & Operation of Shaper, Planer, Slotter. (6 Hrs)

UNIT VI : Unconventional Machining Processes:-

a) Mechanical Processes:- Ultrasonic Machining - principle and applications. process parameters; Abrasive and water parameters involved.
b) Thermal processes:- Election Beam Machining – Generation of beam, principle and applications : Laser Beam machining applications : Plasma-arc machining- Concept and generation of plasma, principle of PAM, applications.

c) Electric discharge Machining - Types die-sinking, wire cut EDM, Mechanism of material removal, process parameters, advantages and applications. (8 Hrs)

BOOKS RECOMMENDED :

Text Books:

1. Manufacturing Technology-Vol 1 & 2; R.L.Timings, S.P. Wilkinson; Pearson Publication.
2. Workshop Technology - By Hajra Choudhaury Vol II.
3. Manufacturing Technology Vol. II P. N. Rao, McGraw Hill Publication

References:-

1. Pandya & Shah, Modern Machining process, Tata McGraw Hill 1998.
2. Workshop Technology, O.P. Khanna, Dhanpatrai & Sons.
3. Workshop Technology - By Raghuwanshi. Vol II.

4ME08 MANUFACTURING TECHNOLOGY - LAB

Practicals:-

1. Demonstration of operations related to lathe, shaper, slotter, drilling & grinding m/cs.
2. One job on lathe covering taper turning and threading.
3. One job on shaping covering plane and inclined surfaces.

The above jobs should include drilling, grinding, tapping etc. Term work should be submitted in the form of journal.

N.B. :- The practical examination shall consists of preparation of practical jobs and assessment by external and internal examiner.

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4ME04 BASIC ELECTRICAL DRIVES AND CONTROL

Course Learning Objectives :

1. To study the working of electrical drives and their components
2. To study the basics of DC motors and their characteristics
3. To study the working of AC motors, Induction motors and concept of braking
4. To study the different speed control methods of A.C. and D.C. motors
5. To study and design of transducers and their applications
6. To study the industrial applications of different drives

Course Outcomes :

Students will be able to -

1. Understand the working of electrical drives and their components
2. Understand the basics of DC motors and their characteristics
3. Understand the working of AC motors, induction motors and concept of braking
4. Understand the different speed control methods of A.C. and D.C. motors
5. Understand the design of transducers and their applications
6. Understand the industrial applications of different drives

SECTION-A

Unit I : Concept of general electric drives, classification and comparison of electrical drive system, Cooling and heating of electric motors. Introduction to mechatronics, Theory and principle of Power Transistor, SCR. **(**8 Hrs**)**

Unit II : Basic characteristics of D.C. motor, Torque equation, Modified speed – Torque characteristics. Starting and braking of Electrical D.C. motors, comparison of mechanical and electrical braking methods. Introduction, Principle, construction and working of Servo motors, stepper motors, Brushless D.C. motors. **(**8 Hrs**)**

Unit III : Classification of A.C. motors, construction, types, principle of working and characteristics of 3 phase Induction motors, applications. Starting and braking of 3 phase induction motors. Classification of single phase induction motors. construction, principle and working and applications. Principle and working of universal motor. **(**8 Hours**)**

SECTION-B

Unit IV : Conventional methods of speed control of A.C. and D.C. motors. Thyristorized stator voltage control of 3 phase induction motor, (v/f) control method, slip-power recovery scheme. Thyristorized armature voltage control of D.C. motors using phase control & Thyristorized chopper. **(**8 Hours**)**

Unit V : Basic principle, construction & applications of sensors and transducers, contact - non- contact type, optical proximity sensors. Switches, contact type, magnet type, electromagnetic type, sound, light, pressure, vibration transducers, Hall effect-sensors A.C./D.C. Tachogenerators. **(**8 Hours**)**

Unit VI: Industrial applications - classes of duty selection of an electric drive for particular applications such as steel mill, paper mill, cement mill, textile mill, sugar mill, electric traction, coal mining, etc. Induction heating, surface hardening & Dielectric heating. **(8 Hours)**

BOOKS RECOMMENDED :

Text Books:

1. A First Course on Electrical Drives - S.K. Pillai.
2. Basic Electrical Technology (Vol. 11) - B.L. Theraja

Reference Books :

1. Drives and Control - N. Dutta
2. Mechatronics - W. Bolton, Addison Wesley, Longman Ltd.
3. A Course in Electrical, Electronics Measurement and Instrumentation, By A.K.Sawhney, Dhanpat Rai & Sons,

4ME09 BASIC ELECTRICAL DRIVES AND CONTROL - LAB

List of Experiments :

Any EIGHT practicals from the following list :

1. To study the Specification of Various Electrical Machines.
2. To study the D.C. Motor Starters.
3. To study the Running and Reversing of D.C. Motor.
4. Speed Measurements using Magnetic Pick-up.
5. To study the Speed reversal of counter Current Breaking of 3-phase Induction Motor.
6. To control the speed of D.C. Motor by a) Armature Control b) Field Control.
7. To perform Load Test on Induction Motor.
8. To study Dynamic/Rheostatic Breaking of D.C. Motor.
9. To study Characteristics of Thyristor.
10. To study the speed -Torque Characteristic of Servo Motor.

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4ME05 HYDRAULIC AND PNEUMATIC SYSTEMS

Course Learning Objectives:

1. To get fundamental background about the hydroelectric power plants
2. To study operation, working principle & performance characteristics of hydraulic turbines
3. To study operation, working principle & performance characteristics of centrifugal pump, reciprocating pump and other hydraulic pumps
4. To study the behavior of compressible fluid flow
5. To study different hydrostatic & hydro kinematics industrial applications

Course Outcomes:

Students will be able to -

1. Demonstrate basic concepts of prime movers and turbines
2. Utilize the knowledge of centrifugal and reciprocating pumps for applications
3. Reveal the importance of other water lifting devices
4. Solve the elementary treatment on compressible fluid flow
5. Understand the concept of hydrostatic and hydrokinetic systems
6. Use the knowledge of hydraulics & pneumatics in developing project work.

SECTION - A

Unit I : Hydraulic Turbines - Theory of impulse and reaction turbines. Pelton, Francis and Kaplan turbines, their construction, classification, analysis, characteristics and governing, draft tube. (10 Hours)

Unit II : Centrifugal pumps :- Basic Theory, classification, construction, operation, characteristics, multistage, NPSH and cavitations in pumps. (7 Hours)

Unit III:

1. Axial flow pump :- Basic theory, construction, & operation.
2. Other water lifting devices :- (a) Air lift pump. (b) Jet Pump. (c) Hydraulic Ram.
3. Computational Fluid Dynamics (CFD)
4. Introduction to CFD: Necessity, limitations, philosophy behind CFD, applications (6 Hours)

SECTION - B

Unit IV : Positive Displacement and other Pumps: Reciprocating pump theory, Slip, Indicator diagram, Effect of acceleration, air vessels. Comparison of centrifugal and reciprocating pumps, performance characteristics. (9 Hours)

Unit V : Compressible fluid flow :- Perfect gas relationship, speed of sound wave, mach number, Isothermal and isotropic flows, shock waves. (8 Hours)

Unit VI : Hydraulic accumulator, Hydraulic intensifier, Hydraulic Press, hydraulic crane, hydraulic lift, hydraulic coupling, hydraulic torque converter. (8 Hours)

BOOKS RECOMMENDED :-

Text Books:-

1. CSP Ojha, R. Berndtsson, Fluid mechanics and machinery; Oxford University.
2. Bansal R.K., Fluid mechanics and fluid machines; Laxmi publications.

Reference Books:-

1. Jagdish Lal, Hydraulic machines; Metropolitan Book Co. Pvt. Ltd.
2. Dr. Modi & Seth, Hydraulics and Fluid Mechanics; Standard house book.
3. Sen gupta, Computational fluid dynamics; Pearson Publishers.
4. Sameer sheikh, Iliyas Khan, Treaties on Hydraulics; Pneumatics, R.K. Publication.

4ME10 HYDRAULIC & PNEUMATIC SYSTEMS - LAB

List of Practicals:- At least **SIX** (6) practicals based on following :

1) Trial/Study of Pelton wheel
2) Trial/Study of Francis Turbine
3) Trial/Study of Kaplan Turbine
4) Trial/Study of centrifugal pump
5) Trial/Study of reciprocating pump
6) Trial/Study of axial flow pump
7) Trial/Study of hydraulic ram
8) Trial/Study of multistage pump
9) Trial/Study of special pumps (air lift pump/ jet pump)
10) Trial/Study of Gear pump
10) Any one practical based on CFD software

Note : Practical Examination : Practical examination shall consist of Viva Voce/performance based on above syllabus & practical work.

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SYLLABUS PRESCRIBED FOR BACHELOR OF MECHANICAL ENGINEERING SEMESTER PATTERN (CHOICE BASED CREDIT SYSTEM) FIFTH : SEMESTER

5ME01 HEAT TRANSFER

Course Learning Objectives:

1. To study applications of heat transfer in engineering, basic laws, one dimensional conduction, combined conduction - convection, conduction with internal heat generation.
2. To study insulations, critical radius concept, conduction through extended surfaces, fin efficiency and effectiveness, Biot number, Newton's law of cooling, transient heat conduction
3. To study radiation theories, the basic laws, concept of shape factor, radiation heat transfer equations, radiation errors in temperature measurement, radiation shield.
4. To study forced convection in the light of boundary layer theory, hydrodynamic and thermal boundary layers, dimensionless numbers, empirical correlations and forced convective calculations.
5. To study free convection over horizontal and vertical surfaces, velocity and thermal boundary layers, empirical correlations and free convective calculations, condensation and boiling heat transfer.
6. To study various types of heat exchangers, overall heat transfer coefficient, fouling, LMTD and NTU methods, working of heat pipe.

Course Outcomes:

1. Apply the concept of heat transfer, laws of heat transfer and various mathematical equations.
2. Demonstrate the knowledge of determining the thermal conductivity of various materials.
3. Understanding and verifying various laws of radiation.
4. Capable to explain the concept of heat exchanger and demonstrate the calculations of efficiency.

UNIT - I : Introduction, heat transfer in engineering, modes of heat transfer, basic laws of heat transfer and their basic equations. Conduction- thermal conductivity and thermal diffusivity effect of phase & temperature on thermal conductivity, one dimensional steady state heat conduction through slab, cylinder & sphere-simple and composite. Combined conduction- convection, overall heattransfer coefficient. General heat conduction differential equation. One dimensional steady state conduction with internal heat generation for infinite slab, wire & cylinder. **(8 Hrs)**

UNIT II : Insulations, critical radius of insulation, Conduction through extended surfaces, analysis of a uniform C.S. fin, fin efficiency, fin effectiveness, Biot number. Introduction to unsteady state heat conduction, Newton’s law of cooling, lumped heat capacityanalysis. **(8 Hrs)**

UNIT III :

Radiation-general concepts and definitions, black body & greybody concept. Laws of radiation- Kirchoff's, Plank's, Stefan- Boltzman's, Wien's law. Concept of shape factor, emissivity factor and radiation heat transfer equation. (No numericals).Radiation errors in temperature, measurement, radiation shield.**(7 Hrs)**

UNIT IV: Forced convection- heat convection, forced and natural convection, boundary layer theory, hydrodynamic & thermal boundary layers, boundary layer thickness. Laminar & turbulentflow over flat plate and through pipes & tubes (only concept, no derivation & analytical treatment). Dimensionless number and their physical significance Reynold, Prandtl, Nusselt, Grashoff number, empirical correlations for forced convection for flow over flat plate, through pipes & tubes & their applications in problem solving. **(8 Hrs)**

UNIT V: Free convection- velocity and thermal boundary layers for vertical plate, free convection over vertical cylinder and horizontal plate/cylinder (only concept, no derivation & analytical treatment). Use of empirical correlations in problem solving. Condensation & Boiling - introduction to condensation heat transfer, film & drop condensation. Boiling heat transfer, pool boiling curves. **(7 Hrs)**

UNIT VI : Heat exchanger - applications, classification, overall heat transfer coefficient, fouling. L.M.T.D. & E.N.T.U. methods, temperature profiles, selection of heat exchangers. Introduction to workingof heat pipe with and without wick. **(7 Hrs)**

Books Recommended

Text Books:-

1. Heat and Mass Transfer; R.K Rajput; S. Chand, New Delhi
2. Heat and Mass Transfer; V.M. Domkundwar; Dhanpat Rai & Co. Delhi
3. Heat Transfer; A. F.Mills, V. Ganesan, Pearson Publication

Reference Books:-

1. Heat Transfer; J.P. Holman; McGraw Hill
2. Heat Transfer; P.K. Nag; TMH.
3. Heat and Mass Transfer Data book, V.M. Domkundwar, Dhanpat Rai & Co.
4. Heat and Mass Transfer Data book; C.P. Kothandaraman; New age International

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5ME02 METROLOGY & QUALITY CONTROL

Course Learning Objectives:

1. To study generalized production technology, applications, general configuration and functional elements of inspection instruments.
2. To study about quality in production and services and quality management.
3. To study application of non destructive test for increasing productivity and efficiency of the work.
4. To study design and applications of various gauges and comparators used in inspection.
5. To study various techniques for the inspection of gears and threads.

6. To study various techniques for angular measurement, surface texture measurement, and geometric features measurement.
7. To study advance inspection techniques CMM, profile projector etc.

Course Outcomes:

1. Create & apply the concept of inspection, quality control and its importance to industry.
2. Demonstrate the skills of controlling various out of control processes using statistical quality control tools.
3. Understand the importance of improving production and productivity using work study approach.
4. Apply the knowledge of various measurement standards and techniques in the industry to measure various parameters related to metrology.
5.

UNIT I : Concept of quality and quality control, quality of design and quality of conformance, Quality characteristics, Cost of quality & Value of quality, Specification of quality, quality control & inspection.
Concept of TQM & Quality assurance,
Concept of variation, variable and attribute data, Frequencydistribution, Measures of Central tendency-
Mean, mode & median, Measures of dispersion. -Range, std.deviation & variance. (8 **Hrs**)

UNIT II : Concept of universe and population, Normal distribution curve; Control charts for variables, process capability, Control charts for attributes; comparison between variable charts and attribute charts; precision & accuracy, Sampling plans,Operating Characteristic curve, Quality circle. (8 **Hrs**)

UNIT III : Introduction to Non-Destructive testing, Ultrasonic testing, X-ray or Radiography Testing, Liquid Penetrant testing, Magnetic Particle Testing, Eddy current testing, it's applications, Advantages & Disadvantages. (7 **Hrs**)

UNIT IV : Standards of measurements: line standards, end standard, wave length standard. Limits, fits and gauges: terminology of limits, Fits and gauges, concept of interchangeability, allowance tolerance, Indian Standard Specification for limits, fits and gauges, B.S. System. Limit gauging - designof Go, No Go gauges. (8 **Hrs**)

UNIT V : Linear measurement: various comparators such as mechanical, electrical, optical, pneumatic comparators, their principle, operations and applications.
Angular measurements: vernier, optical, bevel protractor universal bevel protector, Sine bar level clinometers, tapergauges. Thread measurement: screw thread limit and fit limits gauging of screw threads (8 **Hrs**)

UNIT VI : Gear measurement : alignment error, master gear, Parkinson tester.

Study and use of optical dividing head, auto collimator, tool makers microscope.

Interferometry, flatness testing, squareness testing. Surface texture testing.

Coordinate measuring machine- types, role and application. **(7 Hrs**)

Books Recommended:

Text Books:

1. Engineering Metrology – R.K.Jain - Khanna Publishers.
2. Statistical Quality Control- M. Mahajan – Dhanpatrai & Co. Pvt.Ltd.
3. Non Destructive Testing techniques by Ravi Prakash, New Age Publications.

Reference Books:

1. Quality Control - By Juran - Mc. Graw Hill Pub. Company.
2. Statistical Quality Control- By Grant E.L. – R.S.L.Leavgen Worth-.Mc. Graw Hill Pub. Company
3. Statistical Quality Control- By Gupta - Dhanpatrai & Com. Pvt. Ltd

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5ME03 KINEMATICS OF MACHINES

Course Learning Objectives:

1. To get the basic Knowledge about the mechanism used in automobiles, industrial machines etc.
2. To study about the synthesis and analysis of the mechanism used in machines.
3. To get the operational knowledge about the power transmitting devices used in automobiles.
4. To study the designing and importance of cams in machines.
5. To study the most effective power transmission device used in automobiles, industrial equipments, toys etc **.**

Course Outcomes:

Students will be able to-

1. Understand & apply the concept and its applications of link, mechanisms and machines.
2. Demonstrate the ability to analyze the mechanisms and machines on the basis of velocity and acceleration and they will show the ability to solve analytical methods.
3. Show the ability to use graphical and analytical methods for synthesis of mechanisms to develop mini projects in the course duration.
4. Understand the practical for study of brake, clutch, dynamometer, gear train etc.

Unit I: 1.Introduction to study of mechanisms, machines, different types of links, kinematic pairs. Grashof's law- class-I and class –II mechanisms. Grubler's criterion, Kutzbach's criterion for planer mechanism. Inversions of four bar, single slider, double slider mechanisms.

2. Transmission angle, Mechanical Advantage, Transmission angle and Mechanical Advantage of 4-bar mechanism. **(7 Hrs)**

Unit II: 1**. Velocity analysis**: - Relative velocity method, method of equivalent mechanisms, Instantaneous centre of rotation method for 4-bar mechanism, body and space centroids.

2**. Acceleration analysis**:- Relative acceleration method and analytical method. **(8 Hrs)**

Unit III: Synthesis of Mechanisms:- Introduction to type, number and dimensional synthesis, graphical method of two position, three position and four position synthesis for input output coordination, Freudenstien's equation, Blosch's method. **(7 Hrs)**

Unit IV: Frictional torque in pivot and collar bearing.

Clutches and Dynamometers: types, constructional details, operation. **(7 Hrs)**

Unit V: Special purpose mechanisms:- Steering mechanisms, Geneva wheel mechanism. **Cams**:- Introduction, types of cam & follower, different motions of followers, graphical layout of cam profiles, cam with specified contours. **(8 Hrs)**

Unit VI: 1. **Gear**: Introduction, terminology, gear tooth profiles, law of gearing, involumetry, interference of spur gears, minimum number of teeth to avoid interference. 2.**Gear Trains**:- Types of gear trains and its speed ratio applications. **(7 Hrs)**

Books Recommended:

Text Books:

1) Theory of Machines, P.L.Ballaney, Published by Dhanpat Rai and sons-N Delhi.
2) Theory of Machines, S.S.Ratan, Published by Tata Mc Graw Hill.
3) Theory of Machine, R.S.Khurmi and Gupta J.K., Published by Eurasia Publishing house-N Delhi.

Reference Books:

1) Theory of Machines and Mechanisms, J.E.Shigley, Uicker and Gordon, Published by Oxford University press-New York.
2) Theory of Machines, V.P.Singh, Published by Dhanpat Rai-N Delhi.
3) Theory of Machines and Mechanisms, Ghosh and Amitabh, Published Affiliated East West Press, N-Delhi.

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5ME04 MEASUREMENT SYSTEMS

Course Learning Objectives:

1. To study the generalized measurement system and the general performance characteristics of measuring instruments, applications, general configuration and functional elements of measuring instruments.
2. To study the strain gauges, their types, strain gauge circuits for strain measurement and to study the pressure measurement methods and devices
3. To study the types, constructional details and working of force, torque and flow measuring devices.
4. To study the different types of temperature measuring devices, standards, construction details and their working and to study the different types of liquid level measuring devices.
5. To study the mechanical and electrical types of speed measuring devices, contact and contactless speed measuring devices and their applications.
6. To study the methods of vibrations measurement and methods of linear and angular displacements.

Course Outcomes:

1. Understand & apply the concept of measurement system and will know its importance related to the industry.
2. Demonstrate the ability to measure various parameters like pressure, flow, speed, vibration etc.
3. Understand to use various measuring instruments.

4. Understand the practical approach of engineering and will be confident in industry.

UNIT I : 1. Generalized Measurement system: Significance of measurement, generalized systems. application of measuring instruments. Types of measuring instruments.

2. General configuration and functional elements of measuring instruments, types of inputs, various methods of correction for interfering and modifying inputs. (6 Hrs)

UNIT II : General performance Characteristics:-

1. Static characteristics, different types of errors, combination of component errors in overall systems.
2. Dynamic characteristics : General mathematical model of zero order, first order and second order instruments, response of first and second order instruments to following inputs step, ramp, impulse and frequency. **(8 Hrs)**

UNIT III : Strain Measurement :

1. Types of strain gauges, strain gauge circuits, calibration, Temperature compensation, use of strain gauges on rotating shafts, selection and installation of strain gauges.
2. Pressure Measurements:-
   Basic methods of pressure measurement: strain gauge pressure cell, High pressure measurement Bridgeman type, low pressure Measurement - Mcleod, Knudsen, ionisation, Thermal conductivity gauges.**(8 Hrs)**

UNIT IV : 1. Force Measurement: Various mechanical. Hydraulic, pneumatic and electrical methods.

2. Torque and Power Measurements : Various mechanical, hydraulic & electric methods.
3. Flow Measurements : Construction- orifice, Rota meter. Pressure probes- Pitot static tube, turbine meter, electro-magnetic flow meter. **(6 Hrs)**

UNIT V : 1. Temperature Measurements : Standards, Various temperature measuring devices, Bimetallic strip, pressure thermometers, thermo couples, electrical resistance thermometers, Thermistors, radiation Thermometers.

2. Liquid Level Measurements : Various methods such as- single float, displacement or force transducers. Pressure sensitivity, bubbler or Page system, capacitance variation type (for both conducting and non conducting type liquids) Resistance variation type. **(8 Hrs)**

UNIT VI: 1. Speed Measurements : Various mechanical type tachometers, electrical types tachometers, stroboscope etc.

2. Vibration Measurements : Seismic, Strain gauge and peizoelectic accelerometers.
3. Displacement measurements : Linear and angular displacement measurements, LVDT, LDR, Capacitive & inductive pick ups.

(8 Hrs)

Books RecommendedText Books:-

1. Measurement Systems : - By Erenest O. Doebelins - MC Graw Hill.
2. Mechanical Measurement & Control: By D.S.Kumar.

References Books:-

1. Mechanical Measurements :- By T.G.Beckwith & N.L.Bulk - AddisonWerllv.
2. Instrumental Measurement & Analysis : By Nakra Choudhari TataMc Graw Hill.
3. Mechanical Measurement & Instrumentation :By R.K.Rajput,KatsonsBooks Publications

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5ME05 OPEN ELECTIVE-I
(1) PRODUCTION MANAGEMENT

Course Learning Objectives:

1. To study the new product design & manufacturing process technology.
2. To study the objectives of forecasting, factors affecting forecasting.
3. To study method study, work measurement.
4. To study objectives and functions of Production Planning and Control.
5. To study inventory control & inventory control application
6. To study quality management, quality related costs, quality function deployment & total quality management.

Course Outcomes:

1. Apply the knowledge of operations management and its applications in industrial environment.
2. Demonstrate the knowledge of advanced manufacturing technologies and philosophies.
3. Students will demonstrate the importance of inventory control, JIT in manufacturing.
4. Apply the basic concept of quality management, TQM etc.

UNIT I : Designing products, services and processes; Historical evolution of productions and operations management, new product designs, manufacturing process technology.
Flexible manufacturing systems (FMS) and computer integrated manufacturing (CIM). (9 Hrs.)

UNIT II : Sales Forecasting: Objectives, types of forecasting, factors affecting forecasting, process of sales forecasting, methods of sales forecasting. (7 Hrs.)

UNIT III : Work study: method study, recording techniques of method study, principles of motion economy. Work measurement techniques. (7 Hrs.)

UNIT IV: Production planning and control: Objectives and functions of PPC, types

of production systems, principles of sound production control system. (7 Hrs.)

UNIT V: Inventory Control: Demand and control system characteristics, inventory concepts, costs Modeling, Deterministic inventory models, stochastic inventory models, inventory control application, just-in-time manufacturing. (7 Hrs.)

UNIT VI: Quality Management: Quality and quality related costs, quality function deployment(QFD), Taguchi's off-line quality control methods, managerial responsibility in managing for quality products & services. TQM. Failure analysis, bath tub curve, Reliability of system. (8 Hrs.)

Books Recommended

Text Books:

1. Production and operations management- concepts models and Behaviour by Everett E. Adam,Jr., & Ronald J. Ebert (Prentice- Hallof India)
2. Industrial engineering & production Management by M. Mahajan(Dhanpat Rai & Co.)

References Books

1. Production and operations management – Total Quality and responsiveness by Hamid Noori & Russell Radfort (Mc Graw Hill, Inc.)
2. Industrial engineering & management by O. P. Khanna (Dhanpat Rai& Co.)
3. Production and Operations Management; J.P. Saxena; McGraw Hill

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5ME05 OPEN ELECTIVE-I
(2) MANUFACTURING TECHNIQUES

COURSE LEARNING OBJECTIVES

1. To study the fundamentals of different manufacturing processes and various activities in manufacturing.
2. To study the fundamentals of metals & alloys, properties of engineering materials like ferrous, non- ferrous metals and their alloys
3. To study different machine tools. cutting tools used in machine shop , various operations performed with working principles of these machine tools
4. To study the activities related to mechanical working of metals, various hot working & cold working operations fundamentals of metal forming ; sheet metal working processes with different tools and equipment
5. To study the necessary details regarding pattern making, moulding, core making and casting with foundry tools & equipment, also melting practice by cupola furnace.
6. To study different Joining processes, basic terms of welding processes tike arc welding, gas welding, resistance welding. friction welding , soldering ; brazing processes with tools & processes.
7. To study the methods of producing metal powders
8. To study plastic part manufacturing by different processes like extrusion. Injection, blow, compression, and transfer moulding processes.

COURSE OUTCOMES:

1. Apply the knowledge of various manufacturing techniques and its applications in engineering.
2. Understand the knowledge of machining operations, sheet metal working and processes.
3. Students will show the ability to apply various joining methods in practice.
4. Students will exhibit the knowledge of powder metallurgy.

Unit I : Overview of manufacturing: Classification of manufacturing processes, selection of manufacturing processes, types & properties of materials, selection of materials, Introduction to conventional and non-conventional machining processes. **(6Hrs)**

Unit II : Introduction to cutting type shaping processes, Basic concept of metal cutting, Types of cutting tools, Orthogonal & oblique cutting, General purpose machines Vs Special purpose machines. (8Hrs)

Unit III: Introduction & application of various metal cutting operations – Turning, drilling, boring, milling, shaping, planning and grinding process. (8Hrs)

Unit IV: Introduction to metal forming and sheet metal process: Forming process- Forging, rolling, extrusion, wire drawing. Sheet metal processes- Forming, bending, drawing, coining, embossing. Cutting process: Punching, blanking, shearing, lancing. (7Hrs)

Unit V : Metal casting: Steps involved in casting, advantages of casting, pattern, difference between pattern and casting, pattern allowances, material used for patterns, molding sand, sand mould making core, types of cores, defects of castings, melting furnace(Cupola), casting process and its applications. (6Hrs)

Unit VI: Joining process with its types, advantages and disadvantages of riveting, soldering, brazing. Arc welding, gas welding, resistance welding, friction welding. (6Hrs)

Books Recommended:
Text Books:
1. Manufacturing processes –Workshop practice, R.A. Khan, Ali Hassan, Scitech Pub.
2. Workshop Technology - Hajra Chaudhary, Dhanpat Rai and Sons.
Reference Books :
1. Processes and materials of manufacture E.P. Degarmo, Prentice Hall of India (PHI)
2. Material and processes in manufacturing Lindberg, Tata McGraw Hill Pub.

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5ME06 HEATTRANSFER-LAB.

Course learning objective: The lab work should clear the vision about all the modes of heat transfer. The practical knowledge should enhance the approach of student towards real life applications of the subject.

Course Outcome:

Upon successful completion of lab Course, student will be able to: i) Understand various modes of heat transfer and ii) evaluate various parameters of the heat transfer process

List of Practicals (Any six of the following):-

1. Determination of thermal conductivity of a metal bar.
2. Determination of thermal conductivity of insulating powder.
3. Study of heat transfer through composite wall.
4. Study of heat transfer through composite cylinders.
5. Determination of fin efficiency.
6. Verification of Stefan-Boltzman's law.
7. Determination of emissivity of grey body.
8. Determination of heat transfer coefficient for forced convection.
9. Determination of heat transfer coefficient for natural convection.
10. Study of pool & nucleate boiling.
11. Trial on double pipe heat exchanger.
12. Determination of efficiency of cross flow heat exchanger.
13. To write a computer program for conduction heat transfer problem.

Practical Examination:- The practical examination shall consist of oral on the term work and syllabus.

5ME07 METROLOGY & QUALITY CONTROL-LAB.

Course learning objective:

The course aims at understanding the principles of metrology for precision measurement of various mechanical components using various measuring tools. Students shall also learn to use standard practices and standard data, learn to use statistical concept, control chart for variables, control chart for attributes.

Course Outcome: Upon successful completion of lab Course, students will be able to

i) Explain the principles involved in measurement and inspection.
ii) Select and use appropriate measurement instrument for a given application
iii) Apply the basics of sampling in the context of manufacturing

Practicals : At least six from the below list.

1. Determination of Linear dimensions of a given specimen/part using Precision/Non-Precision Measuring instruments.
2. Determination of Angular Measurement using Precision/Non-Precision Measuring instruments.
3. Measurement of Gear Tooth Thickness by Gear Tooth VernierCaliper/Constant Chord/Span Micrometer.
4. Measurement of Circularity/Roundness of a given specimen.
5. Measurement of Screw Thread Element by Floating Carriage Micrometer.
6. Testing of Surfaces by using Optical Flat.
7. Measurements of various angles of single point cutting tool by usingProfile Projector and Tool Maker's Microscope.
8. Preparation of Variable Control Charts for the given lot of sample.
9. Preparation of Attribute Control Charts for the given lot of sample.

Practical Examination :-

The practical examination shall consist of oral on term work.

5ME08 KINEMNATICS OF MACHINES - LAB.

Course Learning Objectives: Objectives of this lab are to impart practical knowledge on design and analysis of mechanisms for the specified type of motion in a machine. With the study of rigid bodies motions and forces for the transmission systems, machine kinematics can be well understood.

Course Outcome: On successful completion of the course students will be able to:
Design linkage, cam and gear mechanisms for a given motion or a given input/output motion or force relationship, identify the basic relations between velocity & acceleration and use graphical and analytic methods to study the motions of various mechanisms

PRACTICALS:- At least eight practicals from the below list shall be performed.

1. To Study, Analyse and drawing of inversions of four bar mechanism to identify the types and number of links, types of motion and its mode of fixing arrangement for the required application.
2. To Study and analyse of inversions of slider crank mechanism using working models and graphical representations to find type & number kinematic pair , type of joint and Degree of freedom.
3. To Study and analyse of inversions of double slider crank mechanism using working models and graphical representations to find type & number kinematic pair , type of joint and Degree of freedom.
4. To determine Velocity and acceleration of links in mechanism by relative velocity method. (2 Problem)
5. To determine Velocity and acceleration of Piston of a reciprocating engine by clein's construction method.(2 Problem)
6. To find braking force, braking toque of internal expanding and external expanding brake .
7. To study, understand and observe the actual working and function of each part of single plate clutch by dismantling and assembling.
8. To study, understand and observe the actual working and function of each part of centrifugal clutch by dismantling and assembling.
9. Study of dynamometers.
10. To draw Cam profile for a given follower type and follower motion. (2 Problem.)
11. To Study and find train value and speed ratio of various types of gear trains
12. To study and drawing of Simple four bar Mechanism using position synthesis.
13. To Study and drawing of four bar mechanism by input-output coordination methods using Bloch's Synthesis and Freudenstein's equation.
14. To study interference and undercutting of spur gear pair using graphical layout.
15. To study and drawing of Generation of Involute and Cycloidal Spur Gear Tooth Profile.

The practical examination shall consist of viva-voce on the above syllabus & practical work.

5ME09 MEASUREMENT SYSTEMS-LAB.

Course Learning Objectives : i)To study various sensers and measuring instruments required to measure various properties and quantities occurring in a typical

engineering system. ii)To understand general performance characteristics of measuring instruments, applications and general configuration of the measuring instruments.

Course Outcome: Upon completion of this course students will be able to:

i) Choose appropriate measuring device for measurement of various quantities
ii) Analyse the performance of various
iii) Analyse and execute the calibration process for measuring instruments

List of Practicals :

At least eight practicals from the following list:

1. Measurement of strain using strain gauges.
2. Calibration of pressure gauge with pressure gauge tester.
3. Measurement of linear displacement by LDR and inductive pick-uptransducers.
4. Performance of capacitance transducer as an angular displacement measuring device.
5. Performance of inductive Transducers.
6. Measurement of flow using optical flow meter and Rotameter.
7. Speed measurement by a stroboscope.
8. Speed measurement by magnetic pick up or photo electric pick up tachometer.
9. Pressure measurement by strains gauge type transducer.
10. Vibration measurement by using Seismic Transducer.
11. Measurement of Liquid level by using capacitive pickup transducer.
12. Temperature measurement using contact and non contact type instruments or various types of sensors.

*The practical examination shall consist of viva-voce on the above syllabus & practical work.

SEMESTER : SIXTH

6ME01 DESIGN OF MACHINE ELEMENTS

COURSE LEARNING OBJECTIVES (CLOs):

1. To study the concept of stresses and understand the design procedure of riveted and welded joints.
2. To study design procedure of knuckle joint, springs and power screw.
3. To analyze & select types of shafts, keys, couplings for various machines and industrial applications.

COURSE OUTCOMES (COs):

1. Understand the concept of various stresses and apply the design procedure to riveted joints and welded joints.
2. Understand design procedure of knuckle joint, springs and power screw.
3. Analyze & select types of shafts, keys, couplings for various machines and industrial applications.
4. Analyze the various types of bearings and understand the design procedure of IC Engine parts.

Unit I : (A) Meaning of design, Phases of design, Simple stresses, Thermal stresses, Impact Stress, Torsional stress, bending stresses in straight & curved beams, it's applications, Hooks, C-clamps.

(B) Rivetted Joints- Design, failures, strength & efficiency of riveted joint.

(C) Welded Joint- Strength, of transverse & parallel fillet welded section. **(11 hrs)**

Unit II :(A) Design of knuckle joint.

(B) Design of spiral & leaf spring.

(C) Design of power screw- Torque required to raise loads, efficiency & helix angle, overhauling & self locking of screw, ACME threads, stresses in power screws. **(11 hrs)**

Unit III : (A) Design of Shaft – Subjected to twisting, bending & combined twisting & bending loads, based on rigidity.

(B) Design of coupling, rigid coupling, sleeve, muff coupling, flange coupling & flexible coupling. **(11 hrs)**

Unit IV : (A) Antifriction bearing: Types of bearing, construction, life of bearings, selection of bearings.

(B) Journal bearing: Lubrication, selection of lubrication, design procedure & numerical.

(C) Design of IC Engine parts: Connecting rod, design of flywheel based on TM diagram. **(11 hrs)**

Books Recommended :-

Text Books:-

1. Machine Design by Dr. P.C. Sharma & dr. D. K. Agrawal, Katsons Publications Ltd.
2. Machine Design by R.K.Jain ,Khanna Publisher's
3. Machine Design, R.S. Khurmi, J.K. gupta, Eurasia Publications, New Delhi.
4. Machine Design Data book by PSG, Coimbtore
5. Machine Design data book by Mahadevan

Reference Books:-

1. Design of Machine Element by V.B. Bhandari, Tata McGraw Hill Publuication.
2. Machine Design – Jindal, Pearson Publication.
3. Design of Machine Element – C. S. Sharma & Kamlesh Purohit, PHI Publication.

6ME02 DYNAMICS OF MACHINES

Course Learning Objectives:

1. To study Static force analysis and Dynamic force analysis of plane mechanisms.
2. To demonstrate the use of gyroscopic effect on ship, aeroplane, four wheeler and two wheeler
3. To determine natural frequency vibrations.
4. To seek the knowledge of static and dynamic balancing.

Course Outcomes:

Students will be able to

1. Apply basic concept of static force analysis and lubrication mechanism.
2. Understand the knowledge of dynamic force analysis analyticaaly and graphically .
3. Apply the knowledge of space mechanism and vehicle dynamics.
4. Understand concept of free vibration and force vibration, concept of Torsional vibration.
5. Analyze the concept of balancing of machinery.

Unit I: 1. Static equilibrium, superstition principle, Static force analysis applied to plane motion mechanisms, virtual work method, static force analysis without and with friction.
2. Theory of hydrodynamic lubrication, boundary lubrication, film lubrication, rolling friction, performance of bearing.
(8 Hrs)

Unit II: 1. D'Alemberts Principle. Engine force analysis-piston effort, thrust along connecting rod, side of cylinder, on the bearings, crank effort and turning moment on the crank shaft.
2. Dynamic equivalent system of connecting rod.
3.Turning moment diagrams for two stroke, four stroke and multi cylinder engines, fluctuations of speed & energy, Flywheel requirements.
(7 Hrs)

Unit III: 1**. Space mechanism**:- Gyroscope, gyroscopic effect as applied to ship, aeroplane, four wheeler, two wheeler, universal joint.
2**. Vehical dynamics**: - Coefficient of adhesion, resistance to vehicle motion, relative drive effectiveness, braking of vehicles.
(7 Hrs)

Unit IV: Types of vibrations, elements of mechanical vibrating systems, degree of freedom in mechanical vibratory system.

1.**Longitudinal vibrations**- Natural frequency of free longitudinal vibrations by equilibrium, energy and Rayleigh method. Effect of inertia constraint in longitudinal vibrations. Damped vibrations with mass, spring and dash pot. Definitions of logarithmic decrement, magnification factor, transmissibility, vibration isolation.
2. **Torsional vibration**- single rotor systems, Two Rotor system, three rotor system, geared systems. **(8 Hrs)**

Unit V: 1.**Transverse vibrations**- Natural frequency of free transverse vibrations. Effect of inertia constraints in transverse vibrations. Natural frequency of free transverse vibrations due to point load and uniform distributed load acting over a simply supported shaft. Frequency of free transverse vibrations of a shaft subject to a number of point loads by energy and Dunkerley's method.
2.**Whirling or critical speed shaft**.
(6 Hrs)

Unit VI: Balancing :- Balancing of rotating masses in same and different transverse planes, Partial balancing of reciprocating masses & Study of its effect. **(8 Hrs)**

Books Recommended:

Text Books:

1) Theory of Machines, P.L.Ballaney, Published by Dhanpat Rai andsons-N Delhi.
2) Theory of Machines, S.S.Ratan, Published by Tata Mc Graw Hill.
3) Theory of Machines, V.P.Singh, Published by Dhanpat Rai-N Delhi.
4) Theory of Machine, R.S.Khurmi and Gupta J.K., Published by EurasiaPublishing house-N Delhi.

Reference Books:

1) Theory of Machines and Mechanisms, J.E.Shigley, Uicker andGordon, Published by Oxford University press-New York.
2) Theory of Machines and Mechanisms, Ghosh and Amitabh, Published Affiliated East West Press N-Delhi.

6ME03 CONTROL SYSTEM ENGINEERING

COURSE LEARNING OBJECTIVES:

1. To study the basics of control systems and their mathematical modeling along with reduction methods.
2. Study the basic control actions and Industrial controllers.
3. To study the analysis of control systems with respect to transient time response and their errors.
4. To study the different pneumatic controllers and prime movers and their actions.
5. To understand stability analysis, frequency analysis by using bode plot for analytical problems.
6. Study of important automatic speed control systems.

COURSE OUTCOMES:

1. Understand the basic system concept and study different types of systems.

2. Understand the concept Transient- Response analysis and will apply in numerical methods, the knowledge of basic control action and industrial controllers.
3. Understand the concept of Stability and exhibit the knowledge of root locus concept.
4. Understand the concept of Frequency Response method and use bode diagram in solving analytical problems.

Unit I: Introduction system concept, open & closed loop systems, Mathematical models of physical systems, transfer functions. Block diagrams reduction and signal flow graphs.(9 Hrs)

Unit II : Basic control actions and Industrial controllers :-Classification of industrial automatic controllers, control actions, proportional controllers, obtaining derivative and integral control action, effects of integral and derivative control action on systems performance.(7 Hrs)

Unit III : Transient Response Analysis :- Introduction Std. Test signals, steady state response of first and second order systems for stop, ramp and impulse input, transient response specifications,steady state error & error constants.(8 Hrs)

Unit IV: Concept stability, necessary condition for stability, Rauths stability criterion, Root locus concept, construction of Root loci, systems with transporation lag.(9 Hrs)

Unit V : Frequency Response methods :-Introduction, concept of Bode diagrams.(8 Hrs)

Unit VI : Study of important automatic speed control systems in machine tools, Prime movers, system generators, etc. Analysis of performance characteristics.(7 Hrs)

BOOKS RECOMMENDED:-

TEXT BOOKS :

1. Automatic Control Enginering by F. H. Ravan Mc-Graw-Hill.
2. Modern Control Engg. - by Katsuhiko Ogata, PHI, .
3. Control System Engg. - by Nagrath & Gopal,

REFERENCE BOOKS:

1) Automatic Control Engg. - by Kuo B.C. & F. Golnaraghi,
2) Modern Control System by Richard C. Dorf, Robert H. Bishop,

6ME04 PROF. ELECTIVE I
(1) TOOL ENGINEERING

Course Learning Objectives (CLOs):

1)To study the basic geometries of different cutting tools, chip formation mechanism, tool force analysis etc. in metal cutting.
2)To understand the steps in designing and drawing of single and multipoint cutting tools and form tools.
3) To study the basic principles of workpiece positioning and clamping. To get acquainted with designs of locators, clamps, drill bushes and methods of location.
4) To understand the design and operation of various types of Jigs and Fixtures.

5) To develop a graphical design of a jig or fixture suitable to the requirements of a workpiece.
6)To understand the theory of metal cutting and how to estimate the required force and clearance amount in sheet metal cutting and forming operations.
7)To study construction and working of various types of dies used for different press working operations.
8) To study the steps in designing and drawing of different cutting, drawing and forming dies in press working.

Course Outcomes:

1. Create the design of single and multi point cutting tools.
2. Apply the knowledge related to machining in order to estimate tool life and selection of cutting fluids.
3. Create the design of multipoint tools like twist drills, reamers, broach and milling cutters & press working dies like punching, blanking and drawing.
4. Analyze the real time problems of work holding by designing jigs and fixtures.

Unit 1:
Single Point cutting Tool:
Shear angle, shear strain, velocity relations, un-deformed chip thickness, Merchant's circle, energy relations, nomenclature, single point cutting tool design, recommended speed, feed and depth of cut Form tools.
Graphical approach of circular form tool design. (08 Hours)

Unit II:
Jig & Fixture Design: Economics, principles of locations, types of locations, prevention of jamming, problems of chip & dust in location, use of dowels. Redundant location, Principles of clamping, types of clamps, power clamping, Tool guiding & tool setting, types of drill Jigs & fixtures, (07 Hours)

Unit III:
Jig & Fixture Design:
Design of Plate, Channel, Box, Turnover and Post type Drill Jigs.
Design of Turning, Milling, Fixture, Broaching, Assembly & Welding Fixtures.
(07 Hours)

Unit IV:
Multi-point Cutting Tools:
Types, Geometric elements and forces in various tools like Twist drills & Reamers, Circular Broaches, Milling Cutters, Taps and Dies, Gear shaper cutter & Gear Hobs.(07 Hours)

Unit V:
Press tools: Classification of presses, Theory of sheet metal cutting, clearance, cutting force calculations, Methods of reducing cutting forces, Centre of pressure & its significance, Classification of press working operations, Theory of bending, spring back action in metals, drawing fundamentals, calculation of drawing & bending forces, planning for cupping operation, Stock layout. (07 Hours)

Unit VI :
Design of Press working Tools:
Types of die construction, function & nomenclature of die components, Cutting Dies-Blanking & Punching,
Forming Dies-Forming, Drawing and Bending etc. Design of Compound, Combination and progressive dies Miscellaneous dies- Horn die, Cam-action die, Rubber & Building die, Suppress die (08 Hours)

Text Books:
1. Tool Design - Cyril Donaldson (Tata Mc-graw Hill)
2. Jigs & Fixtures - P.H.Joshi (Tata Mc-graw Hill)
3. Fundamentals of Metal Cutting & M/c Tools - Juneja (New Age International).
4. Fundamentals of Tool Design - A.Kumar (Dhanpatrai & Sons).
5. A Text book of Production Engineering- P.C.sharma (S.Chand Publication).

REFERENCE BOOKS :
1. Metal Cutting Theory & Cutting Tool Design- Arshinov (Mir Publications)
2. Tool Design - ASTME (ASTME)
3. Jigs and Fixture- Grantt.

PROFESSIONAL ELECTIVE – I

6ME04 (2) NON-CONVENTIONAL ENERGY SYSTEMS

Course Learning Objectives(CLOs):

1. To study the introduction to renewable and non-renewable resources of energy.
2. To study the radiation transmission through covers & Solar Energy collections.
3. To study the solar energy utilisation and solar energy storage.
4. To study energy from ocean and energy from wind.
5. To study biomass energy resources like biomass and biodiesel.
6. To study photo voltaic cell, fuel cell and geothermal energy.

Course Outcomes (COs):

1. Able to study the concept of renewable and non-renewable sources.
2. Apply the basic concept of solar energy utilization and storage.
3. Apply the concept of energy from ocean and wind.
4. Study the concept of bio-mass energy resources.

PROFESSIONALELECTIVE–I

6ME04 (2)NON-CONVENTIONALENERGYSYSTEMS

UNITI:

1. **Introduction:-** Renewable &Non-renewable energy sources. Overview and development of World Energy Scenario.
2. **SolarRadiation:**Solar constant, Definitions of basicearth-sunangles. Types of

Solar radiation, Measurement of solar radiation using Pyrheliometer, Pyranometer and Sunshine Recorder, estimation of solar radiation intensity.(7 hrs)

UNIT II:

1. **Solar Collectors:-**classifications of collectors- concentrating, non-concentrating collectors and Evacuated tube solarcollectors, it's construction, and working.
2. **Solar Energy Storage & Utilization:-**Methods of storage such as Mechanical, Thermal, Electrical, Thermochemical and Electromagnetic storage. Applications of solar energy in heating,cooling,pumping,powerproduction,distillation,drying,etc. (7 Hrs)

UNIT III:

Direct Energy Conversion:-

1. **Solar Photovoltaic cells :**Principle, Construction and Working, Conversion efficiency.
2. **FuelCells:**working principle,types offuelcells, applications.
3. **Geothermal Energy Resources:** Hot Dry Rock system, Vapour dominated, liquid dominated,flash steam,binary fluid and total flow concept of power generation. **(8Hrs)**

UNIT IV: Energy from Ocean:

1. **Tidal Power:-**Types of tidal plants such as single and two basin plants, power developed &operation of tidal power plant.
2. **Ocean thermal energy conversion system:-** Construction and working of open cycle and closed cycle OTEC systems.**(7Hrs)**

UNITV:WindPower:- Introduction,Principles of wind energy conversion, Operation, maintenance and economics. Wind patterns and Wind speed data,Types of wind mills,application for pumping and power generation. Conversion efficiency, Site selection.**(8Hrs)**

UNITVI:BiomassEnergyResources: Mechanism of green plant photo synthesis.efficiencyy of conversion,solar energy plantation,Biogas-Types of bio gas plants,factors affecting production rates. Types of gasifiers,Introduction to bio-dieseland ethanol as alternative fuels, properties of biofuel.**(7Hrs)**

Books Recommended:

TEXT BOOKS:-

1. Solar Energy, S.P.Sukhatme,TMH
2. Non-Conventional Energy Sources, G.D.Rai, Khanna Publications
3. Non-Conventional Energy Sources, B. H. Khan

REFERENCE BOOKS:-

1. Treatise on Solar Energy : H.P. Garg; John Wiley & Sons
Renewable Energy Conversion, Transmission and Storage, Bent Sorenson; Elsevier Publication
2. Renewalle Energy; GodfreyBoyle, Oxford University Press, Mumbai.

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6ME04 PROF. ELECTIVE I
(3) COMPUTER AIDED DESIGN & SIMULATION

Course Learning Objectives(CLOs):

1. To study product cycle & fundamentals of CAD/CAM.
2. To understand the concept of representations of curves and surfaces.
3. To study the solid modeling techniques.
4. To study the geometric transformation techniques.
5. To study basic probability & statistics and physical modeling.
6. To study Simulation of Mechanical Systems & Simulation of Manufacturing systems.

Course Outcomes (COs):

1. Understand the concept of CAD/ CAM and CIM .
2. Apply knowledge using CAD modeling for component design
3. Apply the knowledge of geometric transformation.
4. Understand the Mechanical & Manufacturing simulation systems.

Unit I: Fundamentals of CAD/CAM

Product cycle and scope of CAD/CAM/CIM in product cycle, CAD/CAM, Hardware and software, selection of software, CAD workstation configurations.

(6 Hrs)

Unit II: Representations of curves and surfaces

Introduction to analytical curves, synthetic curves: Hermite cubic Spline, Bezier Curve, B-Spline curve. Surface Representation : Synthetic Surfaces, Applications of surface modeling.

(6 Hrs)

Unit III: Solid Modeling

2D Vs 3D modeling, Comparison of Wireframe, surface and solid modeling techniques, Geometry Vs Topology, Requirements of Solid Modeling Methods: Constructive Solid Geometry (CSG), Boundary Representation (B-rep), etc.

(6 Hrs)

Unit IV: Geometric transformation

2D geometric transformations, Homogeneous co- ordinate representation, Composite Transformations, 3D transformations, Inverse transformations, geometric mapping.(8 Hrs)

Unit V: Introduction to statistics and physical modeling

A review of basic probability and statistics, random variables and their properties , Estimation of means variances and correlation.

Physical Modeling- Concept of System and environment, Principles of modeling, types of models.(8Hrs)

Unit VI: Simulation of Mechanical Systems

Basic Simulation modeling, Role of simulation in model evaluation and studies, advantages of simulation

Simulation of manufacturing Systems: Introduction to Flexible manufacturing systems, Simulation software for manufacturing, (8 Hrs)

Book's Recommended-

Text Books:

1) P. N. Rao; CAD/CAM Principles and Applications; McGraw Hills Publications.
2) Mikel P. Groover and Emory W. Zimmers: Computer Aided Design and Manufacturing, Prentice hall.
3) Ibrahim Zeid: Mastering in CAD- CAM, Tata McGraw Hill Publication.
4) Geoffrey Gordon, System Simulation; Prentice Hall

Reference Book:

1) Mikell P. Groover: Automation, Production systems & Computer Integraded manufacturing, Prentice Hall.
2) Robert E. Shannon; System Simulation: The Art and Science ; Prentice Hall
3) J. Schwarzenbach and K.F. Gill Edward Arnold; System Modelling and Control
4) P. Radhakrishnan and Subramaniam: CAD/CAM/CIM, wiley Eastern Ltd.

6ME05 OPEN ELECTIVE-II
(1) NON-CONVENTIONAL ENERGY SYSTEMS

Course Learning Objectives(CLOs):

1. To study the introduction to renewable and non-renewable resources of energy.
2. To study the radiation transmission through covers & Solar Energy collections.
3. To study the solar energy utilisation and solar energy storage.
4. To study energy from ocean and energy from wind.
5. To study biomass energy resources like biomass and biodiesel.
6. To study photo voltaic cell, fuel cell and geothermal energy.

Course Outcomes (COs):

1. Understand concept of renewable and non-renewable sources.
2. Understand the basic concept of radiation transmission through covers and solar energy collections, the basic concept of Solar energy utilization and storage.
3. Demonstrate, concept of energy from ocean and wind.
4. Understand the concept of bio-mass energy resources, concept of direct energy conversion and fuel cell.

UNIT I

3. **Introduction:-** Global and Indian energy scenario, Need of Renewable energy, need, Renewable and non renewable energy sources, energy and environment,
4. **SolarRadiation:**Solar constant, Definitions of basic earth-sun angles. Types of Solar radiation, Measurement of solar radiation using Pyrheliometer, Pyranometer and Sunshine Recorder, estimation of solar radiation intensity. (7 hrs)

UNIT II

3. Solar thermal systems. Low temperature applications: solar water heating, space heating, drying. High temperature applications, dish and parabolic collectors. Central tower solar thermal power plants.
4. Solar Photovoltaic Systems: Basic principle of power generation in a PV cell ; Types of photovoltaic cell, Application of PV ; Brief outline of solar PV stand-alone system ; Storage and Balance of system. (8 Hrs)

Unit III

Wind Energy Systems: Potential of wind electricity generation in India and current scenario. Types of turbines, Coefficient of Power, Betz limit, Wind electric generators, Power curve; wind characteristics and site selection; Windfarms for bulk power supply to grid. (7 Hrs.)

Unit IV

Biomass Energy: Biomass: Sources and Characteristics; Wet biogas plants ; Biomass gasifiers: Classification and Operating characteristics; Updraft and Downdraft gasifiers; Gasifier based electricity generating systems. Introduction to biodiesel and ethanol as alternative fuels, properties of biofuel (7 Hrs.)

Unit V

Ocean Energy: Tidal power plants : single basin and two basis plants, Ocean Thermal Electricity Conversion (OTEC) , Electricity generation from Waves.
Geothermal Energy: Principle, Geothermal sites in India ; Geothermal power plants.
Fuel Cells: Principles, types of fuel cells, (7 Hrs.)

UNIT VI

4. **Fuel Cells :** working principle, types of fuel cells, applications.
5. **Geothermal Energy Resources:** Hot Dry Rock system, Vapor dominated, liquid dominated, flash steam, binary fluid and total flow concept of power generation.

(8Hrs)

Books Recommended:

Text Books:-

1. Solar Energy; S.P. Sukhatme; TMH
2. Non-Conventional Energy Sources; G.D. Rai; Khanna Publications
3. Non-Conventional Energy Sources; B. H. Khan

Reference Books:-

1. Treatise on Solar Energy; H.P. Garg; John Wiley & Sons.
2. Renewable Energy Conversion, Transmission and Storage; BentSorensen; Elsevier Publication
3. Renewable Energy; Godfrey Boyle; Oxford University Press, Mumbai
4. Renewable Energy Sources and Emerging Technology; D.P. Kothari, K.C. Singal, Rakesh Ranjan; PHI

6ME05 OPEN ELECTIVE-II
(2) AUTOMOBILE ENGINEERING

Course Learning Objectives:

1. To study the Introduction of automobiles, engine types and working of SI and CI engines.
2. To study the fuel feed systems, their types and to understand the basics of cooling system.
3. To study the electrical system, Battery capacity and its ratings, starter motor drive and to understand the basics of Ignition system.
4. To study the basics of transmission system, clutches, gear boxes and to understand the principle of differential.
5. To study the braking system, steering system, wheel balancing and alignment and to study the introduction of power steering.
6. To study the basics of suspension system, shock absorbers and to study the types of lubricants and lubrication system, crankcase ventilation.

Course Outcomes (COs):

1. Understand the basics of automobile engineering and its components.
2. Analyze &develop about the cooling system and its function.
3. Understand basic concept of transmission system and types of gears box, basic concept of electrical system and ignition system.
4. Apply the knowledge of suspension and lubrication.

UNIT I : Introduction, Classification of automobiles, chassis layout, basic working of SI and CI
engines, engine parts, engine types, Multiple cylinder engines. (7 Hrs)

UNIT II : Fuel feed systems- fuel feed systems for petrol and diesel engines, Basic principles of Multipoint Fuel Injection Systems(MPFI) and Common Rail Diesel Injection Systems(CRDI). Cooling system: purpose, Air cooling and liquid cooling system, radiator, by pass recirculation system, antifreeze mixtures. (7 Hrs)
UNIT III : The electrical system. Battery Capacity, standard capacity ratings, starter motor drive-Bendix drive. Ignition system:- Battery coil ignition system, Electronic ignition system
(7 Hrs)

UNIT IV: Transmission system:- Layout, Working principle of clutch, single plate friction clutch and multiplate clutch, Gear Boxes:- Sliding mesh, constant mesh gear box, Propeller shaft, Hotchkiss drive, torque tube drive, differential. (8 Hrs)
UNITV: Braking system: Mechanical, hydraulic brakes, power brakes and vacuum brakes. Steering system:- Function, types of linkages, steering gears, wheel balancing, wheel alignment, camber, castor, king pin inclination, toe-in& toe-out & their effects, Introduction to power steering. (7 Hrs)
UNIT VI: Suspensions : shock absorbers, Rigid axle and independent suspension system, Auto lubrication :-Types of lubricants, their ratings, multi viscosity oils. Engine lubrication:- types of lubricating systems, full pressure system, dry sump system, crankcase ventilation. (6Hrs)

Books Recommended

Text Books:-

1. Automobile Engineering- Vol. I & II; Kirpal Singh; Standard Publishers Distributors
2. Automobile Engineering; R.K. Rajput; Laxmi Publications, New Delhi

Reference Books:-

1. Automotive Mechanics; Crouse & Anglin; TMH.
2. Automotive Mechanics; J. Heitner; East West Press
3. Automotive Mechanics; S. Srinivasan; TMH.

6ME06 DESIGN OF MACHINE ELEMENTS-LAB.

Course learning objective:

1. To study the basic design principles
2. To familiarize with use of design data books & various codes of practice
3. To make conversant with preparation of working drawings based on designs

Course Outcome: After successfully completion of this course students will be able to:

1. Design various machine elements like joints, springs, couplings etc, under various conditions
2. Convert design dimensions into working/manufacturing drawing
3. Use design data book/standard codes to standardize the designed dimensions

Practical Term Work :

At least Six exercises based on the following:

1. Design of Cotter or Knuckle joint.
2. Design & drawing of screw jack.
3. Design & drawing of Riveted joints.
4. Design & drawing of leaf spring.
5. Design of shaft on the basis of various loading.
6. Design and drawing of Coupling(any one type).
7. Design and drawing of Journal Bearing Plumber Block Type).
8. Design and drawing of connecting rod in IC Engine.
9. Design and drawing of Flywheel .
10. Determine Hydrodynamic lubrication profile using Journal Bearing Apparatus.

6ME07 DYNAMICS OF MACHINES -LAB.

Course learning objective:

Course Outcome:

Practicals:-

At least eight practical from the following list:

1. Study of static force analysis of mechanism. (any 2 problem)
2. Determining the inertia forces of connecting rod
3. Determination of gyroscopic couple using motorized gyroscope .
4. Study of vehicle dynamics.
5. To study the longitudinal vibration of helical spring and to determine the frequency and time period of oscillation theoretically and experimentally.
6. Experiment on free and damped vibration of systems with one degree of freedom.
7. Experiment on forced damped vibration of systems with one degree of freedom.

8. Experiment on free damped torsional vibration.
9. To verify the Dunkerley's rule.
10. To determine the natural frequency of free torsional vibration of single rotor system.
11. To determine the natural frequency of free torsional vibration of two rotor system.
12. Experiment on whirling speed of shaft.
13. Experiment on static balancing of rotating masses.
14. Experiment on dynamic balancing of rotating masses.

6ME08 PROF. ELECTIVE I – LAB
(1) TOOL ENGINEERING– LAB.

Course learning objective:

1)To study the basic geometries of different cutting tools,
2. To study cutting forces involved in machining operation using tool dynamometer.
3. To understand the steps involved in designing and drawing of various tools.
4) To understand the design and operation of various types of Jigs and Fixtures.

Course Outcome: On completion of this course students will be able to :

1. Create the design of single and multi point cutting tools.
2. Create the design of multipoint tools like twist drills, reamers, broach and milling cutters & press working dies like punching, blanking and drawing.
3. Analyze the real time problems of work holding by designing jigs and fixtures.

TERM WORK:
(Any Six of the following)-
1. Design & Drawing of single point cutting tool.
2. Design & Drawing of Form Tools(Using Graphical Method).
3. Measurement of forces in Orthogonal cutting by Lathe Tool Dynamometer. 4. Measurement of forces & Torque in Drilling by Drill Tool Dynamometer.
5. Study of geometric Elements & Forces in Multi-Point Cutting Tool. 6. Design & drawing of Post Drill Jig.
7. Design & Drawing of Turnover Drill Jig.
8. Design & Drawing of Milling Fixture.
9. Design & Drawing of Turning Fixture.
10. Design & Drawing of Compound Die.
11. Design & Drawing of Progressive Die Die.
12. Design & Drawing of Drawing die.

Practical Examination : Practical exam shall consist of viva-voce based on the term work and theory syllabus.

6ME08 PROF. ELECTIVE I – LAB
(2) NON-CONVENTIONAL ENERGY SYSTEMS – LAB.

Course learning objective:
Course Outcome:

List of practicals :

Any six practicals will be based on the following topics :-

1. Study of Pyrheliometer and measurement of direct radiation.
2. Study of pyranometer and measurement of global and diffuse radiation.
3. Study of sunshine recorder and measurement of sunshine hours.
4. Study and testing of a flat plate recorder.
5. Study of biogas plant.
6. Study of photovoltaic system,
7. Study of various types of Wind mill.
8. Study of various solar equipments.

6ME08 PROF. ELECTIVE I – LAB

(3) CAD & SIMULATION

Course learning objective:

Course Outcome:

Practicals:-

Any six practicals from the list should be performed.

1. Creation of 2D drawing (Sketching Module) of any mechanical machine component using any modeling/drawing software.

2. Creation of isometric view from given orthographic view of any mechanical machine part using any modeling software.

3. Creation of 3D drawing of any mechanical machine part using any modeling software.

4. Creation of assembly of Knuckle joint/ Cotter joint using any modeling software.

5. Creation of sheet metal component using any modeling software.

6. Simulation of Four bar chain mechanism using any modeling software.

7. Simulation of Slider crank chain mechanism using any modeling software.

6ME09 RESEARCH SKILLS – LAB

Course learning objective:

Course Outcome:

Students will have to perform one task from each group.

Group A

To design/fabricate any one system of the following:

1) Model based upon science principles.
2) Purely mechanical model for the betterment of rural life
3) Electromechanical model
4) Computer based model using any CAD software
5) Pneumatic/hydraulic system for industrial/social application.
6) Automated system for industrial/social application.
7) A system using non conventional energy source
8) Aurdino/IoT based system for industrial/domestic application

Group B

Prepare a research report on any one of the following:

1) To set a manufacturing unit of any product.
2) Market research for launching a new product.
3) Study of any Small Scale Industry.
4) Collection and analysis of data for any research problem.
5) Study of Intellectual Property Right (IPR) process.
6) Study of various sources of finance/government schemes to set a new business.

SYLLABUS PRESCRIBED FOR BACHELOROF
MECHANICAL ENGINEERING
SEMESTER PATTERN (CHOICE BASED CREDIT GRADE SYSTEM)

SEMESTER: SEVEN

7ME01 MECHATRONICS

Course Learning Objectives (CLOs):

1. To study various types of switches, sensors, motors and their working.
1. To understand the concept of computer process control.
2. To study various parts of mechatronic system.
3. To study various types of valves and their working.
4. To understand and create pneumatic and hydraulic circuits for various industrial applications.

Course outcomes (CO):

2. Understand the concept of computer process control.
3. Create the working models for various mechatronics system for industrial applications.
4. Create mini projects on material handling systems like pick and place type robot, machine loading system etc.
5. Create pneumatic and hydraulic circuits for various industrial applications.

Section-A

Unit I : Introduction to Mechatronics –
Definition, Block diagram & Example, Basics of Sensors, Position & Speed Sensors, Proximity Sensors & Switches, LVDT, Digital optical encoder, Temperature Sensors Actuators-Functions, Electromagnetic Principles, Solenoids and Relays, working of DC motors and stepper motors, hydraulic and pneumatic actuators,(6 Hrs.)

Unit II: Data Acquisition: Analog signal processing using operational amplifier-Introduction, types of amplifiers, sample and hold circuit, introduction to data acaquisiton, sampling thermo, Quantizing theory, Analog to digital conversion, Analog to digital convertor, Digital to analog conversion, Multiplexer. (6Hrs)

Unit III: Mechatronic Systems – control architecture Introduction, Control architecture, Analog circuits, digital circuits, Design of logic networks, sequential logic, flip-flops, application of flip-flops, micro-controlrs, Programmable logic controller. (6Hrs)

SECTION - B

Unit IV: Control Valves –
Study of different control components and pneumatic & Hydraulic system-Construction, worling and function of Directional control valve, Flow control valves, Pressure relief valve, pressure reducing valve, sequence valve with symbols.(7 Hrs)

Unit V: Pneumatic System –
Design and analysis of pneumatic circuits, Synchronizing, Power chucking operations, controlling the rate of speed of piston, circuit to move with piece around

a corner, circuit to move a workpiece at a constant speed. (6 Hrs)

Unit VI: Hydraulic System –

Design analysis of Hydraulic systems-Sequencing, pneumo-hydraulic, regeneration circuit, circuit to control tool movement on lathers, grinders, etc.(7Hrs)

Books Recommended :

TEXT BOOKS:

1. Introduction to Mechatronics and Measurement systems- 2/e by Aciatore and M.B.Histant, Tata McGraw Hill edition.
2. Pneumatics and Hydrautics by H.L.Stewart.

REFERENCE BOOKS:

1) Introduction to Mechatronics by Appus Kuttan K.K.- Oxford University Press.
2) Mechatronics – A multidisciplinary approach 4/e by W.Bolton-Pearson Publication,
3) Automation, Production systems and CIM by M.P Groover- Pearson Publication.

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7ME02 PRODUCTIVITY TECHNIQUES

Course Learning Objectives:

1-To measure and evaluate productivity
2-To Plan and implement various productivity techniques
3-Reengineer the process for improve productivity
4-To implement BPR tools for improving the productivity

Course Outcome: After learning the course the students should be able to:

1. Understand Productivity.
2. Differentiate Method Study & Work Measurement.
3. Apply Ergonomics Principles.
4. Analyze Wedge payment & Incentive Plans.
5. Implement reengineering.
6. Understand different Maintenance methods.

SECTION-A

UNIT-I – **Productivity** Definition, Concept and Importance of productivity, Difference between Production and Productivity, Tools of productivity, Reasons for low productivity, Factors that help increasing productivity, Productivity index, Productivity ratio , Kinds of productivity measurement, Causes of low productivity and techniques of their elimination, Factors affecting productivity, Technical methods to improve productivity, Main contributors to productivity improvement, Advantages from increased productivity. (7 Hrs)

UNIT-II-**Method Study** Definition, Concept , Objectives and Procedure of method study, Process chart symbols, recording techniques like Flow process charts, Operation, Flow and Two handed Process charts, Flow diagram, String diagram, Multiple Activity chart, Operation Analysis, Analysis of motion, Motion economy, Design of work place layout, Therbligs, SIMO chart. (7 Hrs)

UNIT-III-**Work Measurement** Definition, Concept and Objectives of work measurement, Stop watch procedure for collecting time study data, Time estimating techniques like analytical estimating, Predetermine Motion Time System-PMTS, Elemental Motion Time System, Basic Motion Time System, Method Time Measurement, Work factor. (7 Hrs)

SECTION-B

UNIT-IV-Ergonomics Introduction, Principles, Work system design, Man-machine system, Human behavior and equipment design, Tools, Techniques and applications, Effect of environment on performance of worker. (7 Hrs)

UNIT-V- **Performance Rating, Wage Payment & Incentive Plans** Introduction, Various incentive schemes, Performance Rating.

Contemporary Issues in Productivity Activities of National Productivity Council and other organizations, Productivity Scenario and changes. (7 Hrs)

UNIT-VI-**Business Process Re-engineering (BPR)** Introduction, Development of Business Process Re-engine, BPR is not for everyone, Advantages of BPR, Steps involved in BPR, Application of BPR, Training for BPR, When to reengineer, Ways to fail at BPR, Requirements of BPR, Human Resource Engineering, Fundamentals of BPR, Implementation methodology of BPR, Organizational re-engineering, Organizational reengineering process, Reengineering values, Approach to reengineering, Re-engineering tools, What re-engineering is not, Kinds of changes that occurs in re-engineering, succeeding. (7 Hrs)

Recommended Books:

Text Books:

1-Work Study, Khanna , Dhanpat Rai Publications
2-Total Quality Management , K.C.Arora, Katsons
3-Industrial Engineering and Management, Khana, Dhanpat Rai

Reference Books:

1. Introduction to Work study, ILO, Oxford
2. Industrial Engineering and Management, Reddy, New Age
3. Industrial Engineering and Management, Verma

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7ME03 INDUSTRIAL MANAGEMENT & COSTING

Course Learning Objectives (CLOs):

1. To study basic concepts & techniques of management.
2. To study the concept of marketing management.
3. To understand the personnel management & materials management techniques.
4. To study the estimation procedure for raw material and machining processes in manufacturing.
5. To study the costing process & costing techniques.
6. To studybusiness finance, financial statements and depreciation analysis.

Course Objectives (COs):

1. Understand the working of business environment.
2. Understand the management thoughts, its evolution and functions.
3. Apply standard and scientific techniques in materials management.
4. Evaluate time, costs, cost sheet and depreciation of industry.

Section-A

UNITI : Concept, Principles and Techniques of Management; Evolution of management thoughts, functions of management, organizationstructure & relationship.(6-Hrs)

UNITII: Marketing and Management : Marketing strategy market research, buying, motives, types of market, new product development, Product life cycle, Sales Organization, advertising,methods of selling, consumer behaviour. .(6-Hrs)

UNITIII: a) Functions of personnel management, Human resource planning, Recruitment, training and development, workers participation in management, joint consultation, collective bargaining.

b) Materials management, classes of materials, scope of material control, scope

and function of purchasing department, purchasing procedure, inventory control, ordering procedure, material identification, store function. . (7-Hrs)

SECTION - B

UNIT IV: Objectives, functions, principle factors of estimating and estimating procedure, Estimation of weights & materials, Estimation of machining time, estimation of fabrication cost, forging cost, and foundry cost. (6-Hrs)

UNIT V : a) Introduction to costing and costing Techniques: Definitions, objectives, elements of costs, components of cost, job costing, simple process costing, normal and subnormal losses in process, waste, scrap. (8 Hours)

UNITVI: a) Financing of Business: - Basis of business finance, need of finance, Kinds of capital, sources of fixed & working capital.

b) Financial statements :- Profit and loss statement, balance sheet

c) Depreciation Analysis: - Causes and significance, methods of calculation of depreciation. (7 Hrs)

Books Recommended:

TEXT BOOKS:

1. Management-principles, processes and practicals, Anil Bhat, Aryakumar; Oxford University Press
2. Management Accounting; Paresh Shah; Oxford University Press
3. Estimating and costing; TTTI Madras.

REFERENCE BOOKS:

1. Essentials of Management; Koontz, Harold; McGraw-Hill Education(India)
2. Cost Accounting; Jawahar Lal; Tata Mcgraw Hill Publishing
3. Cost Accounting by Bhar.

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7ME04 ENERGY CONVERSION – II

Course Learning Objectives(CLOs):

1. To study the construction, working and overall performance of a reciprocating compressor.
2. To study the construction, working and overall performance of a rotary compressor.
3. To study the vapour compression refrigeration system with reference to domestic refrigerator.
4. To study various types of air conditioning systems.
5. To study various aspects of a gas turbine plant along with different techniques to improve its performance.

Course Outcomes(CO):

1. Understand the working of different types of compressors.
2. Analyze, handle and resolve the problems related to working of air compressor.
3. Understand the principle of working of refrigeration systems, air conditioning and its applications.
4. Understand various nuclear reactions and issues related to working and maintenance of nuclear power generation.

SECTION – A

UNIT-I: **Reciprocating, Air Compressions**: - Industrial uses of compressed air , Methods of compression and efficiencies of compression, Methods of reducing losses during compression

single and multistage of compressions, clearance volume and its effect on work done and volumetric efficiency, condition for minimum work in tow stage compression, intercooling and its effects, Overall, isothermal and adiabatic efficiencies, IHP, BHP,requirements and after cooler. (7 Hours)

UNIT-II: **Rotary Compressors** :- Comparison between reciprocating and rotary compressors, difference between fans, blowers and compressors, general equations for rotary machines, Vane, Roots blower, construction, working and velocity diagrams of centrifugal and axial flow compressors, performance characteristics of blowers and compressors. (8 Hours)

UNIT-III: **Refrigeration:** Principle of refrigeration, Applications, Unit of refrigeration, Carnot vapour cycle, reversed heat engine, CoP.

Air refrigeration Sysytem, Vapour compression Refrigeration cycle Coefficient of Performance, Numericals based on simple saturated cycle.

Vapour absorption refrigeration systems, (8 hours)

Section-B

UNIT- IV Air-conditioning: Principle of Air conditioning , Classification and applications of Air conditioning system, Psychrometry, Psychrometric chart, Psychrometric processes related to Air conditioning, Adiabatic Mixing of two Air-streams. Elementary simple problems based on Psychrometric chart. (7 hours)

UNIT -V: **Classification of gas turbines**, construction and working Gas turbine ideal and actual cycles constant volume, constant pressure, (Open and Closed) cycle analysis, Inter cooling, Regeneration and reheating application, optimum and maximum pressure ratios, work rations, Performance characteristics. Fields of application of gas turbine power plant, Introduction to Jet Propulsion, Ram jet, turbo jet. (No numerical treatment for Jet Propulsion). (8 Hours)

UNIT-VI: **Introduction to Automobiles and Electric vehicles:**,

General lay out of the automobile, Classification of automobiles, various subsystems and their role. Basics of vehicle performance

Introduction to Hybrid and Electric Vehicles: basic concept of hybrid and electric vehicles and their configurations, environmental importance of hybrid and electric vehicles, Basic concept of electric traction and architecture. Introduction to electric components used in hybrid and electric vehicles, Configuration and control of; drives use in EV. (8 Hours)

RECOMMENDED BOOKS:-

TEXT BOOKS:

1. Steam and gas turbines R, Yadav; Central Publication Allahabad.
2. Thermal Engineering, Domkundwar, Kothandarawar, Dhanpat Rai &Co.
3. Power Plant Engineering; R.K.Rajput; Laxmi publication.
4. Solar Energy by S.P.Sukhatme; Tata McGraw-Hill in New Delhi

REFERENCE BOOKS:

1. Thermal engineering by Mahesh M.Rathore; Tata McGraw-Hill in New Delhi

2. Gas Turbines Theory- By Cohen and C.F.Rogers, P.H.I.H. Saravanamuttoo Heritage Publishers,
3. Gas Turbines and Rotary compressors, Khajuria and Dubey, Dhanpat Rai & Co.
4. Thermal Engineering: R.K.Rajput, Laxmi Publication.
5. Renewable Energy; Godbfrey Boyle, Oxford University Press.

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7ME05 PROFESSIONAL ELECTIVE – II

7ME05 (i) COMPUTER INTEGRATED MANUFACTURING

Course Learning Objectives:

1-Apply technical knowledge of manufacturing processes to the fabrication of mechanical parts.

2-To produce knowledgeable users of CAD systems.

3-Understand the various CAD/CAM and CNC processes.

4-To understand the associativity between design and manufacturing

Course Outcomes:

1- Able to Specify a quality control method for analyzing a finished product.

2-To develop a strategy for implementing computer integrated manufacturing.

3-To synthesize and apply the concepts learnt

4-Describe various operation in numerical control system and part programming

5- Describe CNC machining and interfaces of CAM and CNC

6-Undertake, under supervision, laboratory experiments to design in CAD and to program in CAM for machining.

SECTION A

Unit I - Computer aided design, Fundamentals of CAD, Design process, Application of computer for Design, The design of workstation, Function of graphic package , constructing the geometry, Transformation (2D), wire frame , Surface , Solid modeling, Benefits of CAD. **(7-Hrs)**

Unit II-Computer aided manufacturing:- Automation and its types, Numerical control, Basic concept, NC Control- point to point, Straight line, Continuous path control, Machine control unit, Drives in NC/CNC- Servo and Stepper motors, CNC & DNC types. **(7-Hrs)**

Unit III-CNC Part Programming: Part programming manual, Computer assisted part programming, Programming formats, Programming codes, Programming for drilling, milling, turning.

Programming with APT: MACRO statements, Subroutine and loops in programming. **(7-Hrs)**

SECTION B

Unit IV-Robotics: Technical features of robots, Geometric configurations of robots, Robot anatomy, Arm geometry, End effectors, Drives system, sensors- tactile, proximity range finder, machine vision, work cell controller and interlocking sensor commands, programming technique for robot, Application of robots in manufacturing, Economic justification of robots (Payback, Returns on Investment methods). **(7-Hrs)**

Unit V -Flexible Manufacturing System:

Basic concept, group technology, part families, part classification and coding system, GT machine cells, Types of FMS, FMS layout configurations, Planning of FMS, Types of

CAPP. **(7-Hrs)**

Unit VI-Computer Integrated Manufacturing:

Concept, Elements of CIM system, Structure of CIM data base system, CIM wheel, CIM shop floor control and process monitoring, Automation.

Inspection and testing: - Online and offline inspection, Distributed inspection.

ASRS and its elements, AGVS, Guidance, routing and traffic control in AGV. **(7-Hrs)**

Books Recommended:

Text Books:

1) Robotics by Rajput

2) CAD/CAM by P.N. Rao

Reference Books:

3) Computer aided Design and Manufacturing by Sadhu Singh

4) Production system, Automation and CIM, Mikhal Groover, Pearson Publication.

5) CNC Machines: M. Aditham & B.S. Pabla, New Age International

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7ME05 PROFESSIONAL ELECTIVE – II
(ii) AUTOMOBILE ENGINEERING

Course Learning Objectives (CLOs):

1) To study types of automobiles, chassis and engine types, engine parts, firing orders for multicylinder engines, general considerations of engine balancing.

2) To study the fuel feed systems, fuel pump, fuel filters, air filters, MPFI and CRDI systems, types of cooling systems, antifreeze mixtures.

3) To study electrical system, battery capacity and ratings, starter motor drives, ignition systems, ignition timing and its effect on engine performance, ignition advance mechanisms.

4) To study the transmission system, types of clutches and gear boxes, overdrive, propeller shaft, differential gear, rear axle drives, automatic transmission.

5) To study braking system, types of brakes, steering system, steering gears, steering gear ratio, wheel balancing and alignment, power steering.

6) To study suspension systems, shock absorbers, different lubricants and their properties, engine lubrication systems, oil pumps, chassis lubrication, crankcase ventilation.

COURSE OUTCOMES (COs):

1. Understand the basics of automobile engineering and its components.
2. Idea creation of cooling system, electrical system and ignition system.
3. Analysis of transmission system and types of gears box.
4. Design and development of suspension and lubrication.

SECTION – A

Unit I : Classification of automobiles, chasis types, Power Unit- Functions and locations power for propulsion, engine parts- types, construction and functions, Multiple cylinderengines, General considerations of engine balancing, firing order.(7 -Hrs)

Unit II : Lubrication system: Purpose, types of lubricants, Types of lubricating system-splash, pressure and dry sump lubricating system.

Fuel supply system: types of fuel supply system, components of fuel supply

system, M.P.F.I. and C.R.D.I.

Cooling system – purpose, types, bypass recirculation system and antifreeze mixture.(6-Hrs)

Unit III: Ignition system- types of ignition system- Battery and Electronic ignition system, Ignition timing, Ignition advance mechanism – centrifugal and vaccum type advanced mechanism.

Starting system- Purpose, starting drives- Bendix drive.(7 Hrs)

SECTION – B

Unit IV : Transmission system : Clutches, Single plate & multiplate, Gear Boxes :- Sliding mesh, constant meshand synchromesh gear box, Automatic gear box.

Differential- Construction and working.

Suspension system- types, telescopic type, shock absorber.

(8 Hrs)

Unit V: Braking system:- Mechanical, Hydraulic, Vaccum and air brake system, Antibraking system. Steering system:- Layout, steering gears, wheel alignment, steering geometry, camber, caster, king pin inclination and toe in and out,

Power steering- Principle and working.. (7-Hrs)

Unit VI : Electric &Hybrid vehicles. Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives. Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Hybridization of different energy storage devices (8 Hrs)

Books Recommended :

TEXT BOOKS :

1. Automobile Engineering- Vol.I & II, Kirpal Singh, Standard Publishers Distributors
2. Automobile Engineering – R.K.Rajput; Laxmi publications, New Delhi.
3. Iqbal Hussain, "Electric & Hybrid Vehicles – Design Fundamentals", Second Edition, CRC Press, 2011.

REFERENCE BOOKS:

1. Automotive Mechanics; Crouse & Anglin, TMH.
2. Automotive Mechanics ; J Heitner; East West Press
3. Automotive Mechanics ; S.Srinivisan; TMH.
4. James Larminie, "Electric Vehicle Technology Explained", John Wiley & Sons, 2003

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7ME05 PROFESSIONAL ELECTIVE – II

(iii) DESIGN OF TRANSMISSION SYSTEM

COURSE LEARNINGS 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.

3-To learn to use/selection of standard data and catalogues from data book .

COURSE OUTCOMES:

Upon the completion of this course the students will be able to design of transmission systems for engines and machines elements includes -

1.Slection of belts, chains and rope drives
2. Failure theories Gears & design of spur gear
3. Interpret the concepts of design of fluid couplings and torque converters
4. Design of gear boxes
5. Design of design of cams, brakes and clutches

SECTION-A

UNIT I -DESIGN OF FLEXIBLE ELEMENTS

a) Design &Selection of Flat belts,
b) Selection of V belts,
c) Selection of hoisting wire ropes ,
d) Selection of transmission roller chains and Sprockets.

(07 Hrs.)

UNIT II -SPUR GEAR

Speed ratios and number of teeth, Force analysis, Tooth stresses, Dynamic effects, Fatigue strength ,Factor of safety ,Gear materials, Design of straight tooth spur.

(06 Hrs.)

UNIT III – FLUID COUPLING AND TORQUE CONVERTER

a)Fluid Coupling- Fluid Coupling Diagram, Working Of Fluid Coupling, Application of Fluid Coupling.

b) Torque Converters – Torque Converter Diagram ,working of Torque converter , Application of Torque Converter. Difference between Fluid Coupling and Torque Converter.

(06 Hrs.)

SECTION-B

UNIT IV GEAR BOXES

Geometric progression ,Standard step ratio , Ray diagram, kinematics layout, Design of sliding mesh gear box ,working of constant mesh gear box ,working of multi speed gear boxs.

(07 Hrs.)

UNIT V CAMS

Cam Design: Types, pressure angle and under cutting base circle determination, forces and surface stresses.

(06 Hrs.)

UNIT VI CLUTCHES AND BRAKES

a) Design of plate clutches, axial clutches, cone clutches, internal expanding rim clutches, Concept & working of Electromagnetic clutches.
b) Design of Band and Block brakes, external shoe brakes, Internal expanding shoe brake.

(07 Hrs.)

Books Recommended:

Text Books-

1) Machine Design- R.S.Khurmi and Gupta J.K., Published by S Chand.
2) Machine Design-Dr.P.C.Sharma, D.K.Agrawal, S.K.Kataria and Son's Publications.
3) Prabhu. T.J., "Design of Transmission Elements", Mani Offset, Chennai

Reference Books-

1) Machine Design Exercises - S.N. Trikha, Khanna Publications, Delhi
2) Machine Design - An Integrated Approach - Robert L. Norton - Pearson Education Asia.
3) Maitra G.M., Prasad L.V., "Hand book of Mechanical Design", II Edition, Tata McGrawHill.
4) Machine Design fundamentals –Mechanical designer workbook, J.E.Shigley, Published by

Mc Graw hill .
5) Design of Machine Elements-V B Bhandari,McGraw hill .
6) Machine Elements in Mechanical M.F. Spotts , prentice hall india,
7) Machine Design, Black P.H., Published by Mc Graw Hill.
8) Design Data Book by- P.S.G. Coimbatore,
9) Design Data Book by V.B.Bhandari,

(Use of any data book from the above will be permitted during the examination).

7ME05 PROFESSINAL ELECTIVE - II

7ME05 (iv) COMPUTATIONAL FLUID DYNAMICS

Course Learning Objectives:

- To numerically **solve** governing partial differential equations for physical problems in fluid mechanics and heat transfer.
- To **analyze** different mathematical models and computational methods for transport processes.
- To **study**, and **apply** discretization methods & schemes and analyze its effect on the accuracy of numerical solution and computational time.
- To **demonstrate** the ability to use modern CFD software tools.

Course Outcomes:

On completion of the course, student will be able to

- Numerically **solve** the governing partial differential equations of fluid flow and heat transfer problems.
- **Construct** and solve the different mathematical models and computational methods for fluid flows.
- **Apply** the discretization methods to solve fluid flow and heat transfer problems.
- **Choose** and justify the CFD schemes for the respective fluid flow/transport phenomena problem.
- **Perform** verification and validation of numerical model.
- **Demonstrate** the ability to use modern CFD software tools.

Section – A

Unit – I:

Governing equations and Boundary conditions:

Introduction to Computational Fluid Dynamics, Governing equations of fluid dynamics: Continuity, momentum and energy equations, Classification of partial differential equations: parabolic, elliptic, hyperbolic. Boundary and initial conditions; physical behaviour, overview of finite difference, finite element and finite volume methods. Overview of numerical methods. (7-Hrs)

Unit – II:

Finite Difference Method - Derivation of finite difference equations – Simple Methods – General Methods for first and second order accuracy- explicit, implicit, stability requirement, boundary conditions. Convergence, Errors and analysis of stability.

Methods of Solution: Solution of finite difference equations Solution procedures: direct and iterative methods. (7-Hrs)

Unit – III:

Finite volume method: fundamental concepts, discretization of 1-D steady state and 1-D unsteady state diffusion problems, explicit and implicit schemes, consistency, stability and convergence, discretization of 1-D and 2-D diffusion problems. Difference between the FDM and FVM methods. (7-Hrs)

Section - B

Unit – IV:

Grid Generation Method: Definition and types of grid, Transformation of equation, Matrices and Jacobians, Stretched Grids, Elliptic Grids, Adaptive grids.

Numerical solution of the flow field: QUICK and SIMPLE algorithm. (7-Hrs)

Unit – V:

Turbulence models: Reynolds Average Navier-Stokes equation, RANS turbulence Models, two equation (k-Є) models, Large Eddy Simulation. (Elementary treatment only) (7-Hrs)

Unit – VI:

Introduction to CFD software and Applications:

Application of modern CFD software Open FOAM/ANSYS/FLUENT/STAR-CCM+/MATLAB: analysis for fluid and heat transfer problems. Heat transfer analysis in a double pipe heat exchanger. Internal fluid flow and heat transfer study in a centrifugal pump. Heat conduction study in 2D flat plate. Simulation of a generic convection-diffusion transport equation with forced/natural convention over flat plat/in pipe. External flow analysis over airfoil and over cylinder. (7-Hrs)

Books Recommended:-

Text Books:

1. Anderson, D., Tannehill, J. C., &Pletcher, R. H. (2016). Computational fluid mechanics and heat transfer. CRC Press.
2. Patankar, Suhas. Numerical heat transfer and fluid flow. Taylor & Francis, 2018.
3. Introduction to Computational Fluid Dynamics Anil W. Date Cambridge University Press, 2005.
4. Ghoshdastidar, P.S., Computer Simulation of flow and heat transfer, Tata McGraw

Reference books:

1. Introduction to Computational Fluid Dynamics: The Finite Volume Method, Versteeg, H. K. and Malalasekara, W., Second Edition (Indian Reprint) Pearson Education, 2008.
2. Muralidhar, K., &Sundarajan, T. (2003). Computational fluid flow and heat transfer. Alpha Science International.
3. Chung, T. J. (2010). Computational fluid dynamics. Cambridge university press.
4. ProdipNiyogi, Chakrabarty .S.K., Laha .M.K. Introduction to Computational Fluid Dynamics, Pearson Education, 2005.

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7ME06 MECHATRONICS – LAB.

Course Learning Objectives:

1. Understand key elements of Mechatronics system, representation into block diagram

2. Understand concept of transfer function, reduction and analysis

3. Understand principles of sensors, its characteristics, interfacing with DAQ microcontroller

4. Understand the concept of PLC system and its ladder programming, and significance of PLC systems in industrial application

5. Understand the system modeling and analysis in time domain and frequency domain.

6. Understand control actions such as Proportional, derivative and integral and study its significance in industrial applications.

Course Outcomes:

1 - Identification of key elements of mechatronics system and its representation in terms of block diagram.

2 - Understanding the concept of signal processing and use of interfacing systems such as ADC, DAC, digital I/O .

3 - Interfacing of Sensors, Actuators using appropriate DAQ micro-controller.

4 - Time and Frequency domain analysis of system model (for control application).

5 - PID control implementation on real time systems.

6 - Development of PLC ladder programming and implementation of real life system.

List of Practicals (Any- 5):

1. Study of pneumatic system
2. Study of PLC and implementation of real life system.
3. Study of Pick & Place robot.
4. Study of bottling plant
5. Study of digital to analog converter
6. Study of D.C. motor control unit.
7. To study applications of sensors and actuators

***Practical Examination:**

Practical Examination shall consist of viva voce based on the term work and syllabus.

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7ME07 ENERGY CONVERSION II – LAB.

Course Learning Objectives:

1-To study performance of a reciprocating compressor.
2-To study the construction, working and overall performance of a rotary compressor.
3-To study the vapour compression refrigeration system with reference to domestic refrigerator.
4-To study various types of air conditioning systems.
5-To study gas turbine plant with different techniques to improve its performance.

Course Outcomes: Students are able to-

1-Understand the working of different types of compressors.
2-Analyze, handle and resolve the problems related to working of air compressor.
3-Understand the principle of working of refrigeration systems, air conditioning and its applications.
4-Understand various nuclear reactions and issues related to working and maintenance of nuclear power generation.

List of Experiments(any 8) :

Any six of the following :-

1. Trial on reciprocating compressor.
2. Trial on centrifugal blower.
3. Studies of domestic refrigerator.
4. COP calculation of vapour compression system.
5. Study of vapour absorption system

6. Study of room air conditioner.
7. Study of gas turbine with the help of models.
8. Study of general layout of conventional automobile and its subsystems
9. Study of the general layout of electric vehicle

Practical Examination shall consist of viva voce based on above term work.

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PROFESSIONAL ELECTIVE – II`

7ME08 (i) COMPUTER INTEGRATED MANUFACTURING- LAB.

Course Learnig Objectives:

1-Apply knowledge of manufacturing processes .

2-knowledgeable users of CAD systems.

3-Understand the various CAD/CAM and CNC processes.

4-Understand the application based conceptual knowledge design and manufacturing for COE

Course Outcomes:

1- Able to Specify a quality control & analyzing a finished product.

2-To Apply strategy for implementing computer integrated manufacturing.

3-To synthesize and apply the concepts learnt

4-To Understand laboratory experiments to design in CAD and to program in CAM for machining.

List of Practicals(Any 6):

1. Preparation of Manual part program.
2. Preparation of CNC part program.
3. Study of anatomy, configuration of industrial robot.
4. Simulation of CNC Machining.
5. Performance on NC and CNC m/c.
6. Study of programming methods of industrial robots.
7. Creation of 2D Drawing (Sketching module) of any mechanical machine component using any modeling /drafting software.
8. Creation of 3D drawing (part Module) of any mechanical machine parts using any modeling software.

Practical Examination shall consist of viva voce based on above term work.

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7ME08 PROFESSIONAL ELECTIVE – II
(ii) AUTOMOBILE ENGINEERING Lab

Course Learning Objectives (CLOs):

1) To study types of automobiles and its parts functioning.
2) To study the fuel feed systems ,cooling.
3) To study electrical system, battery capacity and ratings.
4) To study the transmission system

5) To study braking system

6) To study and understand suspension systems

COURSE OUTCOMES (COs):

1. Apply basic principles and knowledge of automobile engineering and its components for proper functioning.
2. Analysis concept of cooling system, electrical system and ignition system.
3. Interpret basic concept of transmission system and types of gears box.
4. Remember the concept of suspension and lubrication.

List of Practicals (Any 6):-

1) Classification of Automobiles & Automobile Chassis

2) Study of Differential Mechanism of an Automobile .

3) Study & Application of Multiple Clutch of an Automobile

4)Study ,working and operation of Braking System (Hydraulic / Air Brake)

5) Study and Demonstration of different circuit of carburetor

6) Checking the spark plug and setting the port and check the ignition in the spark plug

7) Study & Demostraion of Electrical System of an Automobile

8) Study the assembly of Car Engine

9) Study and demonstration of E vehicle.

10) Study of types of Batteries and Batteries maintenance used in E vehicle.

11) To study the stepper motor and to execute microprocessor computer based control of the same by changing number of steps, the direction of rotation and speed E vehicle.

Practical Examination shall consist of viva voce based on above term work.

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7ME08 PROFESSIONAL ELECTIVE- II

(iii) DESIGN OF TRANSMISSION SYSTEMS - LAB.

COURSE LEARNINGS OBJECTIVES:

1-To **apply** standard design procedure available for Design of Transmission of Mechanical elements.

2-**learnt** to use/selection of standard data from catalogues/data book .

COURSE OUTCOMES:

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

1. to **implement** and **selection** of belts, chains and rope drives
2. to **identify** failure spur gear and design its dimensions.
3. to **study** idea of fluid couplings and torque converters
4. to **interpret** design of gear boxes
5. to **analyze** failure theories of cams, brakes and clutches

List of Exercises for Term Work

1) Sheet 1: Design of Flexible Elements (any one –flat belt drive, V belt drive or Wire rope).

2) Sheet 2: Design and Selection of Roller Chain with sprocket.

3) Sheet 3: Design of spur gear.

4) Sheet 4: Design Fluid Coupling.

5) Sheet 5: Design of Torque Converter.

6) Sheet 6: Design of sliding mesh gear box.

7) Sheet 7: Design of Plane flat Radial Cam.

8) Design of Clutch (any one - plate clutches, axial clutches, cone clutches, internal expanding rim clutches)

9) Design of Brake (any one - external shoe brakes or Internal expanding shoe brake).

Note: - Minimum 5 term work should be submitted for lab work

***Practical Examination:-**shall consist of Viva-voce on the above syllabus and submission of term work .

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7ME08 Professional Elective –II

(iv) COMPUTATIONAL FLUID DYNAMICS -LAB.

COURSE OBJECTIVES

- To utilize the various computational tools to understand the fluid flow.
- To employ the various computational tools to comprehend heat transfer problems.
- To apply the knowledge of several numerical schemes to solve the governing equations of physical systems.
- To understand and simulate several flow situations with forced/natural convection with Internal and external flows.
- To validate the simulation results with that of existing experimental/analytical results.

COURSE OUTCOMES

On completion of the course, student will be able to

- **Understand** the computational software tools to analyse the fluid flow problems.
- **Utilize** various computational tools to comprehend heat transfer problems.
- **Classify** and evaluate the physics of problems and apply the appropriate discretization schemes.
- **Analyze**and understand the results through post-processing for a given problem.
- **Compare** the simulation results with that of existing experimental/analytical results.

LIST OF EXPERIMENTS: (Any six experiments)

1. Perform numerical analysis on flow through pipe with varying Reynolds Number.
2. To calculate hydrodynamic length and boundary layer thickness for pipe flow numerically.
3. To calculate lift and drag co-efficient for a cylinder by using numerical analysis.
4. External flow analysis over airfoil for different angle of attacks.
5. Fluid flow and heat transfer analysis in a double pipe heat exchanger.
6. Perform Numerical analysis on compressible flow in nozzle.
7. Perform Numerical analysis on heat conduction through wall.
8. Couette flow analysis for either explicit or implicit formulation (Parabolic equation).
9. Heat conduction in 2D flat plate with explicit and implicit formulation (Elliptic equation).
10. Perform Numerical analysis on steady flow past a cylinder
11. Study of different turbulent models to analyze the flow in a pipe for various Reynolds number.
12. Perform Numerical analysis on convective heat transfer.

Practical Examination shall consist of viva voce based on above term work.

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7ME09 TECHNICAL SEMINAR & PROJECT

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SYLLABUS PRESCRIBED FOR BACHELOR OF MECHANICAL ENGINEERING SEMESTER PATTERN (CHOICE BASED CREDIT GRADE SYSTEM)

SEMESTER: EIGHTH

8ME01 OPERATION RESEARCH TECHNIQUES

COURSE LEARNIONG OBJECTIVES (CLOs):

1. To study operation research models and linear programming methods.
2. To understand transportation models and assignment models.
3. To study waiting line models and understand the concept of sequencing.
4. To study replacement models and simulation models.
5. To understand the concept network models, CPM and PERT analysis.

COURSE OUTCOMES(CO):

1. Understand the knowledge of OR and OR models.
2. Analyze the transportation problems and related issues.
3. Understand the concept network models, CPM and PERT analysis.
4. Understand the concept replacement models and solve the problem on simulation techniques.

SECTION – A

UNIT I: Operations Research : Introduction, characteristics, Phases, Limitations, Models and classification of O.R.Models.

Linear Programming : Formulation, Standard Form, Graphical and simplex methods, Primal-Dual relationship. (8 Hrs)

UNIT II : **Transportation Models : Introduction**, LP Formulation of transportation problems, Methods for finding initial solution, MODI method.

Assignment Models : Introduction, Mathematical statement and solution methods of assignm. Problems, variations of assignment Problems. (6 Hrs)

UNITIII: **Network Models :** Network construction, PERT analysis, CPM analysis, cost analysis & Crashing the network, Updating resources smoothing and leveling. (6 Hrs)

SECTION- B

UNITIV: Waiting line models : Introduction, characteristics, classification, analysis of M/M/1 and M/M/s models.

Sequencing : processing of n jobs through two machines, n jobs through m machines, two jobs through m machines**.** (7 Hrs)

UNIT V: **Replacement models :** introduction, value of money, individual and group replacement policies.

` **Simulation :** introduction, Monte Carlo simulation, advantages and limitations, applications of simulation to queuing models, inventory models, maintenance models , etc. (7 Hrs)

UNITVI: **Dynamic programming**: introduction, characteristics, applications of dynamic programming to capital budgeting, production scheduling, travelling sales men, cargo loading problems, etc.(6 Hrs)

RECOMMENDED BOOKS:

TEXT BOOKS:

1. Operations Research and Theory applications- II ed.J.K.Sharma;Macmilan Business Books
2. Operations Research; Prem kumar Gupta, D.S.Hira; S.Chand & Co. ltd.

REFERENCE BOOKS:

1. Inroduction to Research Operation, 7th Edition; Hiller/Lieberman; TataMacgraw Hills.
2. Operations Research : An Introduction, 7th Edition, H.A.Taha; PHI.
3. Operations Research: Principles and practices; 2nd Edition, Ravindran,Philips, Solberg, John Willey & Sons.
4. Operations Research: Kapoor.

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8ME02 I. C. ENGINES

COURSE LEARNING OBJECTIVES (CLOs):

1. To study basic of engines, Air standard cycles, Fuel air cycle, actual cycle and review of other losses in IC engines.
2. To study conventional fuels, requirement, properties, fuel additive and limitations of fossil fuels.
3. To study stages of combustion, factors influencing various stages, Detonation, Factors and effect of detonation, rating of fuel and combustion chambers.
4. To study delay period, diesel knock, cetane rating, requirements of combustion chamber and methods of generating turbulence.
5. To Evaluate performance of Engines by using heat balance sheet, excess air calculation and determination of friction power, effect of supercharging.
6. To study Emission from Engines, EURO emission norms and Recent trends in Engines.

COURSE OUTCOMES(COs):

1. Remember fundamentals of I.C. engines, their types and cycle analysis.
2. Remember the knowledge of fuels and alternative fuels, study of fuel injection pump.
3. Remember the concept of combustion of CI engine.
4. Understand the concept of supercharging its objectives, advantages and limitations.

Section-A

UNIT I: **Introduction to IC Engines and cycle analysis:** Basic of I.C. Engines , Details of two stroke and four stroke engines, Air standard cycles, Fuel air cycle and actual cycle. Variation in specific heat, Dissociation and their effect on engine performance. Review of other losses in IC engines. (7 Hrs)

UNIT II: Fuels and alternative fuels : Conventional fuels for IC engines, requirement, properties, fuel additive, limitations of fossil fuels. Review of various alternative/non-conventional fuels . Studies of fuel injection systems : Fuel pump

and their working, differenttypes of fuel feed systems, studies of injectors nozzles, Bosch type fuel pump. (8 Hrs)

UNIT III: **Combustion SI Engine:**- Stages of combustion, factors influencing various stages, Normal and abnormal combustion, Detonation, Factors responsible for detonation. Effect of detonation. Octane rating of fuel, Requirement of combustion chambers for SI engines, important types, relative advantages and disadvantages and application. (8 Hrs.)

SECTION - B

UNIT IV: Combustion in CI. Engines:- Stages of combustion in CI Engines, Delay period, factor affecting delay period, diesel knock, cetane rating, Requirements of combustion chamber for CI Engines. Methods of generating turbulence in combustion chamber. Typesof combustion chambers for CI Engies.(8 Hours)

UNIT V: **Performance testing of IC Engines:** Evaluation of various performance parameters of IC Engines including heat balance, sheet and excess air calculation. Methods of determination of friction power. Supercharging : Basic principles, objectives, arrangements for super charging, advantages and limitations of super charging. (8 Hours)

UNIT VI: **Emission from IC Engines :** review, their effect on human health, cause of formation and approaches to control this pollutants. Study of BIS, EURO emission norms, IC Engines: Recent trends: Microprocessor based engines, management multi-point fuel injection engines, common rail direct injections engines, variable valve timing engines. (8 Hours)

Books Recommended:

TEXT BOOKS:

1. Internal combustion Engines - M.L.Mathur & Sharma Dhanpatrai &Sons.
2. Internal combustion Engines – V.Ganeshan, Tata Mcgraw Hills.

REFERENCE BOOKS:

1. Internal combustion Engines Fundaments- John B. Heywood, McgrawHills

Internal combustion Engines & Air Pollution- Obert E.F.IntextEducational.

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8ME03 PROFESSIONAL ELECTIVE – III
(i) ENERGY CONSERVATION & MANAGEMENT

Course Learning Objectives:

Students are expected to learn the importance and the need for conserving the Energy and apply the knowledge gain through methodologies and the management techniques in the energy conservation.

Course Outcome:

After learning the course the students should be able:

1. To understand the basic knowledge of different terms & principles of energy conservation, audit and management.
2. To Evaluate the energy saving & conservation in different mechanical utilities
3. To understand efficient heat & electricity utilization, saving and recovery in different thermal and electrical system.
4. To prepare energy audit report for different energy conservation instances.

Section - A

Unit-I: Energy Scenario and importance of energy conservation

Energy Scenario: Classification of Energy, Indian energy scenario, Sectorial energy consumption (domestic, industrial and other sectors), energy needs of growing economy, energy intensity, long term energy scenario, energy pricing, energy security, energy conservation and its importance, energy strategy for the future. Energy Conservation Act 2001 and related policies: Schemes of Bureau of Energy Efficiency (BEE), State Designated Agencies, Electricity Act 2003. Clean Development Mechanism (CDM). (7-Hrs)

Unit-II: Thermal Systems: Boilers and Industrial furnaces

Energy conservation opportunities in Boilers, efficiency testing, excess air control, performance evaluation, analysis of losses, feed water treatment, blow down, energy conservation opportunities. Boiler efficiency calculation, evaporation ratio and efficiency for coal, oil and gas. Steam distribution & use – steam traps, condensate recovery, flash steam utilization.

Electrical, Induction furnaces- Energy saving measures. (7-Hrs)

Unit-III: Thermal Systems: Fans, Blowers and HVAC

Energy conservation in Pumps, Fans (flow control) and blowers, Pumps and Pumping systems - Classification, Performance, Factors affecting pump performance, efficiency. Compressed Air Systems, Performance monitoring and compressed air-distribution system. Factors affecting cooling tower performance and Energy saving opportunities

Refrigeration and air conditioning systems – Waste heat recovery recuperators, heat sheets, heat pipes, heat pumps. Energy conservation methods. (7-Hrs)

Section - B

Unit-IV: Electrical Systems

AC / DC current systems, Demand control, power factor correction, load management, Motor drives: motor efficiency testing, energy efficient motors, motor speed control, electrical distribution systems – Transformers – Power quality – harmonic distortion. Reduction of losses – Power factor. Lighting: lighting levels, efficient options. (7-Hrs)

Unit-V: Energy auditing

Definition, energy audit, need, types of energy audit. Energy management (audit) approach-understanding energy costs, Bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel and energy substitution, energy audit instruments and metering. (7-Hrs)

Unit-VI: Energy Management and Economics

Energy resource management – Energy Management information systems (EMIS) – Energy Monitoring and Targeting: Defining monitoring & targeting, elements of monitoring & targeting.

Energy economics – discount rate, payback period, internal rate of Return, life cycle costing – Financing energy conservation Projects. (7-Hrs)

Books Recommende:-

Text Books:

1. L.C. Witte, P.S. Schmidt, D.R. Brown, Industrial Energy Management and Utilisation, Hemisphere Publ, Washington, 1988.
2. O. Callaghn, P.W. Design and Management for Energy Conservation, Pergamon Press, Oxford, 1981.
3. IDryden, I.G.C. The Efficient Use of Energy, Butterworths, London, 1982

REFERENCES BOOKS:

1Turner, W.C. Energy Management Hand Book, Wiley, New York, 1982.

2. 4Murphy, W.R. and Mc KAY, G. Energy Management, Butterworths, London 1987.

3.Energy Conservation Guidebook, Dale R Patrick, Stephen W Fardo, 2nd Edition, CRC Press .

4. Handbook of Energy Audits, Albert Thumann, 6th Edition, The Fairmont Press

5.Trivedi, P.R, Jolka K.R., Energy Management, Commonwealth Publication, New elhi,1997.

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8ME03 PROFESSIONAL ELECTIVE – III
(ii) RODUCTION PLANNING AND CONTROL

COURSE LEARNING OBJECTIVES (CLOs);

1. To understand the importance of production planning and control, its functions, advantages.
2. To apply the skills of calculating for sales forecasts using various forecasting methods.
3. To remember concept of machine capacity, loading of machines and man machine activity charts.
4. To study the concept of inventory control & various cases of inventory system and modern techniques/philosophies of management like CIM, JIT, MRP-I and MRP-II.

COURSE OUTCOMES (COs):

1. Understand the importance of production planning and control, its functions, advantages.
2. Apply the skills of calculating for sales forecasts using various forecasting methods.
3. Remember concept of machine capacity, loading of machines and man machine activity charts.
4. Understand concept of inventory control & various cases of inventory system and modern techniques/philosophies of management like CIM, JIT, MRP-I and MRP-II.

SECTION – A

Unit I :- INTRODUCTION

Objectives and Advantages of PPC, Production procedure, functions of PPC, production consumptions cycle, centralised & decentralised PPC, Pre-requisite of PPC.(7-Hrs)

Unit II :- PRODUCTION FORCASTING :-

Introduction, definition and importance of forecasts, Qualitative model: Delphi techniques, Quantitative models :- Simple moving average, weighted moving average, simple experimental smoothing.

Forecasing error and selection of forecasting model. Types of forecaste: Constant,linear cycle forecaster, Verification and conrolling, The moving range chart, Average MR, out of control conditions.(8-Hrs)

Unit III: PRODUCTION PLANNING : - The production order, Procedure for formulating Production order, masier Program, Basic problems in production planning, Quantities in batch production, criteria for batch, size determination, minimum cost batch size, production range, Maximum profit Batch size, Maximum return, Rate of return, Economic Batch size.(7-Hrs)

SECTION – B

Unit IV : MACHINE OUTPUT :

Machine output, multi machine supervision by one operator, Machine interference, Ashcroft labels, average number of consecutive servicing task, the Ashcraft Number.(7-Hrs)

Unit V: ANALYTICAL STRUCTURE OF INVENTORY: - Definition of inventory, Types of inventory and the classification, structure of inventory problems and its analysis, the relevant cost, objectives of carrying inventories, selective inventory analysis. Static Model :- General characteristic, incremental analysis, opportunity cost, cost of risk, decision criteria under uncertaincy.(7-Hrs)

Unit VI: A) DYNAMIC MODEL :- CERTAINITY CASE ;- General characteristic, optimum lot size model win constant demand, quntity discounts. Risk Case :- General characteritics, P-system and Q-system.

B) Material Requirment planning (MRP) :- Introduction to MRP, Manufacturing Resource Planning (MRP-IT), just in time (JIT), comparison of MRP, MRP-II, Entrepreneurship Resource Planning (ERP). (8 Hrs.)

Books Recommended:

TEXT BOOKS :

1. Elements of Production Planning and Control by Simuel Eilon –Universal Publishing Corporation ltd.Mumbai
2. Production Control – John E.Biegal- Prentice Hall of India.
3. Inventory control, Theory & Practice- Start & Miller

REFERENCE BOOKS:

1. Production Planning and control and Management:- K.C.Jain &L.N.Agrawal.
2. Production & Operation Mgmt.;- E.E.Adam, Jr.R.J.Ether, Prentics Hall of India.
3. Industrial Engineering and Production Management- M.Mahajan-Dhanpat Rai.

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8ME03 PROFESSIONAL ELECTIVE – III
(iii) PRODUCT DESIGN & DEVELOPMENT

Course Learning Objectives:

This course aims at introducing the students to the basic concepts of engineering design and product development with focus on the front-end processes. At the end of this course the student is expected to demonstrate an understanding of the overview of all the product development processes and knowledge of concept generation and selection tools.

Course Outcomes:

After successfully completion of this course students will be able to:

1. Manage the development of an idea from concept through to production.
2. Employ research and analysis methodologies as it pertains to the product design process, meaning, and user experience.
3. Apply creative process techniques in synthesizing information, problem-solving and critical thinking.
4. Demonstrate, apply, explain, and recognize basic engineering, mechanical, and technical principles for decision making
5. Use sustainable materials and manufacturing processes & Carry out cost and benefit analysis through various cost models.

Section-A

UNIT I Introduction to product design:

The morphology of design, Primary design phases & flowcharting, Role of allowance, Process capability and tolerance in detailed design and assembly, detailed design phase. (6-Hrs)

UNIT II Product design practices:

Product strategies, time to market, analysis of the product, the Three S's, standardization, Renard series, Simplification, Designer and his role, Basic design consideration, Procedures and problems faced by industrial designer, Role of aesthetics in product design, functional design practice. (6-Hrs)

UNIT III Product design consideration:

Principal stress trajectories, balanced design, criteria and objectives of design, material toughness: resilience, designing for uniform strength, tension vis-à-vis compression.
Pure struts and pure columns, mapping of principal stresses, buckling and instability, theory of long columns, hollow columns, plastic design, practical ideas for material saving in design, ribs, corrugation, laminated, membranes. (6-Hrs)

Section-B

UNIT IV Design for production:

Producibility requirement, forging design, pressed component design, casting design, design for machining ease, the role of process engineer, ease of location and clamping, die casting and special casting, design of powder metallurgical parts, expanded metal and wire forms. Introduction, properties & classification of plastics, phenol formaldehyde and urea formaldehyde resin products, compression moulding, transfer moulding, injection moulding, high-pressure laminates, forming and drawing of plastic sheets, design of plastic parts, natural & artificial rubber, engineering properties of rubber, Glass & ceramics.Plastic bush bearings, gears & fasteners in plastic, Design recommendation for rubber parts, Distortion in rubber, dimensional effects and tolerances, design factors for ceramics and glass parts, Wood. (6-Hrs)

UNIT V Optimization & economics in design:

Siddal's classification of design approach, Optimization by differential calculus, Langrange multipliers, Linear programming, geometric programming, Johnson's method of optimum design.
Product value, design for safety, reliability and environmental considerations, manufacturing operations in relation to design, economic analysis, profit & competitiveness, break-even analysis, economics of a new product design. (6-Hrs)

UNIT VI Human engineering, value engineering & role of computer in product design

Human being vas applicator of forces, Anthropometry, design of controls& displays, man/machine information exchange, workplace layout from ergonomic consideration, noise, heating and ventilating, lighting.

Introduction to value, maximum value, normal degree of value, importance of value, creativity, steps to problem solving and value analysis, value analysis tests, value engineering idea generation check-list, cost reduction through value engineering, material and process selection in value engineering.

Introduction to product cycle & CAD/CAM, role of computers in manufacturing and design, creation of a manufacturing database, CIM, communication networks, GT, production flow analysis, MRP, FMS, JIT.**(7-Hrs)**

Books Recommended:

Text Books:

1. Anita Goyal, Karl T Ulrich, Steven D Eppinger, "Product Design and Development ", 4th Edition, 2009, Tata McGraw-Hill Education, ISBN-10-007-14679-9.

2. Clive L. Dym, Patrick Little, "Engineering Design: A Project-based Introduction", 3rd Edition, John Wiley & Sons, 2009, ISBN 978-0-470-22596-7

Reference Books:

1. George E.Dieter, Linda C.Schmidt, "Engineering Design", McGraw-Hill International Edition, 4th Edition, 2009, ISBN 978-007-127189-9

2. Kevin Otto, Kristin Wood, "Product Design", Indian Reprint 2004, Pearson Education, ISBN 9788177588217

3. Yousef Haik, T. M. M. Shahin, "Engineering Design Process", 2nd Edition Reprint, Cengage Learning, 2010, ISBN 0495668141

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8ME03 PROFESSINAL ELECTIVE - III
8ME03 (iv) ARTIFICIAL INTELLIGENCE

Course Learning Objectives (CLOs):

1. To understand the basic concepts of Artificial Intelligence.
2. To understand the basic concepts of Expert System.
3. To study the methods of knowledge representation.
4. To understand the Expert system Tools, knowledge base editors, procedure oriented methods, object-oriented methods, logic-based methods, access-oriented methods.
5. To study the methods of Building an expert system.
6. To understand the concept of Fuzzy Engineering & applications of fuzzy expert systems for design of industrial controllers.

Course Outcomes (COs):

1. Understand the concept of knowledge and knowledge base.
2. Apply the skills of development of expert system for industrial problems.
3. Remember the design pre-requisites and design procedure of expert system.
4. Understand the concept of fuzzy logic and will try to implement in project work.

SECTION – A

Unit-I : Introduction to Artificial Intelligence (AI) – Overview of AI, definition and importance of knowledge based systems, representation of knowledge, knowledge organization, knowledgemanipulation, acquisition of knowledge. (6 Hours)

Unit II: Introduction to Expert Systems - Features of expert systems, knowledge engineering, basis expert system terminology, human experts and artificial experts,

algorithmic nd heuristic methods, difference between conventional programs and expert systems, Architecture of expert systems. (8Hours)

Unit III : Knowledge Representation – Rule based methods, rule execution, forward chaining and backward chaning, knowledge representation using semantic nets, structure of semantic nets, Frame-based methods . (8 Hours)

SECTION – B

Unit IV : Expert system Tools – Types of tools for expert system building, system building aids, support facilities, debugging aids, I/O facilities, explanation facilities, knowledge base editors, stages in the development of expert system tools, procedure oriented methods, object-oriented methods, logic-based methods, access-oriented methods. (7 Hours)

Unit V : Building an expert system – Development phased in expert system building, development constraints, reliability, maintainability, examples of expert systems, difficulties in development of expert systems. (7 Hours)

Unit VI: Fuzzy Engineering - Fuzzy logic, fuzzy expert systems, fuzzy sets, membership functions, fuzzy rules for approximate reasoning, fuzzy inference generation, deffufication, development of rules matrix, applications of fuzzy expert systems for design of industrial controllers. (7 Hours)

RECOMMENDED BOOKS:

TEXT BOOKS :

1. A guide to Expert Systems by Donald a. Waterman, Pearson
2. Introduction to Artificial intelligence & Expert Systems by Dan W. Peterson, PHI
3. Fuzzy Logic by John Yen, Reza Langari, Pearson

REFERENCE BOOKS:

1) Expert Systems – Theory & Practice, By Ermine, Jean Louis, PHI
2) Expert systems in Engineering , By D.T.Pham.JFS Pub.
3) Expert system application by Sumit Vadera, Sigma press
4) Artificial Intelligence by Winston P.H., Pearson

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8ME04 PROFESSIONAL ELECTIVE – IV
(i) REFRIGERATION & AIR CONDITIOING

COURSE LEARNING OBJECTIVES (CLOs):

1. Illustrate the fundamental principles and applications of refrigeration and air conditioning system Learning the fundamental principles and different methods of refrigeration and air conditioning.
2. Comparative study of different refrigerants with respect to properties, applications and environmental issues. Study the numbering system of Refrigerants and its classification.
3. Identify the basic components of a refrigeration cycle.Study of various refrigeration cycles and evaluate performance using P-H chart, Mollier charts and/ or refrigerant property tables. Obtain cooling capacity and coefficient of performance by conducting test on vapour compression refrigeration systems
4. Understand the basic air conditioning processes on psychometric charts, calculate cooling load for its applications in comfort and industrial air conditioning. Operate and analyze the refrigeration and air conditioning systems.
5. Study of the various equipment-operating principles, operating and safety controls employed in refrigeration air conditioning systems.

COURSE OUTCOMES:

1. Understand the fundamental basics of simple vapour compression system, types of refrigerant used in refrigeration system.
2. Understand the multistage pressure system, its types and elementary treatment of refrigeration system.
3. Apply the knowledge of refrigeration system and its controls, defrosting.
4. Apply the concept air conditioning system as winter, summer air conditioning system applications and its related issues.

SECTION – A

Unit I : **Introduction to automotive air conditioning**- Vapour compression system:- Analysis of simple vapour compression system. Use of pressure enthalpy. Temperature entropy charts. Effect of operating conditions such as evaporation and condesion pressure, superheating and sub cooling Actual vapour compression system, Refrigerants :- classification: primary & secondary refrigerants, desirable properties of refrigerants; merits & demerits of commonly used refrigerants such as Ammonia R-12, R-22 and their selections and eco friendly refrigeration 134 a, HFC. (8- Hours)

Unit II: **Multi stage pressure systems**- multistage compression: choice of intermediate pressure, complete multi-stage compressions. Multi evaporator systems; single compression individual expansion value, single compression multi expansion valve, individual compressor multi expansion valves, cascade systems, its applications to cryogenics Air liquefaction processes- Linde- Hampson (No numerical treatment to air liquefaction system) (7- Hours)

Unit III : **Refrigeration systems components & controls**:- brief study of refrigerants compressor, condensers, evaporators, expansion valves, drier, fillers, selection criteria for the components of vapours compression systems Flow controls, temperature controls, pressure controls and safety devices. Defrosting systems, testing & charging of refrigeration systems, leak detection. (No analytical treatment is expected) (7- Hours)

SECTION – B

Unit IV : Psychromeric properties of moisair psychrometric chart, concept of thermodynamic wet –bulb temperature, representations of Psychromeric process on Psychromeric charts, mixing of air, evaporating cooling, air washers. Human comfort:- metabolism of human body, factors influencing comfort, concept of effectivetemperature, optimum effective temperature & comfort charts. (7 Hours)

Unit V : **Classification of air conditioning systems & applications**. Unitarysystem package, window type & split type air conditioning. Central system:-System components, types:- direct expansion system, all water system & all air system. Water, summers & year round air conditioning. Transmission & distribution. Types of supply air ducts, consideration for selection & location of outlet, distribution partners of outlet, location of return air opening &introduction to duct design.
(*No numerical treatment is expected*). (7 Hours)

Unit VI : Load calculation & applied Psychromety-basic consideration atheat gains/losses sensible & latent , heat due to occupancy lightening, appliances, products, process, air conditioning systems, safety factor cooling load estimates, heating load estimates. Sensible heat factor by pass factor, apparatus dew point, effective sensible heat factor. (7 Hours)

BOOKS RECOMMENDED:

TEXT BOOKS :

1. Refrigeration & air conditioning; C.P.Arora; Tata Mcgraw HillPublication.
2. Refrigeration & air conditioning; Arora, Domkundwar;Dhanpat RaiPublication.

REFERENCE BOOKS:

1. Principles of Refrigeration; J.Dossat; Pearson Education, Asiapublication
2. Refrigeration & air conditioning- P.L.Balaney
3. Refrigeration & air conditioning- Manohar Prasad.

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8ME04 PROFESSIONAL ELECTIVE – IV

(ii) FINITE ELEMENT ANALYSIS

COURSE LEARNING OBJECTIVES (CLOS):

1. To study the concept of FEM and various methods in it.
2. To understand the knowledge of application of Matrix Algebra & Gausian Elimination.
3. To study the finite element modeling approaches and understand the concept of boundary conditions.
4. To study 2D problems for Constant strain triangle, temperature effects, problem modeling and boundary conditions.
5. To study the concept of heat transfer and fluid flow.

COURSE OUTCOMES:

1. Apply the knowledge of principal of FEA, its types, governing equation, fundamental concept of solid mechanics.
2. Remember the mathematical understanding required for FEA and finite difference techniques.
3. Understand the knowledge of application of FEA such as related to stress on beams, three dimensional frames, heat transfer.
4. Apply the knowledge of FEA in project work.

SECTION - A

Unit I : Introduction : Application, Advantages, Steps of FEM, Stress and Equilibrium, Boundary conditions, Strain Displacement Relations, Stress-strain Relations, Von mises stress, Temperature effect, Potential Energy & Equilibrium, Gelerkin's Method, stiffness (Displacement) Method. (7Hrs)

Unit II : **Matrix Algebra & Gausian Elimination :** Matrix Multiplication, Transposition, Diagonal Matrix, Symetric Matrix, Upper Triangular Matrix, Determinant of Matrix, Matrix Inversion Eligen values & Elgenvectors, Gaussian elimination. (7 Hrs)

Unit III : **ID Problems :** Finite Element modeling, coordinate Shapefunction, The potential Energy approah, The Galerkin'sApproach, assemblies of the global stiffness matrix and loacvectors, Properties of stiffness Matrix, Treatment of boundaryconditions, quadratic Shape Functions, Temperature Effects. (7 Hrs)

SECTION – B

Unit IV : **2D Problems for CST :** Constant strain triangle, isoperimetric Representation , potential Energy energy approach, element stiffness, galaerkin's approach, temperature effects, problem modeling and boundary conditions.(7 Hrs)

Unit V : **Development of equations:** Truss equations, derivation of the stiffness, matrix for a bar element in local coordinate, global stiffness matrix, beam equation. Beam stiffness, example assemblage of beam stiffness matrix, plain stress & plain stress stiffness equations, basic concept of plain stress and plain strain, derivation of the CST stiffness matrix and equations Treatment of body and surface forces. (7 Hrs)

Unit VI : **Heat Transfer :** Derivation of the basic differential equations, Heat transfer with conduction, radiation, ID Formulation using variational method.

Fluid Flow : Derivation of the basic differential equations, Id Finite Element formulation, Computer Implementation (prepossessing, post processing, input data file, mesh generation) (7 Hrs)

BOOKS RECOMMENDED:

TEXT BOOKS :

1. Introduction to Finite Element Engineering – T.R.Chandrupatla,Belegunda; PHI
2. A First course in Finite Element Method- Darya Logon, ThompsonLearning (TL Publisher)

REFERENCE BOOKS:

1. The Finite Element Method in Engineering- S.S.Rao, Elsveir Pub., 4th Edition.
2. Fundamentals of Finite Element Method analysis – D.V.Huttan, Tata Mcgraw Hill
3. Concept & Applications of Finite Element Analysis – Robert D.Cook
4. Finite & Boundary Element Method in Engineering – O.P.Gupta
5. An Introduction to Finite Element Method- J.N.Reddy, Tata Mcgraw Hill, 2nd Edition, 2005.

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8ME04 PROFESSIONAL ELECTIVE – IV

(iii) ROBOTICS & INDUSTRIAL APPLICATIONS

COURSE LEARNING OBJECTIVES :

1. To understand basics of robotics, evolution of robots and their role in industrial automation.
2. To study the Robot's anatomy, joints types, wrist construction, robot standard configurations and their work spaces..
3. To study the construction and working of different types of end Effectors.
4. To study various robot drives, robot motion control and its levels.
5. To understand various methods of teaching and programming the robots.
6. To study principle of working and applications of different types of robot sensors.
7. To study robot kinematics viz. forward, reverse and homogeneous transformation.
8. To study different applications of robots in manufacturing and to understand importance of robot features for a particular application.
9. To study different Quantitative methods to perform economic evaluation of robot project.

COURSE OUTCOMES:

1. Understand the concept of robotics, its history.
2. Remember robot anatomy and various configurations for different industrial applications
3. Understand the concept of kinematic analysis of robots.
4. Remember the concept robot programming, its methods and programming languages.

SECTION – A

Unit I : Fundamentals of Robotics- Introduction, Automation & Robotics- robot applications robotic systems, robot anatomy and robot configurations, Joint types used in robots, robot wrists, joint notation schemes, work value for various robot anatomies, robot Specifications**.** (8 Hrs.)

Unit II : Robots end-effectors-classification of end-effectors, mechanical grippers, hooking or Lifting grippers, grippers for molten metal , plastics, vacuum cups, magnetic grippers Electrostatic grippers, multiple grippers, internal & external grippers, drive systems for gripers, active & passive grippers. Design consideration in gripper, gripper analysis. (7 Hrs.)

Unit III: Robot drives & control-pneumatic power drives, hydraulic systems, electric drives, robot controllers-servo and non servo systems, motion control of robots, point to point and continuous path control, teaching of robots, robot programming methods. (7 Hrs.)

SECTION – B

Unit IV: Robot Sensors: Features, Contact type sensors:- wrist force sensor, binary & analog touch sensor,

Artificial skins, force, torque, encoders, position, velocity sensors,

Non contact type sensors;- vision sensor, proximity, range sensors, safety measures in robot.(7 Hrs.)

Unit V: Robot Kinematics- Forward & reverse kinematics, forward and reverse transformation of two DOF & three DOF 2-D manipulator, homogeneous transformations.(6-Hrs)

Unit VI: Quantitative Techniques for economic performance of robots- Robot investment coats, robot operating expenses. Methods of economic evaluation, method of pay-back period, return on investment method, discounted cash flow method.

VAL Command: robot programming in Val & RAIL. (7 Hrs.)

RECOMMENDED BOOKS:

TEXT BOOKS:

1) Robotics Technology & Flexible Automation by S.RDeb, Tata McGraw Hill.
2) Industrial Robotics by M.P.Groover, McGraw Hill.

REFERENCE BOOKS:

1. Robotics for Engineering, Korean Yoram, McGraw Hill.
2. Robots & Manufacturing automation by Asfahal, C.Ray, John Wiley.
3. Robotic Engineering by Richard D.Klafter, PHI.

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8ME04 PROFESSIONAL ELECTIVE- IV

(iv) RAPID PROTOTYPING

COURSE LEARNING OBJECTIVES (CLOS):

1- Understand the fundamentals of Rapid Prototyping Techniques.

2- Understand the methodology for processing of RP Cad models.

3- Selection of appropriate RP fabrication techniques for the prototyping.

4-Study of prototyping techniques for Reverse engineering.

5- To aquire the necessary knowledge regarding RP softwares.

COURSE OUTCOMES (CO):

1- **Create** and develop overall awareness for design of Rapid prototype.
2- **Apply** fundamentals of RP techniques.
3- **Design and develop** the RP Toolings for using suitable rapid prototyping technique.
4- **Synthesis** of RP techniques for reverse engineering.

Section-A

Unit-I. Introduction to Product Design: Design definitions; Brief history of Industrial designs. Industrial Design chronology, stages in Product development. Cost associated in various stages of Product development.

Prototyping: What is Prototype?, Types of Prototype, Principles of Prototyping, Prototyping Technologies. (7-Hrs)

Unit-II .Basics of Rapid Prototyping: Rapid Prototyping: Working Principles and types of Rapid Prototyping machines. Input devices, Contact and non-contact type digitizers such as Coordinate measuring machines, Laser and White light scanners.

Fields of Application of RP: Idustrial, medical, etc. (7-Hrs)

Unit-III.RP Process: Photo polymerization (Stereo lithography (SL), Microstereolithography), Powder Bed Fusion (Selective laser Sintering (SLS), Electron Beam melting (EBM)), Extrusion-Based RP Systems (Fused Deposition Modeling (FDM)), 3D Printing, Sheet Lamination (Laminated Object Manufacturing (LOM), Ultrasonic Consolidation (UC)), Beam Deposition (Laser Engineered Net Shaping (LENS), Direct Metal Deposition (DMD)).

(8-Hrs)

Section-B

Unit-IV. Physics of RP Process:

Process Physics, Tooling, Process Analysis, Material and technological aspects, Applications, limitations and comparison of various rapid manufacturing processes. Classification of RP Methods.

Pre and Post processing: Pre-processing for RP, Post-processing of RP parts, Errors in RP parts, Part building errors in FDM, STL,LOM, SLS Parts.

.(6-Hrs)

Unit-V. Rapid Tooling: What is Rapid tooling?, Types of Rapid toolings. Benifits of Rapid tooling.

Silicon rubber tooling, Aluminium filled epoxy tooling, Spray metal tooling, Cast kirksite, 3Q keltool, etc. Direct Rapid Tooling Direct. AIM. Quick cast process, Copper polyamide, Rapid Tool, DMILS, Prometal, Sand casting tooling, Laminate tooling soft Tooling vs. hard tooling.

.(6-Hrs)

Unit-VI. Overview of RP Software: STL files, Overview of Solid view, magics, imics, magic communicator, etc. Internet based software, Collaboration tools. .(6-Hrs)

Books Recommended:-

Text Books:

1-Rapid Prototyping by Amitabha Ghosh ,affiliated East –west press pvt.ltd.,New Delhi.

2- Rapid Prototyping by Adithan M.Edition 2018,Atlantic Publishers & distributer pvt.ltd.

3- Additive Manufacturing by C.P.Paul & A.N.Jinoop McGraw Hill 1st Edition 2021

4- Product Design & Development by Karl T.Ulrich & Steven D.Eppinger.,Tata McGraw Hill Publishing.

5- Rapid Prototyping Data Formats by V.V.Prathibha Bharathi. Notion press publishing.

Reference Books:

1-CAD & Rapid Prototyping for product design, Dauglas Bryden, Laurence King Publishing.

2-Rapid Prototyping (Principle and Application),Rafiq Noorani by Wiley Publishing.

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8ME05 I. C. ENGINES- LAB.

COURSE LEARNING OBJECTIVES (CLOs):

1. To study basic of engines, Air standard cycles ,Fuel air cycle, actual cycle and review of other losses in IC engines.
2. To
3. To Evaluate performance of Engines by using heat balance sheet, excess air calculation and determination of friction power, effect of supercharging.
4. To study Emission from Engines, EURO emission norms and Recent trends in Engines.

COURSE OUTCOMES(COs):

1. Remember fundamentals of I.C. engines, their types and cycle analysis.
2. Apply the knowledge of a multi-cylinder petrol engine.
3. Evaluate performance of Engines by using heat balance sheet
4. Study of fuel injection pump and injectors.

List of Experiments (Any Six):

Any six of the following practical should be performed and

1. Performance test on a single cylinder diesel engine.
2. Performance test on a single cylinder petrol engine.
3. Evaluation of the heat balance for single cylinder diesel engine.
4. Performance test on a multi-cylinder petrol engine.
5. Mors test on multi-cylinder petrol engine.
6. Trial on petrol/ diesel engine to plot p-0 and p-V diagram.
7. Measurement of exhaust gas emission from S.I.engine
8. Measurement of smoke density of CI engine exhaust.

9. Study of Bosch type single plunger fuel pump.
10. Study of various types of fuel injectors and nozzles.

It shall consist of viva-voce based on term work and syllabus.

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8ME06 PROFESSIONAL ELECTIVES -IV
(i) REFRIGERATION & AIR CONDITIONING - LAB.

COURSE LEARNING OBJECTIVES (CLOs):

1. Illustrate the fundamental principles and applications of refrigeration and air conditioning system Learning the fundamental principles and different methods of refrigeration and air conditioning.
2. Identify the basic components of a refrigeration cycle. Obtain cooling capacity and coefficient of performance by conducting test on vapour compression refrigeration systems
3. Study of various types of refrigeration systems for various applications like ice plant, water cooler etc.
4. Understand the basic air conditioning processes.
5. Study of the various equipment-operating principles, operating and safety controls employed in refrigeration air conditioning systems.

COURSE OUTCOMES(CO):

1. Understand the fundamental basics of simple vapour compression system, types of refrigerant used in refrigeration system.
2. Apply the knowledge of different applications of refrigeration systems.
3. Apply the knowledge of refrigeration system and its controls, defrosting.
4. Apply the concept air conditioning system.

List of Practicals:-

Any **six** of the following should be conducted and a report thereof should be submitted

1. Trial on Vapour compression system.
2. Trial on Air-conditioning system.
3. Study of Electrolux system.
4. Study of Water cooler.
5. Study of window Air conditioner.
6. Study of household refrigerator.
7. Study of desert cooler.
8. Study of cold storage plant.
9. Testing and changing of refrigeration system.
10. Study of defrosting system.
11. Study/trial of ice plant.
12. Study of various refrigeration and air-conditioning controls.

***Practical Examination: shall consist of viva-voce based on term work report and syllabus.**

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8ME06 PROFESSIONAL ELECTIVE- IV
(ii) FINITE ELEMENT ANALYSIS- LAB.

COURSE LEARNING OBJECTIVES (CLOS):

1-To understand the knowledge of application of Matrix Algebra & Gausian Elimination.
2-Design of finite element modeling approaches and understand the concept of boundary conditions.
3-Formulation of 2D problems for Constant strain triangle, temperature effects, problem modeling and boundary conditions.
4-Understand concept FEA applied for heat transfer and fluid flow.

COURSE OUTCOMES:

1-Apply the knowledge of principal of FEA, its types, governing equation, fundamental concept of solid mechanics.
2-Remember the mathematical understanding required for FEA and finite difference techniques.
3-Application of FEA such as related to stress on beams, three dimensional frames.
4-Apply the knowledge of FEA in heat transfer and fluid flow.

List of Practicals(Any-5):

1. Study of a FEA modeling & FEA packages.
2. Stress Analysis of bars having
i) Constant cross section area
ii) Tapered cross section area
iii) Stepped bar.
3. Stress Analysis of beam (Simply supported or Cantilever) carrying point load and uniformly distributed load.
4. Solve any one 2D problem on CST element.
5. Solve any one problem on truss element
6. Solve any one problem on axi-symmetric element
7. Solve any one problem on steady state heat condition

***PRACTICAL EXAMINATION:** -shall consist of viva-voce based on term work report and syllabus.

*****

8ME06 PROFESSIONAL ELECTIVE-IV

(iii) ROBOTICS & INDUSTRIAL APPLICATIONS-LAB

Course Learning Objectives:

1) To understand the basic concepts associated with the robot functioning and applications of Robots.
2) To study about the robot motion analysis of robot.
3) To study about the drives and control system used in Robots.
4) To understand the concepts of end effectors, sensors and vision system used in robots
5) To learn about robot programming.

Course Outcomes:

After successfully completion of this course students will be able to:

1) To know about fundamental knowledge about the robot
2) To know about robot motion analysis.
3) To know about drives and control system used in robots.
4) To know about end effectors, sensors and vision system.
5) To know about robot programming methods and languages.

List of Prcticals : (Any-5)

1-Study of components of a real Robot & its DH Parameters.
2-Demostration of Robot with 2DOF,3DOF,4DOF,etc.
3-Study of positioning and orientation of Robot arm.
4-Programming of the Robot for Industrial Application (actual trial on robot ,if available or trial on simulation software).
5-Robotic Control Experiment demonstration using available hardware or software.
6-Integration of assorted sensors(IR,Potentiometer,starin gages,etc.) micro controllers & ROS (Robot Operating System) in a Robotic system.
7- Industrial Robot application (Any one Miniproject)
8-Study of Robot Simulation Software (on any one application).

Practical Examination shall consist of viva voce based on above term work.

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8ME06 PROFESSIONAL ELECTIVE- IV
(iv) RAPID PROTOTYPING- LAB.

COURSE LEARNING OBJECTIVES (CLOS):

1- Study the fundamentals of Rapid Prototyping Techniques.
2- Understand the use of techniques for processing of Cad models for RP.
3- Use of suitable RP fabrication techniques for prototyping.
4-Use of prototyping techniques for reverse engineering.
5- To get the introduction regarding RP software.

COURSE OUTCOMES (CO):

1- Create and develop overall awareness for design of Rapid prototype.
2- Apply fundamentals of RP techniques.
3- Selection of appropriate tooling for rapid prototyping process.
4- Synthesis of RP techniques for reverse engineering.

List of Practical (Any-5):

1-To create a 3-D model of a machine component for RP
2- Generation of a Process Plan for fabrication of a product on the basis of CAD Model.
3- Fabrication of part on available RP setup.
4- Post processing of fabricated Additive Manufactured product/prototype.
5- Inspection of fabricated product/prototype for dimensional accuracy and defects.
6- Post processing of CAD model and generation of .stl file using suitable software.
7- Study of principles of various pixel generation techniques and forms of raw materials in RP.

***PRACTICAL EXAMINATION:**-shall consist of viva-voce based on term work report and syllabus.

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8ME07 PROJECT

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NOTIFICATION

No. 88 /2022 Date : 21 /07/2022

Subject : Revised Syllabi of Semester V to VIII of B.E. Mechanical Engineering (C.B.C.S.) as per A.I.C.T.E. Model Curriculum.

It is notified for general information of all concerned that the authorities of the University have accepted to implement revised syllabi of Semester **V to VIII of B.E. Mechanical Engineering (C.B.C.S.)** as per A.I.C.T.E. Model Curriculum to be implemented from the academic session 2022-23 onwards as per ñ**Appendix – A**ò as given below:

Sd/-
(Dr.T.R.Deshmukh)
Registrar

ñ**Appendix – A**ò

SYLLABUS OF B.E. SEM. V TO VIII (MECHANICAL ENGINEERING) [C.B.C.S.]

(5ME05) OPEN ELECTIVE – I (i) INDUSTRIAL ROBOTICS & APPLICATIONS

Course Learning Objectives (Clos) :
1. To understand basics of robotics, evolution of robots and their role in industrial automation.
2. To study the Robot's anatomy, joints types, wrist construction, robot standard configurations and their work space.
3. To study the construction and working of different types of end Effectors.
4. To study various robot drives, robot motion control and its levels.
5. To understand various methods of teaching and programming the robots.
6. To study principle of working and applications of different types of robot sensors.
7. To study different applications of robots in manufacturing and to understand importance of robot features for a particular application.

Course Outcomes (Cos):
1. Understand the concept of robotics, its history.
2. Remember robot anatomy and various configurations for different industrial applications
3. Understand the need of a particular type of robot depending on the its application in manufacturing.
4. Remember the concept of robot programming, their methods and programming languages.

SYLLABUS

Unit I : Fundamentals of Robotics : Introduction, Automation & Robotics- robot applications robotic systems, robot anatomy and robot configurations, Joint types used in robots, robot wrists, joint notation schemes, work value for various robot anatomies, robot Specifications**.** (8 Hrs.)

Unit II : Robots end-effectors :Classification of end-effectors, mechanical grippers, hooking or Lifting grippers, grippers for molten metal , plastics, vacuum cups, magnetic grippers Electrostatic grippers, multiple grippers, internal & external grippers, drive systems for gripers, active & passive grippers. Design consideration in gripper. (7 Hrs.)

Unit III: Robot drives & control-pneumatic power drives, hydraulic systems, electric drives, robot controllers-servo and non servo systems, motion control of robots, point to point and continuous path control. (7 Hrs.)

Unit IV: Robot Sensors: Contact type sensors- wrist force sensor, binary & analog touch sensor, , force, torque, encoders, position, velocity sensors, Non contact type sensors- vision sensor, proximity, range sensors. (7 Hrs.)

Unit V:.Robot Programming: Programming Methods for Industrial Robot, Robot programming languages, VAL Commands, robot programming in Val & RAIL. (6-Hrs)

Unit VI: Robot Applications: Robot Applications in Industry- Material Handling, Part Processing, Assembly, Inspection and Quality Control, Feature requirements of Machine Loading-Unloading & Palletizing Robot, Welding Robot, Assembly Robot, Painting Robot, Part Sorting & Inspection Robot.
Robot Applications in electronic component fabrication, assembling miniature components on PCBs, applying ad hesives, inspections, testing (7 Hrs.)

RECOMMENDED BOOKS:

Text Books:
1) Industrial Robotics by M.P.Groover, McGraw Hill.
2) Robotics and Automation by R. K. Rajput, S. Chand Publications Ltd.
3) Robotics Technology & Flexible Automation by S.RDeb, Tata McGraw Hill.

Reference Books:
1. Robotics for Engineering, Korean Yoram, McGraw Hill.
2. Robots & Manufacturing automation by Asfahal, C.Ray, John Wiley.
3. Robotic Engineering by Richard D.Klafter, PHI.

5ME05 OPEN ELECTIVE –I (ii) MODERN MANUFACTURING TECHNIQUES

Course Learning Objectives (Clos) :
1. able to understand importance of nontraditional machining processes.
2. able to understand knowledge of Rapid Prototyping methods.
2. able to study the process of USM, AJM& ECM.
3. able to study and understand the process of surface finish and its applications.
4. to study the principle of working of EBM and its applications.

Course Outcomes (Cos) :
1. To make the students to understand the concept of advanced manufacturing techniques evolved in industrial manufacturing scenario.
2. To remember, learn and understand the advanced manufacturing techniques f USM, AJM, ECM, CM, EDM, PM, EBM & LSB.
3. To understand the need of a particular type of composite materials and its manufacturing methods.

SYLLABUS

Unit-I: Rapid Prototyping Method:- study of RP relevance in precision manufacturing, sterolithography ,fused deposition methods, materials, principle of prototyping and various applications . (7-Hrs)

Unit-II: Ultrasonic Machining:-elements of the process of UM, mechanics of material removal, process parameters, applications and limitations.
Abrasive water jet machining: - elements of the process of AWJM, mechanics of material removal, process parameters, applications and limitations. **(**7-Hrs)

Unit-III: Electro Chemical Process:- basic fundamentals of Electro Chemical grinding, metal removal rate in ECM,Tooling and applications**.**
Chemical Machining: - basic fundamentals of CM, principle of material removal-maskants-elements .Advantages and applications of CM. (7-Hrs)

Unit-IV: Thermal Metal Removal Process:- basic principle of spark erosion (EDM),wire cut EDM & Electric discharge grinding process ,principle of working and applications . (7-Hrs)

Unit-V: Electron Beam Machining: - generation and control of EBM for machining, theory of EBM, applications and limitations.
Laser Beam Machining: process description, mechanism of material removal in LBM, process parameters, applications and limitations**.** (7-Hrs)

Unit-VI: Composite Materials: - classification of composites.
Manufacturing methods: spray Lay-up, Wet/Hand Lay-up, Vacuum bagging, Resin transfer moulding (RTM) ,Resin Film infusion and applications of composites**.** (7-Hrs)

BOOKS RECOMMENDED:

Text Books:
1. Advanced machining process ,V.K.Jai, Allied publishers.
2. Modern machining process, Pande P.C. & Shah H.S.Tata Mc-Graw Hills.
3. Manufacturing Technology, Volume-II, Rao P.N., Tata Mc-Graw Hills.

Reference Books:
1. Principles of Modern Manufacturing, Mikell P.Groover, SI version, Wiley India Edition.
2. Manufactring Technology, Kalpakzian, Pearson.
3. Production Technology, Volume-II, Khanna O.P., Dhanpat Rai Publisher, New Delhi.
4. Non-Conventional Machining , Mishra P.K.,Narosa Publisher, New Delhi.
5. Composite Materials ï production, properties, testing and applications, K.Shrivasan, Narosa Pubications,

SEMESTER SIXTH

6 ME04 PROF. ELECT. – I (i) NON-CONVENTIONAL ENERGY SOURCES

Course Learning Objectives (CLOs):
1. To study the introduction to renewable and non-renewable resources of energy.
2. To study the radiation transmission through covers & Solar Energy collections.
3. To study the solar energy utilization and solar energy storage.
4. To study energy from ocean and energy from wind.
5. To study biomass energy resources like biomass and biodiesel.
6. To study photo voltaic cell, fuel cell and geothermal energy.

Course Outcomes (COs):
Upon completion of the course, students will be able to:
1. Able to study the concept of renewable and non-renewable sources.
2. Apply the basic concept of solar energy utilization and storage.
3. Apply the concept of energy from ocean and wind.
4. Study the concept of bio-mass energy resources.

SECTION–A

UNIT I:

1. **Introduction:-** Renewable & Non-renewable sources. Need of renewable energy sources, Overview of Global and Indian Energy Scenario.
2. **Solar Radiation:** Solar constant, Definitions of basic earth-sun angles. Types of Solar radiation, Measurement of solar radiation using Pyrheliometer, Pyranometer and Sunshine Recorder, estimation of solar radiation intensity. (8 Hrs.)

UNIT II:

1. **Solar Collectors:-**classifications of collectors- concentrating, non-concentrating collectors and Evacuated tube solar collectors, its construction, and working.
2. **Solar Energy Storage & Utilization:-**Methods of storage such as Mechanical, Thermal, Electrical, Thermo-chemical and Electromagnetic storage. Properties of storage materials and different arrangements of storages. Applications of solar energy in heating, cooling, pumping, power production, distillation, drying, etc. (7 Hrs.)

UNIT III: Direct Energy Conversion:

1. **Solar Photovoltaic cells:** Principle, Construction and Working, Conversion efficiency. Power output and performance.
2. **Fuel Cells:** working principle, types of fuel cells, applications.
3. **Geothermal Energy Resources:** Hot Dry Rock system, Vapour dominated, liquid dominated, flash steam, binary fluid and total flow concept of power generation. (8Hrs)

SECTION - B

UNIT IV: Energy from Ocean:

1. **Tidal Power:-**Types of tidal plants such as single and two basin plants, power developed & operation of tidal power plant.
2. **Ocean thermal energy conversion system:-** Construction and working of open cycle and closed cycle OTEC systems. (7 Hrs)

UNIT V: Wind Power:- Introduction, Principles of wind energy conversion, Operation, maintenance and economics. Wind patterns and Wind speed data, Types of wind mills, application for pumping and power generation. Conversion efficiency, Site selection. (8Hrs)

UNITVI: Biomass Energy Resources: Mechanism of green plant photosynthesis. Efficiency of conversion, solar energy plantation, Bio-gas – Types of biogas plants, factors affecting production rates. Types of gasifiers, Introduction to bio-diesel and ethanol as alternative fuels, properties of bio-fuel. (7 Hrs)

BOOKS RECOMMENDED:

Text Books:

1. Solar Energy; S.P. Sukhatme; TMH
2. Non-Conventional Energy Sources; G.D. Rai; Khanna Publications
3. Non-Conventional Energy Sources; B. H. Khan.

Reference Books:

1. Treatise on Solar Energy; H.P. Garg; John Wiley & Sons.
2. Renewable Energy Conversion, Transmission and Storage; Bent Sorensen; Elsevier Publication
3. Renewable Energy; Godfrey Boyle; Oxford University Press, Mumbai
4. Renewable Energy Sources and Emerging Technology; D.P. Kothari, K.C. Singal, Rakesh Ranjan; PHI.

6ME04 PROF. ELECT. – I (ii) PROJECT MANAGEMENT

Course Learning Objectives:

This course focuses on project management methodology that will allow students to learn how to initiate and manage projects efficiently and effectively. The overall learning shall resolve project identification evaluating its technical and economic feasibility and developing skills for its planning, and establishing controls. Relevant techniques, writing skills and monitoring methods shall be dealt with in details.

Course Outcomes:

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

- Apply project selection methods to evaluate the feasibility of projects.
- Use appropriate project management practices, tools, and methodologies.
- Define, analyze, refine, and document project requirements, assumptions, and constraints.
- Analyze and refine project time and cost estimates to define project baseline, schedule and budget.
- Organize and manage critical resources for effective project implementation
- Identify, analyze, quantify and mitigate risks in implementing project

SECTION – A

Unit I: Project Identification considering objectives and SWOT analysis, Screening of Project Ideas, Technical, Market, Financial, Socioeconomic and Ecological Appraisal of a project demand forecasting, secondary data, accuracy, confidence level, uncertainty. (7 hrs.)

Unit II: Technical feasibility: Process selection, Level of automation, plant capacity, acquiring technology, Appropriate technology plant location, Equipment selection & procurement, Govt. policies. Value analysis and project evaluation. (8 hrs.)

Unit III: Economic feasibility: Cost of Project, working capital analysis, fixed cost, means of finance, estimation of sales & production price analysis, Breakeven point, Projected cash flow statements, projected balance sheet, projected profit & loss statement, projected cash flow, rate of return, Discounted payback period, cost benefit analysis, return after taxes. (9 hrs.)

SECTION – B

Unit IV: Project Planning and Control: Work break down structure and network development. Basic Scheduling, Critical Path and four kinds of floats. Scheduling under probabilistic durations, Time Cost tradeoffs, CPM, PERT, Optimum project duration, Integrated resource Management. (9 hrs.)

Unit V: Project report: Preparation of project report, risk analysis, sensitivity analysis, methods of raising capital. (7 hrs.)

Unit VI: Initial review, performance analysis, ratio analysis, sickness, project revival, Project Monitoring with PERT/Cost, Organizational aspects, Computer packages and Project Completion environ-mental & social aspects. (8 hrs.)

BOOKS RECOMMENDED:

Text Books:

1. Prasanna Chandra,ñProjects: Planning, Analysis, Selection, Financing, Implementation, and Reviewò, 9th Edition, McGraw Hill Education (India) Pvt. Ltd. 2019.
2. Choudhry S., Project Management, Tata McGraw-Hill, 1988.
3. P. Gopalakrishnan and V. E. Ramamoorthy, Textbook of Project Management, Laxmi Publications; Laxmi Publications Pvt Ltd., First edition 2014.
4. L.S. Srinath, PERT and CPM: Principles and Applications, Affiliated East-West Press (Pvt.) Ltd. 3rd Edition, 2001.
5. M. Y. Khan, P. K. Jain, Financial Management: Text, Problems and Cases,McGraw Hill Education; Eighth edition, 2018.

Reference Books:

1. Harold Kerzner, Project Management: A Systems Approach to Planning, Scheduling, and Controlling**,** Wiley; 13th edition, 2022.
2. A Guide to the Project Management Body of knowledge PMBOK Guide, 6th Edition, Project Management Institute 2017.
3. John M. Nicholas, Herman Steyn, Project Management for Business, Engineering, and Technology, A Butterworth-Heinemann Title; 3rd edition, 2008.

6ME04 PROF. ELECT. - I (ii) LEAN MANUFACTURING

Course Learning Objectives:

- To introduce basics of Lean Manufacturing System& Its Applications.
- To illustrate Different Concept & Elements of lean manufacturing
- To interpret different approaches for lean manufacturing implementation.
- To introduce concept of Six Sigma and its applications.

Course Outcomes (CO): After completion of course student will be able to:

- Explain the concept, history and applications of lean manufacturing
- Interpret different element of lean manufacturing
- Interpret different tools of lean manufacturing
- Apply lean manufacturing in real life situation.
- Identify the barriers in implementation of Lean Manufacturing
- Explain the concept of Six Sigma

Unit I: Introduction to lean manufacturing:
Historical evolution of lean manufacturing, objectives of lean manufacturing, key principles and implications of lean manufacturing, traditional versus lean manufacturing, 10 steps to lean production, necessity of lean manufacturing systems, limitations and applications of lean manufacturing. (7 Hrs)

Unit II: Concepts in lean manufacturing: Overview of Toyota Production System (TPS), Concept of value in lean, concept of waste in lean, the 7 wastes, their causes and effects. (6 Hrs.)

Unit III: Lean Tools and Methodology:
Primary tools of lean manufacturing such as 5S, Total productive maintenance (TPM), Pillars of TPM, Work Place Organization, Work Cell (6 Hrs)

Unit IV: Secondary Tools of Lean Manufacturing: Introduction and applications of: Just-In-Time (JIT), Kaizen, Poke Yoke, Kanban system , single minute exchange of die (SMED). (7 Hrs)

Unit V: Implementation of Lean Manufacturing : Different approaches for lean manufacturing implementation, important factors in lean implementation, barriers and limitation in lean implementation. (6 Hrs)

Unit VI: Introduction to Six Sigma : Meaning of Six Sigma, Why Six Sigma?, Six Sigma improvement model, building Six Sigma organization and culture, applications of Six Sigma. (7 Hrs)

Text Books :
1. Lean Thinking by James Womack and Danial Jones, Free press.
2. The Toyota way of Field Book by Jeffery Liker and David Meier, Mcgraw ï Hill.
3. The Kaizen Blitz by Laraia, Moody and Hall, Weily.

Reference Books:
1. Lean Production Simplified by Pascal Dennies, Productivity Press.
2. Statistical Quality Control, M. Mahajan, Dhanpatrai and Co. Pvt. Ltd.

6ME05 OPEN ELECTIVE – II (i) RENEWABLE ENERGY TECHNOLOGIES

Course Learning Objectives (CLOs):

1. To study the introduction to renewable and non-renewable resources of energy.
2. To study the radiation transmission through covers & Solar Energy collections.
3. To study the solar energy utilization and solar energy storage.
4. To study energy from ocean and energy from wind.
5. To study biomass energy resources like biomass and biodiesel.
6. To study photo voltaic cell, fuel cell and geothermal energy.

Course Outcomes (COs):
Upon completion of the course, students will be able to:

1. Understand concept of renewable energy sources and its importance.
2. Understand the basic concept of radiation transmission through covers and solar energy collections, the basic concept of Solar energy utilization and storage.
3. Demonstrate, concept of energy from ocean and wind.
4. Understand the concept of bio-mass energy resources, concept of direct energy conversion and fuel cell.

SYLLABUS

UNIT I: Introduction:- Renewable &Non-renewable sources. Need of renewable energy sources, Overview of Global and Indian Energy Scenario.
Solar Radiation: Solar constant, Definitions of basic earth-sun angles. Types of Solar radiation, Measurement of solar radiation using Pyrheliometer, Pyranometer and Sunshine Recorder. (7Hrs)

UNIT II: Solar Collectors:-classifications of collectors- concentrating,non-concentrating collectors and Evacuated tube solar collectors, itôs construction, and working.
Solar Energy Storage & Utilization: Methods of storage such as Mechanical, Thermal, Electrical, Thermo-chemical and Electromagnetic storage. Applications of solar energy in heating, cooling, pumping, power production, distillation, drying, etc. (7Hrs)

UNIT III: Direct Energy Conversion:

1. **Solar Photo voltaic cells:** Principle, Construction and Working, Conversion efficiency.
2. **Fuel Cells:** working principle, types of fuel cells, applications.
3. **Geothermal Energy Resources:** Hot Dry Rock system, Vapour dominated, liquid dominated, flash steam, binary fluid and total flow concept of power generation. (7 Hrs)

UNIT IV: Energy from Ocean:

Tidal Power:-Types of tidal plants such as single and two basin plants, power developed & operation of tidal power plant. **Ocean thermal energy conversion system:-** Construction and working of open cycle and closed cycle OTEC systems. (7Hrs)

UNIT V: Wind Power: Introduction, Principles of wind energy conversion, Operation, maintenance and economics. Wind patterns and Wind speed data, Types of wind mills, application for pumping and power generation. Conversion efficiency, Site selection. (No derivations and numericals). (7 Hrs)

UNITVI: Biomass Energy Resources: Mechanism of green plant photosynthesis. Efficiency of conversion, solar energy plantation, Biogas-**Ty**pes of biogas plants, factors affecting production rates. Types of gasifiers, Introduction to bio-diesel and ethanol as alternative fuels, properties of bio-fuel. (7Hrs)

BOOKS RECOMMENDED:

Text Books:
1. Solar Energy; S.P. Sukhatme; TMH.
2. Non-Conventional Energy Sources; G.D. Rai; Khanna Publications.
3. Non-Conventional Energy Sources; B. H. Khan.

Reference Books:
1. Treatise on Solar Energy; H.P. Garg; John Wiley & Sons.
2. Renewable Energy Conversion, Transmission and Storage; Bent Sorensen; Elsevier Publication.
3. Renewable Energy; Godfrey Boyle; Oxford University Press, Mumbai.
4. Renewable Energy Sources and Emerging Technology; D.P. Kothari, K.C. Singal, Rakesh Ranjan; PHI.

6ME05 OPEN ELECTIVE –II (ii) AUTOMOBILE ENGINEERING AND ELECTRIC VEHICLES

Course Learning Objectives (CLOs):
1. To study the Introduction of automobiles, engine types and working of SI and CI engines.
2. To study the fuel feed systems, their types and to understand the basics of cooling system.
3. To study the electrical system, Battery capacity and its ratings, starter motor drive and to understand the basics of lubrication system.
4. To study the basics of transmission system, clutches, gear boxes and suspension system.
5. To study the braking system, steering system, wheel balancing and alignment and to study the introduction of power steering.
6. To study the basics of Electric vehicle and to study the working of electric vehicles.

Course Outcomes (COs):
1. Understand the basics of automobile engineering and its components.
2. Analyze &develop about the cooling system and its function.
3. Understand basic concept of transmission system and types of gears box, basic concept of electrical system and ignition system.
4. Apply the knowledge of suspension and lubrication.
5. Understand the concept of Electric vehicle.

SYLLABUS

UNIT I: Introduction, Classification of automobiles, chassis layout, basic working of SI and CI engines, engine parts, Multiple cylinder engines. (7 Hrs)

UNIT II: Fuel feed systems- fuel feed systems for petrol and diesel engines, Basic principles of Multipoint Fuel Injection Systems (MPFI) and Common Rail Diesel Injection Systems (CRDI). **Cooling system:** purpose, Air cooling and water cooling system, antifreeze mixtures. (7 Hrs)

UNIT III: The electrical system:-. Battery Capacity, standard capacity ratings, starter motor drive-Bendix drive. Introduction to Ignition system. Introduction of charging unit for electric vehicle.
Lubrication: Types of lubricants and their applications in automobile. (7 Hrs)

UNIT IV: Transmission system:- Layout, Working principle of clutch, working of Gear Box:- Sliding mesh, Propeller shaft, Principle of differential.
Suspensions system: shock absorbers and independent suspension system. (8 Hrs)

UNIT V: Braking system: Working of Mechanical and hydraulic brakes.
Steering system:- Function, types of linkages, wheel balancing, wheel alignment, Introduction of camber, castor, king pin inclination, toe-in& toe-out & their effects. Introduction to power steering. (7 Hrs)

UNIT VI: Introduction to Electric Vehicle, need, Types of Electric vehicle, components, working, advantages, limitations. (6Hrs)

BOOKS RECOMMENDED:
Text Books:-
1. Automobile Engineering- Vol. I & II; Kirpal Singh; Standard Publishers Distributors
2. Automobile Engineering; R.K. Rajput; Laxmi Publications, New Delhi .
3. Electric and Hybrid Vehicles; Husain, I. CRC Press.

Reference Books:-

1. Automotive Mechanics; Crouse & Anglin; TMH.
2. Automotive Mechanics; J. Heitner; East West Press.
3. Automotive Mechanics; S. Srinivasan; TMH.
4. James Larminie, ñElectric Vehicle Technology Explainedò, John Wiley & Sons, 2003.

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6ME08 COMPUTER AIDED DESIGN & SIMULATION -LAB. [Only Practical]

Course Learning Objectives (CLOs):

1. To understand fundamentals of CAD.
2. To study the solid modeling techniques.
3. To study the geometric transformation techniques.
4. To demonstrate Simulation of Mechanical Systems.

Course Outcomes (COs):

1. Understand the concept of CAD and simulation.
2. Apply knowledge using CAD modeling for component design
3. Apply the knowledge of geometric transformation.
4. Analyse the Mechanical & Manufacturing systems through simulation.

Practicals:- Any six practicals from the list should be performed.

1. Creation of 2D drawing (Sketching Module) of any mechanical machine component using any modeling/drawing software.
2. Creation of isometric view from given orthographic view of any mechanical machine part using any modeling software.
3. Creation of 3D drawing of any mechanical machine part using any modeling software.
4. Creation of assembly of Knuckle joint/ Cotter joint using any modeling software.
5. Creation of sheet metal component using any modeling software.
6. Simulation of Four bar chain mechanism using any modeling software.
7. Simulation of Slider crank chain mechanism using any modeling software.
8. Simulation of Cam and Follower mechanism.
9. Simulation of Spring-mass system.
10. Thermal Analysis of a 2D component
11. Stress analysis of plate with circular hole
12. Stress analysis of beams(cantilever or simply supported)

Practical Examination:-The practical examination shall consist of oral on the term work and syllabus.

Text Books:

1) P. N. Rao; CAD/CAM Principles and Applications; Mc-Graw Hills Publications.
2) Mikel P. Groover and Emory W. Zimmers: Computer Aided Design and Manufacturing, Prentice hall.
3) Ibrahim Zeid: Mastering in CAD- CAM, Tata McGraw Hill Publication.
4) Geoffrey Gordon, System Simulation; Prentice Hall.

Reference Books:

1) Mikell P. Groover: ñAutomation, Production systems & Computer Integrated Manufacturingò, Prentice Hall.
2) Robert E. Shannon; ñSystem Simulation: The Art and Scienceò; Prentice Hall.
3) J. Schwarzenbach and K.F. Gill Edward Arnold; óSystem Modelling and Controlô
4) P. Radhakrishnan and Subramaniam: ñCAD/CAM/CIMò, wiley Eastern Ltd.

SEMESTER VII

7ME09 TECHNICAL SEMINAR AND PROJECT

Course Learning Objectives (CLOs):

1. To collect information on novel and latest development in core and allied area of the subject.
2. To encourage the process of independent thinking and working together in a group.
3. To implement innovative ideas for social benefit
4. To develop the ability to describe, interpret and analyze technical issues.

Course Outcomes (COs): After completion of course, student will be able to:

1. Prepare a well-organized report employing elements of technical writing and critical thinking.
2. Demonstrate the ability to describe, interpret and analyze technical issues.
3. Apply principles of ethics and standards, skill of presentation and communication techniques.
4. Work in a group to develop the leadership/interpersonal skills for finishing task within timeframe.

Brief Guidelines:

Student shall select a topic of seminar which is not covered in curriculum. Topics shall be approved by the concerned guide and Program in charge as per the department policy . Students should know the functional and technical details of selected topic after carrying out the conceptual study. Before the end of semester, student shall deliver a seminar and required to submit the seminar report in concerned with guide, Program in charge as per department policy Student shall deliver a seminar based on submitted report. The presentation and oral examination on selected seminar topic shall be assessed by panel of examiners mentioned in syllabus scheme.

B.E. (MECHANICAL ENGINEERING SEMESTER - VIII (C.B.C.S.)

8ME07 PROJECT

Course Learning objectives (CLOs):

1. To understand the basic concepts & broad principles of projects.
2. To understand the value of achieving perfection in project implementation & completion.
3. To apply the theoretical concepts to solve problems with teamwork and multidisciplinary approach.
4. To demonstrate professionalism with ethics; present effective communication skills and relate engineering issues to broader societal context.

Course outcomes (COs):

1. Apply creative process techniques in synthesizing information, problem-solving and critical thinking to demonstrate a sound technical knowledge of their selected project topic.
2. Undertake problem identification, formulation and solution.
3. Design engineering solutions to complex problems utilizing a systems approach.
4. Conduct an engineering project, use sustainable materials and manufacturing processes & Carry out cost and benefit analysis through various cost models.
5. Demonstrate the knowledge, skills and attitudes of a professional engineer.

Brief Guideline: Earlier knowledge and experience of Research Skill-Lab (6ME09) and Technical seminar &Project (7ME09) , the student should complete implementation of ideas as formulated in Project . It may involve coding, experimentation, data analysis within realistic constraints such as economic, environmental, social, ethical, health and safety, and sustainability. It may also include testing, results and report writing. Each student group should submit complete project report at the end of Semester-VIII in the form of Hard bound. The Internal Continuous assessment shall be done throughout the VII and VIII semester under the observance of supervisor/guide as per department policy. The Final External Assessment and evaluation for the project shall also include presentation and demonstration by the students as per the syllabus scheme.

Suggestive outline for the complete project report is as follows (depends on the topic, objectives and scope of the project) :-

ABSTRACT :

Chapter 1: Introduction Background • Motivation• Scope• Objective• Organization of Report• Summary•

Chapter 2: Literature Review, Critical literature Review analysis ,Drawback and salient feature ,Research Gap ,Problem identification and Problem definition .

Chapter 3. Methodology : Design & development / Experimentation & observation / Survey & Data collection ,Data arrangement, Data Analysis as per the scope and limitations of the study.

Chapter 4: Testing, Analysis & Validation, Data interpretation ,optimization ,etc.

Chapter 5: Result and Discussion

Chapter 5: Conclusion

- Scope for Future Work
- References/Bibliography
- Index
- Appendix/annexure, etc.
- Publications/copy right/patent, if any.

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