MECHANICAL ENGINEERING COURSE STRUCTURE
B. Tech. (AUTONOMOUS)
Duration: 4 years (Eight Semesters)

1st SEMESTER

Sl. No.	Subject Type	Subject Code	Subject Name	Teaching Hours/Week			Credit	Maximum Marks			
				L	T	P		IA	EA	PA	Total
1	Basic Science Course	UBSPH111	Physics	3	1	0	4	30	70	0	100
2	Basic Science Course	UBSMH102	Mathematics-I	3	1	0	4	30	70	0	100
3	Engineering Science Course	UESEE113	Basic Electrical Engineering	3	1	0	4	30	70	0	100
4	Basic Science Course	ULCPH111	Physics Lab	0	0	3	1.5	0	0	100	100
5	Engineering Science Course	ULCEE113	Basic Electrical Engineering Lab	0	0	2	1	0	0	100	100
6	Engineering Science Course	ULCME114	Workshop\Basic Manufacturing Practices Lab	1	0	4	3	0	0	100	100
			Total				**17.5**				**600**
7	**Mandatory Course**		**Induction Programme**				**0**				

2nd SEMESTER

Sl. No.	Subject Type	Subject Code	Subject Name	Teaching Hours/Week			Credit	Maximum Marks			
				L	T	P		IA	EA	PA	Total
1	Basic Science Course	UBSCH101	Chemistry	3	1	0	4	30	70	0	100
2	Basic Science Course	UBSMH202	Mathematics-II	3	1	0	4	30	70	0	100
3	Engineering Science Course	UESCS103	Programming for Problem Solving	3	0	0	3	30	70	0	100
4	Humanities &Social Sciences	UHSMH205	English	2	0	0	2	30	70	0	100
5	Basic Science Course	ULCCH101	Chemistry Lab	0	0	3	1.5	0	0	100	100
6	Engineering Science Course	ULCCS103	Programming for Problem Solving Lab	0	0	4	2	0	0	100	100
7	Engineering Science Course	ULCME104	Engineering Graphics and Design Lab	1	0	4	3	0	0	100	100
8	HS	ULCMH204	English Lab	0	0	2	1	0	0	100	100
			Total				**20.5**				**800**

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3rd SEMESTER

Sl. No.	Subject Type	Subject Code	Subject Name	Teaching Hours/Week			Credit	Maximum Marks			
				L	T	P		IA	EA	PA	Total
1	Core Course–1	UPCME301	Introduction to Material Science	3	0	0	3	30	70	0	100
2	Core Course 2	UPCME302	Fluid Mechanics & Hydraulic Machines	3	0	0	3	30	70	0	100
3	Core Course3	UPCME302	Engineering Thermodynamics	3	1	0	4	30	70	0	100
4	Engg. Science Course1	UPCME303	Engineering Mechanics	3	0	0	3	30	70	0	100
5	Basic Science Course1	UBSMH301	Mathematics-III	3	1	0	4	30	70	0	100
6	Humanities Science Course1	UHSMH212	Organizational Behavior	3	0	0	3	30	70	0	100
7	Lab Course	ULCME301	Fluid Thermal Lab	0	0	3	1.5	0	0	100	100
8	Lab Course	ULCME302	Machine Drawing	0	0	3	1.5	0	0	100	100
			Total				**23**				**800**

4thSEMESTER

Sl. No.	Subject Type	Subject Code	Subject Name	Teaching Hours/Week			Credit	Maximum Marks			
				L	T	P		IA	EA	PA	Total
1	Core Course4	UPCME401	IC Engine & Gas Turbine	3	0	0	3	30	70	0	100
2	Core Course5	UPCME402	Mechanics of Solids	3	1	0	4	30	70	0	100
3	Core Course6	UPCME403	Manufacturing Processes	3	0	0	3	30	70	0	100
4	Engg. Science Course2	UPCME404	Optimization Techniques	3	0	0	3	30	70	0	100
5	Humanities Science Course2	UHSMH211	Engineering Economics	3	0	0	3	30	70	0	100
6	Lab Course	ULCME401	Production and Material testing Lab	0	0	3	1.5	0	0	100	100
7	Lab Course	ULCME402	Manufacturing Process Lab	0	0	3	1.5	0	0	100	100
8	Lab Course	ULCME403	Machine Dynamics & IC Engine lab	0	0	3	1.5	0	0	100	100
9	Mandatory Course	UMCCE401	Environmental Science	2	0	0	0	30	70	0	100
			Total				**20.5**				**900**
10	**Summer Internship programme (4 to 8 weeks) is mandatory as per AICTE rule**										

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5thSEMESTER

Sl. No.	Subject Type	Subject Code	Subject Name	Teaching Hours per Week			Credit	Maximum Marks			
				L	T	P		IA	EA	PA	Total
1	Core Course7	UPCME501	Mechanisms of Machines	3	0	0	3	30	70	0	100
2	Core Course8	UPCME502	Heat Transfer	3	0	0	3	30	70	0	100
3	Core Course9	UPCME503	Machining Science & Machine Tools	3	0	0	3	30	70	0	100
4	Core Course10	UPCME504	Design of Machine Element (open Book)	3	0	0	3	30	70	0	100
5	Programme Elective-I	UPEME501	Mechanical Measurement & Metrology	3	0	0	3	30	70	0	100
		UPEME502	Quality Control & Reliability								
		UPEME503	Micro Fabrication								
		UPEME504	Surface Engineering								
6	Open Elective-I			3	0	0	3	30	70	0	100
7	Lab Course	ULCME501	Machining Lab	0	0	3	1.5	0	0	100	100
8	Lab Course	ULCME502	Heat Transfer	0	0	3	1.5	0	0	100	100
9	Lab Course	ULCME503	Measurement and Metrology	0	0	3	1.5	0	0	100	100
			Total				**22.5**				**900**

6thSEMESTER

Sl. No.	Subject Type	Subject Code	Subject Name	Teaching Hours/Week			Credit	Maximum Marks			
				L	T	P		IA	EA	PA	Total
1	Core Course11	UPCME601	Machine Dynamics	3	0	0	3	30	70	0	100
2	Core Course12	UPCME602	Refrigeration and Air conditioning	3	0	0	3	30	70	0	100
3	Programme Elective-II	UPEME601	Advanced Fluid Mechanics	3	0	0	3	30	70	0	100
		UPEME602	Gas Dynamics								
		UPEME603	Combustion theory								
		UPEME604	Tribology								
4	Programme Elective-III	UPEME605	Advanced Mechanics of Solids (AMOS)	3	0	0	3	30	70	0	100
		UPEME606	Simulation, Modelling & Control								
		UPEME607	Soft Computing Applications								

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		UPEME608	Computer Aided Design								
5	Open Elective-II			3	0	0	3	30	70	0	100
6	Lab Course	ULCME601	Design of Machine Component Lab	0	0	3	1.5	0	0	100	100
7	Lab Course	ULCME602	Numerical Computation lab	0	0	3	1.5	0	0	100	100
8	Lab Course	ULCME603	RAC Lab	0	0	4	2	0	0	100	100
			Total				**20**				**800**
9	**Summer Internship programme (4 to 8 weeks) is mandatory as per AICTE rule**										

7th SEMESTER

Sl. No.	Subject Type	Subject Code	Subject Name	Teaching Hours/Week			Credit	Maximum Marks			
				L	T	P		IA	EA	PA	Total
1	Core Course13	UPCME701	Project and Production Management	3	0	0	3	30	70	0	100
2	Programme Elective-IV	UPEME701	Power Plant Engineering	3	0	0	3	30	70	0	100
		UPEME702	Non-conventional Energy /								
		UPEME703	Automobile Engineering								
		UPEME704	Automatic Control System								
3	Programme Elective-V	UPEME705	Advanced Manufacturing Processes	3	0	0	3	30	70	0	100
		UPEME706	Micro Electro Mechanical System (MEMS)								
		UPEME707	Ergonomics								
		UPEME708	Product Design & Production Tooling								
4	Open Elective-III			3	0	0	3	30	70	0	100
5	Humanities Science Course	UHSMH701	Entrepreneurship Development	3	0	0	3	30	70	0	100
6	Project Course	UPRME701	Project Stage-1	0	0	6	3	0	0	100	100
7	Seminar	USEME701	Internship Seminar	0	0	2	1	0	0	100	100
			Total				**19**				**700**

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8th SEMESTER

Sl. No.	Subject Type	Subject Code	Subject Name	Teaching Hours/Week			Credit	Maximum Marks			
				L	T	P		IA	EA	PA	Total
1	Programme Elective-VI	UPEME801	Mechanical Vibration	3	0	0	3	30	70	0	100
		UPEME802	Finite Element Methods								
		UPEME803	Mechatronics								
		UPEME804	Robotics								
2	Open Elective-IV			3	0	0	3	30	70	0	100
3	Open Elective-V			3	0	0	3	30	70	0	100
4	Project Course	UPRME801	Project Stage-2	0	0		7	0	0	100	100
5	Core Course	UPCME801	Comprehensive VivaVoce	0	0	2	1	0	0	100	100
			Total				**17**				**500**

Open Electives:

(Offered by Mechanical Engineering for all B.Tech Programmes)

Open Elective-I	UOEME501	Thermodynamics and Heat Transfer
	UOEME502	Applied Thermal Engineering
Open Elective-II	UOEME601	Basic Manufacturing Process
Open Elective-III	UOEME701	Project and Production Management
	UOEME702	Mechanics of Solids
Open Elective-IV	UOEME801	Fluid Mechanics & Hydraulic Machines
	UOEME802	Mechanism of Machines
Open Elective-V	UOEME803	Quality Engineering and Management

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Semester Wise Credits Break Up								
Subject Type **Semester**	**Professional Core**	**Basic Science**	**Engineering Science**	**Humanities**	**Program Elective**	**Open Elective**	**Project /Seminar**	**Total**
1st		9.5	8					**17.5**
2nd		9.5	8	3				**20.5**
3rd	13	4	3	3				**23**
4th	14.5		3	3				**20.5**
5th	16.5				3			**22.5**
6th	11				6	3		**20**
7th				3	6	6	4	**19**
8th					3	6	8	**17**
Total	**58**	**23**	**22**	**12**	**18**	**15**	**12**	**160**

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3rd Semester

UPCME301 Introduction to Material Science

Objectives:

1. Understanding of the correlation between the internal structure of materials, their mechanical properties and various methods to quantify their mechanical integrity and failure criteria.
2. To provide a detailed interpretation of equilibrium phase diagrams
3. Learning about different phases and heat treatment methods to tailor the properties of Fe-C alloys.

Course Outcomes:

1. Student will be able to identify crystal structures for various materials and understand the defects in such structures
2. Understand how to tailor material properties of ferrous and non-ferrous alloys
3. How to quantify mechanical integrity and failure in materials

Course Content:

Module-I (08 Hours)

Classification of Engineering Materials, Engineering properties of materials. Characteristic property of metals, bonding in solids, primary bonds like ionic, covalent and metallic bond, crystal systems, common crystal structure of metals, representations of planes and directions in crystals, atomic packing in crystals, calculation of packing density, voids in common crystal structures and imperfections crystals.

Module-2 (08 Hours)

Concept of plastic deformation of metals, critical resolve shear stress, dislocation theory, deformation by slip and twin, plastic deformation in polycrystalline metals, yield point phenomenon and related effects, concept of cold working preferred orientation. Annealing; recovery; recrystalization and grain growth; hot working.

Concept of alloy formation, types of alloys, solid solutions, factors governing solids solubility viz. size factor, valency factor, crystal structure factor and chemical affinity factor; order/ disorder transformation.

Module-3 (10 Hours)

Binary phase diagrams (a) Isomorphism system, (b) Eutectic system, (c) Peritectic system, (d)Eutectoid system and (e) Peritectoid system. Allotropic transformation. Lever rule and its application, Interpretation of solidification behaviors and microstructure of different alloys belonging to those systems, Effect of non-equilibrium cooling, coring and homogenization.

Iron-cementite and iron-graphite phase diagrams, microstructure and properties of different alloys (alloy steels; stainless steel, tool steel, HSS, high strength low alloy steel) types of cast iron, their

microstructures and typical uses. Specification of steel. T.T.T. diagram: concept of heat treatment of steels i.e. annealing, normalizing, hardening and tempering; microstructural effects brought about by these processes and their influences on mechanical properties; factor affecting hardenability.

Module-4 (10 Hours)

Optical properties of Materials: Scattering, Refraction, Theory of Refraction and absorption, Atomic Theory of optical properties. Lasers, Optical fibres- Principle, structure, application of optical fibres.

Plastic-: Thermosetting and thermoplastics.

Ceramics: Types, structure, Mechanical properties, application

Composite Materials: Agglomerated Materials: Cermets .Reinforced Materials: Reinforced Concrete. Fibre reinforced plastics, Properties of composites, Metal matrix composites, manufacturing procedure for fiber reinforced composite.

Text Books:

1. Introduction to Physical Metallurgy by Avner, Tata McGraw Hill
2. Materials Science and Engineering by W.D.Callister, Wiley and Sons Inc.
3. Physical Metallurgy: Principles and Practice by Ragahvan, PHI

Reference Books

1. Engineering Physical Metallurgy and Heat Treatment by Y.Lakhtin, Mir Publisher, Moscow.
2. Elements of Material Science and Engineering, L.H.Van Vlack, Addison Wesley
3. Materials Science and Engineering by V.Raghavan, Prentice Hall of India Pvt.Ltd.
4. Elements of Materials Science & Engineering by Van Vlack, Pearson
5. Mechanical Metallurgy by Dieter, Tata MacGraw Hill
6. Composite Material science and Engineering by K. K. Chawla, Springer
7. Material Science and Metallurgy, by U. C. Jindal, Pearson

UPCME302 Fluid Mechanics & Hydraulic Machines

Objectives:

1. To learn about the application of mass and momentum conservation laws for fluid flows
2. To understand the importance of dimensional analysis
3. To obtain the velocity and pressure variations in various types of simple flows
4. To analyze the flow in water pumps and turbines.

Course Outcomes:

Upon completion of this course, students will be able to

1. Mathematically analyze simple flow situations
2. Evaluate the performance of pumps and turbines

Module: 1 (12 Hour)

Introduction and Fluid Statics- properties of fluids, concept of continuum, pressure and stress tensor Brief description of Newtonian and Non Newtonian fluids, Pascal's Law of Hydrostatics, Pressure and

its measurement by different manometers, force on submerged surfaces (Inclined), Buoyancy and stability of floating and submerged bodies.

Fluid Kinematics - Lagrangian and Eulerian description, streamline, streakline and pathline, continuity equation (Only the 3D general form for Cartesian and cylindrical coordinates), stream function, rotation and angular deformation, irrotational flow, velocity potential

Module II: (13 Hour)

Inviscid flow - Euler equation, Bernoullis equation and its applications to venture meter, orifice meter and siphons, Reynolds transport theorem, conservation of mass, Linear and angular momentum, linear and angular momentum, Stokes law of viscosity and Navier-Stokes equations (Only the 3D general form for Cartesian and cylindrical coordinates), some exact solutions such as, Flow in straight channel and Hagen Poiseuille Flow, Dimensional analysis and similarity - Buckingham Pi theorem.

Module III: (15 Hours)

Internal flows: Pipe flows, friction factor, Moody Diagram, major and minor losses, pipe networks External flows: Prandtl's Boundary layer equation over a flat plate (Only Equations), momentum integral method, and flow separation

Potential Flow - elementary plane flow in 2D Plane (Uniform flow and Vortex flow), Flow about a cylinder without circulation, Drag and lift of cylinder without circulation.

Fluid Machinery - similarity, Euler equation for turbo machines, Pelton wheel, Francis and Kaplan Turbines, centrifugal

Books:

1. S. K. Som, G. Biswas, S. Chakraborty, Introduction to fluid Mechanics and Fluid Machines, 3rd Edition,McGrawhill.
2. Y. Cengel, J. M. Cimbala, Fluid Mechanics, 3e (Sie) - Fundamentals and Applications, Mc Graw Hill
3. K. Subramanya, Hydraulic Machines, Mcgraw Hill
4. Robert W. Fox, Alan T. Mcdonald, Fluid Mechanics, Wiley
5. Ethirajan Rathakrishnan, Fluid Mechanics, PHI
6. P. N. Modi, S. M. Seth, Hydraulics and Fluid Mechanics Including Hydraulics Machines, Standard Book House.

UPCME302 Engineering Thermodynamics

Course Outcome

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

1. Understand the concepts and application of laws of thermodynamics.
2. Distinguish between steady flow and unsteady flow energy equation and related problems
3. Understand the concepts Pure substance and uses of steam table and mollier chart
4. Understand the concepts reactive system and chemical equilibrium
5. Solve different problems related to property, work, energy and heat
6. Solve problem related to entropy and Availability
7. Understand Vapour cycle and solve related problems

Module-1 (18 Hr)

Introduction: Fundamental Concepts: definitions of system and surrounding, concept of control

volume, thermodynamic state, concepts of simple compressible substances, pure substance and phase, thermodynamic processes and thermodynamic equilibrium; Temperature and Zeroth law; Thermodynamic properties and use of tables of thermodynamic properties; Idea of a generalized chart and the law of corresponding states; Concept of ideal gases and their equations of state; Thermodynamic concept of energy; Modes of work and heat transfer.

First Law of Thermodynamics: The first law referred to cyclic and non-cyclic processes, concept of internal energy of a system, conservation of energy for simple compressible closed systems; Definitions of enthalpy and specific heats; Conservation of energy for an open system or control volume, steady & transient processes.

Second Law of Thermodynamics: The directional constraints on natural processes; Formal statements; Concept of reversibility; Carnot principle; Absolute thermodynamic temperature scale

Module-2 (18 Hr)

Entropy, Clausius Inequality, change in entropy in various thermodynamic processes, TdS relations, entropy balance for closed and open systems, Principle of increase-in-Entropy, entropy generation.

Energy: Concept of reversible work & irreversibility; Second law efficiency; Energy change of a system: closed & open systems, exergy transfer by heat, work and mass, energy destruction, energy balance in closed & open systems.

Properties of pure substances Properties of pure substances: p-v, p-T, T-S, h-S diagram for steam, different types of steam, Introduction to steam tables with respect to specific volume, pressure, temperature, enthalpy and entropy

Module-3 (12 Hr)

Vapour Cycles: Carnot cycle; Simple Rankine cycle, Techniques for efficiency improvement, Reheat and Regenerative cycles with open & closed feed water heater; Cogeneration (Back pressure and Pass-out turbines), Combined cycle power generation systems, Binary vapour cycles.

Thermodynamic Property Relations: Maxwell relations; Clausius-Clapeyron equation; Difference in heat capacities; Ratio of heat capacities; Joule-Thompson coefficient.

Text books:

1. Engineering Thermodynamics by P. K. Nag, Publisher:TMH
2. Engineering Thermodynamics by P. Chattopadhyay, OXFORD
3. Fundamentals of Thermodynamics by Sonntag, Borgnakke, Van Wylen, John Wiley & Sons
4. Fundamentals of Engineering Thermodynamics by E. Rathakrishnan, PHI

Reference

1. Engineering Thermodynamics by M.Achyuthan, PHI
2. Engineering Thermodynamics by Y.V.C. Rao, University Press
3. Thermodynamics and Thermal Engineering by Kothandaraman & Domkundwar, Dhanpat Rai
4. Applied Thermodynamics by P.L.Ballaney, Khanna Publishers
5. Steam Tables in SI Units by Ramalingam, Scitech
6. Steam Tables by C.P.Kothandaraman, New Age International

UPCME303 Engineering Mechanics

Objectives

The students completing this course are expected to understand the concepts of forces and its resolution in different planes, resultant of force system, Forces acting on a body, their free body diagrams using graphical methods. They are required to understand the concepts of centre of gravity and moments of inertia and their application, Analysis of frames and trusses, different types of motion.

Module-1

Basic Concepts of Statics: Scalar and vector quantities- Representation vectors- Free vector force, Specification of force- Effect of force on rigid body- Free body diagram.

Concurrent Forces and Parallel Forces in a Plane: Principles of statics- Equilibrium of concurrent forces in a plane- Method of projections- Equilibrium of three forces in a plane Method of moments- Friction. Two parallel forces- General case of parallel forces in a plane-Centre of parallel forces and centre of gravity- Centroids of composite plane figures and curves- Distributed force in a plane.

Module-2

General Case of Forces in a Plane: Composition of forces in a plane- Equilibrium of forces in a plane- Plane trusses, Funicular polygon, Maxwell diagrams, method of joints, method of sections- Plane frame- method of members, Distributed force in a plane- Flexible suspension cables.

Force Systems in Space: Concurrent forces in space; method of projections, method of moments; Couples in space- Parallel forces in space- Centre of parallel forces and centre of gravity- General case of forces in space.

Module-3

Basic concepts of Dynamics: Kinematics- Kinetics- Newton laws of motion- Particle- Rigid body- Path of particle.

Rectilinear Translation: Kinematics of rectilinear motion Principles of dynamics, Differential equation of rectilinear motion- Motion of a particle acted upon by a constant force, Force as a function of time- Force proportional to displacement; free vibrations- D'Alembert's principle- Momentum and impulse- Work and energy- Ideal systems: conservation of energy.

Curvilinear Translation: Kinematics of curvilinear motion- Differential equations of curvilinear- Motion of a projectile- D'Alembert's principle- Moment of momentum- work and energy in curvilinear motion.

Module-4

Rotation of rigid body about a fixed axis: Kinematics of rotation- Equation of motion for a rigid body rotating about a fixed axis- Rotation under the action of a constant moment . The compound pendulum- General case of moment proportional to angle of rotation- D'Alembert's principle in rotation.

Plane Motion of a Rigid Body: Kinematics of plane motion- Instantaneous center Equations of plane motion- D'Alembert's principle in plane motion- The principle of angular momentum in plane motion- Energy equation for plane motion.

Text Book:

1. Engineering Mechanics by S.Timoshenko and D.HYoung McGraw-Hill.

References:

1. Engineering Mechanics, Vol.1 & 2 by J.L. Meriems and L.G. Kraige.

2. Engineering Mechanics by Singer.
3. Engineering Mechanics by K.L. Kumar, Tata Mc-Graw Hill.

UBSMH301 Mathematics-III

Course Objectives:

1. To give an exposure to the students the basic concepts of Probability and Statistical methods and their application.
2. To use appropriate statistical terms to describe data.
3. To use appropriate statistical methods to collect, organize, display and analyze relevant data.
4. To serve as a foundation to analyze problems in Science and Engineering applications through Statistical testing Method.

Course Outcomes: On successful completion of this course, the students will be able to

1. Have a fundamental knowledge of the concepts of probability theory,
2. Do correlation and regression and fitting of different types of curves,
3. Apply sampling theory and theory of estimation in various engineering problems and do various tests of hypothesis and significance,
4. Use calculators and tables to perform simple statistical analyses for small samples and use popular statistics packages, such as SAS, SPSS, S-Plus, R or MATLAB to perform simple and sophisticated analyses for large samples.

Course Content:

Module I(10 Hours)

Probability: Introduction, Probability of an event, additive rule & multiplication rule, conditional probability, Bayes' rule, random variable, discrete and continuous probability distribution, Joint probability distribution, Mathematical expectations, Variance and Co- variance of random variables, Mean and Co- variance of linear combination of random variables, Chebyshev theorem,

Module II (12 Hours)

Discrete Probability Distribution: Binomial & Multinomial, Hyper-geometric, Geometric, Poisson distribution.

Continuous Probability Distribution: Uniform , Normal , Exponential Distribution, Weibull's Distribution, Chi-square Distribution, Sampling Distribution: Sampling Distribution of S^2, t Distribution, F Distribution.

Module III (10 Hours)

Estimation of parameter: methods of estimation, Estimating the mean of a single sample, Standard error, Prediction interval, Tolerance limits, Estimating the difference between means of two samples, Estimating proportion and variance of single sample, Estimating the difference between two proportions and variances of two samples, maximum likelihood estimation .

Module IV (13 Hours)

Testing of hypothesis: one and two tailed test, test on a single mean when variance is known & variance is unknown. Test on two means, test on single mean and two mean populations. One and two

sample test for variance. χ^2 test for goodness of fit and test for independence.

Introduction to linear regression: Simple regression models, method of least squares, Properties of least square estimators, Inferences concerning the regression coefficients, Coefficients of determination and its application.

Statistical quality control (Simple Idea only)

Text Books :

1. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers & Keying Ye, "Probability & Statistics for Engineers & Scientists", Eighth Edition, 2007, Pearson Education Inc., New Delhi.
2. Jay L. Devore, "Probability and Statistics for Engineering and Sciences", Seventh Edition, Thomson/CENGAGE Learning India Pvt. Ltd

Reference books:

1. William Mendenhall, Robert J. Beaver & Barbara M. Beaver, "Introduction to Probability and Statistics", 13th Edition, 2009, CENGAGE Learning India Pvt. Ltd., New Delhi.
2. T. Veerarajan," Probability, Statistics and Random Processes", Tata McGraw Hill
3. Ronald Deep, " Probability and Statistics", Academic Press

UHSMH301 Organizational Behaviour

Module-1 (12 Hrs)

The study of Organisational Behaviour: Definition, Meaning, Why study OB; Learning – Principles of learning and learning theories; Personality- Meaning, Determinants, Types, Personality and OB; Perception- Perceptual Process, perceptual errors, Importance of perception in organizations; Motivation-Nature and Importance, Theories of motivation (Herzberg, Maslow, McGregor) .

Module -2:(12 hours) **Group level:**

Groups in Organizations –Nature, Types, Reasons behind forming groups, Determinants, factors contributing to Group Cohesiveness, Group Decision Making- Process, advantages and disadvantages; Team- Effective Team Building; Types of Leadership- Effective Leadership, Styles of leadership, Leadership Theories-Trait Theory and Contingency Theory, Leadership and Followership; Conflict-Healthy Vs Unhealthy conflict, Conflict Resolution Techniques

Module - 3 : Structural level (10hrs):

Organizational Culture: culture and organizational effectiveness; Organizational Change: Types of change, Reasons to change, Resistance to change and to manage resistance. Introduction to organisational development.

Text Books:

1. Stephens P Robbins, Organisational Behaviour, PHI
2. K. Aswatthappa, Organisational Behaviour, HPH

Reference Books:

1. Kavita Singh, Organisational Behaviour, Pearson
2. D.K.Bhttacharya, Organisational Behaviour, OUP

3. PradeepKhandelwal, Organisational Behaviour, TMH
4. Keith Davis, Organisational Behaviour, McGrawHill
5. Nelson Quick, ORGB, Cengage Learning

ULCME301 Fluid Thermal Lab

Any 10 experiments from the following

1. Determination of Metacentric Height and application to stability of floating bodies.
2. Determination of Cv and Cd of Orifices.
3. Experiments on impact of Jets
4. Study on Pelton / Francis / Kaplan Turbine
5. Experiments on performance of centrifugal pump
6. Experiments on performance of reciprocating pump
7. Experiments on Reynold's Apparatus
8. Experiments on Flow through pipes
9. Experiments on performance of Gear pump
10. Verifications of momentum equation
11. Study of steam power plant.
12. Study of refrigeration system.
13. Study of gas turbine power plant.
14. Measurement of steam quality using calorimeter
15. Verification of Joule-Thomson coefficient.

ULCME302 Machine Drawing

Orthographic and Sectional drawing of Machine components: (Any seven)

Screw threads, Screwed fastenings, Turn Buckle, Keys, Cotter joints and Knuckle joints; Pulley; Flanged coupling, Pedestal Bearing or Plummer Block.

Fundamentals of AutoCAD (Two classes)

1. Dimension & annotations
2. Use of Layers
3. Working with constraint in dimension
4. Creating assembly
5. Axi-symmetrical parts
6. Creating surface features
7. Working with bill of material

Drawing of the following using AUTOCAD: (Any two)

1. Projection of solids
2. Nut & bolt and Fasteners
3. Cotter joint
4. Expansion joint
5. Shaft coupling

Text Books:

1. Machine Drawing by N.D.Bhatt, V.M.Panchal, Charotar Publishing House.
2. Machine Drawing by N.D.Junarkar, Pearson Education
3. Machine Drawing with AutoCAD by Goutam Pohit and Goutam Ghosh, Pearson Education
4. Machine Drawing includes AutoCAD by Ajeet Singh, Tata MacGraw Hil

4th Semester

UPCME401 IC Engine & Gas Turbine

Course outcomes

1. Understand various types of I.C. Engines and Cycles of operation.
2. Analyze the effect of various operating variables on engine performance
3. Identify fuel metering and fuel supply systems for different types of engines
4. Understand normal and abnormal combustion phenomena in SI and CI engines
5. Evaluate performance Analysis of IC Engine and Justify the suitability of IC Engine for different application
6. Understand the conventional and non-conventional fuels for IC engines and effects of emission formation of IC engines, its effects and the legislation standards.
7. Analyze & Solve the performance of Gas Turbine

Course Content

Module 1 (12 hours)

Introduction: Classification, Engine nomenclature, engine operating and performance parameters, Valve timing diagram of SI & CI Engines, Comparison of SI and CI engine.

Thermodynamic Analysis of cycles: Air standard cycles: Carnot cycle, Stirling cycle, Ericsson cycle, Otto cycle, Diesel cycle, Dual cycle, Comparison of the Otto, Diesel and Dual Cycle. Striling cycle.

Significance of Fuel-Air & Actual cycles of I.C. engines. Comparison with Air Standard Cycles. Analysis of Fuel-Air & Actual cycles (Effect of chemical equilibrium and variable specific heats. Effect of air fuel ratio and exhaust gas dilution. Time Loss Factor, Heat Loss Factor, Exhaust Blow down, Loss Due to Gas Exchange Processes, Volumetric Efficiency, Loss due to Rubbing Friction)

Carburetion: Requirement of carburetor**,** Factors Affecting Carburetion, Principle of Carburetion, Simple Carburetor and its drawbacks, Calculation of the Air–Fuel Ratio, Modern Carburetors.

Module 2 (12 hours)

Fuel Injection: Functional Requirements of an Injection System, Classification of Injection Systems, Fuel Feed Pump, Injection Pump, Injection Pump Governor, Mechanical Governor, Pneumatic Governor, Fuel Injector, Nozzle, Injection in SI Engine, Electronic Injection Systems, Multi-Point Fuel Injection (MPFI) System, Functional Divisions of MPFI System, Injection Timing, Group Gasoline Injection System, Electronic Diesel Injection System.

Ignition: Energy requirement for ignition, requirements of an ignition system, conventional ignition systems, modern ignition systems (TCI and CDI), firing order, Ignition timing, Spark advance mechanism,

Combustion in SI engines – stages of combustion, ignition lag, engine variable affecting flame propagation, detonation, effects of detonation & its control, octane rating, combustion chamber design principle and types.

Combustion in CI engines – stages, delay period and it's, variable, diesel knock and its control, Cetane rating of fuels, different types of combustion chambers.

Super Charging & Scavenging: Thermodynamics Cycles of supercharging. Effect of supercharging, Efficiency of supercharged engines. Methods of super charging, supercharging and scavenging of 2-stroke engines.

Module 3 (12 hours)

Testing and performance – Review of IC engine testing, and trial calculation on testing at different load characteristics, Performance characteristics such as brake thermal efficiency volumetric efficiency BSFC, Economical running, Williams line, interrelationship of various engines variables, performance graphs.

Engine Emission and control:

Introduction, constituents of exhaust gas, effects on human health and **causes of formation and their measurement pollution control device and EURO standards**

Alternative fuels for IC engines like LPG, CNG, Alcohols, Hydrogen etc., their need, properties, engine modification and performance.

Module 4 (08 hours)

Gas Turbines: Introduction, Bryton cycle. Open and closed cycle gas turbines, Analysis of practical gas turbine cycle.

Air Craft Propulsion: Analysis of Turbo Jet, Turbo Prop, Turbo fan & Ram jet engines.

Axial Flow & Centrifugal Compressor: Basic construction of centrifugal and axial flow compressor, Velocity diagram, performance characteristics of centrifugal and axial flow compressor, effects of slip, surging and stalling on compressor.

TEXTS & REFERENCE BOOKS:

1. IC Engines, Mathur & Sharma

2. Internal Combustion Engines, V. Ganesan, TMH, 3rd edition
3. Gas Turbines, V.Ganesan, TMH, 3rd edition
4. Heywood J.B., "Internal combustion Engine Fundamentals", McGraw Hill, 1988
5. Obert E.F., "Internal combustion Engine and Air Pollution", Intext Educational Pub,1974
6. Ganesan V., "Internal combustion Engines", 6 th Ed.Tata Mc Graw Hill Publishing Co.
7. Domkundwar V.M. "Internal Combustion Engines"-Mathur M.C.,Sharma R.D.,"Internal combustion engines",8th Ed.;
8. Dhanpat Rai publication.,2003 PulkrabekW, "Engineering Fundamentals Of Internal Combustion Engine", Prentice Hall, 1997
9. Fundamentals IC Engines, J.B.Heywood, McGraw Hill
10. A course in IC Engines, V.M.Domkundwar, Dhanpat rai and sons
11. Gas Turbines, Cohen and Roser
12. An Introduction to Energy Conversion, Vol.III, V.Kadambi and Manohar Prasad, New Age International
13. Internal Combustion Engines, K.K.Ramalngam, Scitech Publications

UPCME402 Mechanics of Solids

Prerequisites: (i) Physics 1, (ii) Mathematics course with ordinary differential equations and (iii) Engineering Mechanics

Objectives:

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

Course Outcomes:

After completing this course, the students should be able to

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

Module – 1

SIMPLE STRESSES & STRAINS : Elasticity and plasticity – Types of stresses & strains–Hooke's law – stress– strain diagram for mild steel – Working stress – Factor of safety – Lateral strain, Poisson's ratio & volumetric strain – Bars of varying section – composite bars – Temperature stresses- Principal planes and principal stresses -Mohr's circle - Relation between elastic constants, Strain energy – Resilience – Gradual, sudden, impact and shock loadings.

SHEAR FORCE AND BENDING MOMENT : Definition of beam – Types of beams – Concept of shear force and bending moment – S.F and B.M diagrams for cantilever, simply supported and overhanging beams subjected to point loads, u.d.l, uniformly varying loads and combination of these loads – Point of contra flexure – Relation between S.F., B.M and rate of loading at a section of a beam.

Module – 2

FLEXURAL STRESSES : Theory of simple bending – Assumptions – Derivation of bending equation, Determination bending stresses – section modulus of rectangular and circular sections

(Solid and Hollow), Angle and Channel sections – Design of simple beam sections.

SHEAR STRESSES: Derivation of formula – Shear stress distribution across various beams sections like rectangular, circular, triangular, I, T angle sections.

DEFLECTION OF BEAMS : Bending into a circular arc – slope, deflection and radius of curvature – Differential equation for the elastic line of a beam – Determination of slope and deflection for cantilever and simply supported beams subjected to point loads, - U.D.L uniformly varying load. Mohr's theorems – Moment area method – application to simple cases including overhanging beams, Statically Indeterminate Beams and solution methods.

Module – 3

THIN CYLINDERS: Thin seamless cylindrical shells – Derivation of formula for longitudinal and circumferential stresses – hoop, longitudinal and Volumetric strains – changes in dia, and volume of thin cylinders – Riveted boiler shells – Thin spherical shells.

THICK CYLINDERS: –lame's equation – cylinders subjected to inside & outside pressures – compound cylinders.

TORSION: Introduction-Derivation- Torsion of Circular shafts- Pure Shear-Transmission of power by circular shafts, Shafts in series, Shafts in parallel.

COLUMNS:

Buckling and Stability, Columns with Pinned ends, Columns with other support Conditions, Limitations of Euler's Formula, Rankine's Formula,

Text Books:

1. Strength of materials /GH Ryder/ Mc Millan publishers India Ltd
2. Solid Mechanics, by Popov
3. Mechanics of Materials/Gere and Timoshenko, CBS Publishers

References:

1. Strength of Materials -By Jindal, Umesh Publications.
2. Analysis of structures by Vazirani and Ratwani.
3. Mechanics of Structures Vol-III, by S.B.Junnarkar.
4. Strength of Materials by S.Timoshenko
5. Strength of Materials by Andrew Pytel and Ferdinond L. Singer Longman.

UPCME403 Manufacturing Processes

Course objectives:

To study various casting, welding and forming methods including advanced techniques, with emphasis on basic principles, limitations and application areas.

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

1. Identify types of pattern, core, core print and gating system in metal casting processes.
2. To obtain knowledge of various metal joining processes.
3. Acquire the knowledge of Powder metallurgy and its application .
4. Understand and apply process-maps for metal forming processes using plasticity principles

Module-1 (12 hours)

Types of patterns, Pattern materials and Pattern allowances. Molding Materials - sand molding, metal molding, investment molding, shell molding, Composition of molding sand, additives, Binders, Properties of molding sand and sand testing.

Melting furnaces - cupola, resistance furnace, induction and arc furnace, Solidification of castings, design of risers and runners, feeding distance, centre line freezing resistance chills and chaplets, Degasification and inoculation of metals.

Casting methods like continuous casting, centrifugal casting, disc casting, Casting defects.

Module-2 (12 hours)

Classification of welding processes, gas welding, electric arc, arc length, power sources, constant current and constant voltage power sources; ISI classification of coated electrodes;

Special welding methods: MMAW, GTAW, GMAW, GMAW-CO2 welding, submerged arc welding, electro-slag welding, electron beam welding, laser beam welding, ultrasonic welding and resistance welding, welding defects, arc blow, non-destructive examination of weldments.

Brazing and soldering

Module-3 (14 hours)

Brief introduction to powder metallurgy processes.

Mechanism of plastic deformation, fundamentals of plasticity, Dependence of stress strain diagram on Strain rate and temperature. Hot and cold working of metals, classification of metal forming processes. Rolling: Pressure and Forces in rolling, types of rolling mills, rolling defects, Forging: Smith Forging, Drop and Press forging, M/c forging, Forging defects.

Extrusions: Direct, Indirect, Impact and Hydrostatic extrusion and their applications, Extrusion of tubes, Wire drawing methods and variables in wire-drawing, Brief introduction to sheet metal working: Bending, Forming and Deep drawing, shearing, Brief introduction to explosive forming.

Books:

1. Manufacturing Technology by P.N.Rao, Tata McGraw Hill publication.
2. Welding Technology by R.A. Little, TMH
3. Manufacturing Science by A.Ghosh and A K Malick, EWP
4. Fundamentals of metal casting technology by P.C. Mukherjee, Oxford PIBI.
5. A Text Book of Production Engineering by P.C.Sharma, S.Chand

UPCME404 Optimization Techniques

Course Objectives:

1. To understand the theory of optimization methods and algorithms developed for solving various types of optimization problems.
2. To introduce the students about optimization concepts, formulation of engineering problems amenable to optimization.
3. To provide students with the modeling skills necessary to describe, formulate, solve and interpret optimization problems in engineering.
4. To find the solution of optimal decision making and engineering design problems in which the objective and constraints are linear or nonlinear functions .

Course Outcomes

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

1. understand and use methods for constrained and unconstrained Optimization,
2. understand the mathematical background to solve optimization problems,
3. formulate and solve nonlinear programming problems from real field data,
4. demonstrate the ability to choose and justify optimization techniques that are appropriate for solving realistic engineering problems.

Course Content:

Module-1:

Idea of Engineering optimization problems, Classification of optimization algorithms, Modeling of problems and principle of modeling. Linear Programming: Formulation of LPP, Graphical solution, Simplex method, Big M method, Revised simplex method, Duality theory and its application, Dual simplex method, Sensitivity analysis in linear programming.

Module-2:

Transportation problems: Finding an initial basic feasible solution by Northwest Corner rule, Least cost rule, Vogel's approximation method, Degeneracy, Optimality test, MODI method, Stepping stone method. Assignment problems: Hungarian method for solution of Assignment problems.

Integer Programming: Branch and Bound algorithm for solution of Integer Programming problems.

Queuing models: General characteristics, Markovian queuing model, M/M/1 model, Limited queue capacity, Multiple server, Finite sources, .

Module-3:

Introduction to non-linear programming, Unconstrained optimization: Fibonacci and Golden Section Search method, Steepest Descent Method, Constrained optimization with equality constraint: Lagrange multiplier, Projected gradient method, Constrained optimization with inequality constraint: Kuhn-Tucker condition, Primal-Dual Method, Quadratic programming.

Text Book :

1. Ravindran, D. T. Philips, J. Solberg, " Operations Research- Principle and Practice", Second edition, Wiley India Pvt Ltd
2. Kalyanmoy Deb, " Optimization for Engineering Design", PHI Learning Pvt Ltd

Reference Books :

1. An introduction to Linear Algebra by V. Krishnamurthy, V. P. Mainra and J. L. Arora, East West Publication
2. M.Artin, Algebra, Prentice-Hall of India.
3. Hoffman and Kunze, Linear Algebra, 2nd ed., PHI.
4. H.A.Taha,A.M.Natarajan, P.Balasubramanie, A.Tamilarasi, "Operations Research", Eighth Edition, Pearson Education
5. F.S.Hiller, G.J.Lieberman, " Operations Research", Eighth Edition, Tata McDraw Hill
6. P.K.Gupta, D.S.Hira, "Operations Research", S.Chand and Company Ltd.
7. KantiSwarup, P. K. Gupta, Man Mohan, "Operations Research", Sultan Chand and Sons

UHSMH401 Engineering Economics

Modules - 1 (12 Hours)

Engineering Economics- Nature, Scope, Basic problems of an economy, Micro Economics and Macro Economics.

Demand- Meaning of demand, Demand function, Law of Demand and its exceptions, Determinants of demand, Demand Estimation and Forecasting, Elasticity of demand & its measurement (Simple numerical problems to be solved), Supply-Meaning of supply, Law of supply and its exception, Determinants of supply, Elasticity of supply, Determination of market equilibrium (Simple numerical problems to be solved).

Production-Production function, Laws of returns: Law of variable proportion, Law of returns to scale

Modules - 2 (12 Hours)

Cost and revenue concepts, Basic understanding of different market structures, Determination of equilibrium price under perfect competition (Simple numerical problems to be solved), Break Even Analysis-linear approach (Simple numerical problems to be solved).

Banking -Commercial bank, Functions of commercial bank, Central bank, Functions of Central Bank.

Inflation-Meaning of inflation, types, causes, measures to control inflation.

National Income-Definition, Concepts of national income, Method of measuring national income.

Modules - 3 (12 Hours)

Time value of money- Interest - Simple and compound, nominal and effective rate of interest, Cash flow diagrams, Principles of economic equivalence.

Evaluation of engineering projects-Present worth method, Future worth method, Annual worth method, Internal rate of return method, Cost benefit analysis for public projects.

Depreciation- Depreciation of capital assert, Causes of depreciation, Methods of calculating depreciation (Straight line method, Declining balance method), After tax comparison of project.

Text Books

1. Riggs, Bedworth and Randhwa, "Engineering Economics", McGraw Hill Education India
2. DevigaVengedasalam "Principles of Economics", Oxford University Press.
3. William G.Sullivan, ElinM.Wicks, C. PatricKoelling"Engineering Economy", Pearson

4. R. PaneerSelvam, "Engineering Economics", PHI
5. S.P.Gupta, "Macro Economics", TMH.
6. S.B. Gupta,"Monetary Economics", Sultan Chand and Co.

ULCME401 Production and Material Testing Lab

Any eight of the following experiments

1. Study of microstructure of steel specimen
2. Determination of tensile strength/ compressive strength/ bending strength of materials by Universal Testing Machine
3. Double shear test in Universal Testing Machine
4. Determination of Impact strength of material (Charpy and Izod)
5. Determination of Hardness strength of materials (Brinnel, Rockwell and Vickers)
6. Determination of Rigidity modulus of material
7. Determination of Fatigue strength of material
8. Estimation of Spring Constant under Tension and Compression.
9. Strain measurement using Strain Gauge.
10. Stress measurement using strain rosette

ULCME402 Manufacturing Process Lab

Any six of the following experiments

1. Determination of grain size, clay content, permeability and green compressive strength of molding sand. (2 to 3 experiments)
2. Foundry Practices
3. Preparation of a wood pattern.
4. Determination of strength of brazed and solder joints
5. Practice and preparation of job in TIG/MIG welding
6. Practice and preparation of job in sheet metal using processes like forming and deep drawing.
8. Demonstration of different rolling mills
9. Demonstration of Extrusion processes

ULCME403 Machine Dynamics & IC Engine lab

Any six of the following experiments

1. Dynamic analysis of Epi-cyclic gear trains
2. Measurement of cutting forces in Drilling, turning and Milling using Dynamometers.
3. Velocity ratios of simple, compound, epicyclic and differential gear trains.
4. Radius of gyration of compound pendulum / connecting rod
5. Experiment on Screw Jack
6. Experiment on Journal Bearing Apparatus
7. Experiment/Study on clutches
8. Experiments on Simple / Compound / Reverted / Epicyclic Gear trains
9. Experiment on Brake
10. Experiment on Coriolis component of acceleration

Any four of the following experiments

1. Study of Cut-Sections of 2 stroke and 4 stroke Diesel Engine.
2. Study of Cut-Sections of 2 stroke and 4 stroke Petrol Engine.
3. Load test on 4-stroke single cylinder C.I. engine / S.I. engine.
4. Morse Test on multi-cylinder S.I. or C.I. engine
5. Load test on variable compression ratio S.I. engine
6. Load test and Heat balance on 2 stroke S.I. Engine
7. Valve timing diagram of an IC engine
8. Analysis of exhaust gas of automobile

5th Semester

UPCME501 Mechanisms of Machines

Prerequisites: Engineering Mechanics, Mechanics of Solid, Engineering Mathematics, Material Science

Course objectives:

This course is ideal vehicle for introducing the mechanical engineering students to the process of design. The objectives of the course learning are:

- The objective of kinematics is to achieve various means of transforming motion to a specific kind needed in various applications.
- The objective of dynamics is analysis of the behaviour of a given machine or mechanism when subjected to dynamic force.
- The objectives of Kinematics and dynamics of machines are to use the general concepts which are previously studied with illustrative examples to developing methods and performing analysis of real designs.
- Hence the KDM involves a great deal of creative details.

Course Outcome:

On successful completion of this course the students should be able to:

- Understand the requisites of *Machine Design* as Kinematic and dynamics of machinery and mechanics of material forms this subject. Therefore this course is ideal vehicle for introducing the mechanical engineering students to the process of design.
- Able to do Basic Kinematic concepts and definitions of Mechanism
- Conversion with Kinematic Analysis and synthesis
- Able to use friction theory to brakes, dynamometers, belt, rope, chain and clutches
- Understanding basics of gear and gear trains

Course Content:

Module – I : (10 Lectures)

Kinematic fundamental: Introduction to mechanisms and its terminologies - Degree of freedom – Mobility - Kutzbach criterion - Grüebler's criterion for planar mechanisms, Grashoff's law, Kinematic Inversions of 4-bar chain - Single slider and double slider crank chains, Quick return mechanism, Limiting positions, Mechanical advantage - Transmission angle and toggle position, Ratchets and escapements, Indexing Mechanisms, Rocking Mechanisms, Straight line generators.

Kinematic Analysis : Graphical analysis of position, velocity and acceleration of simple mechanisms having turning, sliding and rolling pair, Coriolis acceleration using graphical relative motion method, Aronhold-Kennedy Theorem, Instantaneous center method - Four bar and slider crank mechanisms - Analytical method for four bar and slider crank mechanisms.

Module – II : (10 Lectures)

Mechanism Synthesis : Classification of kinematic synthesis problems - Two position synthesis of

slider crank and crank rocker mechanisms, Three position synthesis of double rocker mechanism, Chebychev spacing for precision positions, Freudenstein analytical method, synthesis of function generator using three precision positions, Graphical and analytical design of a four bar linkage for body guidance, path generation by graphical method.

Mechanism Trains : Spur gear terminology and definitions, fundamental law of gearing, Theory of shape and action of tooth properties and methods of generation of standard tooth profiles, Standard proportions, Force analysis, Path of contact, Arc of contact, Contact ratio, Interference and Undercutting, Methods for eliminating Interference, Minimum number of teeth to avoid interference. Gear trains, Speed ratio, train value, Parallel axis gear trains, Epicyclic Gear Trains, Sun and Planet Gear, Differentials – Automobile gear box.

Module – III : (16 Lectures)

Dynamics of Machinery

Friction Effects: Screw jack, Friction between pivot and collars, single, multi-plate and cone clutches, Anti friction bearing, film friction, friction circle, friction axis.

Flexible Mechanical Elements: Belt, rope and chain drives, Initial tension, Effect of centrifugal tension on power transmission, Maximum power transmission capacity, Belt creep and slip.

Brakes & Dynamometers : Classification of brakes, Analysis of simple block, Band and internal expanding shoe brake, Braking of a vehicle. Absorption and transmission dynamometers, Prony brake, Rope brake dynamometer, Belt transmission, epicyclic train, torsion dynamometer.

Text Books

1. Kinematics and Dynamics of Machinery by R L Norton, Tata MacGraw Hill
2. Theory of Machines and Mechanisms by John J. Uicker Jr., Gordon R. Pennock and Joseph E. Shigley, Oxford University Press
3. Theory of Machines by S.S.Rattan, Tata MacGraw Hill
4. Theory of Machines by Thomas Bevan, CBS Publications

Reference

1. Kinematics and Dynamics of Machinery by Charles E. Wilson and J.Peter Saddler, Pearson Education
2. Mechanism and Machine Theory by J.S.Rao and R.V.Dukipatti, New Age International.
3. Theory of Mechanisms and Machines by A. Ghosh & A. K. Mallick, East West Press.
4. Kinematics and Dynamics of Machines by G.H. Martin, McGraw-Hill.
5. Mechanisms and Dynamics of Machinery by Hamilton H Mabie and Charles F Reinholtz, John-Wiley and Sons.
6. Kinematics, Dynamics, and Design of Machinery by Kenneth J Waldron and Gary L Kinzel, John-Wiley and Sons.

UPCME502 Heat Transfer

Course outcomes:

1. Apply basic principles of fluid mechanics, thermodynamics, and heat transfer for engineering applications.
2. Analyze the mechanism of conduction and its application to thermal and energy systems.

3. Solve the complex problems of convection heat transfer in fluids for implementation in various industrial and scientific systems.
4. Access the phenomena of boiling and condensation applicable to design of industrial and thermal systems.
5. Develop an efficient heat exchange process for design and fabrication of heat exchangers used in various industrial purposes.
6. Formulate an analysis of radiation heat exchange process in various thermal and energy systems for the solution of heat transfer problems.

Module 1: (14 Classes)

Basic concepts: conduction, convection and radiation Laws. General equation of heat conduction. Derivation in Cartesian, cylindrical and spherical coordinates. One dimensional steady state heat conduction in simple geometries, plane wall, cylinder and sphere. Heat transfer composite walls , composite cylinders and composite spheres. Critical thickness of insulation, Thermal contact resistance. Overall heat transfer coefficient, Electrical analogy, Heat generation in plane wall, cylinder and sphere. Extended surfaces. General equations, types and applications of fins, Fin efficiency and effectiveness – Fin performance. Unsteady state heat conduction. Lumped parameter system

Module 2: (12 Classes)

Forced convection, Convection Boundary layer theory. Thermal boundary layer. Conservation equations of mass, momentum and energy for laminar flow over a flat plate. Turbulent flow over a flat plate, Flow over cylinders, spheres, tube bank. Internal flow through pipes, annular spaces, Analogy between momentum and heat transfer

Natural convection in vertical, inclined and horizontal surfaces. Mixed convection, Dimensional analysis.

Boiling, Pool boiling , flow boiling. Regimes of Boiling. Forced convection boiling Condensation, Film condensation, dropwise condensation

Module 3: (14 Classes)

Basic concepts, laws of radiation, Wien's displacement law, Stefan Boltzman law, Kirchoff law, Black body radiation, Grey body radiation, Shape factor algebra , Electrical analogy, Radiation shields, Solar radiation, Introduction to gas radiation.

Heat exchange between black bodies through non-absorbing medium. Gray bodies and real bodies. Heat exchange between gray bodies. Radiosity and irradiation. Electrical analogy and radiation network for a 2-surface and 3-surface enclosures in non-absorbing medium, radiation shields.

Heat exchangers: Types of heat exchangers and heat exchanger configurations. The overall heat transfer coefficient and fouling factor. LMTD and effectiveness-NTU analysis of heat exchangers.

Text books

1. Heat transfer, J P Holman and S. Bhattacharya, McGraw Hill Education, 10th Edition.

2.Heat Transfer, R.C. Sachdeva, (2010) Fundamentals of Heat and Mass Transfer (SI Units)

3. Heat and Mass Transfer, R. K. Rajput, S. Chand & Company, 5th Edition

4. Heat Tranfer, P. K. Nag

Reference books

1. Introduction to Heat Transfer, S. K. Som, PHI Learning Private Ltd, 2013.

2 Heat and Mass Transfer, Y. A. Cengel and A. J. Ghajar, McGraw Hill Education, 4th Edition

UPCME503 Machining Science & Machine Tools

Course objectives:

To provide clear view on theory of metal cutting and tool geometry and to impart knowledge about mechanisms involved in the conventional and Non-conventional machines.

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

1. Interpret and design the geometry of single point cutting tool and multi point cutting tools
2. Acquire the mechanisms involved in lathe, shaper, drilling, milling, planer machines
3. Understand the working principle of USM, LBM, ECM, EDM, AJM, EDM

Module-1 (12 hours)

Theory of metal cutting: Definition of tool, Classification and tool angles. Cutting tool materials & their properties. Orthogonal and oblique cutting. Mechanism of chip formation, types of chips, tool geometry and tool signature for ASA & ORS system, Machinability, Merchant's theory of mechanics of metal cutting, Relationship between cutting velocity, shear velocity & chip velocity & Force, speed, feed and depth of cut, Design of single point turning tool, optimum value of tool angles, Tool life and factors affecting on it, Tool life calculation, Economic tool life, influence of tool geometry on tool life, Tool wear, Tool wear types (crater and flank), chip formation mechanisms & types of chip formation, Cutting fluids types and characteristics.

Module-2 (14 hours)

Conventional machine tools:

Lathe: Principles, construction, types, production machine tools capstan & turret lathe, single point cutting tool layout, thread cutting mechanisms, calculations of cutting velocity, feed and depth of cut.

Shaper, Planer: Construction, operations, Quick return mechanism.

Milling: Construction, milling cutters, up milling & down milling, dividing and indexing mechanisms, maximum chip thickness & power required, Gear shaper and Gear hobbing machines

Drilling and Boring: Construction, classifications, drilling and boring tools, nomenclature & geometry of twist drill (Multi point cutting tools)

Grinding and super finishing: Grinding wheels, abrasive & bonds, cutting action, grinding wheel specifications, grinding wheel wear-attritions wear, fracture wear. Dressing and Truing, maximum chip thickness, classification of grinding- surface and cylindrical grinding, center less grinding. Super finishing: Honing, lapping & polishing

Module-3 (12 hours)

Introduction to non-conventional machining process: Needs & benefits, working principle and applications: Ultrasonic machining(USM), Laser Beam Machining (LBM), Electro Discharge Machining (EDM), Wire EDM, Electro Chemical Machining (ECM), Abrasive Jet Machining (AJM), Water Jet Machining (WJM),Plasma Arc Machining (PAM).

References:

1. Metal cutting theory and practice- Amitabh Bhttacharya, central Book Publication, Calcutta.

2. Manufacturing science- A. Ghosh, A. K. Mallik, Affiliated East-West press.

3. Manufacturing Technology- P. N. Rao, Tata McGraw hill publications.

4. Modern manufacturing process- P.C. Pandey & H. S. Shan, McGraw hill publications.
5. Advance machining process- V. K. Jain, Allied publishers.
6. Production Engineering- P. C. Sharma, S. Chand, Company limited New Delhi.

UPCME504 Design of Machine Element (open Book)

Prerequisites: Engineering Mechanics, Mechanics of Solid, Machine Theory, Material Science

Course learning objectives

A suitable combination of the two subjects, mechanism & machine theory and mechanics of material forms the subject *Machine Design*. The creation of a scheme for the construction and assembly of a machine is called *Machine Design*. The objectives of the course learning are:

1. Conception of an arrangement of components or elements or parts, which will accomplish the desired purpose.
2. Definition of the geometry of each part and material
3. The processing
4. Construction and assembly based on design details

Hence the design process involves a great deal of creative details

Course Outcome

On successful completion of this course the students should be able to:

1. Understand the design principles: i.e., Mechanical Engg. Design, phases of Design, design considerations, factor of safety, stress concentration, methods of reducing stress concentration, Notch sensitivity, Types of loading,
2. Able to do design of permanent joints
3. Conversion with the design of springs
4. Able to do Design of bearings.

Module-1 (12 hours)

1. Mechanical engineering design: Introduction to design procedure, Stages in design, Code and Standardization, Interchangeability, Preferred numbers, Fits and Tolerances, Engineering materials: Ferrous, Non-ferrous, Non-metals, design requirements – properties of materials, Material selection, Use of Data books.

2. Fundamentals of Machine Design: Types of load, Modes of failure, factor of safety concepts, Theories of Failure, concept and mitigation of stress concentration, Fatigue failure and curve, endurance limit and factors affecting it, Notch sensitivity, Goodman, Gerber and Soderberg criteria.

Module-2 (12 hours)

3. Machine Element Design: Design of Joints: Rivets, welds and threaded fasteners based on different types of loading, Boiler joints, cotter joints and knuckle joints.

4. Design of Keys, Shaft and Couplings: Classification of keys and pins, Design of keys and pins, Theories of failure, Design of shafts: based on strength, torsional rigidity and fluctuating load, ASME code for shaft design, Design of couplings: Rigid coupling, Flexible coupling.

Module-3 (12 hours)

5. Design of Mechanical Springs: Types of helical springs, Design of Helical springs, bulking of spring, spring surge, end condition of springs, Design of leaf springs: nipping.

6. Bearings: Types and selection of ball and roller bearings, Dynamic and static load ratings, Bearing life, Design of sliding contact bearings, Journal bearing, foot step bearing.

Text Books:

1. Mechanical Engineering Design, J.E.Shigley, C.R.Mischke, R.G.Budynas and K.J.Nisbett, TMH
2. Design of Machine Elements, V.B. Bhandari, Tata McGraw Hill
3. Machine Design Theory and Practice, Deutschman, D., Michels, W.J. and Wilson, C.E., , Macmillan,

Reference Books:

1. Fundamentals of Machine Component Design by R.C.Juvinall and K.M.Marshek, John Wiley & Sons
2. Machine Design, P.C.Sharma and D.K.Agrawal, S.K.Kataria & Sons
3. Machine Design, Pandya and Shah, Charotar Book Stall
4. Machine Design, Robert L. Norton, Pearson Education Asia.

Design Data Hand Books:

1. P.S.G. Design Data Hand Book, PSG College of Tech Coimbature

UPEME501 Mechanical Measurement & Metrology

Course Outcomes:

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

1. Understand the principles of measurement instrument and their applications
2. To obtain knowledge about standards of measurements and comparators.
3. Acquire the knowledge of limits, fit, and tolerances.

Module 1

Mechanical Measurements: Introduction to measurement and measuring instruments. General concept–Generalized measurement system and its elements-Unit sand standards-measuring instruments: sensitivity, stability, range, accuracy and precision-static and dynamic response-repeatability-systematic, Source of error, statistical analysis of error and random errors- correction, calibration. Dimensional and geometric tolerance. **Sensors and Transducers**: Types of sensors, types of transducers and their characteristics.**Measurement of Pressure:** Gravitational, directing acting, elastic and indirect type pressure transducers, Measurement of very low pressures (high vacuum). **Strain Measurement**: Types of strain gauges and their working, strain gauge circuits, temperature compensation. Strain rosettes, calibration.**Flow Measurement:** Flow characteristics obstruction meters, Obstruction meter for compressible fluids- Orifice, Venturimeter and Pitot tube, the variable-area meter, Turbine Flow meters.**Temperature Measurement**: Thermometers, bimetallic thermocouples, thermistors and pyrometers. **Measurements of Force, Torque:** Different types of load cells, elastic transducers, pneumatic & hydraulic systems. Seismic instruments.

Module 2

Coordinate measuring machine (CMM): Need, constructional features and types, **Metrology and Inspection:** Standards of linear measurement, line and end standards. Interchange ability and standardization. Linear and angular measurements devices and systems. **Comparators:** Sigma, Johansson's Microkrator. Limit gauges classification, Taylor's Principle of Gauge Design.

Module 3

Limits, Fits &Tolerance and Surface roughness: Introduction to Limits, Fits, Tolerances and IS standards, Limit-gauges, and surface-roughness. Measurement of geometric forms like straightness, flatness, roundness. Tool makers microscope, profile projector, autocollimator. **Interferometry**: principle and use of interferometry, optical flat. Measurement of screw threads and gears. Surface texture: quantitative evaluation of surface roughness and its measurement.

Books:

1. Experimental Methods for Engineers by Holman, MCGRAW HILL INDIA
2. Mechanical Measurements by Beckwith, Pearson
3. Principles of Measurement Systems by Bentley, Pearson
4. Metrology of Measurements by Bewoor and Kulkarni, MCGRAW HILL INDIA
7. Jain, RK, "Engineering Metrology" Khanna Publishers
8. Jain, R.K., "Mechanical Measurement" Khanna Publishers
9. Gupta SC, Engineering Metrology, Dhanpat Rai Publications

UPEME502 Quality Control & Reliability

Module- I (8 hours)

Attributes of quality, Evolution of philosophy of Quality Management: Inspection, Quality Control, Quality Assurance, Total Quality Management, Cost of quality

Acceptance sampling: Design of single sampling plan. Double, multiple and sequential sampling plans, O.C. curve, Producer‟s risk and consumer‟s risk, AOQ, AOQL

Module-II (10 hours)

Statistical process control, Use of control charts and process engineering techniques for implementing quality plan, X-Chart, R-Chart, p-chart, np-chart, c-chart, cusum-chart, Process capability analysis, statistical tolerance analysis

Experimental designs and factorial experiments: 2^kfactorial experiments, Taguchi philosophy; Loss function; Signal to noise ratio, Orthogonal arrays for parameter and tolerance design.

Module-III (6 hours)

Definition – Reliability vs quality; Reliability function – MTBF, MTTR, availability; Bathtubcurve – time dependent failure models – distributions – normal, weibull; Reliability of system and models – serial, parallel and combined configuration; Economic analysis and life cycle cost; Proactive, preventive, predictive maintenance; Maintainability and availability

Module-IV (8 hours)

Quality Improvement: Fundamentals of TQM; Some important philosophies and their impact on quality (Deming, Juran, Crossby); Quality circle, QC Tools;Service Quality; Quality Standard: Product and Process Standard, Introduction to ISO 9000 and 14000 standards; Concept of Six Sigma, Lean Management and TPM

Books

1. Quality Planning and Analysis, Juran J M and Gryna F M, TMH
2. Statistical Process Control and Improvement, A. Mitra, Pearson.
3. Introduction to Statistical Quality control, D.C. Montgonery, John Wiley & sons.
4. Introduction to /reliability and MaitainabilityEngg E. Ebeling, MC-Graw Hill.
5. Quality control and Application ,B.L. Hansen and P.M. Ghare, Prentice Hall of India.
6. Statistical Quality Control, M. Mahajan, Dhanpat Rai & Sons.
7. K C Jain and A K Chitale, Quality Assurance and Total Quality Management, Khanna Publishers
8. K.S. Krishnamoorthi& V. Ram Krishnamoorthi, "A First Course in Quality Engineering" CRC Press

UPEME503 Micro Fabrication

Course objectives:

To introduce studentsdifferent methods of microfabricationand appreciate Integration processes in detail. To educate on the applications of Micro fabrication techniques to disciplines beyond Mechanical engineering.

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

1. Ability to design micro systems using micro machining techniques and know different micro fabrication system.
2. Select the correct fabrication process for a specific micro-device or microsystem. Resource planning for a given microsystem fabrication and Be familiar with it.
3. Identify how physical and chemical phenomena govern miniaturized systems for various applications

Module-I (9 hours)

Introduction to Micro fabrication technologies and Materials for fabrication: substrate and wafers, siliconas a substrate material, crystal structure, single crystal andpolycrystalline, mechanical properties, siliconcompounds, silicon piezo-resistors, gallium arsenide, quartz, piezo-electric crystals, polymers, packagingmaterials, Fabrication equipment, Growth technology, Silicon-based process

Module-II (10 hours)

Fabrication Processes: Photolithography, X-ray and electron beam lithography, Thin film deposition-spin coating, thermal oxidation,chemical vapour deposition (CVD), electron beam evaporation, Physical vapor deposition- Deposition epitaxy, sputtering; Doping- diffusion, ion

implantation;Etching- wet etching, dry etching,Silicon Anisotropic Etching, Dry Etching of Silicon-Plasma Etching- Deep Reaction Ion Etching (DRIE)- Isotropic Wet Etching- Gas Phase Etchants-photoresists, Case studies.

Module-III (17 hours)

Micro system manufacturing: Bulk Micro manufacturing- surface micro machining- Wafer bonding-glass-frit, anodic and fusion bonding- Structural and Sacrificial Materials- Acceleration of sacrificial Etch- LIGA- SLIGA-applications; Micro system packaging materials - die level - device level - system level - packaging techniques- die preparation- surface bonding - wire bonding - sealing. Mechanical micromachining- Chip formation- Size effect in micromachining- micro turning, micro milling,micro drilling- Micromachining tool design- Precision Grinding- Partial ductile mode grinding-Ultraprecision grinding- Binder less wheel- Free form optics.

Module-IV (8 hours)

Microfabrication process integrations, Wafer IC manufacturing- feature micro fabrication technologies- PSM- IC industry- New Materials- Bonding and layer transfer- devices- clean room-yield modelmicro fabrication industries.

Books:

1. Sami Franssila, "Introduction to Micro Fabrication", John Wiley and sons Ltd., UK, 2004
2. Mark J. Jackson, "Microfabrication and Nanomanufacturing", CRC Press, 2006.
3. Peter Van Zant, "Microchip fabrication", McGraw Hill, 2004.
4. V. K. Jain, "Micromanufacturing",CRC press, 2012.
5. N. P. Mahalik, "Micromanufacturing & Nanotechnology", Springer.

UPEME504 Surface Engineering

Module-1

Philosophy of surface engineering, general applications and requirements; Corrosion Processes: Basic principles of electrochemistry and aqueous corrosion processes; pitting, crevice and exfoliation corrosion; influence of deposits and anaerobic conditions; corrosion control; high temperature oxidation and hot corrosion; corrosion/mechanical property interactions.

Module-2

Friction and Wear: Abrasive, erosive and sliding wear. The interaction between wear and Corrosion. Analytical Techniques: X-ray diffraction, TEM, SEM and WDP analysis, surface analysis by other techniques;

Module-3

Surface Engineering: Philosophy; surface engineering as part of a manufacturing process; integrating coating systems into the design process; Coating Manufacture: Electro deposition; flame and plasma spraying; physical vapor deposition; chemical vapor deposition; surface treatments; paint and paint systems; Applications: Coating systems for corrosion and wear protection; new coating concepts including multi-layer structures, functionally gradient materials, intermetallic barrier coatings and thermal barrier coatings.

Books:

1. Surface Wear Analysis, Treatment & Prevention - ASM Inernational, Materials Park, OH, U. S. A., 1st Ed. 1995

2. Advanced Thermally Assisted Surface Engineering - Kluwer Academic Publisher, MA, USA, 2nd ed. 2002.

ULCME501 Machining Lab

Any six of the following experiments

1. Job on lathe with tapper turning, thread cutting, knurling and groove cutting (3 experiments).
2. Gear cutting (with index head) on milling machine
3. Working with shaper, Planner and slotting machine.
4. Working with surface and cylindrical grinding.
5. Determination of cutting force using Lathe tool dynamometer.
6. Determination of cutting force in drilling using drill tool dynamometer.
7. Study of Non-traditional machining processes.(USM, AJM, EDM, ECM)
8. Study of CNC Lathe and demonstration of making job in CNC lathe.
9. Study of CNC Milling machine and demonstration of making job in CNC Milling machine

ULCME502 Heat Transfer

1. Determination of Thermal conductivity of composite slab
2. Determination of heat transfer coefficient in natural/forced convention.
3. Determination of surface emissivity
4. Performance test on parallel flow and counter flow heat exchanger
5. Efficiency and effectiveness of fins (Natural / Forced convection)
6. Determination of Critical heat flux during boiling heat transfer.
7. Verification of Stefan Boltzman's law.

ULCME503 Measurement and Metrology

Any eight of the following experiments

1. Calibration of LVDT using indicator / CRO
2. Calibration of load cell using electrical resistance strain gauge
3. Calibration of a Rotameter for fluid flow measurement
4. Calibration of thermo couples
5. Calibration of Bourden Tube Pressure Gauge and measurement of pressure using manometer

6. Experiment on Pneumatic trainer
7. Experiment on Hydraulic trainer
8. Determination of damping coefficient of vibration absorbing materials using vibration measuring equipment.
10. Strain measurement using resistant strain gauge
11. Measurement of straightness and flatness
12. Measurement of roughness of the surface
13. Experiment on slip gauges and sine bar
14. Experimental stress analysis through Photo-elasticity.

6th Semester

UPCME601 Machine Dynamics

Prerequisites:

Engineering Mechanics, Mechanics of Solid, Engineering Mathematics, Material Science, Kinematics and Dynamics of Machines

Course objectives:

1. To understand the concepts of turning moment diagrams, flywheel design and the dynamics of reciprocating engines.
2. To be able to design some linkage mechanisms and cam systems to generate specified output motion
3. To understand the balancing procedures for rotating and reciprocating masses, rotors and engines.
4. To understand the fundamentals of free and forced vibrations.
5. To understand the mechanisms for control.

Course Outcome

On successful completion of this course the students should be able to:

1. Demonstrate an understanding of turning moment diagrams in various applications. Demonstrate skills to design flywheel for an IC engine and punching press with the consideration of geometrical and economical constraints.
2. Perform static and dynamic balancing of high speed rotary and reciprocating machines.
3. Analyze free and forced vibrations of machines, engines and structures.
4. Calculate gyroscopic couple on various vehicles and apply concept of governors.

Module – I (12 hours)

1. Combined Static and Inertia Force Analysis: Inertia forces Analysis, Velocity and acceleration of slider crank mechanism by analytical method, Engine force analysis - Piston effort, force acting along the connecting rod, Crank effort. Dynamically equivalent system, compound Pendulum, correction couple.

2. Mechanisms with lower pairs : Motor Vehicle Steering Gears - Davis Steering Gear &

Ackermann Steering Gear, Hooke's Joint.

3. Cams Design: Fundamental law of Cam, Cam Terminology, Classification of Cams and followers, Analysis of follower motions (Displacement, velocity, Acceleration and jerk) – Simple Harmonic, Uniform Velocity and Constant Acceleration & Retardation Types, Generation of Cam Profiles by Graphical Method, Introduction on Cams with specified contours.

Module – 2 (12 hours)

4. Turning Moment Diagram and Flywheel: Turning moment diagram. Turning moment diagrams for different types of engines, Fluctuation of energy and fluctuation of speed. Dynamic Theory of Flywheel, Flywheel of an internal combustion engine and for a punch machine. Determination of flywheel size from Turning Moment Diagram.

5. Mechanism for Control (Governors): Governors - Watt, Porter, Proell, Hartnell, Wilson-Hartnell Governor. Performance parameters: Sensitiveness, Stability, Hunting, Isochronism. Governor Effort and Power, Controlling Force & Controlling Force Curve, Friction & insensitiveness, Comparison between governor and flywheel.

6. Mechanism for Control (Gyroscope): Introduction to Gyroscopes. Gyroscopic forces and Couple. Effect of Gyroscopic Couple on Aeroplanes, Gyroscopic stabilization of ship, Stability of Two Wheelers and Four Wheelers. Rigid disc at an angle fixed to rotating shaft.

Module 3 (12 hours)

7. Balancing of rotating components and linkages: Static and Dynamic Balancing, Balancing of Single Rotating Mass by Balancing Masses in Same plane and in Different planes. Balancing of Several Rotating Masses rotating in same plane and in Different planes. Effect of Inertia Force due to Reciprocating Mass on Engine Frame, Partial balance of single cylinder engines. Primary and Secondary Balance of Multi-cylinder In-line Engines. Balancing of locomotive: variation of tractive force, swaying couple, hammer blow. Direct and Reverse Crank method of balancing for radial engines. Balancing of V-engine. Balancing machines: Pivoted-Cradle Balancing Machine.

8. Vibrations: Introduction to Mechanical Vibration – Definitions, elements of vibratory system, Longitudinal, Torsional & Transverse Systems. Differential equations and solutions of motion for a coupled spring mass system. Determination of natural frequency of vibratory systems using energy method, equilibrium method and Rayleigh's method, Free and Forced Vibration of Un-damped and Damped Single Degree Freedom Systems, Logarithmic decrement, Magnification factor, Vibration isolation and transmissibility, whirling of shafts and Evaluation of Critical Speeds of shafts.

Text Books

1. Theory of Machines by S.S.Rattan, Tata MacGraw Hill
2. Mechanism and Machine Theory by J.S.Rao and R.V.Dukipatti, New Age International.
3. Theory of Mechanisms and Machines by A. Ghosh & A. K. Mallick, East West Press.

Reference

1. Theory of Machines by Thomas Bevan, CBS Publications.
2. Kinematics and Dynamics of Machinery by R.L.Norton, Tata MacGraw Hill
3. Theory of Machines and Mechanisms (India Edition) by John J. Uicker Jr., Gordon R. Pennock and Joseph E. Shigley, Oxford University Press
4. Kinematics & Dynamics of Machinery-Charles E. Wilson & J.Peter Saddler,Pearson Ed.

UPCME602 Refrigeration and Air Conditioning

Objectives:

1. To familiarize with the terminology associated with refrigeration systems and air conditioning

2. To understand basic refrigeration processes

3. To understand the basics of psychrometry and practice of applied psychrometrics

4. To acquire the skills required to model, analyse and design different refrigeration as well as air conditioning processes and components

Course Outcomes:

A student who has done the course will have a good understanding of the working principles of refrigeration and air-conditioning systems.

Course Content:

Module – 1 (12 Hours)

1. Air Refrigeration System : Introduction, Unit of refrigeration, Coefficient of performance,

Reversed Carnot Cycle, Temperature limitations, maximum COP, Bell Coleman air cycle, Simple Air Cycle System for Air-craft with problems.

2. Vapour Compression System : Analysis of theoretical vapour compression cycle,

Representation of cycle on T - S and p - h diagram, Simple saturation cycle, sub-cooled cycle and super-heated cycle, Effect of suction and discharge pressure on performance, Actual vapour compression cycle. Problem illustration and solution.

3. Multi-stage compression and Multi-evaporator systems : Different arrangements of compressors and inter-cooling, Multistage compression with inter-cooling, Multievaporator system, Dual compression system. Simple problems

Module – 2 (12 Hours)

4. Vapour Absorption System : Simple Ammonia - absorption system, Improved absorption system, Analysis of vapour absorption system (Specifically of analyzing coloumn and rectifier), Electrolux / Three fluid system, Lithium-bromide-water vapour absorption system, comparison of absorption system with vapour compression system. Simple Problems and solution.

5. Thermoelectric Refrigeration: Basics and Principle. Defining the figure of Merit. (No Problem)

6. Refrigerants ; Classification of refrigerants and its degignation- Halocarbon (compounds,

Hydrocarbons, Inorganic compounds, Azeotropes, Properties of refrigerants, comparison of common refrigerants, uses of important refrigerants, Brines. Alternative refrigerants (Organic and inorganic compounds).

Module – 3 (10 Hours)

7. Psychrometrics : Properties of air-vapour mixture, Law of water vapour-air mixture,

Enthalpy of moisture, Psychrometric chart, simple heating and cooling, Humidification, Dehumidification,

Mixture of air streams. Review question and discussions

Requirements of comfort air conditioning: Oxygen supply, Heat removal, moisture removal, air motion, purity of air, Thermodynamics of human body, comfort and comfort chart, effective temperature, factors governing optimum effective temperature

Module – 4 (06 Hours)

8. Air Conditioning System: Process in air conditioning: Summer air conditioning, Winter air conditioning and year round air conditioning, Cooling load calculations. Review question and discussions.

TEXT BOOKS :

1. Refrigeration and Air Conditioning by R.C. Arora , PHI Publication

2. Refrigeration and Air conditioning by C.P. Arora, Tata McGraw Hill.

3. 2Refrigeration and Air Conditioning by S.C. Arora and S. Domkundwar, Dhanpat Rai & Sons.

Chapters ; 3,4,5,6,7,11,16,17,19,20

4. Refrigeration and Airconditioning Data book by Manohar Prasad

REFERENCE BOOKS :

1. Refrigeration and Air conditioning by P.L. Ballney, Khanna Publishers.

2. Refrigeration and Air conditioning by Manohar Prasad,New Age international publishers

UPEME601 Advanced Fluid Mechanics

Module 1 (08 Hours)

Concept of continuum and definition of a fluid. Body and surface forces, stress tensor, Scalar and vector fields, Eulerian and Lagrangian description of flow. Motion of fluid element - translation, rotation and vorticity; strain rate tensor, continuity equation, stream function and velocity potential.

Module -2 (10 Hours)

Transport theorems, constitutive equations, derivation of Navier Stokes equations for compressible flow. Exact solutions of Navier Stokes equations : plane Poiseuille flow and Couette flow, Hagen-Poiseuille flow, flow between two concentric rotating cylinders, Stoke's first and second problem, Hiemenz flow, flow near a rotating disk, flow in convergent- divergent channels. Slow viscous flow: Stokes and Oseen's approximation,

Module - 3 (10 Hours)

Theory of hydrodynamic lubrication. Boundary layer: derivation, exact solutions, Blasius, Falkner Skan, series solution and numerical solutions. Approximate methods. Momentum integral method.

Module - 4 (08 Hours)

Two dimensional and axisymmetric jets.Description of turbulent flow, velocity correlations,

Reynold's stresses, Prandtl's Mixing Length Theory, Karman's velocity defect law, universal velocity distribution.

Text Book:

1. Advanced Fluid Mechanics, Som and Biswas, Tata McGraw Hill

Reference Books:

1. Fluid Mechanics, A.K.Mohanty, PHI
2. Fundamentals of Fluid Mechanics, Schlitching
3. Introduction to Fluid Mechanics, Shaughnessy, Oxford University Press
4. Fluid Mechanics:-Frank M .White, TMH
5. Fluid Mechnics:- Cengel and Cimbala, TMH

UPEME602 Gas Dynamics

Course Objectives:

1. To understand the features of compressible isentropic flows and irreversibilities like shocks.
2. To provide a basic knowledge of jet and rocket propulsion technologies.

Course Outcomes:

Upon completion of this course, the students will be able to apply gas dynamics principles to jet and space propulsion systems

Contents:

Module - 1

Compressible flow, definition, Mach waves and Mach cone, stagnation states, Mass, momentum and energy equations of one-dimensional flow, Isentropic flow through variable area ducts, nozzle s and diffusers, subsonic and supersonic flow

Module - 2

Variable area ducts, choked flow, Area-Mach number relations for isentropic flow

Non-isentropic flow in constant area ducts, Rayleigh and Fanno flows, Normal shock relations, oblique shock relations, isentropic and shock tables

Module - 3

Theory of jet propulsion, thrust equation, thrust power and propulsive efficiency, Operating principle and cycle analysis of ramjet, turbojet, turbofan and turboprop engines.

Types of rocket engines, propellants & feeding systems, ignition and combustion, theory of rocket propulsion, performance study, staging, terminal and characteristic velocity, space flights

Text Books:

1. Ahmed F. El-Sayed, Aircraft Prpoulsion and Gas Turbine Engines, CRC Press, 2008.
2. H.S. Mukunda, “Understanding Aerospace Chemical Propulsion”, Interline Publishing, 2004.
3. Hill P. and Peterson C., Mechanics & Thermodynamics of Propulsion, Addison Wesley, 1992.

4. Zucrow N. J., Aircraft and Missile Propulsion, Vol.I& II, John Wiley, 1975.
5. Sutton G.P., Rocket Propulsion Elements, John Wiley, New York, 1986.

UPEME603 Combustion Theory

Course Outcome:

After completing this course students will be able to:

a) Design the combustion chamber of furnaces, boiler, gas turbine and IC engine.
b) Identify the combustion problems in any type of Power plants.
c) Able to compile the type of combustion and give the plan for betterment
d) Able to evaluate the flame propagation in different types of combustion geometry.

Able to predict and solve the combustion problems in IC engine and gas turbine

Module - 1

CYCLE ANALYSIS ; Gas, steam and combined power cycles, refrigeration and air conditioning cycles, The First and Second Laws of Thermodynamics applied to combustion.

Module - 2

COMBUSTION THEORY ; Fuels and types, combustion process, combustion mechanism; Governing equations for a reacting flow, General characteristics of combustion volumetric combustion, explosion and detonation, adiabatic flame temperature, flame propagation, stability, kinetics, combustion aerodynamics, gaseous detonations, flame ignition and extinction and condensed phase combustion, combustion in SI and CI engines, ignition and burning rate analysis.

Module - 3

COMBUSTION SYSTEMS ; Solid burning equipments, stokers, pulverized coal burning systems, cyclone combustors, emissions, types of fluidized beds, fluidized bed combustion, fundamentals bubbling bed, gas and liquid burners types, gas turbine combustion systems, combustion modeling

Module - 4

DESIGN OF COMBUSTION SYSTEMS ; Design of combustion systems for boilers, furnaces, gas turbines and internal combustion engines, combustion chamber performance.

PROPELLANT SYSTEMS; Types, theory of combustion, energy balance calculations

Books:

1. C.R. Ferguson and A.T. Kirk Patrick, ―Internal Combustion Engines, John Wiley & Sons. Inc. 2001.
2. Stephen R Turns, ―Introduction to Combustion: Concepts and Applications, McGraw Hill, 2000
3. G.L. Borman and K.N. Ragland, ―Combustion Engineering, McGraw Hill, 1998.
4. D.Winterbone, ―Advanced Thermodynamics for Engineers, Elsevier, 1996

UPEME604 Tribology

Module - 1 (12 Hours)

Introduction : Lubricant and lubrication, Types of bearings, properties and testing of lubricants,

Basic equations: Generalized Reynolds equation, Flow and Shear Stress, Energy equation, Equation of state Hydro dynamic lubrication: Mechanism of pressure development and load carrying capacity, Plane-slider bearing, Idealized slider bearing with a pivoted shoe, Step bearing, Idealized journal bearing. – infinitely long journal bearing, Petroffs equation for a lightly loaded bearing, narrow bearing,

Module - 2 (11 Hours)

Oil flow and thermal equilibrium - Heat balance of lubricants

Hydrostatic Bearing**:**

Principles, Component of hydrostatic lubrication , Hydrostatic circular thrust bearing , calculation of pressure, load carrying capacity, flow rate , power loss in bearing due to friction.

Module - 3 (12 Hours)

Concept of gas lubricated bearing

Concept of Elastohydrodynamic lubrication, Design and selection of antifriction bearing

Friction and wear of metals :

Theories of friction, surface contaminants, Effect of sliding speed on friction, classification and mechanism of wear, Wear resistant materials.

Text Books

1. Introduction to Tribology of Bearing , B.C .Majumdar , S. Chand & Co

Reference Books

1. Fundamentals of Tribiology , Basu S K., Sengupta A N., Ahuja B. B., , PHI 2006
2. Basic Lubrication theory, A. Cameron, John Wiley & sons
3. Lubrication Fundamentals, D.M.Pirro and A.A.Wessol, CRC Press
4. Theory and Practice of Lubrication for Engineers**,** Fuller, D., New York company 1998
5. Principles and Applications of Tribiology**,** Moore, Pergamaon press 1998
6. Tribiology in Industries**,** Srivastava S., S Chand and Company limited, Delhi 2002
7. Lubrication of bearings – Theoretical Principles and Design**,** Redzimovskay E I.,
Oxford press company 2000

UPEME605 Advanced Mechanics of Solids (AMOS)

Modules - 1 (12 Hours)

Elementary concept of elasticity, stresses in three dimensions, Principal Stresses, Stress Invariants, Mohr's Circle for 3-D state of stress, Octahedral Stresses, State of pure shear, Differential equations of equilibrium and compatibility conditions, plane stress. Analysis of strain, State of strain at a point,

Strain Invariant, Principal Strains, Plane state of strain, Strain measurements. Theories of Failure, Various yield criteria

Modules - 2 (14 Hours)

Energy Methods: Work done by forces and elastic strain energy stored. Reciprocal relations,

Theorem of virtual work, Castigliano's theorems, Bending of beams: Asymmetrical bending, Shear centre, Bending of curved beams, Stress distribution in beam with rectangular, circular and trapezoidal cross section, stresses in crane hooks, ring and chain links., Deflection of thick curved bars. Axisymmetric problems: Thick walled cylinder subjected to internal and external pressures, Compound cylinders, Shrink fit,

Modules - 3 (10 Hours)

Repeated stresses and fatigue in metals, Fatigue tests and fatigue design theory, Goodman, Gerber and Soderberg criteria, Concept of stress concentration, Notch sensitivity. Introduction to Mechanics of Composite Materials: Lamina and Laminates, Micromechanics of FRP Composites. Introduction to Fracture Mechanics: Basic modes of fracture, Fracture toughness evaluation.

Text Book:

1. Advanced Mechanics of Solids, L.S. Srinath, Tata McGraw Hill
2. Advanced Mechanics of Materials: Boresi and Schmdt, Willey
3. Strength of Materials by G. H. Ryder, Macmillan Press

Reference Book:

1. Advanced Mechanics of Materials: Siley and Smith
2. Strength of Materials Vol.II, by S.Timoshenko
3. Mechanics of Materials by Beer and Johnston, Tata McGraw Hill
4. Mechanics of Materials by R.C.Hibbeler, Pearson Education
5. Mechanics of Materials by William F.Riley, Leroy D.Sturges & Don H.Morris, Wiley Student.
6. Mechanics of Materials by James M. Gere, Thomson Learning
7. Strength of Materials by S. S. Rattan, Tata Mc Graw Hill

UPEME606 Simulation, Modeling & Control

Module – 1 (14 Hours)

Basic simulation modeling, Discrete event simulation, Simulation of queuing and inventory systems, Continuous, Discrete-continuous and Monte Carlo simulations.

Statistical models in simulation, Discrete and continuous distributions, Poisson process, Empirical distribution,

Generation of pseudo random numbers, Analysis of simulation data, Parameter estimation, Goodness-of-fit tests, Multivariable time series models.

Modules - 2 (12 Hours)

Overview of feedback control systems, Dynamics of mechanical systems, Differential equations and

state variable form, Models of electromechanical, Heat-and fluid flow models, Linearization and scaling, Models from experimental data, Dynamic response using pole-zero locations, Time domain specifications, Classical 3-term controllers and its digital implementation, Stability analysis by Routh Criterion.

Modules - 3 (10 Hours)

Simulation of manufacturing and material handling systems, Goals and performance measures, Modeling downtime and failures, Trace driven models, Case studies.

Text Books:

1. Discrete-Event system simulation by Jerry Banks, J.S. Carson, B.L. Nelson and D.M. Nicol (Pearson Publications).
2. Feedback control of dynamic systems by G.F. Franklin, J.D. Powell, A-Naeini, Pearson Publications.
3. Simulation modeling and analysis by A.M. Law, W.D. Kelton, Tata McGrawHill Publications.

UPEME607 Soft Computing Applications

Prerequisites Engineering Mathematics

Course objectives:

1. To introduce the concepts of neural networks and advanced neural networks
2. To understand the fundamentals of fuzzy sets and fuzzy logic
3. To establish basic knowledge about optimization techniques in soft computing.

Course Outcome

On successful completion of this course the students should be able to:

1. Design soft computing techniques for various applications domains
2. An ability to design, implement and evaluate a system / computer based system process, component or program to meet desired needs.
3. An ability to identify, formulate and solve engineering problems.

Course Content:

Module – 1: Neural Networks (12 hours)

Introduction to Soft Computing, Artificial Neural Network(ANN) : History, Mathematical model of neuron, Fundamentals of ANN, Basic Models of an artificial Neuron, Neural Network Architecture, Learning methods, Terminologies of ANN, Perceptron, network, Backpropagation network, Backpropagation learning and its applications, Variants of BPA, Associative Memory: Auto correlation, Hetero Correlation, Exponential BAM, Adaptive Resonance Theory: Vector Quantization, ART1, ART2, applications, Kohonen's Self Organizing Map.

Applications - Real life Problems: Design of Journal Bearing, Hot Extrusion of Steel using MATLAB.

Module – 2: Fuzzy Logic Techniques (12 hours)

Uncertainty and Imprecision, Chance vs ambiguity, Fuzzy Sets, Fuzzy Relations, Membership functions, Properties of Membership functions, Fuzzification and Defuzzification. Classical Logic and

Fuzzy logic, Fuzzy Rule based systems, Fuzzy Decision making, Fuzzy Classification, Fuzzy Pattern Recognition, Hybrid Soft Computing Techniques Hybrid system, neural Networks, fuzzy logic.

Applications - Real life Problems: Fuzzy Washing Machines, Fuzzy Systems in Cars, Fuzzy Control of a Cement Kiln, Fuzzy Control of Subway Train using MATLAB.

Module – 3: Optimization Techniques (12 hours)

Derivative based Optimization – Descent Methods – Genetic Algorithms – Ant Colony Optimization – Particle Swarm Optimization

Case Study - fraud detection, health care using Soft computing techniques.

Text Books

1. Neuro Fuzzy and Soft Computing, J. S. R. JANG,C.T. Sun, E. Mitzutani, PHI

2. Neural Networks, Fuzzy Logic, and Genetic Algorithm (synthesis and Application) S.Rajasekaran, G.A. Vijayalakshmi Pai, PHI

Reference

1. Fuzzy Logic with Engineering Applications, T.J. Ross, McGraw Books Hill.

2. Genetic Algorithms: Search, Optimization and Machine Learning, Davis E. Goldberg, Pearson Educaton.

3. Introduction to Artificial Neural systems, Zurada, J.M., Jaico Publishing House.

UPEME608 Computer Aided Design

Course Objective:

To provide an overview of how computers can be utilized in mechanical component design

Course Outcome:

Upon completion of this course, the students can use computer and CAD software for modelling mechanical components

Course Contents:

Fundamentals of Computer Graphics- Product cycle, sequential and concurrent engineering,

Computer Aided Design, CAD system architecture, computer graphics, Coordinate systems, 2D and 3D transformations, viewing transformation

Geometric Modeling- representation of curves, Hermite curves, Bezier curves, B-spline curves, rational curves, Techniques of surface modelling, surface patch, Coons and bicubic patches, Bezier and B-spline surfaces, Solid modelling techniques, CSG and B-rep.

Visual realism- hidden line-surface-solid removal algorithms, shading, colouring, computer animation

Assembly of parts- assembly modelling, interferences of positions and orientation, tolerance analysis, mass property calculations, mechanism simulation and interefence checking

CAD standards- Graphical Kernel System (GKS), standards for vexchange images, Open Graphics Library (OpenGL), Data exchange standards- IGES, STEP, CALS etc., Communication standards

Text Books:

1. Ibrahim Zeid, Mastering CAD CAM, Tata McGraw Hill Publishing Co. 2007.
2. C. McMohan and J. Browne, CAD/CAM Principles, II edition, Pearson Education, 1999.
3. W. M. Neumann and R.F. Sproul, Principles of Computer Gra[hics, McGraw Hill, 1989.
4. D. Hearn and M.P> Baker, Computer Graphics, Prentice Hall Inc., 1992.

ULCME601 Design of Machine Component Lab

1. Design of any one working model related to Design of machine components i.e., Module I and II.
2. Design of any one working model related to Design of machine components i.e., Module III
3. Design & drawing of pressure vessel
4. Design and drawing of lever
5. Design and drawing of belt drive and pulley
6. Design of clutch
7. Design and drawing of brake
8. Design of piston
9. Design of connecting rod, crank shaft

Total number of Design: 1 and 2 are compulsory and any 5 from the rest. One or two designs should be in AutoCad/Pro-E/ CATIA/ANSYS

ULCME601 Numerical Computation lab

1. Basics of MATLAB or similar software/language
2. Finding solution by Numerical Methods (including graphics) for the following: **(Minimum 06 problems)**
   a) Bisection Method
   b) Newton-Raphson Method
   c) Secant Method
   d) Gauss Elimination Method
   e) Numerical Differentiation
   f) Numerical Integration (e.g. Newton Cotes Quadrature)
   g) Curve fitting Method
   h) Initial-Value Problems (e.g. Runge-Kutta Method)
   i) Boundary Value Problem (eg. Shooting Method)

j) Eigen Value Problem

3. Using Solid Modeling software eg. AUTOCAD / ProE / CATIA / SolidWorks etc)

a) Learning the Basics of Solid Modeling Software
b) Describe and Apply the CONE, SPHERE and TORUS command to draw solid primitives
c) Describe and Apply the EXTRUDE and REVOLVE command to draw solid models that can not be drawn with a composition of primitives

ULCME601 RAC Lab

Minimum 05 experiments

1. Determination of C.O. P on vapour compression system
2. Determination of C.O. P on vapour absorption system
3. Performance test on Air conditioning test rig (Window type)
4. Performance test on Air conditioning test rig (Duct type)
5. Determination of C.O.P of ice plant
6. Determination of C.O.P of Heat Pump
7. Performance analysis in an experimental cooling tower.

7th Semester

UPCME701 Project and Production Management

Course Objective:

The course aims at acquainting all engineering graduates irrespective of their specializations the basic issues and tools of managing production and operations functions of an organization.

Module - 1 (12 Hours)

1. Operations Function in an Organization, Manufacturing Vrs Service Operations, System view of Operations, Strategic Role of Operations, Operations Strategies for Competitive Advantage, Operations Quality and Productivity Focus, Meeting Global Challenges of Production and Operations Imperatives.

2. Designing Products, Services and Processes: New Product Design- Product Life Cycle, Product Development Process, Types of Production Systems: Jobshop, Batch, Mass Production; Process Technology Trends, FMS, CIM, CAD, CAM; Design for Services, Services Process Technology.

3. Location and Layout Planning: Factor Influencing Plant and Warehouse Locations, Impact of Location on cost and revenues. Layout Planning: Process Layout, Product Layout, Fixed Position Layout, Line balancing, computerized layout planning- overview, Group Technology

4. Work Study: Methods Study- Techniques of Analysis, recording, improvement and standardization;

Work Measurement : Work Measurement Principles using Stopwatch Time Study, Predetermined Motion Time Standards and Work Sampling, Standard Time Estimation.

Module - 2 (12 Hours)

5. Forecasting : Principles and Method, Moving Average, weighted Moving Average, Exponential Smoothing, Winter's Method for Seasonal Demand, Forecasting Error.

6. Manufacturing Planning and Control: Aggregate Planning, Master Production Scheduling, Material Requirements Planning, Capacity Requirements Planning.

7. Sequencing and Scheduling: Single Machine Sequencing : Basics and Performance Evaluation Criteria, Mean Flow Time, Flowshop sequencing: 2 and 3 machines cases : Johnson's Rule and Jobshop Scheduling: Priority dispatching Rules.

8. Inventory Control: Relevant Costs, Basic EOQ Model, Model with Quantity discount, Economic Batch Quantity, Periodic and Continuous Review Systems, Safety Stock, Reorder Point and Order Quantity Calculations. ABC Analysis.

9. Modern Trends in Manufacturing: Overview of Just in Time (JIT) System, Total Quality Management, Total Productive Maintenance, ISO 9000, Quality Circle, Kaizen, PokaYoke, Supply Chain Management.

Module - 3 (8 Hours)

10. Attributes of a Project, Project Life Cycle

11. Project feasibility Analysis: Technical feasibility, commercial and financial visibility, Environment Analysis. Breakeven Analysis

12. Project Execution: work breakdown structure, Network Techniques: AOA and AON, CPM and PERT, Resource allocation, Crashing and Resource Sharing

Text Books:

1. S.N.Chary, "Production and Operations Management", Tata McGraw Hill.

2. R. Paneerselvam, "Production and Operations Management, Prentice Hall of India.

3. Aswathappa & Bhatt – Production & Operations Management, HPH.

4. Gaither & Frazier - Operations Management, Cengage Publication

5. Russell & Taylor - Operations Management, PHI Publication

6. Chase, Aquilanno, Jacob & Agarwal - Operations Management, TMH Publication.

7. E.E. Adam and R.J. Ebert "Production and Operations Management", Prentice Hall of India

UPEME701 Power Plant Engineering

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

1. Describe different sources of energy, understand & explain the principle of power generation. Select suitable location.
2. Analyze & evaluate the design layout of steam, Nuclear, Oil based Power plant.
3. Calculate the performance of Power plant, Load factor, Capacity factor, Cost of power generation, Energy Tarrifs
4. Describe the working principle of the nuclear power plant and safety involved.

5. Understand the alternative sources of energy and the working of different non conventional power plant

UNIT-I (10 HOURS)

Introduction: Energy sources for electric power generation (Conventional and non-conventional),Principal types of power plant, Brief layout of different power plants, Site selection of power station, Present energy scenario of India, Central power station.

Economics of power generation: Load & load duration curves, Base load and peak load power plant, load estimation, variable load problem, Costs of electric generation (fixed, Operating cost),depreciation and replacement , Factors affecting economics of generation and distribution, energy rates (Tarrifs),Performance and operating characteristics. Economic load sharing.

UNIT-II (10 HOURS)

Steam power plant : Overview of thermodynamic cycle, Heat balance & Efficiencies in steam power plant, Modern high pressure boilers, Deaeration, Coal & ash handling system, Dust Collectors, Co-generation of power plant & process heat, Combined Cycle power plant: Coal based combined plant, Integrated gasification (IGCC), Combined -MHD steam power plant, Thermoelectric steam power plant.

Fuels & Combustion: Fuels, Combustion reaction, Heat & enthalpy of combustion, free energy of formation, Equilibrium constant, Combustion Mechanism, Combustion equipment.

UNIT-III (16 HOURS)

Diesel Power Plants: General layout, Components of Diesel engine power plant, Application of diesel engines in power field, Advantages and disadvantages, Performance characteristics, Diesel plant operation & efficiency, Comparison with steam based power plant.

Nuclear Power Plant: Nuclear fuels, Fusion ,Fission ,Chain reactions, Types of nuclear reactors, Pressurized water reactor, BWR, CANDU reactor, Gas-cooled reactor, Liquid metal fast breeder reactor, Uranium enrichment, Nuclear Safety and disposal of nuclear waste, India's nuclear power stations.

Non-Conventional Power plants: Solar thermal and solar photo voltaic plants, Wind power plants, Bio-mass plants, Geothermal power plant, Tidal power plant,Brief idea about Components, working & selection criteria.

Texts/Reference:

1. Power Plant Engineering: P.K. Nag: Tata McGraw Hill Publisher
2. Power Plant Engineering: G.R.Nagpal: Khanna Publication
3. A Course in Power Plant Engineering: Arora & Dom Kundwar: Dhanpat Rai & Sons
4. Power Plant Engineering: P.C. Sharma: S.K. Kataria & Sons
5. Power Plant Technology, M.M. El-Wakil, McGraw-Hill Education

UPEME702 Non-conventional Energy

Prerequisites: Thermodynamics, Fluid Mechanics

Course outcomes:

- Learn the fundamentals of solar energy conversion systems, available solar energy, solar thermal and PV applications.
- Learn how to advance the current technology of the solar energy systems for making the process economical, environmentally safe and sustainable.
- Learn the basics of wind, geothermal, ocean thermal, tidal, bio mass, wave and fuel cell.
- Apply the non conventional energy sources for day to day applications for better environment.

Module 1: (10 Classes)

Energy, Ecology and environment: Introduction, Classification of Energy Resources, Common Forms of Energy, Energy Chain, Advantages and Disadvantages of Conventional Energy Sources, Importance and Salient Features of Non-Conventional Energy Sources, Environmental and ecological Aspects of Energy use, Environment-Economy-Energy and Sustainable Development, World Energy Status, Energy Scenario in India. Energy Conservation and Energy Storage: Salient Features of "Energy Conservation Act, 2001", Various Aspects of Energy Conservation, Principles of Energy Conservation, General Electrical ECO's (Energy Conservation Opportunities),

Module 2: (15 Classes)

Solar Energy: Basics, The Sun as a Source of Energy, Sun, Earth Radiation Spectrums, Extraterrestrial and Terrestrial Radiations, Spectral Energy Distribution of Solar Radiation, Depletion of Solar Radiation, Measurements of Solar Radiation, Solar Time (Local Apparent Time), Solar Radiation Geometry, Solar Day Length, Empirical Equations for Estimating Solar Radiation(Hourly Global, Diffuse and Beam Radiations) on Horizontal Surface Under cloudless and cloudy Skies, Solar Radiation on Inclined Plane Surface only (empirical relations for numerical). Solar Thermal Systems: Solar Collectors: Flat plate and concentric collectors, Solar Water Heater, Solar Passive Space - Heating and Cooling Systems, Solar Refrigeration and Air Conditioning Systems, Solar Cookers, Solar Furnaces, Solar Green House, Solar Dryer, Solar Distillation (or Desalination of Water), Solar Photovoltaic Systems: Solar Cell Fundamentals, Solar Cell Characteristics, Solar Cell Classification, Solar Cell, Module, Panel and Array Construction, Solar PV Systems, Solar PV Applications.

Module 3: (15 Classes)

Wind Energy: Origin of Winds, Nature of Winds, Wind Turbine Siting, Major Applications of Wind Power, Wind Turbine Types and Their Construction, Wind Energy Conversion Systems (WECS), Effects of Wind Speed and Grid Condition (System Integration), Biomass Energy: Photosynthesis Process, Usable Forms of Biomass, their Composition and Fuel Properties, Biomass Resources , Biomass Conversion Technologies, Urban Waste to Energy Conversion, Biomass Gasification ,Biomass Liquefaction, Biomass to Ethanol Production, Biogas Production from Waste Biomass, Energy Farming. Geothermal Energy: Applications, Origin and Distribution of Geothermal Energy, Types of a. Geothermal Resource. Ocean Energy: Tidal Energy, Wave Energy, Ocean Thermal Energy 8. Fuel Cell Technology: Types, Principle of operation, Advantages and disadvantages.

Text Books:

1. Solar Energy Technology: Sukhatme and Nayak, TMH
2. Renewable Energy Sources and Emerging Technology: D.P.Kothari and etal., PHI
3. Renewable Energy Sources & Conversion Technology: N.K.Bansal, Manfred Kleenman & Michael Meliss, TMH Publication.
4. Non Conventional Energy Sources: B.M Khan, TMH Publications

UPEME703 Automobile Engineering

Course description: After completing this course, students will have a broad and fundamental understanding of Automobile Engineering. Topics range from a classification of automobile to details sub systems of vehicle such as engine, clutch, gear box, transmission line, differential gear box, types of axles, steering system, breaking system and electrical system overdrive suspension system etc. and career options available within this field

Course Objectives:

1. To study basics of principles of actual automobile systems.
2. To study importance and features of different systems like axle, differential, brakes, Steering, suspension, and balancing etc
3. To study working of various Automobile Systems.
4. To know some modern trends in Automotive Vehicles.

Course Outcomes:

Course objectives are to be fulfilled. Students learn and become familiar with

1. Understand the Construction, working and other details about Internal Combustion Engines used in automobiles
2. Identify Construction, working, preventive maintenance, trouble shooting and diagnosis of various Automobile Systems.
3. Understand importance and features of different systems like axle, differential, brakes, steering, suspension, and balancing etc.
4. Identify Modern technology and safety measures used in Automotive Vehicles

Course Content:

Module 1:

Classification of automobiles, chassis, body, layout types, Sub-systems of automobile PowerUnit:- Functions and locations power for propulsion, Engine parts-types, construction and functions, multiple cylinder engines. General considerations of engine balance vibration, firing order road performance curves.

Module 2:

Fuel feed systems: - fuel feed systems for petrol engines. Fuel pumps, Basicprinciples of MPFI and CRDI. Multipoint Fuel Injection Systems (MPFI), Common Rail Diesel Injection Systems (CRDI), Cooling system: purpose, types of cooling system, troubles and remedies of cooling system.

Lubrication: - Types of lubricants, multi viscosity oils, chassis lubrication. Engine lubrication:-types of lubricating systems, crankcase ventilation, and Engine lubrication troubles and remedies.

Module 3:

Transmission system: - Construction, transmission, requirements of single plate friction clutch and multiplate clutch, clutch adjustments, clutch troubles and remedies. Gear Boxes: - Sliding mesh, constant mesh and synchromesh gear box, function of over drives, trouble shooting and remedies. Propeller shaft, Hotchkiss drive torque tube drive, differential, Final drives Types of rear axles.

Module 4:

Braking system:- Mechanical, hydraulic brakes, power brakes, air brakes and vacuum brakes Fault

finding and maintenance of brakes, Steering system:- Function, types of linkages, Steering gears, steering gear ratio. Wheel alignment, steering geometry, & their effects, Introduction of power steering.

Suspensions: - Types of Rigid, axle and independent suspension system, shock absorbers.

Module 5:

Starter motor drive- Bendix drive, over running clutch drive, Solenoid switch; solenoids switch. Ignition system: - Battery coil and magneto ignition system, Ignition timing and its effect on engine performance, Ignition advance mechanisms, Electronic ignition system.

Electrical vehicles: History, electrical vehicles and the environment pollution, description of electric vehicle, operational advantages, present EV performance and applications, battery for EV, Battery types and fuel cells, Solar powered vehicles, hybrid vehicles.

UPEME704 Automatic Control System

Module – 1

Introduction: Control systems, Feedback and its effects. Transfer Function, Block Diagram and Signal Flow Graph: Impulse response and Transfer functions of linear systems, Block diagrams.

Module – 2

Mathematical Modeling of Physical Systems: Equations of electrical networks, Modeling of mechanical system elements, Equations of mechanical systems. State-variable Analysis of Linear Dynamic Systems: Matrix representation of state equations, State transition matrix, State transition equation, relationship between state equations and high-order differential equations, relationship between state equations and transfer functions, Characteristic equation, eigen values and eigen vectors.

Module – 3

Time-Domain Analysis of Control Systems: Typical test signals for the time response of control systems, Time- domain performance of control systems- The steady- state error, Time-domain performance of control systems- Stability of control systems- stability, Characteristic equation and the state transition matrix, Methods of determining stability of linear control systems, Routh- Hurwitz criterion.

Module - 4

Frequency-domain Analysis of Control Systems: Introduction, Nyquist stability criterion, Application of the Nyquist criterion, Stability of multi loop systems, Stability of linear control systems with time delays.

Text Books:

1. Automatic Control Systems, by Benjamin C. Kuo. PHI Publication

2. Control Systems Engineering by Nagrath/Gopal ,New age international.

UPEME705 Advanced Manufacturing Processes

Prerequisite: Basic Manufacturing Process

Module-1

Non-traditional machining processes – classification.

Chemical and electrochemical processes - material removal - maskants and etchants – types of chemical material removal - application and limitations - Electrochemical material removal. Thermo-electrial processes - types - electrical discharging machining, electron beam machining, ion beam machining and plasma arc machining. Mechanical processes - ultrasonic machining abrasive jet machining - abrasive flow machining - water jet cutting.

Module-2

Special Machining Processes - polygonal turning and drilling deep hole drilling and trepanning - shaped tube electrolytic machining - thread rolling - roller burnishing – electrical discharge wire cutting - thermal deburring - orbital grinding micromachining – Numerical control and automated processes.

Module-3

Introduction to nano-technology processes.

Books:

1. Production Technology by HMT, Tata McGraw Hill, 2002.
2. Wellar, P.C., Non-Traditional Machining Processes, SME, Michigan, 1984.
3. Pandey, P.C., Modern Machining Processes, Tata McGraw Hill Company, 2004.
4. Serope Kalpakjian, Manufacturing Processes for Engineering Materials, 3rd ed., Addison Wesicy Publishing Company, 19

UPEME706 Micro Electro Mechanical System (MEMS)

Course objectives:

To gain basic knowledge on overview of Micro electro Mechanical System (MEMS) with emphasis on basic principles, limitations and application in various fields. And to introduce the students various opportunities in the emerging field of MEMS.

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

1. Be fluent with the design, analysis and testing the MEMS based components.
2. Explore the applications of MEMS in various fields.
3. Understand the basic principle of Micro sensors and actuators and be familiar with the important concepts applicable to MEMS, their fabrication.

Course Content:

Module – 1 (10 hours)

Introduction to MEMS and Micro-systems and their products: History of MEMS Development, Microsystems, Characteristics of MEMS, miniaturization, microelectronics integration, applications. Micro-system Modeling and Design: Mechanics of deformable bodies, Energy method, Estimation of stiffness and damping for different micro-structures, Modeling of electro-mechanical systems, Pull-in

voltage.

Module - 2 (12 hours)

Electrical and mechanical properties of MEMS materials: Conductivity of semiconductors, crystal plane and orientation, stress and stain- definition- relationship between tensile stress and stain- mechanical properties of silicon and thin films, Flexural beam bending analysis under single loading condition- Types of beam- deflection of beam-longitudinal stain under pure bending spring constant, torsional deflection, intrinsic stress, resonance and quality factor.

Module - 3 (17 hours)

MEMS Applications: Mechanical sensor, Principles of sensing and actuation, Chemical sensors, Optical sensors, Pressure sensors, Thermal sensors- thermopiles, thermistors, micro-machined thermocouple probes, thermal flow sensors, MEMS magnetic sensor, Piezoelectric material as sensing and actuating elements-capacitance, piezo mechanics, Piezo actuators as grippers, microgrippers, micromotors, microvalves, micropumps, micro accelerometers, microfluidics, shape memory alloy based optical switch, thermally activated MEMS relay, micro spring thermal actuator, data storage cantilever.Radio frequency MEMS: Inductor, Varactor, Filter, Resonator.bio and chemo devices

Module - 4 (8 hours)

Microsystems designand packaging: Design considerations,Mechanical Design, Processdesign, Realization of MEMScomponents using intellisuite.Micro system packaging, PackingTechnologies, Assembly ofMicrosystems, Reliability inMEMS.

Books:

1. Foundations of MEMSby Chang Liu, Pearson International Edition, 2006.
2. Microsensors, MEMS and Smart devices Julian by W.Gardner and Vijay K Varadhan. John Wiley & sons, 2001.
3. Micro and Smart Systems by G.K. Ananthsuresh, K.J. Vinoy, S. Gopalakrishnan, K.N. Bhatand V.K. Atre. Wiley India, New Delhi, 2010.
4. MEMS by N.P. Mahalik, Tata McGraw-Hill, New Delhi, 2007.
5. MEMS and Microsystems: Design and Manufacture by T. Hsu, Tata McGraw-Hill, NewDelhi, 2002.

UPEME707 Ergonomics

Course Outcomes:

On completing this course successfully, the student will be able to:

1. Apply ergonomic principles to the creation of safer, healthier and more efficient and effective activities in the workplace;
2. Conduct ergonomic risk assessments;
3. Develop appropriate control measures for ergonomic risk factors;
4. Design a workplace according to good ergonomic principles;
5. Assess ergonomic aspects of the working environment and work organization.

Course Content:

Module 1

Introduction: The evolution of Ergonomics, reasons to use ergonomics, micro- and macro- ergonomics, performing ergonomics, judging the effectiveness of ergonomics intervention. Discipline approach: Ergonomics/ Human factors: Mutual task comfort: two-way dialogue, communication model, Ergonomics/ human Factors fundamentals, Physiology (work physiology) and stress.

Module 2

Ergonomics Methods and Techniques: Observational experimental methods identified which can be used for investigation, so that work, equipment and planned systems can be improved for human use.

Work Design: Task analysis and allocation of functions, User trials, problem solving-scientific method.

Ergonomic risk assessment: Definitions of hazard and risk, priorities, risk evaluation quantity and quality of risk, overall ergonomic approach, control measures monitoring and feedback

Module-3

Workplace, Job and Product Design:Important aspects in the design of workplaces, jobs and their results - products and services - are outlined, so that more effective and healthier work can be achieved. Existing data and routes to further sources of information are emphasized.

Workspace layout and equipment design:Principles of workstation and system design, space and workstation design principle, risk to health: Musculoskeletal problems, visual fatigue, mental stress, requirement fors eye tests.

Module-4

Design considerations for visual display unit (VDU) stations: Ergonomic factors, workstations, design of work and practice, carrying out assessments of risk at VDU workstation

Controls, Display and information: Visual, auditory and other display, Quantitative and qualitative information, Warning, signs and labels, sources and selection of data, principles of software ergonomics.

Relevant physical factors of the work environment: Lightning- visual acuity and color vision, lightning levels and contracts, reflection and flicker fusion, Noise- noise induced hearing loss, distraction, annoyance and emergency signal, Thermal environment- body temperature regulation, subjective assessment, thermal comfort and discomfort.

Books:

1. Bridger, RS: Introduction to Ergonomics, 2nd Edition, Taylor &Francis, 2003.

2. Dul, J. and Weerdmeester, B. Ergonomics for beginners, a quick reference guide, Taylor & Francis, 1993.

3. Green, W.S. and Jordan, P .W, Human Factors in Product Design, Taylor & rancis, 1999.

4. D. Chakrabarti, Indian Anthropometric Dimensions for ergonomic design practice,

National Institute of Design, Ahmedabad, 1997

5. G. Salvendy (edit), Handbook of Human Factors and ergonomics, John Wiley & Sons,Inc., 1998

6. Singh, S (Edt), Ergonomics Interventions for Health and Productivity, Himanshu

Publications, Udaipur, New Delhi, 2007

UPEME708 Product Design & Production Tooling

Course objectives:

To introduce students Design for Manufacturing and Assembly, analytical tools for developmentas well as conceptualize, design, and manufacture competitively-priced quality products.

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

1. Identify appropriate combination of tools, jigs and fixture, suitable for a particular machining operation
2. Identify press tool requirements to build concepts pertaining to design of press tools
3. Design the forging machine dies
4. learn the modern tools in manufacturing

Course Content

Module – 1: (14 Hours)

Product Design-Product design considerations, product planning, product development, value analysis, product specification. Role of computer in product design. Process Planning – selection of processes, machines and tools. Design of sequence of operations, Time & cost estimation

Module – 2: (14 Hours)

Forging design- allowances, die design for drop forging, design of flash and gutter, upset forging die design. Sheet metal working- Design consideration for shearing, blanking piercing, deep drawing operation, Die design for sheet metal operations, progressive and compound die, strippers , stops, strip layout.

Module – 3: (14 Hours)

Design of jigs and fixtures, principle of location and clamping, clamping methods, locating methods, Drill Jig bushing, Indexing type drilling Jig. Design of single point cutting tool, broach and form tool. Tooling design for turret lathe and automats. Design of limit gauges.

Books:

1. Product Design & Manufacturing, A K Chitale, R C Gupta, Eastern Economy Edition, PHI.
2. Product Design & Development, Karl T Ulrich, Steven D Eppinger, Anita Goyal, Mc Graw Hill.
3. A Textbook of Production Engineering, P.C. Sharma, S. Chand & Co
4. Fundamentals of Tool Engineering design, S.K. Basu, S.N. Mukherjee, R. Mishra, Oxford & IBH Publishing co.
5. Technology of Machine Tools, Krar, Gill, Smid, Tata Mc Graw Hill
6. Jigs & Fixture Design, Edwrd G Hoffman, Cengae Learning.

UHSMH701 Entrepreneurship Development

Module-I: (10 Hours)

Entrepreneurship: Concept of Entrepreneurship and intrapreneurship, Types of Entrepreneur, Nature

and Importance, Entrepreneurial Motivation and Achievement, Entrepreneurial Personality & Traits and Entrepreneurial Skills.

Module - 2: (10 Hours)

Entrepreneurial Environment, Identification of Opportunities, Converting Business opportunities into reality. Start-ups and business incubation, Skill Development. Setting up a Small Enterprise. Issues relating to location, Environmental Problems and Industrial Policies and Regulations.

Module - 3: (10 Hours)

Basics of Accounting, Terms: Assets, Liabilities, Equity, Revenue, Expense,Working capital, Marketing Mix and STP

HRM: Concepts and Function, Labour Laws- Factories Act, Organizational support services – Central and State Government, Incentives and Subsidies.

Module - 4: (10 Hours)

Sickness of Small-Scale Industries, Causes and symptoms of sickness, cures of sickness, Role of Banks and Government in reviving sick industries.

Recommended Books:

1. Entrepreneurship Development and Management, Vasant Desai, HPH
2. Entrepreneurship Management, BholanathDutta, Excel Books
3. Entrepreneurial Development, Sangeeta Sharma, PHI
4. Entrepreneurship, Rajeev Roy, Oxford University Press

8th Semester

UPEME801 Mechanical Vibration

Module – 1 [12 Hours]

1. INTRODUCTION & IMPORTANCE OF MECHANICAL VIBRATION:

Brief history of Mechanical Vibration, Types of Vibration, Simple Harmonic Motion (S.H.M.),

Principle of superposition applied to S.H.M., Beats, Fourier Analysis, Concept of degree of freedom for different vibrating systems.

2. UNDAMPED FREE VIBRATION OF SINGLE DEGREE FREEDOM SYSTEMS: Modeling of Vibrating Systems, Evaluation of natural frequency – differential equation, Energy & Rayleigh's methods, Equivalent systems.

3. DAMPED FREE VIBRATION OF SINGLE DEGREE FREEDOM SYSTEMS: Different types of damping, Equivalent viscous damping, structural damping, Evaluation of damping using free and

forced Vibration technique, Concept of critical damping and its importance, study of vibration response of viscous damped systems for cases of under damping, critical damping and over damping, Logarithmic decrement.

Module – 2 [12 Hours]

4. FORCED VIBRATION OF SINGLE DEGREE FREEDOM SYSTEMS: Steady state solution with viscous damping due to harmonic force, reciprocating and rotating unbalance mass, vibration isolation and transmissibility due to harmonic force excitation and support motion. Vibration measuring instruments – vibrometer and accelerometer. Whirling of shaft with single disc and withour damping, Concept of critical speed and its effect on the rotating shaft.

Module – 3 [10 Hours]

5. UNDAMPED VIBRATION OF TWO DEGREE FREEDOM SYSTEMS: Free vibration of spring coupled and mass coupled systems, Longitudial, Torsional and transverse vibration of two degree freedom systems, influence coefficient technique, Un-damped vibration Absorber.

6. INTRODUCTION TO MULTI-DEGREE FREEDOM SYSTEMS: Normal mode vibration, Co-ordinate coupling-close coupled and far coupled systems,

7. CONTINOUS SYSTEMS: Vibration of strings, longitudinal vibration of rods, torsional vibration of rods, transverse vibration of Euler-beams.

Text Books:

1. Theory of vibration with Applications: W.T. Thomson and Marie Dillon Dahleh, Pearson Education

2. Introductory Course on theory and Practice of Mechanical Vibrations. J.S. Rao & K. Gupta, New Age International Publication, New Delhi, 2007.

Reference Books:

1. Mechanical Vibrations: S.S. Rao, Prarson Education Inc

2. Mechanical Vibrations: S. Graham Kelly, Schaum's outline series, Tata McGraw Hill, Special Indian ed., 2007

3. Mechanical Vibrations: V.P. Singh, Dhanpat Rai & company Pvt. Ltd.

4. Elements of vibration Analysis: Leonard Meirovitch, Tata McGraw Hill, Special Indian ed.

UPEME802 Finite Element Methods

Module - 1

Fundamental Concepts: Introduction, Historical background, Outline of presentation, General procedure for FEA, Stresses and Equilibrium, Boundary conditions, StrainDisplacement relations, Stress-Strain relations, Plane stress, Plane strain problems, Temperature effects, Potential energy and equilibrium. The Rayleigh-Ritz method, Hamilton's principle.Galerkin's method, Saint Venant's principle.

Module - 2

One-dimensional Problems: Introduction, Finite element modeling, Coordinates and Shape functions. The potential energy approach.TheGalerkin approach, Assembly of the global stiffness matrix- mass matrix and load vector, Treatment of boundary conditions, Quadraticshape functions, Temperature

effects. Trusses: Introduction, Plane trusses, Three-dimensional trusses, Assembly of global stiffness matrix for the Banded and Skyline solutions.

Module - 3

Two-dimensional Problems Using Constant Strain Triangles: Introduction, Finite element modeling, Constant strain triangle, In plane and Bending, problem modeling and boundary conditions.

Axisymmetric Solids Subjected to Axisymmetric Loading: Introduction, Axisymmetric formulation, Finite element modeling, Triangular element, Problem modeling and boundary conditions.

Module - 4

Two-dimensional Isoparametric Elements and Numerical Integration: Introduction, The four-node quadrilateral, Numerical integration, requirements, h-refinement and p-refinement, Higher-order elements, Convergence

Beams and Frames: Introduction, Finite element formulation, Load vector, Boundary considerations, Shear force and bending moment, Beams on elastic supports, Plane frames.

Text Book:

1. Introduction to Finite Elements in Engineering, by Tirupathi R. Chandrupatla, Ashok D.Belegundu

References:

1. Introduction to Finite Element Method, by S.S.Rao
2. Finite Element Method, by O.C. Zienkiewicz.
3. Concepts and Applications of Finite Element Analysis, by Robert D. Cook.
4. Introduction to Finite Element Method, by J.N.Reddy.

UPEME803 Mechatronics

Course Objective:

(i) To understand the structure of microprocessors and their applications in mechanical devices

(ii) To understand the principle of automatic control and real time motion control systems, with the help of electrical drives and actuators

(iii) To understand the use of micro-sensors and their applications in various fields

Course Outcomes:

Upon completion of this course, students will get an overview of mechatronics applications and the use of micro-sensors and microprocessors.

Course Contents:

Module 1 (10 Hours)

Evolution of Mechatronics, components of mechatronic system, types of mechatronic products,

Signal theory, signal analysis and processing, Laplace transformation, Z-transformation modulation and de-modulation.

Electrical components and Electronic device –Resister, inductor and capacitor, reactance and impedance. Basic electronics devices junction diodes, Bipolar transistors

Module - 2 (10 Hours)

Basic Digital Technology : Digital number system, Binary number system, Hexadecimal number system, Binary addition, Boolean Algebra, Logic function, Universal GATES, FLIP-FLOP, Registers counters.

System modeling : Frequency response, Mechanical system, electrical system, Thermal system, Fluid system.

Module - 3 (16 Hours)

Actuators- Electric motors; D.C. Motors, Stepper motor, , Hydraulic actuators, Pneumatic actuators

Transducer and Sensors : Principles, difference between transducer and sensors, transducer types – photo emissive, photo conductive, photovoltaic, thermistors, Thermocouple, Inductive, capacitive, Peizoelectric, Hall effect transducers, Ionization transducer, Encoders- Incremental encoder, Optical encoder, Bimetallic strip, Strain gauge, load cell.

Programmable Logic controller : Basic Structure - Programming : Ladder diagram Timers, Internal Relays and Counters - Shift Registers - Master and Jump Controls, data handling , Analog input / output , PLC Selection &Application.

Microprocessor ad Microcontroller: Microprocessor based Digital control, registers, Program counter, Intel -8085 microprocessor

Text Books

1. A Text Books of Mechatronics, R.K.Rajput, S.Chand & company
2. Mechatronics: A Multidisciplinary Approach, William Bolton, Pearson Education
3. Mechatronics, N.G. P.C Mahalik, Tata McGraw Hill
4. Mechatronics, D.G. Alciator, M.B. Histand, Tata McGraw Hill

Reference Books :

1. Mechatronics, A.Smaili & F Mrad, Oxford University Press
2. Mechatronics, K.P.ramchandran, G,K Vijay Raghavan, M. S Balachandran
3. Mechatronics An Intigrated approach, Clarence W de Sliva, CRC Press

UPEME804 Robotics

Prerequisites Engineering Mathematics

Course objectives:

1. To introduce the history, constructional features and other basic information on robotics
2. To introduce to the sensors used in robotics
3. To do the mathematical modelling
4. To teach robot programming of a typical robot as also the concepts of path planning and applications

Course Outcome

On successful completion of this course the students should be able to:

1. Have an awareness of basics of robotics

2. Do robot programming
3. Appreciate the applications of robotics and be able to apply economic measures to justify advantages of robots in industry

Course Content:

Module – 1 (12 hours)

1. Fundamentals of Robotics: Evolution of robots and robotics, Definition of industrial robot, Laws of Robotics, Classification, Robot Anatomy, Work volume and work envelope, Human arm characteristics, Design and control issues, Manipulation and control, Resolution; accuracy and repeatability, Robot configuration, Economic and social issues, Present and future application.
2. Mathematical modeling of a robot: Mapping between frames, Description of objects in space, Transformation of vectors. Direct Kinematic model: Mechanical Structure and notations, Description of links and joints, Kinematic modeling of the manipulator, Denavit-Hartenberg Notation, Kinematic relationship between adjacent links, Manipulator Transformation matrix.

Module – 2 (12 hours)

3. Inverse Kinematics: Manipulator workspace, Solvable of inverse kinematic model, Manipulator Jacobian, Jacobian inverse, Jacobian singularity, Static analysis.
4. Dynamic modeling: Lagrangian mechanics, 2D- Dynamic model, Lagrange-Euler formulation, Newton-Euler formulation.
5. Robot Sensors and Actuators: Internal and external sensors, force sensors, Thermocouples, Performance characteristic of a robot. Hydraulic and pneumatic actuators, Electrical actuators, Brushless permanent magnet DC motor, Servomotor, Stepper motor, Micro actuator, Micro gripper, Micro motor, Drive selection.

Module 3 (12 hours)

6. Robot Programming: Methods – Languages – Capabilities and limitation – Artificial intelligence – Knowledge representation –Search techniques in A I and Robotics
7. Trajectory Planning: Definition and planning tasks, Joint space planning, Cartesian space planning.
8. Applications of Robotics: Capabilities of robots, Material handling, Machine loading and unloading, Robot assembly, Inspection, Welding, Obstacle avoidance.

Text Books

1. Robotics and Control, R.K. Mittal and I.J. Nagrath, Tata McGraw Hill
2. Introduction to Robotics: Mechanics and control, John J Craig, PHI
3. Robotics Technology and Flexible Automation, S.R.Deb and S. Deb, TMH
4. Introduction to Robotics, S. K. Saha, Tata McGraw Hill

Reference

1. Robotic Engineering: An Integrated Approach, R.D. KLAFTER, T. A. Chmielewski, and
2. Industrial Robotics Technology –Programming and Applications, Mikell P. Groover, Mitchell Weiss, McGraw Hill International Edition.
3. Foundation of Robotics: Analysis and Control, Yoshikawa, Prentice Hall of India.
4. Robotics: Control, Sensing, Vision and Intelligence, K.S.Fu, R.C.Gonzalez and C.S.G.Lee, McGraw Hill

5. Robot Dynamics and Control, M.W.Spong and M. Vidyasagar , Wiley India.
6. Industrial Robotics Technology, programming and application, M.P.Groover, TMH.
7. Introduction to Robotics: Analysis, Systems, Applications, S.B.Niku, PHI
8. Robotics: Fundamental Concepts and Analysis, A. Ghosal, Oxford University Press
9. Fundamentals of Robotics: Analysis and Control, R. J. Schilling, PHI
10. Robot Technology: Fundamentals: J. G. Keramas, Cengage Learning

OPEN ELECTIVES

(Offered by Mechanical Engineering for all B.Tech Programmes)

UOEME501 Thermodynamics and Heat Transfer

Module1

Thermodynamic systems. Temperature and the zeroth law of thermodynamics. Thermodynamic scales. Ideal gas. Simple, compressible pure substances: gasses and steam. Expansion work. Friction work. Internal energy. Heat. Enthalpy. Specific heats of gasses. Adiabatic, isothermal, isochoric and isobaric processes. Polytropic processes. First law of thermodynamics. Open and closed systems. Entropy and irreversibilities. Second law of thermodynamics. Thermal engine. Carnot's efficiency.

Module 2

Steam, Steam power plant, boilers, nozzles, turbine, condenser.

Gas turbine: Brayton's cycle. Steam turbine: Rankine cycle. Steam compression refrigeration systems.

Refrigeration - Definition -Unit of refrigeration -Coefficient of performance (COP)-Vapour compression refrigeration with flow diagram-Vapour absorption refrigeration with flow diagram-Refrigerants

Module3

General differential equation for conduction heat transfer. Conduction in a flat wall. Conduction in a cylindric wall. Thermal resistance. Overall heat transfer coefficient.

Free and forced convection mechanism. Interior and exterior convection. Convection over flat surfaces. Convection over cylinders. Convections in pipe flow. Empirical correlations.

Electromagnetic spectrum and radiation physics. Kirchoff's law. Black-body radiation. Grey and real bodies. Radiation functions.

Text books

P.K. Nag, Engineering Thermodynamics, Tata McGraw-Hill Education

Rajput. R. K., Thermal Engineering, S.Chand Publishers

Rajput. R. K., Heat Transfer, S.Chand Publishers

Çengel, Yunus A., Boles, Michael A., Thermodynamics, An Engineering Approach, McGraw Hill

Çengel, Yunus A., Heat Transfer, A Practical Approach, McGraw Hill

UOEME502 Applied Thermal Engineering

Module 1

Thermodynamic systems. Temperature and the zeroth law of thermodynamics. Thermodynamic scales. Ideal gas. Simple, compressible pure substances: gasses and steam. Expansion work. Friction work. Internal energy. Heat. Enthalpy. Specific heats of gasses. Adiabatic, isothermal, isochoric and isobaric processes. Polytropic processes. First law of thermodynamics. Open and closed systems

Steam boiler-Concept-definition-Indian Boilers Regulation (IBR)- Classification of boiler – function of boiler- Low pressure boilers- Sketch and working of Cochran boiler- Babcock and Wilcox boiler- Merits and demerits- High pressure boilers- Sketch and working of Lamont and Benson boiler- Merits and demerits- Comparison of water tube and fire tube boilers- Boiler mountings and accessories, Boiler draught system-concept and classification -steam jet draught.

Module 2

Air compressor-concepts, functions, classification and applications- Single stage reciprocating air compressor- construction and working (with line diagram) Expression for work done and power required by single stage reciprocating compressor (without derivation), Simple problems on work done and power required. Multi stage compression – advantages of multistage compression-Rotary Compressors - working of rotary Compressor-Difference between reciprocating and rotary compressors - concept of screw compressor (oil free).

Refrigeration - Definition -Unit of refrigeration -Coefficient of performance (COP)-Vapour compression refrigeration with flow diagram-Vapour absorption refrigeration with flow diagram-Refrigerants –Types- Factors affecting the choice of refrigerants- properties of good refrigerants. Psychrometry- definition-Psychrometric terms - dry air, saturated air, dry bulb temperatureWet bulb temperature, dew point temperature, relative humidity, absolute humidity, specific humidity. Air Conditioning- classification-winter Air Conditioning-Summer Air conditioning-Year round air conditioning

Module 3

Internal combustion engines, Classification – Components and their function. Valve timing diagram and port timing diagram – actual and theoretical p-V diagram of four stroke and two stroke engines. Simple and complete Carburettor. MPFI, Diesel pump and injector system. Battery and Magneto Ignition System – Principles of Combustion and knocking in SI and CI Engines. Lubrication and Cooling systems. Performance calculation.

Otto, Diesel, Dual, Brayton cycles, Calculation of mean effective pressure, and air standard efficiency – Comparison of cycles.

Text books

P.K. Nag, Engineering Thermodynamics, Tata McGraw-Hill Education

Rajput. R. K., Thermal Engineering, S.Chand Publishers

Rajput. R. K., Heat Transfer, S.Chand Publishers

Çengel, Yunus A., Boles, Michael A., Thermodynamics, An Engineering Approach, McGraw Hill

Çengel, Yunus A., Heat Transfer, A Practical Approach, McGraw Hill

UOEME601 Basic Manufacturing Process

Course objectives:

To provide clear view on theory of metal cutting and tool geometry and to impart knowledge about mechanisms involved in the conventional and Non-conventional machines.

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

1. Interpret and design the geometry of single point cutting tool and multi point cutting tools
2. Acquire the mechanisms involved in lathe, shaper, drilling, milling, planer machines
3. Understand the working principle of USM, LBM, ECM, EDM, AJM, EDM

Course objectives:

To study various casting, welding and forming methods including advanced techniques, with emphasis on basic principles, limitations and application areas.

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

1. Identify types of pattern, core, core print and gating system in metal casting processes.
2. To obtain knowledge of various metal joining processes.
3. Acquire the knowledge of Powder metallurgy and its application .
4. Understand and apply process-maps for metal forming processes using plasticity principles

Module-1 (14 hours)

Conventional Machine Tools:

Lathe: Principles, construction, types, production machine tools Capstan & Turret lathe, single point cutting tool layout, Calculations of cutting velocity, feed and depth of cut.

Shaper, Planer: Construction, Operations, Quick return mechanism.

Milling: Construction, milling cutters, up milling & down milling, Gear shaper and Gear hobbing machines

Drilling and Boring: Construction, classifications, drilling and boring tools

Grinding and super finishing: Grinding wheels, abrasive & bonds, cutting action, classification of grinding- surface and cylindrical grinding, center less grinding.

Super finishing: Honing, lapping & polishing

Introduction to non-conventional machining process: Ultrasonic machining (USM), Laser Beam Machining (LBM), Electro Discharge Machining (EDM), Electro Chemical Machining (ECM),

Module-2 (12 hours)

Casting methods: continuous casting, centrifugal casting, die casting; Casting defects.

Types of patterns, Pattern materials and Pattern allowances.

Molding Materials - sand molding, metal molding, investment molding, shell molding

Melting furnaces - cupola, resistance furnace, induction and arc furnace

Solidification of castings, use of risers and runners

Classification of welding processes, gas welding, electric arc welding, resistance welding

Power sources: constant current and constant voltage power sources;

ISI classification of coated electrodes;

Brazing and soldering

Module-3 (14 hours)

Hot and cold working of metals, classification of metal forming processes. Rolling: types of rolling mills

Forging: Smith Forging, Drop and Press forging, Machine forging

Extrusions: Direct, Indirect, Impact and Hydrostatic extrusion and their applications, Extrusion of tubes, Wire drawing methods

Brief introduction to sheet metal working: Bending, Forming and Deep drawing, shearing

Brief introduction to powder metallurgy processes.

Books:

1. Manufacturing Technology by P.N.Rao, Tata McGraw Hill publication.

2. Welding Technology by R.A. Little, TMH

3. Manufacturing Science by A.Ghosh and A K Malick, EWP

4. Fundamentals of metal casting technology by P.C. Mukherjee, Oxford PIBI.

5. A Text Book of Production Engineering by P.C.Sharma, S.Chand

UOEME701 Project and Production Management

Course Objective:

The course aims at acquainting all engineering graduates irrespective of their specializations the basic issues and tools of managing production and operations functions of an organization.

Module - 1 (12 Hours)

1. Operations Function in an Organization, Manufacturing Vrs Service Operations, System view of Operations, Strategic Role of Operations, Operations Strategies for Competitive Advantage, Operations Quality and Productivity Focus, Meeting Global Challenges of Production and Operations Imperatives.

2. Designing Products, Services and Processes: New Product Design- Product Life Cycle, Product Development Process, Types of Production Systems: Jobshop, Batch, Mass Production; Process Technology Trends, FMS, CIM, CAD, CAM; Design for Services, Services Process Technology.

3. Location and Layout Planning: Factor Influencing Plant and Warehouse Locations, Impact of Location on cost and revenues. Layout Planning: Process Layout, Product Layout, Fixed Position Layout, Line balancing, computerized layout planning- overview, Group Technology

4. Work Study: Methods Study- Techniques of Analysis, recording, improvement and standardization; Work Measurement : Work Measurement Principles using Stopwatch Time Study, Predetermined Motion Time Standards and Work Sampling, Standard Time Estimation.

Module - 2 (12 Hours)

5. Forecasting : Principles and Method, Moving Average, weighted Moving Average, Exponential Smoothing, Winter's Method for Seasonal Demand, Forecasting Error.

6. Manufacturing Planning and Control: Aggregate Planning, Master Production Scheduling, Material Requirements Planning, Capacity Requirements Planning.

7. Sequencing and Scheduling: Single Machine Sequencing : Basics and Performance Evaluation Criteria, Mean Flow Time, Flowshop sequencing: 2 and 3 machines cases : Johnson's Rule and Jobshop Scheduling: Priority dispatching Rules.

8. Inventory Control: Relevant Costs, Basic EOQ Model, Model with Quantity discount, Economic Batch Quantity, Periodic and Continuous Review Systems, Safety Stock, Reorder Point and Order Quantity Calculations. ABC Analysis.

9. Modern Trends in Manufacturing: Overview of Just in Time (JIT) System, Total Quality Management, Total Productive Maintenance, ISO 9000, Quality Circle, Kaizen, PokaYoke, Supply Chain Management.

Module - 3 (8 Hours)

10. Attributes of a Project, Project Life Cycle

11. Project feasibility Analysis: Technical feasibility, commercial and financial visibility, Environment Analysis. Breakeven Analysis

12. Project Execution: work breakdown structure, Network Techniques: AOA and AON, CPM and PERT, Resource allocation, Crashing and Resource Sharing

Text Books:

1. S.N.Chary, "Production and Operations Management", Tata McGraw Hill.

2. R. Paneerselvam, "Production and Operations Management, Prentice Hall of India.

3. Aswathappa & Bhatt – Production & Operations Management, HPH.

4. Gaither & Frazier - Operations Management, Cengage Publication

5. Russell & Taylor - Operations Management, PHI Publication

6. Chase, Aquilanno, Jacob & Agarwal - Operations Management, TMH Publication.

7. E.E. Adam and R.J. Ebert "Production and Operations Management", Prentice Hall of India

UOEME702 Mechanics of Solids

Prerequisites: (i) Physics 1, (ii) Mathematics course with ordinary differential equations and (iii) Engineering Mechanics

Module – 1

SIMPLE STRESSES & STRAINS : Elasticity and plasticity – Types of stresses & strains–Hooke's law – stress– strain diagram for mild steel – Working stress – Factor of safety – Lateral strain, Poisson's ratio & volumetric strain – Bars of varying section – composite bars – Temperature stresses- Principal planes and principal stresses -Mohr's circle - Relation between elastic constants, Strain energy – Resilience – Gradual, sudden, impact and shock loadings.

SHEAR FORCE AND BENDING MOMENT : Definition of beam – Types of beams – Concept of shear force and bending moment – S.F and B.M diagrams for cantilever, simply supported and overhanging beams subjected to point loads, u.d.l, uniformly varying loads and combination of these loads – Point of contra flexure – Relation between S.F., B.M and rate of loading at a section of a beam.

Module – 2

FLEXURAL STRESSES : Theory of simple bending – Assumptions – Derivation of bending equation, Determination bending stresses – section modulus of rectangular and circular sections

(Solid and Hollow), Angle and Channel sections – Design of simple beam sections.

SHEAR STRESSES: Derivation of formula – Shear stress distribution across various beams sections like rectangular, circular, triangular, I, T angle sections.

DEFLECTION OF BEAMS : Bending into a circular arc – slope, deflection and radius of curvature – Differential equation for the elastic line of a beam – Determination of slope and deflection for cantilever and simply supported beams subjected to point loads, - U.D.L uniformly varying load. Mohr's theorems – Moment area method – application to simple cases including overhanging beams, Statically Indeterminate Beams and solution methods.

Module – 3

THIN CYLINDERS: Thin seamless cylindrical shells – Derivation of formula for longitudinal and circumferential stresses – hoop, longitudinal and Volumetric strains – changes in dia, and volume of thin cylinders – Riveted boiler shells – Thin spherical shells.

THICK CYLINDERS: –lame's equation – cylinders subjected to inside & outside pressures – compound cylinders.

TORSION: Introduction-Derivation- Torsion of Circular shafts- Pure Shear-Transmission of power by circular shafts, Shafts in series, Shafts in parallel.

COLUMNS:

Buckling and Stability, Columns with Pinned ends, Columns with other support Conditions, Limitations of Euler's Formula, Rankine's Formula,

Text Books:

1. Strength of materials /GH Ryder/ Mc Millan publishers India Ltd
2. Solid Mechanics, by Popov
3. Mechanics of Materials/Gere and Timoshenko, CBS Publishers

References:

1. Strength of Materials -By Jindal, Umesh Publications.
2. Analysis of structures by Vazirani and Ratwani.
3. Mechanics of Structures Vol-III, by S.B.Junnarkar.
4. Strength of Materials by S.Timoshenko
5. Strength of Materials by Andrew Pytel and Ferdinond L. Singer Longman.

UOEME801 Fluid Mechanics & Hydraulic Machines

Module: 1 (12 Hour)

Introduction and Fluid Statics- properties of fluids, concept of continuum, pressure and stress tensor Brief description of Newtonian and Non Newtonian fluids, Pascal's Law of Hydrostatics, Pressure and its measurement by different manometers, force on submerged surfaces (Inclined), Buoyancy and stability of floating and submerged bodies.

Fluid Kinematics - Lagrangian and Eulerian description, streamline, streakline and pathline, continuity

equation (Only the 3D general form for Cartesian and cylindrical coordinates), stream function, rotation and angular deformation, irrotational flow, velocity potential

Module II: (13 Hour)

Inviscid flow - Euler equation, Bernoullis equation and its applications to venture meter, orifice meter and siphons, Reynolds transport theorem, conservation of mass, Linear and angular momentum, linear and angular momentum, Stokes law of viscosity and Navier-Stokes equations (Only the 3D general form for Cartesian and cylindrical coordinates), some exact solutions such as, Flow in straight channel and Hagen Poiseuille Flow, Dimensional analysis and similarity - Buckingham Pi theorem.

Module III: (15 Hours)

Internal flows: Pipe flows, friction factor, Moody Diagram, major and minor losses, pipe networks External flows: Prandtl's Boundary layer equation over a flat plate (Only Equations), momentum integral method, and flow separation

Potential Flow - elementary plane flow in 2D Plane (Uniform flow and Vortex flow), Flow about a cylinder without circulation, Drag and lift of cylinder without circulation.

Fluid Machinery - similarity, Euler equation for turbo machines, Pelton wheel, Francis and Kaplan Turbines, centrifugal

Books:

1. S. K. Som, G. Biswas, S. Chakraborty, Introduction to fluid Mechanics and Fluid Machines, 3rd Edition,McGrawhill.
2. Y. Cengel, J. M. Cimbala, Fluid Mechanics, 3e (Sie) - Fundamentals and Applications, Mc Graw Hill
3. K. Subramanya, Hydraulic Machines, Mcgraw Hill
4. Robert W. Fox, Alan T. Mcdonald, Fluid Mechanics, Wiley
5. Ethirajan Rathakrishnan, Fluid Mechanics, PHI
6. P. N. Modi, S. M. Seth, Hydraulics and Fluid Mechanics Including Hydraulics Machines, Standard Book House.

UOEME802 Mechanism of Machines

Mechanism of Machines

Module-1:

Introduction of Mechanisms and Machines

Concepts of Kinematics and Dynamics, Mechanisms and Machines, Planar and Spatial Mechanisms, Kinematic Pairs, Kinematic Chains, Kinematic Diagrams, Kinematic Inversion, Four bar chain and Slider Crank Mechanisms and their Inversions, Degrees of Freedom, Straight line mechanisms

Graphical and Analytical Linkage Synthesis

Synthesis, Function, Path, and Motion Generation, Dimensional synthesis (Graphical): Two position synthesis, Three Position synthesis, Coupler curves, Position Analysis: Graphical position analysis of linkages, Algebraic position analysis of linkages, Four bar slider crank position solution

Module-2:

Velocity and Acceleration Analysis

Graphical and analytical velocity analysis of fourbar pin jointed linkages and fourbar slider crank linkages, Instant centers of velocity, Graphical and analytical acceleration analysis of fourbar pin jointed linkages and fourbar slider crank linkages, Graphical velocity and acceleration analysis of quick return mechanisms

Cams

Types of cams, Types of followers, Follower displacement programming, Derivatives of follower Motion, Motions of follower, Layout of cam profiles

Module-3:

Belt, Ropes and Chains

Types of belt drive, Velocity ratio, Slip, Pulley arrangement, Length of belt, Law of belting, Ratio of friction tension, Power transmitted, Maximum power transmitted, Creep, Chains, Chain length, Angular speed ratio

Gears and Gear Trains

Terminology, Law of Gearing, Characteristics of involute and cycloidal action, Interference and undercutting, contact ratio, Types of gears: spur, helical, spiral bevel and worm gears, Gear Trains: Simple, compound & reverted gear trains, epicyclic gear trains

Clutch and Brake

Inclined plane, Pivot and Collars, Friction clutches, Types of brakes, Block and Shoe brakes, Differential band brake, Internal expanding shoe brake, Braking effect in vehicle

Course Outcome

- Understand basic structure and elements of machines
- Identify functional characteristics of various machine elements
- Synthesize various mechanisms based on position, velocity and acceleration requirement
- Determine position, velocity and acceleration of linkages in mechanism at any instant
- Understand basics related to friction and its practical application in mechanical engineering

Books

1. Kinematics and Dynamics of Machinery by R L Norton, Tata MacGraw Hill
2. Theory of Machines and Mechanisms by John J. Uicker Jr., Gordon R. Pennock and Joseph E. Shigley, Oxford University Press
3. Theory of Machines by S.S.Rattan, Tata MacGraw Hill
4. Theory of Machines by Thomas Bevan, CBS Publications
5. Kinematics and Dynamics of Machinery by Charles E. Wilson and J.Peter Saddler, Pearson Education
6. Mechanism and Machine Theory by J.S.Rao and R.V.Dukipatti, New Age International.
7. Theory of Mechanisms and Machines by A. Ghosh & A. K. Mallick, East West Press.
8. Kinematics and Dynamics of Machines by G.H. Martin, McGraw-Hill.
9. Mechanisms and Dynamics of Machinery by Hamilton H Mabie and Charles F Reinholtz, John-Wiley and Sons.
10. Kinematics, Dynamics, and Design of Machinery by Kenneth J Waldron and Gary L Kinzel, John-Wiley and Sons.

UOEME803 Quality Engineering and Management

Module - 1

Attributes of quality, Evolution of philosophy of Quality Management, Economics of quality and measurement of cost of quality, Data presentation techniques for quality analysis,

Statistical process control, Use of control charts and process engineering techniques for implementing quality plan, Machine and process capability analysis, statistical tolerance analysis, Acceptance sampling: Single, double and multiple sampling plans, Acceptance sampling for variables

Module - 2

Reliability analysis and predictions, Bath-Tub Curve, Exponential and Weibull distribution in modelling reliability, System reliability

Experimental designs and factorial experiments: 2k factorial experiments, Taguchi philosophy; Loss function; Signal to noise ratio, Orthogonal arrays for parameter and tolerance design.

Module - 3

Fundamentals of TQM: Customer orientation, Continuous improvement, Total participation; Some important philosophies and their impact on quality (Deming, Juran,Crossby), QC Tools, Components of Total Quality System (TQS), Quality audit,

Introduction to ISO 9000 and 14000 standards.

Books:

1. Fundamental of Quality Control and Improvement, Mitra A, PHI

2. Quality Planning and Analysis, Juran J M and Gryna F M, Tata McGraw Hill"