ANDHRA UNIVERSITY DEPARTMENT OF MECHANICAL ENGINEERING

SCHEME AND SYLLABI (with effect from 2022-23)

B.Tech & B.Tech+M.Tech III Year - I Semester

B.Tech & B.Tech+M.Tech (Mechanical Engineering) III Year - I Semester

Course code	Category	Course Title	Hours per week		Internal Marks	External Marks	Total Marks	Credits
			L	P				
MC3101	PC	Finite Element Analysis	4	0	30	70	100	3
MC3102	PC	Metrology and Computer Numerical Control (CNC)	4	0	30	70	100	3
MC3103	PC	Fluid Mechanics and Machinery	4	0	30	70	100	3
MC3104	PE	Professional Elective-I	4	0	30	70	100	3
MC3105	OE	Open Elective-I	4	0	30	70	100	3
MC3106	PC	Dynamics of Machinery Lab	0	3	50	50	100	1.5
MC3107	PC	Industrial Engineering Lab	0	3	50	50	100	1.5
MC3108	SC	Simulation of Engineering Structures	1	2	50	50	100	2
MC3109	INT	Internship-I			50	50	100	2
							Total Credits	**22**

B.Tech & B.Tech+M.Tech III Year - II Semester

Course code	Category	Course Title	Hours per week		Internal Marks	External Marks	Total Marks	Credits
			L	P				
MC3201	PC	Machine Design	4	0	30	70	100	3
MC3202	PC	Financial Management for Engineers	4	0	30	70	100	3
MC3203	PC	Heat Transfer	4	0	30	70	100	3
MC3204	PE	Professional Elective-II	4	0	30	70	100	3

MC3205	OE	Open Elective-II	4	0	30	70	100	3
MC3206	PC	Metrology & Mechatronics Lab	0	3	50	50	100	1.5
MC3207	PC	Fluid Mechanics and Machinery Lab	0	3	50	50	100	1.5
MC3208	PC	Heat Transfer Lab	0	3	50	50	100	1.5
MC3209	SC	Soft Skills	1	2	50	50	100	2
							Total Credits	**21.5**
Internship-II								

B.Tech & B.Tech+M.Tech (with effect from 2022-23)
IV Year - I Semester

Course code	Category	Course Title	Hours per week		Internal Marks	External Marks	Total Marks	Credits
			L	P				
MC4101	PE	Professional Elective-III	4	0	30	70	100	3
MC4102	PE	Professional Elective-IV	4	0	30	70	100	3
MC4103	PE	Professional Elective-V	4	0	30	70	100	3
MC4104	OE	Open Elective-III	4	0	30	70	100	3
MC4105	OE	Open Elective-IV	4	0	30	70	100	3
MC4106	HSSE	HSS-Elective	4	0	30	70	100	3
MC4107	SC	Computational Fluid Dynamics	1	2	50	50	100	2
MC4108	INT	Internship-II			50	50	100	2
							Total Credits	**22**

B.Tech & B.Tech+M.Tech IV Year - II Semester

Course code	Category	Course Title	Internal Marks	External Marks	Total Marks	Credits
MC4201	PROJ	Project work	100	100	200	14
					Total Credits	**14**

PROFESSIONAL ELECTIVES

1. Mechanics of Materials
2. Mechanical Vibrations
3. Composite Materials
4. Work-Study and Ergonomics
5. Condition Monitoring
6. Automobile Engineering
7. Maintenance Engineering and Management
8. Vehicle Dynamics
9. Computer Aided Design / Computer Aided Manufacturing (CAD/CAM)
10. Refrigeration and Air-conditioning
11. Statistical Quality Control
12. Tool Design
13. Power Plant Engineering
14. Turbo Machinery
15. Gas Dynamics and Space Propulsion

OPEN ELECTIVES

1. Additive Manufacturing
2. Reliability Engineering
3. Structural Health Monitoring
4. Tribology
5. Total Quality Management
6. Solar Energy- Technology and Applications
7. Computational Fluid Dynamics
8. Artificial Neural Networks
9. Instrumentation and Control Systems
10. Renewable Sources of Energy
11. Energy Conservation in Industries
12. Artificial Intelligence and Machine Learning
13. Production Planning and Control

HSS ELECTIVES

1. Organizational Behaviour
2. Industrial Management and Entrepreneurship
3. Operations Research

THIRD YEAR 1ST SEMESTER
MC 3101 FINITE ELEMENT ANALYSIS

Course Objectives:

- This subject deals with fundamentals of the finite element method for the analysis of engineering problems arising in solids and structures and also to introduce the concepts of mathematical modelling of engineering problems.
- Emphasis an ability to apply knowledge of mathematics, science and engineering to do the analysis of simple and complex elastic structures using the finite element analysis.
- To furnish information on the basic concepts, background and methodology of FEM.
- To select suitable elements for Finite element modelling, deriving the necessary elemental matrices and for applying the principles to various mechanical systems
- Demonstrate an ability to design and conduct numerical analysis as well as analyze and interpret the results.
- It deals with ability to identify, formulate, and solve engineering problems using the finite element analysis.
- To solve one dimensional problem in solid mechanics, heat transfer and vibrations.
- To solve two dimensional problems in solid mechanics in terms of plane stress, plane strain and axisymmetric conditions.
- To solve problems using isoparametric formulation and Beams and Frames.

Course Outcomes:

- On completion of course students will be able to gain the knowledge and understand the basics concepts of Finite element analysis and mathematical problems and get experience for problems solving of machine members.
- On completion of course students will be able to get understand advanced computing techniques and tools in the area develop the applications of FEA in engineering. To gain experience in the application of FE analysis to real engineering designs/Problems.
- On completion of course students will be able to gain experience to implement different FEA/FEM tools for solving Structural engineering problems and write code for some of them in MATLAB/PYTHON.
- On completion of course students will be able to get exposure to build up the skills in the actual implementation of FEM methods (e.g. boundary conditions, Elements, Meshing etc.) in using commercial FEM codes. Also get exposure to solve problems by using analysis software's like ANSYS/NISA etc.
- The students will be able to explain the concepts of Mathematical Modelling of Engineering Problems and also the students will be able to solve one-dimensional problems in solid mechanics

- The students will be able to give solution for two-dimensional problems in solid mechanics and also calculate problems using plane stress, plane strain and axisymmetric conditions.
- The students will be able to solve problems using isoparametric formulation, Numerical Integration and Beams and Frames.

SYLLABUS

Fundamental Concepts: Introduction, Historical background, Outline of presentation, General procedure for FEA, Stresses and Equilibrium, Boundary conditions, Strain- Displacement 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.

One-dimensional Problems: Introduction, Finite element modeling, Coordinates and Shape functions. The potential energy approach. The Galerkin approach, Assembly of the global stiffness matrix- mass matrix and load vector, Treatment of boundary conditions, Quadratic shape functions, Temperature effects. Trusses: Introduction, Plane trusses, Three-dimensional trusses, Assembly of global stiffness matrix for the Banded and Skyline solutions.

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.

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, Tirupathi R. Chandrupatla, Ashok D.Belegundu (chapters 1 to 8 only). Pearson Education Limited,4th Edition, 2012

Reference Books:

1. Introduction to Finite Element Method, S.S.Rao, Butterworth-Heinemann, 5th Edition, 2010
2. Finite Element Method, Olek C Zienkiewicz , Robert L Taylor , J.Z. Zhu, Butterworth Heinemann, 7th Edition .
3. Concepts and Applications of Finite Element Analysis, Robert D. Cook.
4. Introduction to Finite Element Method, J.N.Reddy

MC 3102 METROLOGY AND COMPUTER NUMERICAL CONTROL (CNC)

Course Objectives:

The main objectives of this module are:

- To provide to the students an understanding and appreciation of the science of Measurement.
- To expose the students to various mechanical and electrical engineering measuring devices, and understand the different degree of accuracy obtained from different types of instruments.

Course Outcomes:

1. Students will be able to program using G-codes and M-codes and feed to CNC machine to carry out the necessary process.
2. Students will be able to appreciate FMS, perform robot programming along with the hydraulics and pneumatics Students who successfully complete this course will be able to:

- identify the uncertainties in dimensional metrology and the define the measurement standards;
- describe the fundamentals of dimensional and geometrical tolerances;
- use effective methods of measuring straightness, flatness, roundness, profile, screw threads and gear teeth;
- measure dimensions of shafts, bearings and linear surfaces in metric and imperial units using calibers, micrometers, and scales;
- use contour projector ad coordinate measuring machine to record measurements of complex profiles with high sensitivity;
- use gage blocks, fixed gages, pneumatic gages, gage blocks to measure various work pieces;

SYLLABUS

Automatic screw lathes, Multi spindle automatic lathes, Turret lathes, Numerical control, NC operation, Coordinate system, Data input devices, Data storage, Programme editing, Machining centres, Turning centres, Vertical turning centres, Milling centres, Advantages of NC, Computers & NC, CNC, DNC, CNC part programming: Designation of co-ordinate axes for CNC machines, Functions of machine control units, Tape format, Manual part programming and computer assisted part programming (using APT language). Exercises involving simple contours and positioning.

ISO system of limits, Fits and Tolerances, Interchangeability, Plain limit gauges, Measurement of screw threads, major diameters, Minor diameters and effective diameter, Pitch, Limit gauges for internal and external threads, Measurement of spur gears, pitch, profile, lead, backlash, tooth thickness.

Tool maker's microscope, Straightness measurement, Slip gauges, Twisted strip mechanical comparator, Optical lever comparator, Optical projector, Electric comparator, Pneumatic comparator, Squareness testing, Optical bevel protractor, Sine bar, Angle gauges, Precision level, Autocollimeter, Angle dekkor, Optical dividing heads and rotary tables, Flatness measurement, Roundness measurement. Co-ordinate measuring machines.

Surface texture: Parameters, sampling length, Specification, Stylus instruments for surface roughness measurement. Acceptance tests on machine tools: Lathe, Milling machine, Radial drill, Laser equipment.

Text Books:

1. Process & Materials of Manufacture, R.A.Lindberg, 4th edition, Prentice-Hall of India, New Delhi.
2. A Text Book of Engineering Metrology, I.C.Gupta, Dhanpat Rai & Sons, Delhi.
3. CNC and Computer Aided Manufacturing, T.K.Kundra, P.N.Rao & N.K.Tewari, Tata McGraw-Hill Publishing Company Ltd, Delhi.

References Books:

1. A.S.T.M.E., Hand book of Industrial Metrology, Prentice-Hall of India, New Delhi.
2. A.S.T.M.E., Hand book of Manufacturing Engineering.
3. Manufacturing Processes & Materials for Engineers, L.E.Doyle & others, Prentice-Hall of India, New Delhi.

MC 3102 FLUID MECHANICS AND MACHINERY

Course Objectives:

- To prepare the student to get the principles and properties of fluid.
- The student is prepared to learn viscosity, flow measurement concepts.
- The student is made to aware of compressible fluid flow.
- The student is educated with concepts of applications of principles of fluids to fluid machines.
- The student is made to aware of concepts of water jets and hydraulic machines. **Course Outcomes:**

- The student gets knowledge on pressure measurement and determination of properties of fluids.
- The student develops the concept of measurement of flow and equations in viscous flow.
- The student develops an idea of fluid principles in the form of equations in application to fluid machines.
- The student develops the concept of compressible fluid flow.
- The student gets awareness on use of different jets to hydraulic machines.

SYLLABUS

Properties of Fluids- Introduction- Viscosity- Pressure and its measurement, absolute, gauge, atmospheric and vacuum pressure- Manometers, Simple manometers and differential manometers.

Fluid Kinematics and Fluid Dynamics: Types of fluid flow- Continuity equation- Velocity potential function and Stream Function - Equation of Motion- Euler's equation- Bernoulli's equation and its applications- Venturimeter, Orifice Meter, Pitot tube- Momentum Equation- Momentum of momentum Equation.

Viscous Flow: Couette flow- Plane Couette flow, Favourable pressure gradient and adverse pressure gradient- Power absorbed in viscous Flow- Flow through pipes- Hagen Poiseulle flow- Fanings friction factor- Darcy's Weisbach friction factor- Loss of head due to friction in pipes, minor losses and major losses - Flow through branched pipes- Power transmission through pipes.

Compressible Fluid Flow: Thermodynamic relations- Continuity, Momentum and Energy equations- Velocity of sound in a compressible fluid- Mach number and its significance- Limits of incompressibility- Pressure field due to a moving source of disturbance- Propagation of pressure waves in a compressible fluids- Stagnation properties- Stagnation pressure, Temperature and density- Area velocity relationship for compressible flow- Flow of compressible fluid through nozzles- Condition for maximum discharge through nozzles- Variation of mass flow with pressure ratio- Compressible flow through a venturimeter- Pitot static tube in a compressible flow.

Impact of Jets; Impact of jet vane on stationary surfaces- Impact of jet on hinged surfaces and Impact of jet on stationary as well as moving curved vanes- Radial flow over the vanes. **Hydraulic Turbines**: Classification- Pelton wheel- Reaction turbines- Inward and outward radial flow reaction turbines- Francis turbine- Axial flow reaction turbine- Kaplan turbine.

Centrifugal and Reciprocating Pumps: **Centrifugal pumps**: Main parts- Efficiency-
Minimum speed for starting- Multistage centrifugal pumps. Reciprocating Pumps: Main parts- Classification- Velocity and acceleration variation in suction and delivery pipes -Effect of variation of velocity on friction in suction and delivery pipes.

Text Books:

1. Fluid Mechanics and Hydraulic Machines, R. K. Bansal, Laxmi publications.
2. Fluid Mechanics, A.K. Mohanty, Prentice Hall of India Pvt.Ltd.
3. Fluid Mechanics and Fluid Power Engineering , Dr. D.S. Kumar, S.K. Kataria &Sons.

Reference Books:

1. Foundations of Fluid Mechanics, Yuan, Prentice Hall of India.
2. Fluid Mechanics and its Applications, S. K.Gupta and A.K.Gupta, Tata McGraw Hill, New Delhi.
3. Fluid Mechanics and Hydraulic Machines, R. K. Rajput, S.Chand & Co.
4. Fluid Mechanics , Kothandaraman and Rudramoorthy.

MC 3104 PROFESIONAL ELECTIVE-I
MC 3105 OPEN ELECTIVE-I
MC 3106 DYNAMICS OF MACHINERY LABORATORY

Course Objectives:

The objectives of this course are

- To develop competency in conducting laboratory experiments for finding moment of inertia of rigid bodies.
- To make the student familiar with commonly used mechanisms for industrial application.
- To demonstrate the various unbalanced rotating systems.
- To familiarize the various types of vibrations for spring mass system.
- To provide the process of calibration to various measuring instruments.

Course Outcomes:

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

- Determine the moment of inertia of various machine components.
- Perform the kinematic analysis of the mechanisms.
- Analyze the moving parts (rotating parts) for dynamic and static balance.
- Evaluate the natural frequencies of various vibrating systems.
- Apply the principles of calibration for measuring instruments.

List of Experiments:

1. Determination of inertia of the given flywheel and connecting rod.
2. Determination of modulus of rigidity of the given wire with torsion pendulum.
3. Verification of laws of balancing.
4. a) Determination of ratios of angular speeds of shafts connected by Hooke's joint.
   b) Determination of the ratio of times and ram velocities of With worth quick return motion mechanism.
5. To draw curves of slider displacement and crank angle and linear velocities w.r.t. time for a slider crank mechanism and compare with theoretical values.
6. To determine the relation of gyroscopic couple and compare with the theoretical values 7. To determine the radius of gyration of given bar by using bifilar and Trifiller suspension.
8. Find the CG of a connecting rod using free vibration techniques.
9. To determine natural frequency of free torsional vibrations of single rotor system.
10. Find the Natural frequency of the free un-damped vibrations of equivalent spring mass system.
11. Find the Natural frequency of the free damped vibrations of equivalent spring mass system.
12. Find the Natural frequency of the forced damped vibrations of equivalent spring mass system.
13. Find the Natural frequency of the forced un-damped vibrations of equivalent spring mass system.

14. Experiments with piezo-electric pick-up, Inductive pick-ups. Determination of characteristics- Displacement, Velocity and Acceleration.
15. Calibration of the given pressure gauge.
16. Calibration of Rotameter.
17. Calibration of Strain Gauges
    a) Full Bridge
    b) Half Bridge
    c) Quarter Bridge

MC 3107 INDUSTRIAL ENGINEERING LABORATORY

Course Objectives:

- To make student acquainted with the control charts and measure the quality of the product.
- To make the students aware of the different types of process charts used for improving the method of doing the work.
- To help students to learn the different methods of finding the standard time for a job.
- To make the students acquainted with the probability distributions.
- To make the students learn the impact of work on the human physiology and the physiological constraints of the body.

Course Outcomes:

- 1. Students will be able to find the quality of the product using different charts.
- 2. Can improve the method of doing work by applying principle of motion economy and method
- study charts.
- 3. Can find the standard time required for completing a job by different methods..
- 4. Understands the basic probability distributions.
- 5. Understands the impact of work on the human body and also the physiological constraints of the body.

List of Experiments:

1. To measure the skill and dexterity in the movement of Wrist and Fingers using pinboard.
2. To measure the Heart beat using Stethoscope.
3. To show that the sample means from a normal universe follow a normal distribution.
4. To draw the control chart for fraction defective for a given lot of marble balls.
5. To determine the cycle time using PMTS.
6. To draw two handed process charts for

i. Bolt, Washer and nut assembly

ii. Assembly of electric tester.

7. To study the changes in heart rate for different subjects using Tread mill.
8. To draw Multiple Activity chart using an electric toaster.
9. To determine the percentage utilization using work sampling.
10. To study the process capability of a given process.
11. To measure the Heart rate during working and recovery periods of the subjects under different loads, using Bicycle ergometer.
12. To draw flow process charts on activities in Workshop/ Laboratory/Office.
13. To determine the time required to perform motion sequence using work factor system.
14. To draw SIMO charts for

i. Ball point pen assembly

ii. Electric plug assembly.

15. To conduct time study of the bulb holder assembly operation of the existing method.
16. To collect the anthropometrics data using 'Anthropolometer'.

MC 3108 SIMULATION OF ENGINEERING STRUCTURES (SKILL COURSE)

Course Objectives:

- To impart the fundamental knowledge on using various analysis systems in FEA tool like Structural and Thermal Analysis Systems for Engineering Simulation.
- To know various fields of engineering where these tools can be effectively used to improve the output of a product.
- To impart knowledge on how these tools are used in Industries by solving some real time problems using these tools
- To provide brief introduction of Computational Fluid Dynamics along with mechanical engineering application specifically, analysis of fluid mechanics and heat transfer related problems.

Course Outcomes:

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

- The student will be able to appreciate the utility of the tools like ANSYS ,Solid Works etc in solving real time problems and day to day problems.
  Use of these tools for any engineering and real time applications.
  Acquire knowledge on utilizing these tools for a better project in their curriculum as well as they will be prepared to handle industry problems with confidence when it matters to use these tools in their employment.
- Recognize the importance of CFD in Heat and Fluid flow.
- Estimation of drag coefficient in circular pipe under laminar and turbulent flow.

List of Experiments:

1. Structural Analysis using any FEA Package for different structures that can be discretised with 1-D,2-D & 3-D elements
   a) Static Analysis
   b) Buckling Analysis
   c) Modal Analysis
   d) Harmonic Analysis
   e) Random Vibration Analysis
   f) Transient Structural Analysis
   g) Design of the Composite using ACP Pre-Post Module.
2. Thermal Analysis using any FEA Package for different structures that can be discretized with 1-D,2-D & 3-D elements
   a) Steady state thermal analysis
   b) Transient thermal analysis
3. Combination of structural and thermal loads on the various structures.
   a) Thermo Mechanical Analysis

MC 3109 INTERNSHIP-I

THIRD YEAR 2ND SEMESTER MC 3201 DESIGN OF MACHINE ELEMENTS –II

Course Objectives:

- Enable students to attain the basic knowledge required to understand, analyze, design and select the machine elements.

- Reinforce the philosophy that real engineering design problems are open-ended and challenging
- Impart design skills to the students to apply these skills for the problems in real life industrial applications
- Inculcate an attitude of team work, critical thinking, communication, planning and scheduling through design projects
- Create awareness amongst students about safety, ethical, legal, and other societal constraints in execution of their design projects.
- Develop an holistic design approach to find out pragmatic solutions to realistic domestic and industrial problems

Course Outcomes:

- Apply knowledge of machine design for understanding, formulating and solving Engineering problems of gear design and industrial gear boxes.
- Acquire knowledge and hands-on competence in applying the concepts in the design and development of mechanical systems and proficient in Design of Gears, I.C. engine parts, brakes and clutches.
- Demonstrate creativeness in designing new systems components and processes in the field of engineering in general and mechanical engineering in particular to develop capability to analyze Rolling contact bearing and its selection from manufacturer's Catalogue.
- Identify, analyze, and solve mechanical engineering problems of gear boxes, engine parts and other miscellaneous parts for various industrial applications useful to the society.
- Work effectively with engineering and science teams as well as with multidisciplinary designs and expertise in design of Sliding contact bearing in industrial applications and selection of suitable composite materials.

SYLLABUS

Gears: Classification of gears, Terminology, Standard systems of gear tooth, Selection of materials, Design of Spur, Helical, Bevel and Worm gears, Force analysis of spur helical, bevel and worm gears, Gear tooth failure. Face width, beam strength. Lewis equation, Checking the Design for dynamic and wear loads. Thermal design considerations of worm gears.

I.C. Engine parts: I.C. engine. Stresses in engine parts, Design of cylinders and heads. Design of piston. Design of connecting rod and crank shafts.

Clutches and Brakes: Friction clutches. Torque transmitting capacity, multi-plate clutches, Design considerations. Energy considerations and Temperature rise friction materials. Cone clutches, Centrifugal clutches. Brakes. Energy equations. Band and block brakes. Internal expanding shoe brakes, Disc brakes, self-locking, brake design.

Bearings: Sliding contact bearings. Lubrication modes. Temperature effect on viscosity. Journal bearings design. Bearing modulus. McKee's equations. Heating of bearings. Collar and thrust bearings. Roller and ball bearings. Static and dynamic load capacity. Equivalent bearing load. Load-life relationships. Load factor. Selection of bearings from manufacturers catalogue.

Miscellaneous parts: Design of crane hooks, Wire rope construction, Stresses in wire ropes. Design for service like lifts and winches. Chain drives, Nomenclature: Brief outline and simple applications of composite materials.

Text books:

1. Design of Machine Elements, V.B.Bhandari, TMH Publishing Co. Ltd., NewDelhi.
2. Shigley's Mechanical Engineering Design, Richard G. Budynas and J. Keith Nisbett Mc Graw Hill Publications.
3. Machine Design, R.S.Khurmi and J.K.Gupta, S.Chand Publications. **Reference Books**:

1. Machine Design, R.K.Jain, Khanna Publications
2. Machine Design: An Integrated Approach, 2/e by Robert L. Norton ,Pearson Education.

MC 3202 FINANCIAL MANAGEMENT FOR ENGINEERS

Objectives:

1) To provide awareness and understanding of the ways finance helps in reaching business objectives.
2) To familiarise with the form, content and analysis of financial statements and the accounting principles and techniques.
3) To Identify signals pointing to deterioration in financial condition and analyse the reasons for variances between the actual and budgeted results
4) To facilitate in the improvement of organizations' performance by pointing out the importance of cost control, breakeven and variance analysis.

To equip with the ability to communicate comfortably with Financial Executives and discuss the financial performance of the organization effectively.

Outcomes:

1) Ability to Analyse financial statements
2) Understanding costs and methods to reduce them
3) Taking decisions regarding the price of the products services, or both
4) Skill to practice different Budgeting Systems in organisations

SYLLABUS

Accounting concepts and systems - Elements of Financial Statements - Trading, Profit & Loss Statement- Cash Flow Statements - Notes to Accounts - Profits vs. Cash Flows

Analysis of Financial Statements - Financial Analysis - Financial Ratios and their Interpretations covering: Profitability Ratios; Liquidity Ratios; Return on Capital Ratios; - Management of Working Capital: Capital and Its Components - Working Capital Cycle - Working Capital Financing.

Management Decision Making: Cost concepts and its application in Decision Making - Types of cost – Direct& Indirect, Fixed& Variable - Cost Sheet - Cost Volume Profit Analysis - Understanding Cost behaviour – Cost concepts and its application in Decision Making - Relevance of Activity Based Costing - Marginal Costing - Make or Buy - Shut down or continue - Sell or process further - Domestic vs. Export Sales

Budgets and Budgetary Control: Different types of Budgets (Departmental, Function based, Cash, Master) - Budgeting systems (ABC / ZBB / Rolling/ Incremental / Planning) - Variance Analysis - Capital Budgeting and Investment Appraisals - Meaning of Capital Budgeting - Relevance of Capital Budgeting - Techniques of Capital Budgeting - Payback Period - Accounting Rate of Return - Net Present Value - Internal Rate of Return - Discounted Payback Period

Means of Finance: Financial Instruments - Shares, Debentures, Derivatives - Share Capital Vs. Term Loans - Leasing - Financial Markets - Capital Markets - Stock Exchanges

Text Books:

1. Finance for Non-Finance People by Sandeep Goal (2017), Publisher: Taylor and Francis.
2. Finance for Non-Finance Managers by B.K. Chatterjee (1988), Jaico Publishing House, Sold by Amazon
3. Finance for Nonfinancial Managers: Finance for Small Business, Basic Finance Concepts (Accounts and Finance) by Murugesan Ramaswamy (2021), Repro Books-On-Demand

MC 3203 HEAT TRANSFER

Course Objectives:

- Students should familiarize with the basic concepts of conduction and extend the concepts to various geometries under different conditions
- Students with fundamentals of boundary layer to develop logical and mathematical correlations applied for various boundary conditions and facilitate convection calculations
- Students should have an exposure to various laws in radiation and apply the same to heat transfer influenced by radiation.
- Student must learn about different types of heat exchangers used in industrial applications with basic knowledge of heat load calculations
- Students to learn about apparent basics of phase change phenomenon
- Students must have comprehensive knowledge of all modes of heat transfer

Course Outcomes:

- Students would be comfortable with use of equivalent heat transfer circuits. The implications of an internally distributed energy source can be understood clearly and apply the same to various geometries under different conditions
- Students with exposure to boundary layer theory can help them to deal with relevant dimensionless groups, boundary layer approximations and understand the fundamentals of convection
- Students will be cognizant of basic laws of radiation and extend them to different geometries and orientations
- Students can logically identify and estimate heat loads/area required from a given choice of heat exchangers
- Students can identify the essential and physical process of phase change phenomenon and present correlations for approximate engineering calculations.

SYLLABUS

Introduction: Basic modes of heat transfer- Rate equations- Generalized heat conduction equation in Cartesian, Cylindrical and Spherical coordinate systems.

Steady state heat conduction solution for plain and composite slabs, cylinders and spheres- Critical thickness of insulation- Heat conduction through fins of uniform and variable cross section- Fin effectiveness and efficiency.

Unsteady steady state heat conduction- Transient heat conduction- Lumped system analysis, and use of Heisler charts.

Convection: Continuity, momentum and energy equations- Dimensional analysis- Boundary layer theory concepts- Free, and Forced convection- Approximate solution of the boundary layer equations- Laminar and turbulent heat transfer correlation- Momentum equation and velocity profiles in turbulent boundary layers- Application of dimensional analysis to free and forced convection problems- Empirical correlation.

Radiation: Black body radiation- radiation field, Kirchoff's laws- shape factor- Stefan Boltzman equation- Heat radiation through absorbing media- Radiant heat exchange, parallel and perpendicular surfaces- Radiation shields.

Heat Exchangers: Types of heat exchangers- Parallel flow- Counter flow- Cross flow heat exchangers- Overall heat transfer coefficient- LMTD and NTU methods- Fouling in heat exchangers- Heat exchangers with phase change.

Boiling: (Qualitative treatment only) Different regimes of boiling- Nucleate, Transition and Film boiling. Condensation: (Qualitative treatment only) Laminar film condensation- Nusselt's theory- Condensation on vertical flat plate and horizontal tubes- Dropwise condensation.

Text Books:

1. Heat Transfer, J.P.Holman, Int. Student edition, McGraw Hill Book Company.
2. Analysis of Heat transfer, Eckert and Drake, Int. Student edition, McGraw Hill Kogakusha Ltd.

Reference Books:

1. Heat and Mass Transfer , R.K. Rajput, S. Chand & Co.
2. Fundamentals of Engineering Heat and Mass Transfer, R C Sachdeva, New Age International Publishers
3. Fundamentals of Heat and mass transfer, C P Kothandaraman, New Age International Publishers

MC 3204 PROFESIONAL ELECTIVE-II

MC 3205 OPEN ELECTIVE-II

MC 3206 METROLOGY & MECHATRONICS LABORATORY

Course Objectives:

- To demonstrate the fundamentals of Metrology and Measurement Engineering concepts, different tools used for minute measurements, and calibrate various kinds of measuring instruments.
- To demonstrate the involvement of sensors and electronic devices in the mechanical oriented industries by introducing PLC, and Mechatronics equipment.
- To demonstrate the use of logic circuits in controlling various mechanical devices including material handling equipment, lift control systems, pneumatic controller systems etc.

- To demonstrate the techniques and processes followed for calibrating measuring instruments like Micrometer, Mechanical Comparator, and Vernier Caliper etc. and educate students about the metrology equipment.
- To train the students on the fundamentals of logic circuit design, to write ladder logic programs and execute them to control various mechanical devices.

Course Outcomes:

- Students will be able to understand the various logics involved in controlling mechanical industry equipment.
- The student will be able to operate measurement instruments on their own and test different components for their dimensional accuracy.
- A project involving writing ladder logic for controlling a mechanical device, executing the program is required from each student and graded by the instructor, so that the student will be able to understand the Mechatronics concept, practically and from the application point of view.

Metrology Lab. Experiments - (Any Five)

1. Calibration of the following instruments: (using slip gauges)
   i. Calibration of Micrometer. ii. Calibration of Mechanical Comparator.
   iii. Calibration of Vernier Caliper. iv. Calibration of Dial Gauge.
2. Measurement of taper angle using

i. Bevel Protractor ii. Dial Gauge iii. Sine-Bar iv. Auto-Collimator.

3. Alignment tests:

i. Parallelism of the spindle ii. Circularity & Concentricity of the spindle iii..Trueness of running of the spindle.

4. Gear parameters Measurement

i. diameter, pitch/module ii. Pitch circle diameter iii. Pressure angle iv. Tooth thickness.

5. Check the flatness of a surface plate.

i. Using spirit level ii. Using Auto-collimator

6. Using light wave interference:

i. Study of flatness of slip gauges ii. To find the height of a slip gauge.

7. Tool Maker's Microscope:

i. Establish the thread details ii. To find the cutting tool angles.

8. Miscellaneous:

i. To find the diameter of a cylindrical piece ii. Taper angle of a V-block iii. Central distance of two holes of a specimen.

Mechatronics Lab. Experiments - (Any Five)

I. Training on Programmable Logic Controller (any ONE of the Following)

i) Lift Control Using Ladder Logic Programme

ii) Traffic Signal Control using Ladder Logic Programme

II. Training on Programmable Logic Controller - Sensor Training Kit

a) Proximity Switch

b) Photo Electric Switch c) Limit Switch

III. Training on Sensor and Transducer (any ONE of the Following)

i. Linear position or Force applications

a) LVDT (Linear variable differential transformer)

b) The strain gauge Transducer ii. Rotational Speed or Position Measurement (The inductive Transducer) iii). Linear or Rotational Motion

a. D.C. Solenoid

b. D.C. Relay

IV. Training on Automation Studios i. Punch Machine operation

ii. Hydraulic Cylinder operation

V. Training on Material Handling

VI. Training on any Controller Package VII. Training on Servo Fundamental Trainer.

MC 3207 FLUID MECHANICS AND MACHINERY LABORATORY

Course Objectives:

- The student is made to understand fluid mechanics principles.
- The student is taught to use equations applied to flow meters, jets, turbines and pumps.
- The student is made aware related to working of various fluid machines.
- The student is made to understand the concept of drag and discharge.

The student is taught to draw line diagrams to understand the function of equipment.

Course Outcomes:

- The student gets an idea to use continuity, momentum and energy equation principles.
- The students gets awareness to see, record and analyze the observations.
- The student is able to assess the usage of flow meters and notches.
- The student gets idea on estimation of values in jets as well as in turbines.
- The student gets capability in estimation of performance characteristics of pumps.

List of Experiments:

Cycle-1

1. Calibration of flow meters, a) Venturi meter b) Orifice meter c) Nozzle meter
2. Determination of coefficient of discharge for a) small orifice b) cylindrical mouth piece 3. Finding coefficient of discharge for a) rectangular notch b) triangular notch c) trapezoidal notch

Cycle-II

4. To find the force due to Jet of water (Impact of Jets) a) Force on Flat Plate b) Force on Curved Plate
5. To draw the performance characteristics of C.F. pump.
6. To find the specific speed of a) Pelton turbine b) Francis turbine
7. To draw the characteristic curves for reciprocating pump.
8. To draw the pressure distribution and finding coefficient of drag for a) A bluff body b) An Aero foil c) To draw the characteristic curves for the hydraulic ram

MC 3208 HEAT TRANSFER LABORATORY

Course Objectives:

- Students to have practical approach to different modes of heat transfer
- Students to learn about opportunities available to change boundary conditions and study their influence on heat transfer
- Students to learn about steady state conditions and evaluate critical parameters in heat transfer applications
- Students to learn about instrumentation used in heat transfer applications

Course Outcomes:

- Students will have hands on experience handling different experiments in heat transfer
- Students can learn the significance of boundary conditions and their influence on heat transfer
- Students can evaluate critical parameters at steady state conditions.
- Exposure to different measuring instruments can certainly enhance their knowledge in instrumentation also.

List of Experiments:

1. Study of conduction phenomena in the composite lagged pipe system.
2. Determination of emissivity of a test plate.
3. Study of heat transfer in a shell and tube heat exchanger

4. Determination of thermal conductivity of metal rod (copper).
5. Study of heat transfer through a insulating slab
6. Study of heat transfer by free convection through a vertical cylinder
7. Study of heat transfer by forced convection through a horizontal test section.
8. Study of unsteady state conduction heat transfer and temperature distribution with time
9. Determination of free convective heat transfer coefficient from a horizontal cylinder in air.
10. Study of performance of heat pipes
11. Study of temperature distribution, effectiveness and efficiency of pin fin

MC 3209 SOFT SKILLS (SKILL COURSE)

Course Objectives:

- To develop skills to communicate clearly.
- To aid students in building interpersonal skills.
- To enhance team building and time management skills.
- To inculcate active listening and responding skills.

Course Outcomes:

Make use of techniques for self-awareness and self-development.
Apply the conceptual understanding of communication into everyday practice.

- Understand the importance of teamwork and group discussions skills.
- Develop time management and stress management.

SYLLABUS

Introduction to Soft Skills: Communication – Verbal and Non Verbal Communication -
Personal grooming (Etiquette, Attitude, Body Language), Posture, Gestures, Facial Expressions, Eye Contact, Space Distancing, Presentation Skills, Public Speaking, Just a Minute (JAM) sessions, Adaptability.

Goal Setting and Time Management: Immediate, Short term, Long term, Smart Goals, Strategies to Achieve goals, Types of Time, Identifying Time Wasters, Time Management Skills, Stress Busters.

Leadership and Team Management: Qualities of a Good Leader, Team Dynamics, Leadership Styles, Decision Making, Problem Solving, Negotiation Skills.

Group Discussions: Purpose (Intellectual ability, Creativity, Approach to a problem, Tolerance), Group Behaviour, Analysing Performance.

Job Interviews: Identifying job openings, Covering Letter and CVs / Resumes, Interview (Opening, Body-Answer Q, Close-Ask Q), Telephone Interviews, Types of Questions.

Reference Books:

1. Nail the Resume! Great Tips for Creating Dynamite Resumes. Krannich, Caryl, and Krannich, Ronald L. United States, Impact
   Publications, 2005.
2. Brilliant Communication Skills. Hasson, Gill.Great Britain: Pearson Education, 2012
3. How to Prepare for Group Discussion and Interview, Prasad, H. M. New Delhi: Tata McGraw-Hill Education, 2001.
4. Body Language, Pease, Allan, Delhi: Sudha Publications, 1998.
5. Effective Technical Communication: Rizvi, Ashraf M. India, McGraw-Hill Education. 2010
6. Winning at Interviews, Thorpe, Edgar &Showick Thorpe, 2nd Edition. Delhi: Dorling Kindersley, 2006.

MC 4101 PROFESIONAL ELECTIVE-III

MC 4102 PROFESIONAL ELECTIVE-IV

MC 4103 PROFESIONAL ELECTIVE-V

MC 4104 OPEN ELECTIVE-III

MC 4105 OPEN ELECTIVE-IV

MC 4106 HSS-ELECTIVE

MC 4107 COMPUTATIONAL FLUID DYNAMICS (SKILL COURSE)

Computational Fluid Dynamics using any FEA package.

a) CFD modeling for Laminar & Turbulent Pipe Flow,
b) Supersonic Flow over a Wedge,
c) Venturimeter Analysis.
d) Compressible Flow in a Nozzle
e) Airfoil Analysis,
f) Compressible Flow over a Flat Plate.

MC 4108 INTERNSHIP-II

MC 4201 PROJECT WORK

LIST OF PROFESSIONAL ELECTIVES

1. MECHANICS OF MATERIALS

Course Objectives:

- The objective is to make students learn and analyze continuous and fixed beams, columns and struts under different loading conditions, stresses in rotating discs, curved bars, thin and thick Cylinders and shells
- To enrich the student on the concept of fixed beams with uniform Moment of inertia both under stability of beam supports and under sinking & rotation of the supports
- To make the student understand the concept of continuous beams with uniform Moment of inertia both under stability of supports as well as sinking of supports
- To make the student understand the concept of vertical compression loading on an engineering beam with four different end conditions as well as when column with initial curvature , under nonaxial loading condition and along with vertical compression and lateral central point loading
- To make the student understand the concept of curved beams having different cross sections along with calculation of bending stress at any point across the cross section of the curved beam.
- To make the student understand the concept of circular rotating discs having uniform thickness and uniform strength make him capable of calculating the stress on any point of the circular rotating disc.
- To make the student understand the concept of thick cylinder as well as compound cylinder under different pressure conditions so that the student can evaluate radial stress and circumferential stress at any radius of the thick cylinder.

- To make the student understand the energy methods and Castigliano's theorem-1 &2 and their application for cantilever beams and simply supported beams.

Course Outcomes:

- Develop an understanding of methods of analysis used in treating statically indeterminate loading conditions of the beams.
- The student is capable of evaluating an already existing fixed beam with uniform Moment of inertia which is under different loading conditions and with different support conditions and can even able to design a fixed engineering beam for any loading conditions.
- The student is capable of evaluating an already existing continuous beam with uniform Moment of inertia which is under different loading conditions and with different support conditions and can even able to design a continuous engineering beam for any loading conditions
- The student is capable of evaluating any engineering column or strut under different end conditions and under different specified variable loading conditions as mentioned under objectives. Analyze and design columns and long mechanical members under compression.
- Understand the advanced concepts of strength of materials like curved bars, applications of theories of failures in the design of thick cylindrical vessels and pressure vessels etc.
- The student is capable of evaluating curved beams of different cross sections and canable to evaluate the stresses across the cross-sections of the curved beam.

  The student is capable of calculating the radial stress and circumferential stress for rotating circular disc (both hollow and solid) of uniform thickness, and is capable of modeling the thickness of circular rotating disc having uniform strength.
- The student is capable of calculating the radial and circumferential stress for both thick and compound cylinders under different pressurized conditions.
- The student is capable of using different energy methods for evaluating the deflection and slope of simply supported beams and cantilever beams

SYLLABUS

Fixed Beams: Introduction, bending moment diagram for fixed beams - slope and deflection for a fixed beam carrying- point load at center, an eccentric point load, a uniformly distributed load over the entire length, and fixed end moments of fixed beam due to sinking of a support.

Continuous beams: Analysis of continuous beam Introduction, Reactions at the supports, Effect of sinking of supports, bending moment diagram for continuous beams-Clapeyron's equation of three moments, Clapeyron's equation of three moments applied to beams with simply supported ends carrying point loads and uniformly distributed load – continuous beams with end supports fixed carrying point loads and uniformly distributed load

Energy Methods - Strain energy and strain energy density, strain energy due to axial load, shear, flexure and torsion – Castigliano's theorems - I & II and applications, Maxwell's reciprocal theorems.

Columns and Struts: Columns with one end free and the other fixed, Both ends fixed, One end fixed and other hinged, Limitation of Euler's formula, Column with initial curvature, Column carrying eccentric load, Laterally loaded columns with Central point load and Uniformly distributed load, Empirical formulae.

Bending of Curved Bars and Concept of Shear Center: Stresses in curved bars of circular, rectangular and trapezoidal sections and Introduction to Shear Center and unsymmetrical bending and its applications.

Stresses due to rotation: Rotating Rings & Discs Introduction, Wheel rim, disc of uniform thickness, stresses in a rotating ring, stresses in a rotating thin disc- circumferential and radial stresses in a solid disc, disc of uniform strength, circumferential and radial stresses in a hollow disc with a pin hole at the center.

Thick cylinders: Lame's equations, Thick Cylinders subjected to internal and external pressure and compound cylinders and its applications.

Text Books:

1. Analysis of Structures, Vazirani and Ratwani, Vol. 1, 1993 edition, .
2. Chapter VI from Advanced Topics in Strength of Materials, Prof. L.B.Shah and Dr.R.T.Shah.
3. Mechanics of Materials, Gere & Timoshenko, CBS Publishers or Mechanics of Materials, Timoshenko S.P. and James Gere, 5th edition, Van Nostrand Reinhold Co., 2001.

Reference Books:

1. Strength of Materials, Timoshenko.
2. Analysis of structures, Prof V.N.Vazirani &Dr MM Ratwani & Dr S.K.Duggal
3. Strength of Materials, Dr Sadhu Singh, Khanna Publications Pvt. Ltd., 2013.
4. Strength of Materials, S.S. Ramamrutham & R, Narayanan, Dhanpat Rai Publishing Company (P) Limited, 2008.
5. Engineering Mechanics of solids, Egor P. Popov, Second edition, Prentice hall of India Pvt. Ltd, New Delhi.
6. Mechanics of materials, Jhonston Beer and Mazurek Dewol, India Pvt. Ltd, New Delhi. th Edition
7. Strength of materials, R.K.Rajput, 6th edition S.Chand Ltd. publications, 2015.
8. A Text Book of Strength of Materials, R.K.Bansal, 4th edition, Lakshmi Publications Pvt. Ltd. 2017.
9. Boresi and Sidebottom, Advanced Mechanics of Materials, Wiely International, 5/e, 1993.

Web Resources:

1.http://nptel.ac.in/courses/Webcourse-contents/IITROORKEE/ strength%20of%20materials /homepage.htm

2. http://www.aboutcivil.org/solid-mechanics.html

3. http://web.mit.edu/emech/dontindex-build/

2. MECHANICAL VIBRATIONS

Course Objectives:

- To enrich the student on the concept of Mechanical vibrations.
- To make the student understand the concept of single and two degree of freedom systems.
- To make the student understand the use of damping, influence co-efficients, matrix methods and Lagrange's equations.
- To make the student understand the concept of multiple degree of freedom systems.
- To make the student understand the vibration problems in daily life
- To make the student understand the principal of orthogonality classical and energy methods by Rayleigh, Ritz and Gelerkin.

Course Outcomes:

- The student is capable of understanding the various concepts in Mechanical vibrations.
- The student is capable of understanding the concept of single and two degree of freedom systems.
- The student is capable of understanding the concept of multiple degree of freedom systems.
- The student is capable of understanding the different problems in single, two and multiple degree freedom systems.
- The student is capable of understanding the damping, influence co-efficients, matrix methods and Lagrange's equations.
- The student is capable of understanding the principal of orthogonality classical and energy methods by Rayleigh, Ritz and Gelerkin.

SYLLABUS

Undammed free Vibrations of Single degree freedom systems -Introduction –
Derivations and solutions of differential equation – equivalent stiffness of spring (series and parallel) – Rayliegh's energy method.

Damped free vibrations of single degree of freedom systems – Introduction – Different types of damping – Free vibration with viscous damping (over, critical and under damped) – Logarithmic decrement – Viscous dampers (Fluid dashpot and eddy current)

Forced Vibrations of Single Degree of Freedom Systems - Introduction - Forced vibrations with constant harmonic excitation (Steady vibrations) - Energy dissipated by damping - Vibration isolation and transmissibility (Force, Motion, Typical isolators and mount type)

Two Degrees of Freedom Systems – Introduction - Principal modes of vibration - Other cases of simple two degrees of freedom systems (Two masses fixed on a tightly stretched string, Double pendulum , Torsional system) - Systems with damping - Undamped forced vibrations with harmonic excitation – Vibration Absorbers – Vibration Isolation

Multi degree freedom systems (Exact Analysis) – Introduction – Free vibrations –
Influence coefficients – Generalized coordinates– Natural frequencies and mode shapes(Eigen values and Eigen vectors) –modal analysis – Torsional vibration of multi rotor system – Continous system.

Text Books:

1. Mechanical Vibrations, G.K.Groover,Nem Chand & Bros , Roorkee,U.K.,India,2009.
2. Mechanical Vibrations , Singiresu S. Rao,Pearson Global Publications, Sixth Edition,2009

Reference Books:

1. Mechanical Vibrations and Noise engineering, A.G.Ambekar, Printice Hall India Publishers
2. Mechanical Vibrations, J.P. Den Hartog, Dover Publications Inc.,12th Edition , 1985.
3. Mechanical Vibrations, R.Venkatachalam, Prentice Hall India Learning,1st Edition, 2014
4. Elements of Vibration Analysis, Meirovitch, Tata McGraw Hill Edition, 2001
5. Mechanical Vibrations, S.Graham Kelly, Schaum's Outline , Tata McGraw Hill Edition, 2020
6. Vibration Problems in Engineering, Timoshenko and Young.
7. Mechanical Vibrations, Debabrata Nag, Wiley Publications
8. Theory and Practice of Mechanical Vibrations, J.S Rao & K. Gupta, New Age International Publishers, 2nd Edition
9. Mechanical Vibrations, A.H. Church, John Wiley & Sons Inc,1963

3. COMPOSITE MATERIALS

Course objectives:

- To expose the student to different types of composite materials,
- To understand the characteristics of composite materials

Course Outcome:

- Understand the significance of composite materials.
- Distinguish the construction, constituent's phases & characteristics of the composite materials.
- Explain the fabrication techniques of different types of composite materials.

SYLLABUS

Introduction: Classifications of Engineering Materials, Concept of composite materials, Types of reinforcements, Types of matrices, Properties of composites in comparison with standard materials, Applications of metal, ceramic and polymer matrix composites.

Types of Composites: Classification based on Matrix Material: Organic Matrix composites, Polymer matrix composites (PMC), Carbon matrix Composites or Carbon-Carbon Composites, Metal matrix composites (MMC), Ceramic matrix composites (CMC); Classification based on reinforcements: Fiber Reinforced Composites, Fiber Reinforced Polymer (FRP) Composites, Laminar Composites, Particulate Composites, Advantages & limitations of Composites

Manufacturing Methods: Hand and spray lay - up, injection molding, resin injection, filament winding, pultrusion, centrifugal casting. Fiber/Matrix Interface, mechanical. Measurement of interface strength. Characterization of systems; carbon fibre/epoxy, glass fibre/polyester, etc.

Mechanical Properties -Stiffness and Strength: Geometrical aspects – volume and weight fraction. Unidirectional continuous fibre, discontinuous fibers, Short fiber systems, woven reinforcements – Mechanical Testing: Determination of stiffness and strengths of unidirectional composites; tension, compression, flexure and shear.

Laminates: Plate Stiffness and Compliance, Assumptions, Strains, Stress Resultants, Plate Stiffness and Compliance, Computation of Stresses, Types of Laminates -, Symmetric Laminates, Antisymmetric Laminate, Balanced Laminate, Quasi-isotropic Laminates, Cross-ply Laminate, Angle ply Laminate. Orthotropic Laminate, Laminate Moduli, Hygrothermal Stresses.

Text Books:

1. Composite Materials- Science & Engineering, K.K. Chawla, Springer-Verlag, New York, 1987.
2. An Introduction to Composite Materials, Hull, Cambridge, 2nd Edt. 1997.

Reference Books:

1. Materials characterization, Vol. 10, ASM hand book.
2. Engineered Materials Handbook, Vol. 1, ASM International, Ohio, 1988.
3. Composite Materials: Engineering and Science, F.L. Matthews and R.D. Rawlings, Chapman & Hall, London, 1994
4. Engineering Materials: Polymers, Ceramics and Composites A.K Bhargava Prentice Hall India.

4. WORKSTUDY AND ERGONOMICS

Course Objectives:

- To understand the meaning of productivity and the means of increasing the productivity.
- To know about work study and method study. To get acquainted with different methods of recording the work and ways to improve the method of doing work.
- To know the different methods of measuring the work done and compute standard time.
- To know the principles of motion economy.
- To learn about job evaluation and merit rating.
- To understand the meaning of Ergonomics and Anthropometry.

Course Outcomes:

- Understand the factors for low productivity, eliminate them and improve productivity.
- Analyze the existing method of doing work, improve the method by eliminating unwanted steps in the process.
- Will be able to measure the work and find the standard time required for doing the work.
- Will be able to apply principles of motion economy and make work easier and improve the performance of the workers.
- Will be able to analyze the job and fix the monitory benefits.
- Will be able to evaluate the performance of the workers.
- Will be able to understand the importance of ergonomic and measure anthropometric data.

SYLLABUS

Introduction to work study: Scientific management – Productivity - Advantages of work study to management, Supervisors and workers.

Method Study: Introduction - Process charts, Critical Examination, Identification of key activities on process charts, Diagrams and Templates, Therbligs, Micro motion analysis, Memo motion study. Developing new method - Job survey report writing.

Principles of Motion Economy: Related to human body, work place, equipment.

Work Measurement: Work measurement techniques – Rating - Measuring the job –Allowances - Standard time - Synthetic data - Analytical estimating – PMTS ,Work factor, MTM, Activity Sampling, Its applications.

Job Evaluation, Techniques of job evaluation - Merit rating - Incentive plans.

Ergonomics: Basics of Ergonomics, Anthropometry.
Text Books:

1. Introduction to Work Study - International Labour Organization.
2. Elements of Work Study and Ergonomics, Dalela et al, Standard Publications.

Reference Book:

1. Motion and Time Study, Barnes, John Wiely.

5. CONDITION MONITORING

Course Objective:

- The objective of the course is to study the Basics of condition monitoring techniques and the signal processing techniques associated with the instruments used in vibration monitoring, oil analysis etc., its application in industries, case studies related to the condition monitoring of machines and its advantages.

Course Outcomes:

- Be able familiar to condition monitoring technique and its methods.
- Be able to identify the instruments which may be employed for diagnosis of failures.
- Be able to understand diagnose the failures and its consequences and therefore importance of condition monitoring techniques.
- Be able to use the instruments and basic signal processing terminology used while handling the instruments.
- Be able to diagnose a particular failures and will be able to reach to root cause of the failures in machines

SYLLABUS

Maintenance and Condition Monitoring: Importance and necessity of maintenance, Different maintenance strategies.

Techniques of condition monitoring: Different Nondestructive techniques – Visual, Dye Penetration, Acoustic Emission and its applications, X-ray, Radiographic, Magnetic Flux test, Temperature monitoring, Vibration analysis, Oil analysis.

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Oil Analysis: Oil degradation analysis, Abrasive Particle in oil, counters, Particle classification and counter, Spectrometric oil analysis, Performance trend monitoring – Primary and secondary parameters, Ferrography, Corrosion monitoring techniques.

Vibration Measurement: Different sensors for sound and vibration measurement, Data acquisition, Noise and vibration analyzers, Laser vibrometer, Vibration limits & Standards.

Basic signal processing techniques: Fourier analysis, Hilbert Transform, Cepstrum analysis, Digital filtering, Time-frequency analysis, Shock pulse method, Kurtosis.

Condition monitoring of rotating machines: Bearing condition monitoring, gear condition monitoring, Critical speed analysis, Orbit Analysis, Wear behaviour monitoring, Faults in reciprocating machines, Case studies and failure analyses.

Text Books:

1. Vibration based condition monitoring: Industrial aerospace and automotive applications, Robert Bond Randall, Willey publication 2010.
2. Machinery Vibration Analysis & Predictive Maintenance, Cornelius Scheffer, Paresh Girdhar (2004), Elsevier Publication

Reference Books:

1. Handbook of condition monitoring, Rao, B. (1996), Elsevier advanced technology, Oxford.
2. Amiya Ranjan Mohanty, Machinery Condition Monitoring and Principles.(1st edition) 2014 3. Computational Fluid Mechanics and Heat Transfer: D.A. Anderson, J.C. Tannehill and R. H. Pletcher, Hemisphere Publishing Corporation.

6. AUTOMOBILE ENGINEERING

Course Objectives:

- To create awareness about vehicle layout and power transmission from engine to wheels.
- To create awareness about various types of automotive engines and working of conventional and modern automotive / multi-cylinder engines.
- To understand how clutch and gearbox/transmission systems are functioning.
- Able to learn about constructional features of drive shaft, differential, wheels, and tires.
- To understand how electronic sensors and engine management system are useful for optimum performance of modern automotive engines/vehicles.
- To understand the layout and working of electric vehicles.
- To apply the concepts of flexi-fuels in hybrid vehicles.
- To create awareness on vehicle troubles, maintenance, and the motor vehicle act.

Course Outcomes:

- Students gets the basic knowledge on power transmission system-components in automotive vehicles: from well (engine) to wheels.
- The students can learn the developments in engine technology (: technologies related to emission reduction and increase of fuel efficiency): Emission reduction stages: Euro-I to Euro-VI.
- The students are familiar with the constructional features of major components/devices: Engine - Clutch- Gearbox/transmission – Driveshaft Differential - Axles and Wheels (including tires).
- The students can learn the working principle of major automotive components
- Students are familiar with the working of various control systems of automotive vehicles: Power steering, anti-lock braking system, etc.
- Students can understand the power transmission in electric and hybrid vehicles and their safety features.
- Students are familiar with the Indian Motor Vehicle Act.
- The students are prepared to work in automotive industry.

SYLLABUS

Introduction: Automobile Layout, Chassis and Transmission: Introduction to Drive Train:

Clutch, Gearbox, Hook's Joint, Propeller /Drive Shaft, Slip Joint, Final Drive and Differential, Front and Rear Axles, Wheels and Tires. Control systems: Introduction to Steering and Brakes. Electrical system: Introduction to Starting System, Flywheel-Battery-Ignition, dynamo/alternator, cut-out and wiring. Automobile Body: Parts and Streamlining, Automobile types: Front, Rear and Four-wheel drive, and Automotive materials.

Multi-Cylinder Engines: In-line and V type, Multi-Valve Engines, VCR Engines, Turbocharging, Petrol Engines: Carburetted and MPFI, Electronic Ignition, Diesel Engines: Conventional, CRDI, and Dual-Fuel engines. Performance characteristics, Exhaust Emissions and their controlling techniques: EGR and Catalytic Converters, EURO/Bharat Stage Norms: IVI, Manifolds and Mufflers, Engine Cooling and Lubrication.

Clutch: Clutch Assembly: Construction and Working Principle, Types: Single and Multiple Plates, Fluid coupling/Torque converter, Clutch Troubles and Remedies. **Gearbox:** Necessity of Transmission and Transaxle, Construction and Working Principle of Synchromesh (Five and Six Speed) Gearbox, Overdrive, Automatic Gearbox (seven and eight speed) and Epicyclical gear trains. Gearbox Troubles and Remedies. **Drive shaft and Final Drive:** Drive Shaft: Constructional Features: Universal/Hooks Joints Constant Velocity Joint, Slip Joint, and Working Principle. Types of Propeller shafts, Final drive and Differential: Necessity, Constructional Features and Working Principle, Front/Rear Axles: Constructional Features. Types of Rear Axle Floating, Wheels: Disc and Drum type, Tires: Tire Construction, Tube and Tubeless Tires, Radial Tires, Tire inflation and nitrogen filling, Tire specification, Tire rotation and Tire Maintenance.

Suspension System and Vehicle Control: Coil and Leaf Springs, Shock absorbers, Wheel alignment: Kingpin angle, Caster, Camber, Toe-in, and Toe-out, Steering Mechanism and its Elements: Steering gear

box and its types, Steering gear ratio, Steering linkages. Power Steering, Brake system: Parking and Power Brakes, Parts and Working Principle of Mechanical, Air and Hydraulic Brakes: Mater and Wheel cylinder, Properties of Brake (DOT) Fluids, Brake Diagnostics and Service: Brake Bleeding, Anti-lock Braking System (ABS), Automobile Accessories and Tips for Safe Driving.

Electrical and Electronic Systems: Basics of Electrical/Electronic Systems: Battery, starting system, Charging System, Lighting and Signalling System, Electronic Engine Management system, Automotive Embedded Systems: Vehicle Security System. Working Principle of Computer Sensors: Temperature, Flow, Cam, knock, and Oxygen, and ECU/ ECM. Engine Management system.

Electric Vehicles: Layout of electric vehicle, Battery (Lithium-Ion), Traction Battery Pack, Battery Management System, Battery charging optimization, Power Train (electric): Battery Pack, DC-to-AC converter, Electric Traction Motor, Transmission (single ratio), On-Board
Charger, Power Electronic Converters, Power Electronics Controller, Electronic Control Unit, Battery cooling system and Safety of electric vehicle. Performance characteristics of electric vehicle.

Hybrid Vehicles and Flexible Fuels: Layout of hybrid vehicles, Performance and emission characteristics of hybrid vehicles. Alcohol -based fuels and Biofuels.

Trouble Shooting and Maintenance: Engine, Battery and Vehicle Troubles: Diagnostic Information: Symptom descriptions and their Causes and Remedies, Periodic, Preventive and Brake down Maintenance: Engine tuning, Fuel and Air filters, Lubricants, Maintenance of Battery and Electrical/Electronic System, and Tires. The Motor Vehicles Act 2019.

Text Books:

1. Automotive Mechanics, William H. Crouse and Donald L. Anglin, Tata McGraw-Hill Publishing Company Limited, ISBN: 0-07-059054-0
2. Modern Electric, Hybrid Electric, and Fuel Cell Vehicles; Fundamentals, Theory, and Design, Mehrdad Ehsani, Yimin Gao, Sebastien E. Gay, Ali Emadi, Muhammad H. Rashid, CRC Press, Washington
3. Automotive Engines, S Srinivasan, Tata McGraw-Hill Publishing Company Limited, ISBN: 0-07-040265-5

Reference Books:

1. Automotive Mechanics, S. Srinivasan, Tata McGraw-Hill Publishing company Limited, ISBN: 0-07-044941-6
2. Automobile Engineering, KK Jain/ RB Asthana, Tata McGraw-Hill Publishing Company Limited, ISBN: 0-07-044529-X
3. Electric and Hybrid Vehicles, Gianfranco Pistoia, Elsevier
4. Electric and Hybrid Vehicles, Tom Denton.

5. Internal Combustion Engines and Air Pollution, E.F. Obert, Harper & Row International Publishers Inc., ISBN: 0-06-350561-4
6. Internal Combustion Engines, Heywood, John, B. McGraw-Hill Publications Limited.

7. MAINTENANCE ENGINEERING AND MANAGEMENT

Course Objectives:

- To explain maintenance objectives and functions, need for maintenance plan in an organization.
- To explain different maintenance systems and the steps involved in establishing a maintenance plan.
- To explain the maintenance budgeting, Classification of spares & Costs associated with spares inventory.
- To determine the optimal inspection frequency for maximization of profit and minimization of down time.
- To introduce various real time problems with constraints and to make understanding the applications of Reliability and Maintenance analysis in different types of systems.

Course Outcomes:

- Able to implement the objectives and policies of maintenance.
- Able to establish maintenance strategies for maximizing the profit.
- Able to improve uptime of machines by effective budgeting and cost control.
- Able to improve the overall equipment effectiveness.
- Able to apply concept of FMEA & make a diagnosis of maintenance problems.

SYLLABUS

Introduction: Characteristics, Benefits, Objectives and Policies of maintenance, Organization and structure of maintenance system, Mechanics of maintenance system, Planning and scheduling maintenance activities.

Types Of Maintenance: Preventive maintenance - Development of preventive maintenance schedule - Planned prevention of breakdowns, Predictive maintenance, Condition monitoring, Reliability maintenance, reliability models.

Maintenance Management: Maintenance budgeting and cost control, Production maintenance integration, Maintenance manpower planning, Spare parts management.

Total Productive Maintenance: Philosophy, Six Major Losses, Overall equipment effectiveness, TPM Pillars, Computerized maintenance system, Implementation and Operation of an integrated maintenance system, Tero - Technology.

Maintenance Quality: Five Zero Concept, FMEA, Root Cause Analysis, Maintenance Strategies, maintainability, Availability & Criteria.

Text Books:

1. Maintenance Engineering and Management, Mishra, R.C. and Pathak K, PHI Publication,2002
2. Maintenance, Replacement and Reliability, Andrew K.S. Jardine and Albert H.C. Tsan, Taylor and Francis, 2006

Reference Books:

1.Maintenance Management, Carder, A.S, McGraw Hill, NY, 1976.
2. Maintainability Principles and Practices, Blanchard, B.S, McGraw Hill, NY, 1969

8. VEHICLE DYNAMICS

Course Objectives:

- To impart knowledge about the various forces acting on tires and performance of tire
- To study about the various vertical forces acting on a vehicle
- To identify the various longitudinal forces acting and control on a vehicle
- To impart knowledge on various lateral forces acting on a vehicle
- To study the concept of vibration and types of vibration measuring instruments

Course Outcomes:

- The students will be able to explain the various forces acting on tyres and their performance.

The students will be able to explain the concepts involved in vehicle vibration. The students will be able to calculate the natural frequency of Vehicle system with few DOF by considering free and forced vibrations using MATLAB/ Python.

- The students will be able to calculate the various vertical forces acting on a vehicle. The students will be able to perform the simulation of Quarter car model and Half car model for step input using MATLAB/Python.
- The students will be able to describe the various longitudinal forces acting on a vehicle.
- The students will be able to calculate the various lateral forces acting on a vehicle. The students will be able to simulate the steady state handling characteristics of a vehicle based on steering input, vehicle stability on a banked road and curved road-using MATLAB/Python.

SYLLABUS

Introduction to Vehicle Dynamics: Various kinds of vehicles, Motions, Mathematical modelling methods, Multi-body system approach, Lagrangian formulations, Methods of investigations, Stability concepts. Introduction to Modelling and Simulation.

Mechanics of Pneumatic Tyres: Tyre construction, SAE recommended practice, Tyre forces and moments, Rolling resistance of tyres, Tractive effort and longitudinal slip, Cornering properties of tyres, Performance of tyre traction on dry and wet surfaces, Ride properties of tyres.

Longitudinal Performance characteristics of road vehicle: Aerodynamic forces and moments.
Equation of motion. Load distribution for four wheeler. Calculation of Maximum acceleration, Reaction forces for Different drives. Braking and Driving torque. Prediction of Vehicle performance. ABS, stability control, Traction control, stability of vehicle on slope.

Handling and stability characteristics of road vehicles: Steering geometry, Steady state handling characteristics, Steady state response to steering input, Testing of handling characteristics, Transient response characteristics, Directional stability, Effects of tyre factors, Mass distribution and engine location on stability of handling.

Vehicle ride characteristics: Human response to vibration, Vehicle ride models, Introduction to random vibration - 1) Road surface profile as a random function, 2) Frequency response function, 3) Evaluation of vehicle vertical vibration in relation to ride comfort criteria, 4) Active and semi active systems, 5) Optimum design for ride comfort and road holding.

Text Book:

1. Theory of Ground Vehicles, Wong, J.Y., John Wiley and Sons, NY, 1993.

Reference Books:

1. Fundamentals of Vehicle Dynamics, Gillespie, T.D., SAE Publication, Warrendal, USA, 1992.
2. Tyres, Suspension and Handling, Dixon, J.C., SAE Publication, Warrendal, USA and Arnold Publication, London, 1997.
3. Vehicle Dynamics and Control‖, Rajesh Rajamani, 2nd edition, Springer, 2012.
4. Vehicle Dynamics: Theory and Application‖, Reza N. Jazar, 3rd Edition, Springer, 2017.
5. Tire and Vehicle Dynamics‖, Hans B Pacejka, 3rd Edition, Butterworth-Heinemann, Elsevier, 2012.
6.Tires, Suspension, and Handling‖, John C. Dixon, 2nd edition, Society of Automotive Engineers Inc, 1996.

Web Link:

1. Introduction to Vehicle Dynamics, Department of Engineering design, R. Krishnakumar, IITM. https://nptel.ac.in/courses/107106080/

9. COMPUTER AIDED DESIGN /COMPUTER AIDED MANUFACTURING (CAD/CAM)

Course Objectives:

1. General Objectives -

- Understand the importance of the computer aided designing and manufacturing techniques
- Know the development of the various design steps to manufacture the products with high quality in less time

2. Specific Objectives –

- Introduction of the different hardware devices, benefits of display methods in computer aided design (CAD)
- Know the different modelling techniques, finite element analysis procedures to analyse and develop the products
- Application of CAD/CAM packages to solving the real life applications in modeling, analysis and manufacturing
- Motivation of students towards the innovative product development which leads to produce the newly developed automobile and aircraft components.

Course Outcomes:

The main purpose of this course is to make the students aware of :

Application of computer in design and manufacturing of different products

- From the basic principles of production drawing the CAD/CAM techniques were utilized for the different engineering applications
- Students will able to understand the industrial products by fundamental knowledge of geometric modeling and advanced manufacturing concepts
- After successful completion of this course student can know the prerequisites to do the job in CAD/CAM industrye the newly developed automobile and aircraft components

SYLLABUS

Computer Aided Design

Fundamentals of CAD - Introduction - The design process - Application of computers for design - Operating systems - Hardware in CAD: The design work station - I/O Devices - CAD system configuration - Creating database for manufacturing - Benefits of CAD.

Interactive Computer Graphics - Graphic display devices- Graphics system- Graphics standards - Graphical user interface- Transformation systems- 2D and 3D transformations - Linear transformation- windowing – clipping - Geometric Modeling - Modeling Techniques - Wire frame Modeling - Surface Modeling - 3 D Solid Modeling.

Introduction to Finite Element Analysis – Steps of FEM for solving physical problem, CAD techniques to finite element data preparation- Automatic mesh generation- Presentation of results - CAD applications of FEM.

Computer Aided Manufacturing

Group technology: Merits & demerits, Organization, Classification and Coding systems, Cellular manufacturing.

Computer aided process planning: Introduction to process planning, Methods of process planning, Computer aided process planning, CAPP systems

Computer aided material handling: Robots: Structure and operation of Robots, robot sensors and applications. Automatic conveyor systems. Automated guided vehicles.

Computer aided inspection and quality control: Quality assurance and quality control. Contact and Non-contact inspection -Coordinate measuring machine.

FMS & CIMS: Building blocks of Flexible Manufacturing Systems (FMS), Machining systems of FMS, Tool management systems, Advantages of FMS, Computer integrated manufacturing systems (CIMS), Introduction to Additive Manufacturing.

Text Books:

1. CAD/CAM- Computer Aided Design & Manufacturing, M.D.Groover & E.W.Zimmer.
2. Computer Aided Design and Manufacturing, Dr.Sadhu Singh, Khanna Publishers.

Reference Books:

1. Computer Aided Design in Mechanical Engineering, V.Rama Murthy.
2. Elements of Computer Aided Design & Manufacturing, Y.C.Pao.
3. Computer Aided Kinetics for Machine Design, D.L.Ryan.
4. Computer Aided Design and Manufacturing, C.B.Besant & C.W.K.Lui.
5. Computer-Aided Analysis & Design, S. Ghosal, Prentice Hall of India.
6. CAD/CAM/CIM, Radhakrishna, New age international.
7. Computer Integrated Design and Manufacturing, David D.Bedworth, Mark R.Henderson & Philip M.Wolfe, McGraw-Hill Book Company, Singapore.
8. Computer Aided Manufacturing, P.N.Rao, N.K.Tewari & T.K.Kundra, Tata McGraw-Hill publishing company Ltd, NewtDelhi

10. REFRIGERATION AND AIR - CONDITIONING

Course Objectives:

- Students to understand the basic cycles and concepts of refrigeration
- Students to learn about variables influencing performance of vapor compression systems used in industrial and domestic applications

- Students to have an exposure to different types of refrigerants and components vapor compression refrigeration systems
- Student must learn about different types of absorption refrigeration system Students to have an exposure to psychrometry and air conditioning systems..
- Students must have comprehensive knowledge of Refrigeration & Air-conditioning systems

Course Outcomes:

- Students can extend the concepts of thermodynamics and apply to air refrigeration cycles
- Students with exposure to vapor compression system can solve problems on vapor compression refrigeration systems
- Students can understand the importance of eco friendly refrigerants and functioning other vital components in refrigeration systems
- Students can understand and compare working of different types of vapor absorption systems
  Students with basic knowledge of psychrometry can understand working of air conditioning systems

SYLLABUS

Principles of Refrigeration: Refrigeration and II law of thermodynamics- Methods of Refrigeration- Unit of Refrigeration- Applications of Refrigeration. Air cycle Refrigeration:
Reversal Carnot cycle- Bell Colman cycle- Selection of Refrigeration systems for air crafts- Boot strap system- Regenerative cycle- Reduced ambient type- Comparisons of different systems.

Vapour Compression Refrigeration: Wet versus Dry compression- Effect of evaporator pressures and temperatures. Simple vapour compression Refrigeration cycle and its analysis. Advantages and disadvantages of vapour compression Refrigeration system over Air compression Refrigeration system- Methods of improving C.O.P.

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Classification of Refrigerants: Nomenclature- Properties- Secondary refrigerants- Selection of refrigerants- **Condensers-** Air cooled, Water cooled and evaporative type- Evaporators- Once through, flooded, shell and tube Baudelot cooler- **Expansion devices**- Capillary expansion device, Thermostatic expansion device.

Absorption Refrigeration System: Basic absorption system- Aqua ammonia absorption system- Li-Br absorption refrigeration system- Electrolux refrigeration- C.O.P. of absorption refrigeration system- Comparison of vapour compression and vapour absorption system. Steam jet refrigeration system and analysis- Advantages and limitation- Ejector compression system.

Psychrometry: Psychrometric properties and relations- Psy chart- Psy processes- Human comfort and comfort chart- Effective temperature and factors governing effective temperature. **Air conditioning**: Summer, Winter and year round air conditioning- Different types of Air conditioning load - By pass factor, RSHP, GSHF- Fresh air quantity- Cooling coils and Dehumidity- Air washers.

Text Books:

1. A text book of Refrigeration and Air conditioning, R.S. Khurmi and J.K. Gupta Eurasia publishing house (P) Ltd,
2. Arora C P, Refrigeration and Air Conditioning, 3rd Edition, Tata McGraw-Hill, 2017
3. Stoecker W.F and Jones J.W, Refrigeration and Air Conditioning, 2nd Edition, Tata McGrawHill, 1982

Reference Books:

1. ASHRAE Handbook Series: Fundamentals, Refrigeration, Systems and Equipments and HVAC Applications, 2014-18, ASHRAE Inc, Atlanta, USA.
2. Refrigeration and Air conditioning, Jordan R.C. and Priester G.B.
3. Principles of Refrigeration, Dossat Roy J., 4th Edition, Pearson Education Asia,
4. Refrigeration and Air Conditioning, Arora R.C, Prentice Hall India, 2010

11. STATISTICAL QUALITY CONTROL

Course Objectives:

- The different concepts of quality and the present philosophy of quality
- The causes of variation and how they lead to inferior quality
- Use of control charts for both variable type and attribute type of quality characteristics
- The meaning of statistical six-sigma and six sigma procedure
- The difference between the process control and process capability
- The need for concurrent engineering
- The different ways of taking random samples to accept a lot
- The design of sampling plans for required protection
- That there exist different types sampling plans to adopt

Course Outcomes:

- Understands that quality is caused by variation
- Understands to recognize and eliminate the causes of variation
- Designs control charts for both variable and attribute quality characteristics
- Understands the need of six sigma quality
- Performs process capability analysis for process with N-type, L-type and S-type of quality characteristics

- Understands the concept and need for rectifying inspection
- Develops the ability to design different types of sampling plans
- Understands the use of standard sampling plans
- Becomes confident to work in any quality related teams in any type of industry

SYLLABUS

Introduction to quality, definitions, Taguchi's loss function, examples of off-line and on-line quality control techniques, quality costs, Deming's philosophy, introduction to six sigma concept. Shewart's normal bowl, control charts for variables, □X , R and sigma control charts, theory of runs, ARL and ATS, Type-I and Type-II errors

Control charts for attributes, p-chart, standardized p –chart, np-chart, c-chart, u-chart, demerit control chart.

Process capability analysis: using frequency distribution and control charts. Process capability ratios, Cp and Cpk Process capability ratios for nominal the batter type, smaller the better type and larger the better type product specifications.

Sampling plans: single, double, multiple and sequential sampling plans, rectifying inspection, AOQ, AOQL, and ATI. Use of Dodge Romig Tables, Design of single and sequential sampling plans.

Text Books:

1. Introduction to statistical quality control, E.L. Grant
2. Introduction to statistical quality control, D.C. Montgomery

12. TOOL DESIGN

Course Objectives:

- To know what is meant by designing a tool.
- To acquire knowledge on principles and types of locating elements and clamping devices.
- To attain knowledge on the various types of jigs and fixtures.
- To get the knowledge on press tools.
- To obtain familiarity with fixture design of NC machine tools.
- To accomplish awareness on limit gauges.

Course Outcomes:

- Students will be able to have thorough knowledge on locating and clamping devices and □ their applications.
- They will be able to identify the types of jigs and fixtures and their application.
- They will understand the press tool terminology and designing of dies.

- They acquire information regarding tool design for NC machine tools.
- They attain the knowledge of NC cutting tools and their holding methods.
- Students are aware of types and applications of limit gauges.
- They will be familiar with the principles of gauge design and also design of plug gauge,
- ring gauge and snap gauges
- Having good knowledge on the course, the student will be confident to work with the manufacturing industries.

SYLLABUS

Locating and Clamping Devices: Principles of Jigs and Fixtures design; locating principles; locating elements; standard parts; clamping devices; mechanical actuation, pneumatic & hydraulic actuation; analysis of clamping forces; tolerance and error analysis.

Jigs & Fixtures: Drill bushes; different types of Jigs : plate, latch, channel, box, post, angle plate, angular post, turnover, pot jigs; automatic drill jigs, rack & pinion operated, air operated Jigs. General principles of lathe, milling, grinding, drilling and welding fixtures; design and development of Jigs and fixtures for simple components.

Press Tools: Press working terminology; presses and press accessories; computation of capacities and tonnage requirements; design and development of various types of forming and drawing dies.

Design and Manufacturing of cutting tools: Types of cutting tools, general problems in cutting tool design, single point cutting tools, drills, milling cutters, form tools, manufacture of cutting tools.

Design of Limit Gauges: Elements, types and application of limit gauges, gauge materials, their selection, Taylor's principles of gauge design, types and methods to provide gauge tolerances; design of plug & ring / snap gauge for given dimension and application.

Text Books:

1. Tool Design, Donaldson. C, Tata McGraw-Hill, 1986.
2. A Text Book of Production Engineering, Dr.P.C.Sharma, S.Chand publishers.
3. Tool Engineering and Design, G.R.Nagpal, Khanna Publishers.
4. Fundamentals of Tool Engg. Design, Basu, Mukherjee, Mishra, Oxford & IBH Publishing, N. Delhi.

Reference Books:

1. Jigs and Fixtures Handbook , A. K. Goroshkin, Mir Publishers, Moscow, 1983.

2. ASTME Handbook of Fixture Design . Prentice Hall of India Pvt. Ltd.
3. Die Design Handbook , Ivana Suchy, McGraw Hill Book Co., 2005.
4. Production technology, HMT, Tata McGraw Hill.
5. Basic Die Making, P. Eugene Ostergaard, Mc Graw Hill Book, 1963.
6. Principles of Machine Tool, Sen & Bhattacharya, New Central Book Agencies, 1975.
7. Production tooling equipments, S. N. Parsons, Macmillan, 1966.

13. POWER PLANT ENGINEERING

Course Objectives:

- To create awareness about various sources of energy, working of various power plants.
- To create awareness about various sources of energy, working of various thermal power plants and combustion process
- To understand how Diesel and gas power plants are functioning
- Able to learn about nuclear power plants
- To understand how power is achieved from renewable sources of energy and functions of hydroelectric power plants. Also, to apply the concepts of economics in power plants
- To understand how electric power is achieved from solar energy and working principle of photovoltaic solar cells.

Course Outcomes:

- Students are familiar with the basic knowledge on various energy-resources, energy conversion systems and air -pollution caused by the conventional thermal power plants.
- The students can learn the developments in conventional thermal power plants such as fluidized bed combustion and super critical boiler technologies.
- The students are familiar with the constructional and safety features of nuclear power plants and also the working principle of nuclear power plants.
- Students are familiar renewable energy resources and their advantages.
- Students are familiar with the constructional features of photovoltaic solar cells and their working.
- Students are familiar with the installation of solar power plants on rooftops and on water bodies.

Introduction: Introduction to sources of energy in India, Current energy scenario, the need for alternate energy sources, Introduction to various types of power plants, Environmental aspects, and Recent developments in power generation.

Coal Based Thermal / Steam Power Plants: Introduction of thermal power, The Rankine cycle, Thermodynamic processes, Layout and working of coal-thermal/steam power plant, Four Circuits: Coal and ash handling systems/circuits, Air and flue gas circuit; Water and steam circuit: Cooling water circuit. Steam and Heat rate, Subsystems of thermal power plants: Combustion equipment,

combustion of coal, Draught system/chimney draught, and Feed water treatment. Dust collectors, fuels and combustion Flue gas analysis, Fossil fuel steam generators:
Types, Accessories, Feed water heaters, high pressure boilers, Performance of Boilers, steam turbines: Impulse turbines and Reaction turbines, Compounding of turbines, Steam condensers: Condensers classification: Steam Condensers: jet and surface condensers. Cooling towers, Binary cycles and cogeneration systems. Layout and working of modern coal-fired steam power plants, Super Critical Boilers: FBC boilers. Fluidized Bed Combustion and its types.

Diesel, Gas-Turbine and Combined Cycle Power Plants: Components and working of diesel engine plants: Air-intake, fuel, exhaust system and gas turbine power plants: Compressor, combustor, and gas turbine. Analysis of Otto, Diesel, dual and Brayton cycles, Cogeneration, Combined cycle power plants, and Integrated gasifier based combined cycle (IGCC) power plants/ systems.

Nuclear Power Plants: Basics nuclear energy: Methods of enriching Uranium, Fusion and Fission, chain reaction, and uncontrolled chain reactions. Layout, components, and subsystems of nuclear power plants, Working and classification of various nuclear reactors: Boiling Water Reactor (BWR), Pressurized Water Reactor (PWR), Canada Deuterium-Uranium (CANDU) Reactor, Fast Breeder Reactors, Gas Cooled and Liquid Metal Cooled Reactors. Main components of nuclear reactor: Moderators, Reflectors, Shielding, Cladding, and Coolants. Applications of nuclear power plants. Safety measures for nuclear power plants.

Alternative and Other Renewable Sources of Energy: Hydro-Power: Components and working of hydro-electric power plants, hydraulic-turbines, and hydro-plant controls. Geothermal energy, Wind energy, Bioenergy, Hydrogen energy, Energy from oceans, Energy storage, Performance and operating characteristics of power plants. Load factor, Criteria for optimum loading, Energy rates and Economics of power generation.

Solar Power Plants: Basics of Solar Energy: The Sun and solar energy, solar radiation fundamentals, Spectrum of solar radiation, the Earth, Sun-Earth geometry and relationship, role of atmosphere on solar radiation, estimation of solar radiation on Earth. Solar spectrum, Direct and Diffuse radiation, Solar irradiation, solar irradiance, solar constant, Solar insolation, global horizontal irradiance, Number of sunshine hours at a location (peak sun hours), Measurement of solar radiation; Actinometers: Pyranometers and Pyrheliometers.

Solar Photovoltaic Cells: Basics of photovoltaic effect /photovoltaic generation, Constructional features and efficiency of PV cell, Effect of temperature on PV cell efficiency, Types of PV cells: First, second, and third generation solar cells; mono-crystalline, poly-crystalline, multijunction concentrators, and thin-film solar cells, Arrangement of PV cells on PV System: cellmodule-string/panel-array. Rating and efficiency of PV module. Current-voltage characteristics PV arrays. Estimation and measurement of PV Module power. Storage Batteries: Types of batteries, Application of batteries in solar PV system, Battery maintenance and measurements,

Battery Installation for PV system. DC to AC and AC to DC Converter. Installation of standalone solar PV System, Maintenance of solar PV system, Trouble shooting of 1KWP on/off-Grid solar power plant.

Text Books:

1. Modern Power Station Practice: Incorporating Modern Power System Practice-V(8), British Electricity International; Pergamon Press, 1990

2. Power Plant Engineering, Black and Veatch, CBS Publishers

3. Photovoltaic Solar Energy: From Fundamentals to Applications; Angele Reinders, Pierre Ver linden, Wilfried van Sark, Alexandre Freundlich; ISBN:9781118927465

References Books:

1. Power Plant Technology, M. M. EI-Wakil, Mc-Graw Hill Education.
2. Nuclear Power Plant Engineering, Rust, J.H., *Haralson* Publishing Company.
3. Power Plant Theory & Design, Potter P.J. Krieger Publishing.
4. Power Plant Engineering, P K Nag.

14. TURBO MACHINERY

Course Objectives:

- Students to expose to various turbo machines and their energy transfer mechanism.
- Students to understand the working of fans, blowers, compressors and turbines
- Students to get exposed to velocity triangles of prime movers and evaluate their performance.
- Understand critical parameters influencing performance of prime movers

Course Outcomes:

- 1. Students can understand the energy transfer mechanism in turbo machines.
- 2. Students can understand working of various components in turbo machines
- 3. Analyse the velocity triangles and h-s diagrams and evaluate their performance
- 4. Understand the importance of stalling and surging in compressors

Working Principles: Classification of Turbomachines. Energy transfer between fluid and rotor - Euler equation and its interpretation. Velocity triangles. Efficiencies in Compressor and Turbine stages. Degree of reaction. Dimensionless parameters for Turbomachines.

Centrifugal Fans and Blowers: Types – components – working. Flow analysis in impeller blades-volute and diffusers. Velocity triangles - h-s diagram. Stage parameters in fans and blowers. Performance characteristic curves – various losses. Fan – bearings, drives and noise.

Centrifugal Compressor: Components - blade types. Velocity triangles - h-s diagram, stage work. Slip factor and Degree of Reaction. Performance characteristics and various losses. Geometry and performance calculation.

Axial Flow Compressor: Construction details. Work done factor. Velocity triangles - h-s diagram, stage work. Work done factor. Performance characteristics, efficiency and stage losses – Stalling and Surging. Free and Forced vortex flow.

Axial And Radial Flow Turbines: Axial flow turbines - Types – Elements - Stage velocity diagrams - h-s diagram, stage work - impulse and reaction stages. Compounding of turbines. Performance coefficients and losses. Radial flow turbines: Types – Elements - Stage velocity diagrams - h-s diagram, stage work Performance coefficients and losses.

Text Books:

1.Gas Turbines, V.Ganesan, 3rd Edition, Tata McGraw Hill, 2011.
2. Turbines, Compressor and Fans, Yahya, S.M., 4th Edition, Tata McGraw Hill, 2011.

Reference Books:

1. Fluid Mechanics and Thermodynamics of Turbomachinery, Dixon, S.L., 7th Edition, Butterworth-Heinemann, 2014.
2. A Treatise on Turbomachines, Gopalakrishnan .G and Prithvi Raj .D, Scitech Publications (India) Pvt. Ltd., 2nd Edition, 2008.
3.Turbomachinery Performance Analysis, Lewis, R.I., 1st Edition, Arnold Publisher, 1996.
4. Gas Turbine Theory, Saravanamutto, Rogers, Cohen, Straznicky., 6th Edition, Pearson Education Ltd, 2009.
5. Fundamentals of Turbo machinery, Venkanna, B.K., PHI Learning Pvt. Ltd., 2009.

15.GAS DYNAMICS AND SPACE PROPULSION

Course Objectives:

- Students to understand concepts of compressible flow and use of gas tables.
- Students to understand the flow behaviour of fluids in constant area ducts with friction and heat transfer.
- Students to study the formation of shock waves and its effect on flow parameters.
- To study about different types and working of jet propulsion systems
- Exposure to different types of propellants and performance calculations of rocket engines

Course Outcomes:

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

- Understand the concepts of compressible flow and influence of Mach number.
- Evaluate the flow behaviour in constant area ducts with heat transfer., friction and for isothermal flows
- Understand the formation and influence of shock on flow behaviour
- Understand the different types of jet engines and their performance parameters.
- Students will have an understanding about different types of rocket propulsion systems

Basic Concepts and Isentropic Flows: Energy and momentum equations of compressible fluid flows, Concepts of compressible flow – Mach waves and Mach cone. Flow regimes, effect of Mach number on compressibility. Stagnation, static, critical properties and their interrelationship. Isentropic flow and its relations. Isentropic flow through variable area ducts – nozzles and diffusers. Use of Gas tables.

Compressible Flow Through Ducts: Flows through constant area ducts with heat transfer (Rayleigh flow) and Friction (Fanno flow) – variation of flow properties. Choking. Isothermal flow with friction. Use of Gas tables.

Normal And Oblique Shocks: Governing equations - Rankine-Hugoniot Relation. Variation of flow parameters across the normal and oblique shocks. Prandtl – Meyer expansion and relation. Use of Gas tables.

Jet Propulsion: Theory of jet propulsion – thrust equation – Performance parameters - thrust, power and efficiency. Operation, cycle analysis and performance of ram jet, turbojet, turbofan, turbo prop and pulse jet engines.

Space Propulsion: Types of rocket engines and propellants. Characteristic velocity – thrust equation. Theory of single and multistage rocket propulsion. Liquid fuel feeding systems. Solid propellant geometries. Orbital and escape velocity. Rocket performance calculations.

Text Books:

1. Modern Compressible flow, Anderson, J.D., Third Edition, McGraw Hill, 2003.
2.Fundamentals of Compressible Flow with Aircraft and Rocket propulsion, S.M. Yahya, New Age International (P) Limited, 4th Edition, 2012.

Reference Books:

1. Fundamentals of Gas Dynamics, R. D. Zucker and O Biblarz, 2nd edition, Wiley, 2011.
2. Fundamentals of Compressible Fluid Dynamics, Balachandran, P., Prentice-Hall of India, 2007.
3. Gas Dynamics, Radhakrishnan, E., Printice Hall of India, 2006.
4. Mechanics and Thermodynamics of Propulsion, Hill and Peterson, Addison – Wesley, 1965. 5 Fundamentals of Compressible Flow, . Babu, V., CRC Press, 1st Edition, 2008.

LIST OF OPEN ELECTIVES

1. ADDITIVE MANUFACTURING

Course Objectives:

- Importance of AM in Manufacturing
- Different AM Technologies
- Select suitable materials for AM
- Different methods for Post-processing of AM parts
- Design for manufacture of AM Products
- Process Analysis
- Applications of AM in Automobile, Aerospace, Bio-medical etc.
- Future Directions of AM

Course Outcomes:

The main purpose of this course is to make the students aware of :

- Application of computer in design and manufacturing of different products
- From the basic principles of additive manufacturing techniques were utilized for the different engineering applications
- Students will able to understand the industrial products by fundamental knowledge of geometric modeling and advanced manufacturing concepts in additive manufacturing
- After successful completion of this course student can know the prerequisites to do the job in Automobile, Aerospace, Bio-medical industry etc.

SYLLABUS

Introduction to Additive Manufacturing: Introduction to AM, AM evolution, Distinction between AM & CNC machining, Advantages of AM, AM process chain: Conceptualization, CAD, conversion to STL, Transfer to AM, STL file manipulation, Machine setup, build , removal and clean up, post processing.

Classification of AM processes: Liquid polymer system, discrete particle system, molten material systems, solid sheet system.

Design for AM: Motivation, DFMA concepts and objectives, AM unique capabilities, Exploring design freedoms, Design tools for AM, Part Orientation, Removal of Supports, Hollowing out parts, Inclusion of Undercuts and Other Manufacturing Constraining Features, Interlocking Features, Reduction of Part Count in an Assembly, Identification of markings/ numbers etc.

Guidelines for process selection: Introduction, selection methods for a part, challenges of selection, example system for preliminary selection, production planning and control AM

Applications: Functional models, Pattern for investment and vacuum casting, Medical models, art models, Engineering analysis models, Rapid tooling, new materials development, Bi- metallic parts, Re-manufacturing.

Application examples for Aerospace, defense, automobile, Bio-medical and general engineering industries Post processing of AM parts: Support material removal, surface texture improvement, accuracy improvement, aesthetic improvement, preparation for use as a pattern, property enhancements using non-thermal and thermal techniques.

Future Directions of AM: Introduction, new types of products and employment and digiproneurship.

Text Book:

1. Additive Manufacturing Principles, Technologies and Applications, C. P. Paul & A. N. Jinoop, McGrawHill Publications, June 2021

Reference Books:

1. Rapid Prototyping: Principles & Applications, Chua Chee Kai, Leong Kah Fai, World Scientific, 2003.
2. Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, Ian Gibson, David W Rosen, Brent Stucker., Springer, 2010
3. Rapid Prototyping: Theory & Practice, Ali K. Kamrani, Emand Abouel Nasr, Springer, 2006.
4. Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling, D.T. Pham, S.S. Dimov, Springer 2001

2. RELIABILITY ENGINEERING

Course Objectives:

- The interrelation between quality and reliability and importance of reliability
- Basic terminology used in reliability engineering and the difference between failure rate and failure densities
- Modeling of failures of engineering equipment/product/systems using different types of failure rates using a bath tub curve
- Modeling of random failures using exponential distribution
- Modeling of time-dependent failures using Weibull distribution
- Modeling of time dependent failures using normal and lognormal distributions
- Modeling the systems as series, parallel and combined configurations. Also, to find the reliability of k-out-of-n : G systems and complex configurations
- To specify reliability, system effectiveness and life cycle costs concepts, reliability allocation methods

- To incorporate reliability into designs using

Course Outcomes:

- Understands that reliability is concerned with time based performance but a subset of quality
- Understands the general terminology used in reliability engineering and also understands their limitations
- Understands the different types of failures encountered in engineering failure analysis and the probable failure types for different types of products like electronic products, mechanical products, software products etc.,
- Understands the lack of memory property of exponential distribution and its significance in modeling random failures
- Understands that all types of failures- namely DFR , CFR and IFR can be efficiently modeled by a general distribution i.e. Weibull distribution
- Understands the suitability of Normal distribution in reliability engineering and also as a foundation to study the lognormal failures. Also understands the interrelation between normal and lognormal distributions.
- Understands the different configurations used in system reliability modeling.
- Understands the importance of life-cycle costs in the design of reliable products and also understands the methods to allocate reliability to different components.
- Understands the methods to incorporate reliability into products at design stage.

SYLLABUS

Introduction: Concepts of quality and reliability, a brief history, terms, definitions, reliability function, MTTF, Hazard rate function, bath tub curve, conditional reliability.

Constant failure rate models: Exponential reliability, failure modes, failure modes with exponential distribution, applications, two parameter exponential distribution, Poisson process.
Time dependent failure models: Weibull distribution, burn-in screening for Weibull, three parameter Weibull distribution, Normal and Lognormal distributions

Reliability of systems: Series, parallel configurations, combined systems, k-out-of-n systems, complex configurations, common failure modes, minimal cuts and minimal paths.

State dependent systems: Markov analysis, load sharing, standby systems, degraded systems

Physical reliability models: Static models- random stress and random strength, dynamic models- periodic models, random loads.

Design for reliability: Reliability specification, Lifecycle costs, reliability allocation, design methods, failure analysis, FTA.

Reliability testing: Life testing, burn-in testing, acceptance testing-binomial acceptance testing.

Reliability growth testing: Reliability growth process, idealized growth curve, Duane growth model.

Text Book:

1. Introduction to Reliability and Maintenance engineering, Charles E Ebeling, Tata McGrawhill, India.

Reference Books:

1. Introduction to Reliability Engineering, E.E. Lewis, John Wiley& Sons, NewYork
2. Reliability based design, S.S.Rao, McGraw-Hill, New York.

3. STRUCTURAL HEALTH MONITORING

Course Objectives:

- To get a in depth knowledge of technologies in structural health monitoring using smart materials as sensing and actuating elements to interrogate the structures.
- Damage detection techniques such as wave, impedance, and vibration-based damage detection techniques will be discussed and applied to different types of structures.
- Advanced signal processing techniques such as wavelet, neural network, principal component analysis will be used to make the damage more quantifiable.

Course Outcomes:

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

- Diagnosis the distress in the structure understanding the causes and factors.
- Assess the health of structure using static field methods.
- Assess the health of structure using dynamic field tests.
- Suggest repairs and rehabilitation measures of the structure

SYLLABUS

Introduction: Definition, Principles, Significance of SHM, Potential Applications in Civil, Naval, Aerospace and Manufacturing Engineering.

Operational evaluation: Sensor technology, Piezoelectric wafer active sensors, Data acquisition and cleansing procedures, Elastic waves in solid structures, Guided waves.

Feature extraction methods: Identify damage sensitive properties, Signal Processing, Fourier and short term Fourier transform, Wavelet analysis.

Pattern recognition: State –of –Art damage identification and pattern recognition Methods, Neural networks, Feature extraction algorithm.

Case studies: SHM based Flaw detection in mechanical structures - Integrity and damage recognition in plates and pipes, defect identification in weld joints, Wear monitoring in cutting tools.

Text Books:

1. Structural Health Monitoring, Daniel Balageas, Claus_Peter Fritzen, Alfredo Güemes, John Wiley and Sons, 2006
2. Health Monitoring of Structural Materials and Components Methods with Applications, Douglas E Adams, John Wiley and Sons, 2007.

Reference Books:

1. Structural Health Monitoring and Intelligent Infrastructure, Vol1, J. P. Ou, H. Li and Z. D. Duan, Taylor and Francis Group, London, UK, 2006.
2. Structural Health Monitoring with Wafer Active Sensors, Victor Giurglutiu, Academic Press Inc,2007.
3. A Review of Structural Health Monitoring Literature: 1996-2001/ Hoon Sohn/ Chales R.Farrar/Francois M.Hemez/Devin D.Shunk/Daniel W.Stinemates/Brett R. Nadler/Jerry J.Czarnecki*/Los Alamos National Laboratory

4. Damage Identification and Helath Monitoring of Structural and Mechanical Systems from Changes in Their Vibration Characteristics: A Literature Review/ Scott W. Doebling/Charles R. Farrar/Michael B.Prime/Daniel W.Shevitz

4. TRIBOLOGY

Course objectives:

- To expose the student to different types of bearings, bearing materials,
- To understand friction characteristics and power losses in journal bearings To learn theory and concepts about different types of lubrication.

Course Outcomes:

- Understanding friction characteristics in journal bearings.

- Knowledge about different theories of lubrication to reduce friction and wear.

SYLLABUS

Introduction: Tribology, Bearings, Historical Background, Lubricants: Types, selection of lubricants and specific field of applications, Properties and Testing of Lubricants: Viscosity, viscometry, Effect of temperature and pressure on viscosity.

Basic Equations: introduction, generalized Reynolds equation, flow and shear stress, Idealized Hydrodynamic Bearing: Mechanism of pressure development, Plane-slider bearing, idealized Journal Bearing-Infinitely long journal bearing, Petroff equation, Narrow bearing.

Bearing Design: Design of journal bearings, Squeeze film bearings-parallel surface and step bearings, Some situations under squeeze film lubrication and the mechanism of hydrodynamic instability. Introduction to ball bearings.

Surface Engineering: Surface topography, surface characterization, apparent and real area of contact, Surface modification – transformation hardening, surface melting, thermo chemical processes. Surface Coating – plating, fusion processes, vapor phase processes.

Friction and Wear of Metals: Laws of friction, friction theories, measurement methods, friction of metals, surface contaminants, frictional heating, classification and mechanisms of wear, quantitative laws of wear, testing methods and standards, wear resistance materials.

Text Books:

1. Introduction to Tribology of Bearing , B. C. Majumdar.
2. Engineering Tribology, Prasanta Sahoo, PHI Learning Private Ltd, New Delhi, 2011.

Reference Books:

1. Engineering Tribology, J. A. Williams, Oxford Univ. Press, 2005.
2. Handbook of tribology: materials, coatings and surface treatments, B.Bhushan, B.K. Gupta, McGraw-Hill,1997.
3. Friction and Wear of Materials, Ernest Rabinowicz, John Wiley & sons,1995.
4. Tribology, Friction and Wear of Engineering Material, I. M.Hutchings, Edward Arnold, London,1992

5. **TOTAL QUALITY MANAGEMENT**

Course Objectives:

- To understand the concept and philosophy of TQM.
- To get acquainted with the tools of quality control.
- To understand the quality function Quality function deployment, Designing for quality, Manufacturing for quality.
- To learn the importance and use of quality systems-ISO standards.
- To understand the process of implementing the quality tools like KAIZEN,5S,JIT,POKAYOKE,Taguchimethods and the difficulties in implementing them.

Course Outcomes:

- Students will have knowledge of quality and the contributions of quality gurus 'like Deming, Cross by and Miller.
- Canapplythequalityandmanagementtoolsandmethodologiesforsolvingtheproblems.
- Will be able to apply and use functions like quality function deployment, standardization, designing and manufacturing for quality.
- Get acquainted with ISO series and the process of implementing it.
- WillbeabletoapplyqualitytoolslikeKAIZEN,5S,JIT,POKAYOKE,Taguchimethods.

SYLLABUS

Concepts of TQM: Philosophy of TQM, Customer focus, Organization, Top management commitment, Team work, Quality philosophies of Deming, Cross by and Muller.
TQM process: QC tools, Problem solving methodologies, New management tools, Work habits, Quality circles, Bench marking, Strategic quality planning.

TQM Systems: Quality policy deployment, Quality function deployment, Standardization, Designing for quality, Manufacturing for quality.

Quality System: Need for ISO9000 system, Advantages, Clauses of ISO9000, Implementation of ISO9000,Quality costs, Quality auditing, Case studies.

Implementation of TQM: Steps, KAIZEN, 5S, JIT, POKAYOKE, Taguchi methods, Case studies.

Reference Books:

1. Total Quality Management, Rose, J.E., Kogan Page Ltd.,1993.
2. The Essence of Total Quality Management, John Bank, PHI,1993.
3. Beyond Total Quality Management, Greg Bounds, Lyle Yorksetal, McGraw Hill, 1994.
4. The Asian Productivity Organization, Takashi Osada,1991.5.KA
5. ZEN , Masaki Imami, McGrawHill,1986. wari, Sultan Chand & Sons, New Delhi.

6. SOLAR ENERGY - TECHNOLOGY AND APPLICATIONS

Course Objectives:

- To create awareness about various sources of energy.
- To understand the basic characteristics of solar energy, and the measurement of solar radiation on horizontal and inclined surfaces on earth.
- To understand the characteristics of semi-conductive materials and how photo-voltaic cells are functioning
- Able to learn about working of storage batteries.
- Able to learn about constructional features of concentric and non-concentric solar collectors.
- To understand how electric power is achieved from solar energy and working principle of photovoltaic solar cells.
- To understand the working of thermal energy storage systems and their applications.

Course Outcomes:

- Students are familiar with the basic knowledge on the characteristics of solar energy and various energy losses during transmission from Sun to Earth.
- The students can learn the developments in photovoltaic technology (: technologies to increase in conversion efficiency): First, second and third generation PV cells.
- The students are familiar with the constructional features and working principle of photo voltaic cells.
- Students are familiar with the constructional features and working of various types of solar collectors.
- Students can understand the various storage systems for storing solar energy.
- Students are familiar with the installation of on/off gird solar power plants.

Basics of Solar Energy: Energy, the need for alternate energy sources, the Sun and solar energy, solar radiation fundamentals, solar energy-wavelength-frequency, extraterrestrial radiation, Spectrum of solar radiation, the Earth, latitude and longitude, Sun-Earth geometry and relationship, seasons, role of atmosphere on solar radiation, solar angles, air mass and zenith angle, estimation of solar radiation on Earth. Solar spectrum, Direct and Diffuse radiation, Solar irradiation, solar irradiance, solar constant, Solar insolation, global horizontal irradiance,
Number of sunshine hours at a location (peak sun hours), Solar radiation on tilted surfaces. Measurement of solar radiation and instruments; Actinometers: Pyranometers and Pyrheliometers.

Solar Photovoltaic Cells: Basic physics of semiconductor materials, P-type and N-type materials, semiconductor junctions; Electron-hole carrier formation and motion, Basics of photovoltaic effect /photovoltaic generation, Constructional features of PV cells, efficiency of PV cell, Effect of temperature intensity on PV cell efficiency, Types of PV cells: First, second, and third generation solar cells; mono-crystalline/poly-crystalline, multi-junction concentrators, and thin-film solar cells, Arrangement of PV cells on PV System: cell-module-string/panel-array. Rating and

efficiency of PV module. I-V characteristics PV arrays. Estimation and measurement of PV Module power.

Storage Batteries: Types of batteries, Application of batteries in solar PV system, Battery maintenance and measurements, Battery Installation for PV system. DC to AC and AC to DC Converter. Installation of standalone solar PV System, Maintenance of solar PV system, Trouble shooting of 1KWP on/off-Grid solar power plant.

Solar Collectors and Applications: Flat plate collectors: Liquid based and air-based collectors, different configurations; thermal analysis, heat removal factor, overall loss coefficient, temperature distributions, efficiency factor, optical and thermal efficiency; Experimental determination of efficiency, Performance of solar flat plate collectors and Heat capacity effects. Concentrating collectors: Concentration ratio, Tubular absorbers (diffuse back and specular cusp reflectors), Evacuated tube collectors, dish collectors/concentrators, V-troughs/Parabolic troughs, compound parabolic collectors, Linear Fresnel reflector collectors, Fresnel lens for cooking, multi-sectional planar concentrators, Array reflectors (heliostats) with central receiver system (power tower), and thermal performance of concentrating collectors.

Solar Energy Utilizations Methods and Storage Systems: Low Temperature Applications: water heating, air heating, drying, industrial process heat; desalination, green houses, solar ponds, and solar cookers. High Temperature Applications: Schemes for process steam, power generation, air conditioning and refrigeration, cold storages and solar furnaces. Solar energy Applications in Building Design: heating: illuminance, shading and passive cooling, Trombe wall construction.

Text Books:

1. Principles of Solar Engineering, Keith, F. and Kreider J. F.
2. Photovoltaic Solar Energy: From Fundamentals to Applications, Angèle Reinders, Pierre Verlinden, Wilfried van Sark, Alexandre Freundlich, ISBN:9781118927465.
3. Solar Engineering of Thermal Processes, John A. Duffie, William A. Beckman, ISBN: 9781118671603

Reference Books:

1. Solar Energy Thermal Technology, Brian Norton, ISBN: 9781447117445
2. Solar Energy: Fundamentals and Applications, H Garg, J Prakash. Tata McGraw-Hill Education

3.Solar Electric Handbook: Photovoltaic Fundamentals and Applications; Solar Energy International, Pearson Education Publishing

7. COMPUTATIONAL FLUID DYNAMICS

Course Objectives:

To make the learners to

- To provide basic understanding of fundamental concepts involved in CFD and also to comprehend numerical techniques involved in CFD.
- Understand the scope, principles, norms, accountabilities and bounds of contemporary engineering practice in the fluid flow.
- Describe the finite difference method and the finite element method with emphasis on fluid dynamics on various computational problems in fluid dynamics such as boundary conditions and meshing.
- Provide the essential numerical background for solving the partial differential equations governing the fluid flow.
- Develop student's skills by using a commercial software package.

Course Outcomes:

After successful completion of this course, student will be able to:

- Able to describe the concepts involved in CFD simulation and also to develop CFD model for simple flow systems, simulate and better understand underlying physics.
- Should be able to use the various discretization methods, solution procedures and to solve different problems.
- To know the various applications of CFD and basic governing equations of fluid flow and the classification of PDE and discretization techniques and the implicit and explicit methods.
- Understand the philosophy of CFD and derive governing equations of fluid flow and also to Formulate solution techniques for parabolic and hyperbolic equations.
- Familiar with the differential equations for flow phenomena and numerical methods for their solution.
- Use and develop flow simulation software for the most important classes of flows in engineering and science.
- Analyze the different mathematical models and computational methods for flow simulations.
- Define the relevant engineering flow problems and analyzes the CFD results by CFD software. Compare with available data, and discuss the findings.

SYLLABUS

Introduction: Historical Background of CFD, Basics of computational fluid dynamics, Philosophy of Computational Fluid Dynamics: Computational fluid dynamics: Why? – Computational fluid dynamics as a research tool – Computational fluid dynamics as a design tool – The impact of Computational fluid dynamics, Applications, Models of flow and Boundary conditions and steps in CFD.

Governing Equations: Mathematical behaviour of PDEs on CFD - Elliptic, Parabolic and Hyperbolic equations - Well posed problems, Continuity, Momentum and Energy equations in 3 Dimensions, Navier-Stokes equations, Single Generic Integral form equations for Continuity, Momentum and Energy.

Grid Discretization: Basic aspects of discretization, Techniques used--Finite Difference, Finite Volume and Finite Element, Derivation of finite difference equations – Simple Methods – Explicit and Implicit time dependent methods. Stability properties of explicit and implicit methods Finite Volume Techniques - Central, upwind differencing schemes properties of discretization schemes – Conservativeness, Boundedness, Transportiveness, Accuracy

Grid Generation And Transformation: Generation of grid. Types and transformations. Generation of structured grids. Unstructured grids – Mesh refinement – Adaptive mesh. Transformation of non- uniform grids, General transformation of equations, form of governing equations suitable for CFD, Compressed grids, Boundary filled coordinate systems – Elliptic grid generation, Adaptive grids, Modern developments in grid generation.

CFD Techniques: Introduction, CRANK-NICHOLSON technique, Relaxation technique, ADI technique, suitability for different conditions. Errors due to approximation and their analysis-Consistency, Convergence, Stability Analysis.

Text Books:

1. Computational Fluid Mechanics, Anderson, D.C., J.C, Tannehil, and R.H. Fletcher, Hemisphere Publishing Corporation, New York.
2. Computational Fluid Dynamics, T.J.Chung, Cambridge University Press 2002

Reference Books:

1. Computational Methods for Fluid Dynamics, Ferziger, J.H. and M.Peric, Springer, 3rd Edition, 2002.
2. An Introduction to Computational Fluid Dynamics, The Finite Volume Method – Versteeg, H.K. and W.Malalasekera, Second Edition, 2007.
3. Text book of fluid dynamics, Frank Chorlton, CBS Publishers & distributors, 1985.
4. Numerical heat transfer and fluid flow, Suhas V. Patankar, Hema shava Mc Graw Hill. Publishers corporation.
5. Computational Fluid Flow and Heat Transfer, Muralidaran, Narosa Publications

6. Fundamentals of Computational Fluid Dynamics,Tapan K. Sengupta, Universities Press.
7. Introduction to Theoretical and Computational Fluid Dynamics,C. Pozrikidis , Oxford University Press, 2_{nd} Edition.
8. Computational Fluid Dynamics, John D. Anderson, JR, McGraw-Hill Book Co., Inc., New Delhi.
9. Introduction to Computational Fluid Dynamics,A.A. Hirsch, McGraw-Hill, 1989.

Web References:

1. http://ocw.mit.edu/courses/mecharlical-engineering/2-29-numerigalfluidmechanicsfall2011/
2. http:/inptel.ac.in/courses/112105045/ (IIT Kharagpur)
3. http://nptel.ac.in/courses/112107080/ (IIT Roorkee)
4. http://nptel.ac.in/courses/112104030/ (IIT Kanpur)

8. DATA SCIENCE

COURSE OBJECTIVES: From the course the student will learn

1. knowledge and expertise to become a data scientist.
2. Essential concepts of statistics and machine learning that are vital for data science;
3. significance of exploratory data analysis (EDA) in data science.
4. Critically evaluate data visualizations presented on the dashboards
5. Suitability and limitations of tools and techniques related to data science process

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

1. Describe the steps involved in Data Science process and the technologies needed for a data scientist.
2. Identify suitable ML techniques for data modelling and apply them for decision support.
3. handle large datasets with distributed storage and processing system
4. use appropriate tools for data collection, EDA and model building for specific types of data 5. can build a prototype application of Data Science as a case study.

Introduction to Data science, benefits and uses, facets of data, data science process in brief, big data ecosystem and data science. Data Science process: Overview, defining goals and creating project charter, retrieving data, cleansing, integrating and transforming data, exploratory analysis, model building, presenting findings and building applications on top of them

Applications of machine learning in Data science, role of ML in DS, Python tools like sklearn, modelling process for feature engineering, model selection, validation and prediction, types of ML, semi-supervised learning. Handling large data: problems and general techniques for handling large data, programming tips for dealing large data, case studies on DS projects for predicting malicious URLs, for building recommender systems

NoSQL movement for handling Bigdata: Distributing data storage and processing with Hadoop framework, case study on risk assessment for loan sanctioning, ACID principle of relational databases, CAP theorem, base principle of NoSQL databases, types of NoSQL databases, case study on disease diagnosis and profiling

Tools and Applications of Data Science: Introducing **Neo4j** for dealing with graph databases, graph query language **Cypher**, Applications graph databases, Python libraries like nltk and SQLite for handling Text mining and analytics, case study on classifying Reddit posts

Data Visualization and Prototype Application Development: Data Visualization options, Crossfilter, the JavaScript MapReduce library, Creating an interactive dashboard with dc.js, Dashboard development tools, Applying the DS process for respective engineering problem solving scenarios as a detailed case study.

Textbook:

1) Davy Cielen, Arno D.B.Meysman, and Mohamed Ali, "Introducing to Data Science using Python tools", Manning Publications Co, Dreamtech press, 2016
2) Prateek Gupta, "Data Science with Jupyter" BPB publishers, 2019 for basics **Reference Books**:
1) Joel Grus, "Data Science From Scratch", OReilly, 2019
2)Doing Data Science: Straight Talk From The Frontline, 1 st Edition, Cathy O'Neil and Rachel Schutt, O'Reilly, 2013

9. INSTRUMENTATION AND CONTROL SYSTEMS (ICS)

Course Objectives:

- Understand the importance of the Instrumentation methods, Principles and its applications.
- Introduction of the different instrumentation devices, benefits and applications of instrumentation.
- Know the latest development of the various design steps in control systems used in industrial applications.
- Applications of instrumentation devices to solving the real life applications in industries.
- Motivation of students towards the innovative instruments which leads to produce the newly developed automobile and aircraft applications

Course Outcomes:

The main purpose of this course is to make the students aware of :

- Application of instrumentation and control systems in industry
- From the basic principles of instrumentation techniques were utilized for the different engineering applications
- Students will able to understand the industrial products by fundamental knowledge of instrumentation in fibre optics used in defense applications
- After successful completion of this course student can know the prerequisites to do the job in any industry

Instrumentation

Instrumentations: Concepts of measurements, static performance, characteristics accuracy of measurement and its analysis. Instrumentation, for measurement: Force, torque, strain. pressure, flow, temperature and vibration.

Optical Methods of Measurement: Introduction, Laser beam as a light pointer, length/displacement measurement, temperature sensors, seismographic measurement. Introduction to fiber optics, fiber types, properties of optical fibres and a fibre optic sensor configuration.

Control Systems

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.

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.

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, Timedomain 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.

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, , Benjamin C. Kuo.
2. Mechanical Measurements, R.S.Sirohi, H.G. Radha Krishna, Wiley Eastern, New Delhi.

Reference Books:

1. Experimental Methods for Engineers, J.P.Holman, McGraw-Hill Publications.

2. Instrumentation for Engineering Measurements, R.H. Cerni and L.E.Foster, J.Wiley & Sons, New York.
3. Mechanical and Industrial Measurement, R.K.Jain, Khanna publishers, Delhi.
4. Modern Control Engineering, Katsuhiko Ogata, 5th Edition, Pearson Publications, 2010
5. Control Systems Engineering, Nagrath and Gopal , New age International.

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10. RENEWABLE SOURCES OF ENERGY

Course Objectives:

- Understand the necessity for renewable energy source as alternate to fossil fuels
- Exposure to extended applications of solar energy storage systems Exposure to harnessing of wind energy using wind turbines An insight to biomass energy and conversion techniques.
- Exposure to methods of harnessing energy from oceans and geothermal energy .

Course Outcomes:

- Students will realize the importance of renewable energy as alternate to fossil fuels Students can enhance their knowledge by taking up projects in solar energy .
- Students can understand the critical parameters influencing performance of wind turbines
- Students can further explore energy generation opportunities from biomass by taking up projects.
- Students will have an insight to energy recovery opportunities using ocean and geothermal energy

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

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

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

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

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

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Text Books:

1. Non-Conventional Energy Sources, G.D. Rai, Standard Publishers Distributors, 1992.
2. Renewable Energy Resources, John Twidell, Tony Weir, and Anthony D. Weir, Taylor & Francis, 2006.

Reference Books:

1. Non-Conventional Energy Resources, B.H. Khan,McGraw Hill, 2009.
2. Solar Energy – Fundamentals Design, Modelling and applications, G.N. Tiwari, Alpha Science, 2015.
3. Renewable Energy, Power for a Sustainable Future, Godfrey Boyle, Oxford University Press, 2012.
4. Non-Conventional Energy Resources, N.K. Bansal, Vikas Publishing House, 2014.
5. Solar Energy: Principles of Thermal Collection and Storage, S.P. Sukhatme, Tata McGraw Hill, 2009.

11. ENERGY CONSERVATION IN INDUSTRIES

Course Objectives:

- An insight to energy scenario and emphasis need for energy conservation.
- Analyze factors in tariff structure and educate opportunities for energy conservation in transformers
- Exposure to energy conservation opportunities in major thermal utilities
- Exposure to energy conservation opportunities in major electrical utilities and illumination systems
- Apply CUSUM and other financial evaluation techniques and exposure to ESCO concept

Course Outcomes:

- Global and Indian energy scenario will emphasis the need for energy conservation and auditing
- Factors behind energy billing can help to optimize the concept of demand side management for lowering energy costs
- Student will understand avenues available for energy conservation in major thermal utilities
- Student will understand avenues available for energy conservation in major electrical utilities
- Understand CUSUM and other financial evaluation techniques and expose students about energy labelling

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

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

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

Energy Conservation In Major Electrical Utilities: Energy conservation in : Motors - Pumps – Fans – Blowers - Compressed Air Systems - Refrigeration and Air Conditioning Systems - Illumination systems

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

Text Books:

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

Reference Books:

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

12. ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

SYLLABUS

Introduction to Artificial Intelligence: Definitions of Artificial Intelligence, Artificial Intelligence Problems, Topics of Artificial Intelligence, Timelines of Artificial Intelligence, Production Systems, State Space Representation, Branches of Artificial Intelligence, Applications of Artificial Intelligence.
Heuristic Search Techniques- Generate-and-test, Hill Climbing, Search Techniques, Problem Reduction, Constraints Satisfaction, Means-ends Analysis.

Knowledge Representation Structures: First- order Logic- Basic Predicate Representations, Conversion of WFF to Clause Form, Resolution, Resolution Examples, Issues with Resolution, Frames, Conceptual Dependency, Scripts, and Semantic Network.

Reasoning: Types of Reasoning, Non- monotonic Inference Methods, Non- monotonic Reasoning, Truth Maintenance Systems, Reasoning with Fuzzy Logic, Rule- based Reasoning, Diagnosis Reasoning. **Expert Systems-** Characteristics of Expert System, Components of an Expert System, Expert System Development, Knowledge Engineering, Applications of Expert System, Case studies.

Learning: Types of Learning, Machine Learning, Intelligent Agents**. Clustering-** k-Means Clustering, Fuzzy Clustering, Hierarchical Clustering, Cluster Similarity, Case Studies.

Supervised Learning: Support Vector Machines, Case-based Reasoning, Decision Trees- C4.5 Algorithm, ID3 Algorithm, Random Forest, Ensemble Classifiers, and Nearest Neighbourhood. **Artificial Neural Nets –** ANN Basics, ANN- Learning Process, Types of Networks, Perceptron, RBF Networks, ANN Summary, Case Studies.

Text Book:

1. Artificial Intelligence and Machine Learning, by Vinod Chandra S.S and Anand Hareendran S, PHI publishers.

Reference books:

1. Artificial Intelligence by Elaine Rich, Kevin Knight, McGraw-Hill publishers.
2. Machine Learning: The Art and Science of Algorithms that Make Sense of Data by Peter Flach, Cambridge University Press.

13.. PRODUCTION PLANNING AND CONTROL

Course Objectives:

1. The objective of the course is to enable the students to study basic strategies of PPC.
2. To make the student to understand forecasting and its methods.
3. To make the student to understand different functions of PPC.
4. To make the student to understand basic concepts of Lean Manufacturing.

SYLLABUS

Introduction: Definition–Objectives of production Planning and Control Functions of production planning and control – Types of production – Organization of production planning and control department.

Forecasting: Importance– Types of forecasting – Forecasting techniques–qualitative methods and quantitative methods – Delphi, simple average, simple moving average, weighted moving average, exponential smoothing, linear regression.

Inventory management: Functions of inventories–relevant inventory costs– EOQ model

Material Requirement Planning: Bill of material, MRPII, Master Production Scheduling.

Aggregate planning: Chase planning, Expediting, controlling aspects.

Routing: Definition– Routing procedure– Route sheets—Factors affecting routing, procedure– Difference with loading.

Scheduling: Policies – Types of scheduling- Forward and Backward Scheduling – Gantt Charts – Flow shop Scheduling – n jobs and 2 machines, n jobs and 3 machines.

Dispatching: Activities of dispatcher – Dispatching procedure – follow up–priority rules for dispatching jobs.

Introduction to Lean Manufacturing

Course Outcomes:

1. Student shall be able to forecast the appropriate requirement of resources for various production processes and other shop floor activities
2. The student will be able to forecast the appropriate strategy for resource planning through appropriate MRP tool.
3. The students will be able to improve the productivity of shop floor through decision of appropriate production systems such as mass production, batch production etc within existing conditions.
4. The students will be able to identify the bottlenecks of shop floor and remove the same by appropriate design and analysis.

Text Books:

1. Elements of Production Planning and Control, Samuel Eilon, Universal Publications, 2015
2. Modern Production/operation managements, Baffa & Rakesh Sarin , Wiley Publications, 1987

References:

1. Production and Operations Management, S.N.Chary, McGraw-Hill ,2019.
2. Inventory Control Theory and Practice, MartinK. Starrand David W.Miller, Englewood Cliffs, N.J. Prentice-Hall, 1962.
3. Production Control a Quantitative Approach, JohnE.Biegel, Prentice-Hall,1971.
4. Operations Management, Joseph Monks ,McGraw-Hill, 1977.

HSS ELECTIVE
1 . ORGANIZATIONAL BEHAVIOUR

Course Objectives:

- To understand the basic concepts of organisational behaviour, its foundations and importance.
- To enable students to have a basic perspective of Motivation and Motivation theories.
- To acquaint the students about group behaviour in organizations, including communication, leadership conflicts and organizational change and how these are linked to and impact organizational performance.

Course Outcomes:

- Indentifying fundamental aspects of organizational dynamics.
- Evaluate main theories of motivation and formulating suitable motivational strategies.
- Analyze the behaviour of individuals and groups in organizations.
- Understanding of Leadership theories and Leadership behaviour.
- Apply relevant theories, concepts to address important Organizational Behaviour questions.

SYLLABUS

Organizational Behaviour : Concept of Organisation - Concept of Organisational Behaviour - Nature of Organisational Behaviour - Role of Organisational behaviour - Disciplines contributing to Organisational Behaviour.

Motivation: Definition - Nature of Motivation - Role of Motivation - Theories of Motivation : Maslow's Need Hierarchy Theory, Herzberg's Motivation Hygiene Theory and Mc Gregor's Theory X and Theory Y.

Group Dynamics: Meaning - Concept of Group - Types of groups -Formal and Informal groups - Group development - Group cohesiveness and factors affecting group cohesiveness.

Leadership: Concept of Leadership - Difference between Leadership and Management - Importance of Leadership - Leadership styles: Autocratic leadership, Participative leadership and Free Rein leadership.

Communication: Meaning - Communication Process - Forms of communication: Oral, Written and Non- Verbal communication - Direction of communication : Downward, Upward and Horizontal communication.

Organisational conflits : Concept of conflict - Reasons for conflict - Types of Conflict: Intrapersonal conflict, Interpersonal conflict, Intragroup conflict, Intergroup conflict, Inter organisational conflict - Conflict management.

Organisational Change: Nature - Factors in Organizational change -Planned change: Process of planned change - Resistance to change: Factors in resistance to change - Overcoming resistance to change.

Text Books:

1. Organisational Beaviour, L.M.Prasad, Sultan Chand & Sons, New Delhi -110002
2. Organisational Behaviour, K. Aswathappa, Himalaya Publishing House, New Delhi

Reference Book:
1. Organisational Behaviour, Stephen Robbins, Pearsons Education, New Delhi.

2. INDUSTRIAL MANAGEMENT AND ENTREPRENEURSHIP

Course Objectives:

- To familiarize the students with the concepts of Management.
- To relate the concepts of Management with industrial organizations.
- To explain the factors affecting productivity and how productivity can be increased in an Industrial undertaking.
- To set forth a basic framework for understanding Entrepreneurship.

Course Outcomes:

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

- Understand the roles, skills and functions of management.
- Distinguish the different types of business organizations.
- Identify the factors involved in Production Operations Management.
- Diagnose organizational problems and take suitable decisions.
- Establish good Human Resource Management practices.
- Acquire necessary knowledge and skills required for organizing and carrying out entrepreneurial activities.

SYLLABUS

Basic Concepts of Management:
Management :- Definition, Nature and Importance ; Functions of the Management; Levels of Management; F.W Taylor's Scientific Management; Henry Fayol's Principles of Management; **Forms of Business Organizations:** Introduction, **Types of Business organizations: Private Sector**- Individual Ownership , Partnership, Joint stock companies and Co-Operative organizations**; Public**

sector- Departmental Organizations, Public Corporations and Government Companies; The Joint sector Management.

Production and operations Management: Plant location- Factors to be considered in the selection of Plant location; Break - even analysis- Significance and managerial applications; Importance of Production Planning and Control and its Functions; Human Resource Management and Functions of Human Resource Manager (in brief); Functions of Marketing; Methods of Raising Finance.

Entrepreneurship : Definition, Characteristics and Skills , Types of Entrepreneurs, Entrepreneur vs. Professional Managers, , Growth of Entrepreneurs, Nature and Importance of Entrepreneurs, Women Entrepreneurs, Problems of Entrepreneurship.

Entrepreneurial Development and Project Management: Institutions in aid of Entrepreneurship Development, Idea generation: Sources and Techniques;, Stages in Project formulation ; Steps for starting a small enterprise - Incentives for Small Scale Industries by Government.

Text Books:

1. Industrial Organization & Engineering Economics, Sharma,S.C, and Banga, T.R., Khanna Publishers, Delhi, 2000.
2 .The Dynamics of Entrepreneurial Development and Management (Planning for future Sustainable growth), Vasant Desai , Himalayan Publishing House, 2018.

Reference Books:

1. Management Science**,** Aryasri , A.R., McGraw HIll Education (India Private Limited , New Delhi 2014.
2. Entrepreneurship, Sheela, P. , and Jagadeswara Rao, K., Shree Publishing House, Guntur, Andhra Pradesh, 2017.

3. OPERATIONS RESEARCH

Course Objectives:

- Formulate a real world problem as a mathematical programming model. Provide knowledge of optimization techniques and approaches.
- Understand and study inventory problems.
- Know the network models.
- Put on knowledge in solving replacement problems and different queueing models

Course Outcomes:

- Learned to translate a real-world problem into a mathematical formulation.
- Formulate and Solve Transportation, Assignment and sequencing problems.
- Resolve inventory problems.
- Able to solve maximum flow and shortest path problems.
- Capable to solve replacement problems and analyze queueing models.

SYLLABUS

Introduction: Definitions of Operations Research; Phases of Operations Research; Types of Operations Research models; applications, merits and demerits of Operations Research.

Allocation: Linear Programming problem formulation; Basic assumptions; Graphical solution; Simplex method; Artificial variable technique; Two phase method; Big M method; Duality principle; Primal and Dual relation.

Transportation: Formulation; Solution methods; Unbalanced transportation problems - North west corner rule; Least cost entry method; Vogel's approximation method; Optimal solution; degeneracy.

Assignment: Formulation; Variations in Assignment problem; Travelling salesman problem.

Sequencing: Sequencing of - *n* jobs through two machines; *n* jobs through three machines; *n* jobs through *m* machines; 2 jobs through *m* machines.

Inventory Control: Introduction; Types of Inventory; Inventory costs; Deterministic models - Economic order quantity (EOQ) and Economic Production Quantity (EPQ) with and without shortages; Quantity discounts; P system; Q system; Inventory control Techniques.

Network Analysis: Network definitions; Time estimates in network analysis; Labeling using Fulkerson's rule; Forward pass computations; Backward pass computations; Project management using Critical Path Method(CPM) and Programme Evaluation and Review Technique(PERT).

Replacement: Introduction, Replacement of items that deteriorate with time - Value of money unchanging and changing, Replacement of items that fail completely.

Queueing models: Introduction; Single channel poisson arrivals; Exponential service times; Unrestricted queue with infinite population and finite population models; Multi channel poisson arrivals; Exponential service times with infinite population and restricted queue.

Text Books:

1. Operations Research- An Introduction, TAHA , Prentice Hall, 2009.
2. Introduction to Operations Research , F.S. Hiller, G.J. Liberman,B. Nag and P.Basu “, Mc Graw Hill Education(India), 2012.
3. Operations Research , S.D.Sharma, Kedarnadh Ramnadh & Co.,2017

Reference Books:

1. Operations Research, R. Pannerselvam PHI..
2. Operations Research, Richard Bronson, Schaum’s Series, Mc Graw Hill 3. Operations Research- Theory and Practice, N.V.S.Raju, BS publications.
4. Operations Research, V.K. Kapoor , Sultan Chand & Sons.