### U.P. TECHNICAL UNIVERSITY, LUCKNOW

**STUDY & EVALUATION SCHEME**

B. Tech. Mechanical Engineering / Production Engineering / Industrial & Production Engineering / Mechanical & Industrial Engineering

*Effective from Session 20016-17*

**YEAR IV, SEMESTER-VII**

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**Note-**

- Practical Training-1 & 2 (4-weeks each) done after 4th & 6th Semesters would be evaluated in 7th semester through report and viva voce etc.
- Project should be initiated in 7th semester beginning (End Semester Examination to be conducted for evaluation for 7th sem), and should be complete by the end of 8th semester with good Report and power-point Presentation etc.

**Open Electives – I**

- NOE-071 Entrepreneurship Development
- NOE-072 Quality Management
- NOE-073 Operations Research
- NOE-074 Introduction to Biotechnology

**Departmental Elective III**

- NME-031 Computer Aided Manufacturing
- NME-032 Project Management
- NME-033 Computational Fluid Dynamics
- NME-034 Composite materials

**Departmental Elective IV**

- NME-041 Total Quality Management
- NME-042 Thermal Turbo Machines
- NME-043 Mechanical System Design
- NME-044 Automation and Robotics
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**PRACTICAL/DESIGN/DRAWING**

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**Open Electives – II**

- NOE-081 Non Conventional Energy Resources
- NOE-082 Nonlinear Dynamic Systems
- NOE-083 Product Development
- NOE-084 Automation and Robotics

**Departmental Elective V**

- NME-051 Operations Research
- NME-052 Design of Thermal Systems
- NME-053 Advance Synthesis of machines
- NME-054 Industrial Automation
- NME-055 Advance Welding Technology

**Departmental Elective VI**

- NME-061 Experimental Stress Analysis
- NME-062 Plant Layout and Material Handling
- NME-063 Additive Manufacturing
- NME-064 Computer Aided Process Planning
- NME-065 Non Destructive Testing
U.P. TECHNICAL UNIVERSITY, LUCKNOW
STUDY & EVALUATION SCHEME
B. Tech. Mechanical Engineering
[Effective from Session 2016-17]

YEAR IV, SEMESTER-VIII

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THEORY SUBJECT

1. NOE-081 to 084 Open Elective -II 3 1 0 30 20 50 100 150 4
2. NME-801 Power Plant Engineering 3 1 0 30 20 50 100 150 4
3. NME-051 to NME-055 Departmental Elective -V 3 1 0 30 20 50 100 150 4
4. NME-061 to NME-065 Departmental Elective -VI 3 1 0 30 20 50 100 150 4

PRACTICAL/DESIGN/DRAWING

5. NME-851 SEMINAR 0 0 3 - 50 50 - 50 2
6. NME-852 PROJECT 0 0 12 - 100 100 200 300 7
7. GP-801 GP - - - - - 50 - 50 -

TOTAL 12 4 15 - 1000 25

Open Electives – II
NOE-081 Non Conventional Energy Resources
NOE-082 Nonlinear Dynamic Systems
NOE-083 Product Development
NOE-084 Automation and Robotics

Departmental Elective V

NME-051 Operations Research
NME-052 Design of Thermal Systems
NME-053 Advance Synthesis of machines
NME-054 Industrial Automation
NME-055 Advance Welding Technology

Departmental Elective VI

NME-061 Experimental Stress Analysis
NME-062 Plant Layout and Material Handling
NME-063 Additive Manufacturing
NME-064 Computer Aided Process Planning
NME-065 Non Destructive Testing.
UNIT-I
Introduction: Introduction to CAD/CAED/CAE, Elements of CAD, Essential requirements of CAD, Concepts of integrated CAD/CAM, Necessity & its importance, Engineering Applications Computer Graphics-I CAD/CAM systems,


UNIT-II

UNIT-III
Curves: Curves representation, Properties of curve design and representation, Interpolation vs approximation, Parametric representation of analytic curves, Parametric continuity conditions, Parametric representation of synthetic curves-Hermite cubic splines-Blending function formulation and its properties, Bezier curves-Blending function formulation and its properties, Composite Bezier curves, B-spline curves and its properties, Periodic and non-periodic B-spline curves

UNIT-IV
3D Graphics: Polygon surfaces-Polygon mesh representations, Quadric and Superquadric surfaces and blobby objects; Solid modeling-Solid entities, Fundamentals of Solid modeling-Set theory, regularized set operations; Half spaces, Boundary representation, Constructive solid geometry, Sweep representation, Color models. Basic application commands for 2d drafting software like AutoCAD/Draftsight (any one)&3d solid modeling software Solidworks/Autodesk Inventor/PTC Creo /Catia (Any one)etc.

UNIT-V
Finite Element Analysis: Basic concept of the finite element method, comparison of FEM with direct analytical solutions; Steps in finite element analysis of physical systems, Finite Element analysis of 1-D problems like spring, bar, truss and beam elements formulation by direct approach; development of elemental stiffness equations and their assembly, solution and its post processing.

Books and References:
2. CAD/CAM, by Groover and Zimmers, Prentice Hall India Ltd.
4. CAD/CAM: Computer Aided Design and Manufacturing, by Groover, Pearson India
6. Finite Element Method By S S Rao

NME-702: AUTOMOBILE ENGINEERING

UNIT-I
Introduction:
Basic concepts of Automobile Engineering and general configuration of an automobile, Power and Torque characteristics. Rolling, air and gradient resistance. Tractive effort. Gear Box. Gear ratio determination.

UNIT-II
Transmission System:

UNIT-III
Braking System:
General requirements, Road, tyre adhesion, weight transfer, Braking ratio. Mechanical brakes, Hydraulic brakes. Vacuum and air brakes. Thermal aspects.

Chasis and Suspension System:
Loads on the frame, Strength and stiffness, Independent front & rear suspension, Perpendicular arm type, Parallel arm type, Dead axle suspension system, Live axis suspension system, Air suspension & shock absorbers.

UNIT-IV
Electrical System:
Types of starting motors, generator & regulators, lighting system, Ignition system, Horn, Battery etc.

Fuel Supply System:
Diesel & Petrol vehicle system such as Fuel Injection Pump, Injector & Fuel Pump, Carburetor etc. MPFI.

UNIT-V
Emission standards and pollution control:
Maintenance system:
Preventive maintenance, break down maintenance and over hauling.

Books and References:
1. Automotive Engineering- Hietner
3. Automobile Engineering - Narang.
4. Automobile Engineering –TTTI, Pearson India
5. Automotive Mechanics- Crouse
7. Automobile Engineering –Ramakrishna, PHI, India

**NME:801 POWER PLANT ENGINEERING**

**UNIT-I**
Introduction
Power and energy, sources of energy, review of thermodynamic cycles related to power plants, fuels and combustion calculations.

Load estimation, load curves, various terms and factors involved in power plant calculations. Effect of variable load on power plant operation, Selection of power plant units.

Power plant economics and selection
Effect of plant type on costs, rates, fixed elements, energy elements, customer elements and investor.s profit; depreciation and replacement, theory of rates. Economics of plant selection, other considerations in plant selection.

**UNIT-II**
Steam power plant
General layout of steam power plant, Power plant boilers including critical and super critical boilers. Fluidized bed boilers, boilers mountings and accessories, Different systems such as coal handling system, pulverizers and coal burners, combustion system, draft, ash handling system, Dust collection system, Feed water treatment and condenser and cooling towers and cooling ponds, Turbine auxiliary systems such as governing, feed heating, reheating , flange heating and gland leakage. Operation and maintenance of steam power plant, heat balance and efficiency, Site selection of a steam power plant.

**UNIT-III**
Diesel power plant
General layout, Components of Diesel power plant, Performance of diesel power plant, fuel system, lubrication system, air intake and admission system, supercharging system, exhaust system, diesel plant operation and efficiency, heat balance, Site selection of diesel power plant, Comparative study of diesel power plant with steam power plant.

Gas turbine power plant
Layout of gas turbine power plant, Elements of gas turbine power plants, Gas turbine fuels, cogeneration, auxiliary systems such as fuel, controls and lubrication, operation and maintenance, Combined cycle power plants, Site selection of gas turbine power plant

UNIT-IV
Nuclear power plant
Principles of nuclear energy, Lay out of nuclear power plant, Basic components of nuclear reactions, nuclear power station, Nuclear waste disposal, Site selection of nuclear power plants.

Hydro electric station Hydrology, Principles of working, applications, site selection, classification and arrangements, hydro-electric plants, run off size of plant and choice of units, operation and maintenance, hydro systems, interconnected systems.

Non Conventional Power Plants
Introduction to non-conventional power plants (Solar, wind, geothermal, tidal) etc.

UNIT-V
Electrical system
Generators and generator cooling, transformers and their cooling, bus bar, etc.

Instrumentation
Purpose, classification, selection and application, recorders and their use, listing of various control rooms.

Pollution
Pollution due to power generation

Books and References:
1. Power Plant Engineering, by F.T. Morse, Affiliated East-West Press Pvt. Ltd
2. Power Plant Engineering by Hedge, Pearson India
6. Power Plant Engineering by Gupta, PHI India

NPI- 801 : QUALITY CONTROL

UNIT-I

Control Charts for SQC: Statistical Quality Control (SQC). Control charts for variables such as X, R charts and control charts for attributes such as p-chart, c-chart. Construction & use of the control charts. Process capability.

UNIT-III

UNIT-IV

Defect Diagnosis and prevention: Basic causes of failure, curve/control of failure. MTBF. Maintainability, Condition monitoring and diagnostic techniques.

Value Engineering: Elements of value analysis, Techniques.

Unit-V:

Other Factors in Quality: Human Factors such as attitude and errors. Material-Quality, Quality circles, Quality in sales & service.

Books and Reference:
1. Statistical Quality Control by Grant and Leavwarth, McGraw Hill

NME-751:CAD/CAM LAB L T P
0 1 2

Total TEN Experiments are to carried out. FIVE Experiments each from CAD and CAM.

A. CAD Experiments

1. Line Drawing or Circle Drawing experiment: Writing and validation of computer program.
3. Design of machine component or other system experiment: Writing and validation of computer program.
4. Understanding and use of any 3-D Modeling Software commands.
5. Pro/E/Idea etc. Experiment: Solid modeling of a machine component
6. Writing a small program for FEM for 2 spring system and validation of program or using a FEM Package
7. Root findings or curve fitting experiment: Writing and validation of computer program.
8. Numerical differentiation or numerical integration experiment: Writing and validation of computer program.

B. CAM Experiments

1. To study the characteristic features of CNC machine
2. Part Programming (in word address format) experiment for turning operation (including operations such as grooving and threading) and running on CNC machine
3. Part Programming (in word address format or ATP) experiment for drilling operation (point to point) and running on CNC machine
4. Part Programming (in word address format or ATP) experiment for milling operation (contouring) and running on CNC machine
5. Experiment on Robot and programs
6. Experiment on Transfer line/Material handling
7. Experiment on difference between ordinary and NC machine, study or retrofitting
8. Experiment on study of system devices such as motors and feedback devices
9. Experiment on Mecatronics and controls

NME-752: I.C. ENGINES AND AUTOMOBILE LAB

Experiments : Say minimum 10 experiments out of following in depth and details.

1. Performance Analysis of Four stroke S.I. Engine- Determination of indicated and brake thermal efficiency, specific fuel consumption at different loads, Energy Balance.
2. Determination of Indicated H.P. of I.C. Engine by Morse Test.
4. Study & experiment on Valve mechanism.
5. Study & experiment on Gear Box.
6. Study & experiment on Differential Gear Mechanism of Rear Axle.
7. Study & experiment on Steering Mechanism.
8. Study & experiment on Automobile Braking System.
9. Study & experiment on Chassis and Suspension System.
10. Study & experiment on Ignition system of I.C. Engine.
11. Study & experiment on Fuel Supply System of S.I. Engines- Carburetor, Fuel Injection Pump and MPFI.
13. Study & experiment on Air Conditioning System of an Automobile.
14. Comparative study of technical specifications of common small cars (such as Maruti Swift, Hyundai i20, Cheverlet Aveo, Tata Indica, Ford Fusion etc.
15. Comparative study & technical features of common scooters & motorcycles available in India.
16. Visit of an Automobile factory.
17. Visit to a Modern Automobile Workshop.
18. Experiment on Engine Tuning.
DEPARTMENT ELECTIVE-III

NME-031: COMPUTER AIDED MANUFACTURING (CAM)  

UNIT-I  

UNIT-II  

UNIT-III  
Computer Numerical Control (CNC) : Features of CNC, Elements of CNC machines, the machine control unit for CNC, Direct Numerical Control(DNC) and Adaptive Controls. System Devices: Drives, Feedback devices, Counting devices, DAC and ADCs, Interpolator systems, Control loop circuit elements in PTP system, Contouring system, Incremental and absolute systems.

UNIT-IV  
NC Part Programming- (a) Manual (word address format) programming Examples Drilling, Turning and Milling; canned cycles, Subroutine, and Macro. (b) Computer Assisted Part programming (APT) Geometry, Motion and Additional statements, Macro- statement.

UNIT-V  

Books and References:
3. Computer Aided Manufacturing, by Cheng, Pearson India
5. CAD/CAM: Computer Aided Design and Manufacturing, by M. Groover, Pearson India.
6. CAD/CAM: Concepts and Applications by Alavala, PHI India
UNIT-I
Project Management Concepts
Introduction, project characteristics, taxonomy of projects, project identification and formulation. Establishing the project and goals. Nature & context of project management; phases of PM, A framework for PM issues, PM as a conversion process, project environment & complexity. Organizing human resources, organizing systems & procedures for implementation. Project direction.

UNIT-II
Project Organization & Project Contracts
Introduction, functional organization, project organization, matrix organization, modified matrix organization, pure project organization, selection of project organization structure, project breakdown structures, project contracts, types of contracts, types of payments to contractors.

UNIT-III
Project Appraisal & Cost Estimation
Introduction, technical appraisal, commercial appraisal, economic appraisal, financial appraisal, management appraisal, social cost/benefit analysis, project risk analysis. Cost analysis of the project, components of capital cost of a project, modern approach to project performance analysis.

UNIT-IV
Project Planning & Scheduling
Introduction to PERT & CPM, planning and scheduling networks, time estimation, determination of critical path, CPM model, event slacks & floats, PERT model, expected time for activities, expected length of critical path, calculating the project length and variance, PERT & CPM cost accounting systems, lowest cost schedule, crashing of networks, linear programming formulation of event oriented networks, updating of networks, LOB technique.

UNIT-V
Modification & Extensions of Network Models
Complexity of project scheduling with limited resources, resource leveling of project schedules, resource allocation in project scheduling - heuristic solution. Precedence networking- examples with algorithm, decision networks, probabilistic networks, computer aided project management-
essential requirements of PM software, software packages for CPM. Enterprise-wide PM, using spreadsheets for financial projections.

Books and References:
1. Project Management by Harvey Maylor, Pearson India
2. Project Management by Choudhury, McGraw Hill
3. Project Management by K. Nagarajan
5. Project Management: A Life Cycle Approach by Kanda, PHI, India

NME-033: COMPUTATIONAL FLUID DYNAMICS

UNIT - I
GOVERNING EQUATIONS AND BOUNDARY CONDITIONS:

UNIT - II
FINITE DIFFERENCE METHOD:

UNIT - III
FINITE VOLUME METHOD (FVM) FOR DIFFUSION:
Finite volume formulation for steady state One, Two and Three dimensional diffusion problems. One dimensional unsteady heat conduction through Explicit, Crank Nicolson and fully implicit schemes.

UNIT - IV
FINITE VOLUME METHOD FOR CONVECTION DIFFUSION:

UNIT - V
CALCULATION FLOW FIELD BY FVM:
Representation of the pressure gradient term and continuity equation. Staggered grid. Momentum equations. Pressure and Velocity corrections; Pressure Correction equation, SIMPLE algorithm and its variants. Turbulence models, mixing length model, Two equation (k-\(\varepsilon\)) models. High and low Reynolds number models

Books and References:

NME-034: COMPOSITE MATERIALS

UNIT-1
Introduction: Classifications of Engineering Materials, Concept of composite materials, Matrix materials, Functions of a Matrix, Desired Properties of a Matrix, Polymer Matrix (Thermosets and Thermoplastics), Metal matrix, Ceramic matrix, Carbon Matrix, Glass Matrix etc.

UNIT-II
Types of Reinforcements/Fibers: Role and Selection of reinforcement materials, Types of fibres, Glass fibers, Carbon fibers, Aramid fibers, Metal fibers, Alumina fibers, Boron Fibers, Silicon carbide fibers, Quartz and Silica fibers, Multiphase fibers, Whiskers, Flakes etc., Mechanical properties of fibres. Material properties that can be improved by forming a composite material and its engineering potential.

UNIT-III
Various 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, Comparison with Metals, Advantages & limitations of Composites.

UNIT-IV
Fabrication methods: Processing of Composite Materials: Overall considerations, Autoclave curing, Other Manufacturing Processes like filament welding, compression molding, resin-transplant method, pltrusion, pre-peg layer, Fiber-only performs, Combined Fiber-Matrix

UNIT-V
Testing of Composites: Mechanical testing of composites, tensile testing, Compressive testing, Intra-laminar shear testing, Inter-laminar shear testing, Fracture testing etc.

Books and References:
4. Thermal Analysis of Materials, by R.F. Speyer, Marcel Decker
7. Material Science and Engineering (SIE) with CD, by Smith, McGraw Hill

DEPARTMENT ELECTIVE-IV

NME-041: TOTAL QUALITY MANAGEMENT (TQM)  

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UNIT -I
Quality Concepts
Evolution of Quality control, concept change, TQM Modern concept, Quality concept in design, Review off design, Evolution of proto type.

Control on Purchased Product
Procurement of various products, evaluation of supplies, capacity verification, Development of sources, procurement procedure.

Manufacturing Quality
Methods and Techniques for manufacture, Inspection and control of product, Quality in sales and services, Guarantee, analysis of claims.

UNIT -II
Quality Management
Organization structure and design, Quality function, decentralization, Designing and fitting organization for different types products and company, Economics of quality value and contribution, Quality cost, optimizing quality cost, seduction programme.

Human Factor in Quality
Attitude of top management, co-operation, of groups, operators attitude, responsibility, causes of operators error and corrective methods.

UNIT -III
Tools and Techniques
Seven QC tools (Histogram, Check sheet, Ishikawa diagram, Pareto, Scatter diagram, Control chart, flow chart).

Control Charts
Theory of control charts, measurement range, construction and analysis of R charts, process capability study, use of control charts.

Attributes of Control Charts
Defects, construction and analysis off-chart, improvement by control chart, variable sample size, construction and analysis of C-chart.

UNIT -IV
Defects Diagnosis and Prevention
Defect study, identification and analysis of defects, corrective measure, factors affecting reliability, MTTF, calculation of reliability, Building reliability in the product, evaluation of reliability, interpretation of test results, reliability control, maintainability, zero defects, quality circle.

UNIT -V
ISO-9000 and its concept of Quality Management
ISO 9000 & ISO 14000 series, Quality information system and documentation, Auditing, Taguchi method, JIT in some details.

Books and References:
1. Total Quality Management, by Dale H. Besterfield, Pearson India
6. Total Quality Management, by Poornima Chantimath, Pearson India
7. Quality Management by Bedi, Oxford University Press.
8. Total Quality Management-Text and Cases, by Janakiraman & Gopal, PHI, India.
UNIT-I
Brief history of turbo machinery, introduction to blowers, pumps, compressors, steam & gas turbines, turbojet, Review of laws of thermodynamics & SFEE in reference to turbomachinery, Energy transfer in turbo machines, Euler’s equation, Definition of various efficiencies, Preheat factor, Reheat factor, Blade classification, Blade terminology, Cascade testing, Velocity diagrams for axial and radial turbomachinery and pumps.

UNIT-II
Centrifugal compressors- Principle of operation, work done and pressure rise, Velocity diagram for centrifugal compressor, Slip factor, Stage pressure rise, Loading coefficient, Diffuser, degree of reaction, Effect of impeller blade profile, Pre-whirl and inlet guide vanes, Centrifugal Compressor characteristic curves.

Axial flow compressor- Principle of operation and working, Energy transfer, Velocity diagram for axial compressor, Factors affecting stage pressure ratio, Blockage incompressor annulus, Degree of reaction, 3-D flow, Design process, blade design, calculation of stage performance, Axial compressor performance characteristic curves.

UNIT-III

UNIT-IV
Steam turbines- Constructional details, working of steam turbine.

Pumps: Classification of Pumps, Main components, indicator diagram and modification due to piston acceleration, Performance characteristics, Cavitation and its control, Miscellaneous types of pumps.


UNIT-V
Gas Turbine Starting & Control Systems: Starting ignition system, Combustion system types, Safety limits & control.

Turbine Blade coding: Different cooling techniques, Types of coolants, Comparative evaluation of different cooling techniques.

Mechanical Design consideration: Overall design choices, Material selection, Design with traditional materials.

Books and References:
2. Fundamentals of Turbomachinery by Venkanna, PHI, India
UNIT-I

**Engineering process and System Approach**
Basic concepts of systems, Attributes characterizing a system, types of system, Application of system concepts, Advantages of system approach, Problems concerning systems, Concurrent engineering, A case study-Viscous lubrication system in wire drawing.

**Problem Formulation**: Nature of engineering problems, Need statement, hierarchical nature of systems, hierarchical nature of problem environment, problem scope and constraint, A case study: heating duct insulation system, high speed belt drive system.

UNIT-II

**System Theories**: Introduction, System Analysis, Black box approach, state theory approach, component integration approach, Decision process approach, A case study- automobile instrumentation panel system.

**System modeling**
Introduction, Model types and purpose, linear systems, mathematical modeling, concepts, A case study compound bar system.

UNIT-III

**Graph Modeling and Analysis**
Graph Modeling and analysis process, path problem, Network flow problem, A case study: Material handling system.

**Optimization Concepts**
Optimization processes, Selection of goals and objectives-criteria, methods of optimization, analytical, combinational, subjective. A case study: aluminium extrusion system.

UNIT-IV

**System Evaluation**
Feasibility assessment, planning horizon, time value of money, Financial analysis, A case study: Manufacture of maize starch system.

**Calculus Method for Optimization**
Model with single decision variable, model with two decision variables, model with equality constraints, model with inequality constraints, A case study: Optimization of an insulation system.
UNIT-V
Decision Analysis
Elements of a decision problem, decision making, under certainty, uncertainty risk and conflict probability, density function, Expected monetary value, Utility value, Baye’s theorem, A case study: Installation of machinery.

System Simulation
Simulation concepts, simulation models, computer application in simulation, spread sheet simulation, Simulation process, problem definition, input model construction and solution, limitation of simulation approach, A case study: Inventory control in production plant.

Books and References:
3. Design Engineering-JR Dixon, TMH, New Delhi
4. An Introduction to Engineering Design Method-V Gupta and PN Murthy, TMH, New Delhi
5. Engineering Design-Robert Matousck, Blackie and son ltd. Glasgow
6. Optimization Techniques-SS Rao

NME-044: AUTOMATION AND ROBOTICS

UNIT- I
AUTOMATION:
Definition, Advantages, goals, types, need, laws and principles of Automation. Elements of Automation.
Fluid power and its elements, application of fluid power, Pneumatics vs. Hydraulics, benefit and limitations of pneumatics and hydraulics systems, Role of Robotics in Industrial Automation.

UNIT- II
Manufacturing Automation:
Classification and type of automatic transfer machines; Automation in part handling and feeding, Analysis of automated flow lines, design of single model, multimodel and mixed model production lines. Programmable Manufacturing Automation CNC machine tools, Machining centers, Programmable robots, Robot time estimation in manufacturing operations.

UNIT- III
ROBOTICS
Robot anatomy, configuration of robots, joint notation schemes, work volume, manipulator kinematics, position representation, forward and reverse transformations, homogeneous
transformations in robot kinematics, D-H notations, kinematics equations, introduction to robot arm dynamics.

**UNIT -IV**

**ROBOT DRIVES AND POWER TRANSMISSION SYSTEMS**


**ROBOT END EFFECTORS**

Classification of End effectors – active and passive grippers, Tools as end effectors, Drive system for grippers. Mechanical, vacuum and magnetic grippers. Gripper force analysis and gripper design.

**UNIT- V**

**ROBOT SIMULATION**

Methods of robot programming, Simulation concept, Off-line programming, advantages of off-line programming.

**ROBOT APPLICATIONS**

Robot applications in manufacturing-Material transfer and machine loading/unloading, Processing operations like Welding & painting, Assembly operations, Inspection automation, Limitation of usage of robots in processing operation.

Robot cell design and control, Robot cell layouts-Multiple robots & Machine interference.

**Books and Reference :**

3. Robotic: Control, Sensing, Vision and Intelligence, by Fu, McGraw Hill.
4. Introduction to Industrial Robotics, by Nagrajan, Pearson India
5. Robotics, by J.J. Craig, Addison-Wesley.
7. Robots & Manufacturing Automation, by Asfahl, Wiley
10. Introduction to AI Robotics, by Murphy, PHI, India.

**DEPARTMENT ELECTIVE-V**

**NME-051: OPERATIONS RESEARCH**

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UNIT-I


UNIT-II

Transportation Problem: Methods of obtaining initial and optimum solution, degeneracy in transportation problems, unbalanced Transportation Problem.

Assignment Problem: Methods of obtaining optimum solution, Maximization problem, travelling salesman problem.

UNIT-III

Game Theory: two person Zero sum game, Solution with/without saddle point, dominance rule, Different methods like Algebraic, Graphical and game problem as a special case of Linear Programming.

Sequencing: Basic assumptions, n Jobs through 2-3 machines, 2 Jobs on m machines.

UNIT-IV

Stochastic inventory models: Single & multi period models with continuous & discrete demands, Service level & reorder policy.

Simulation: Use, advantages & limitations, Monte-carlo simulation, Application to queuing, inventory & other problems.

UNIT-V

Queuing models: Characteristics of Queuing Model, M/M/1 and M/M/S system, cost consideration.

Project management: Basic Concept of network Scheduling, Rules for drawing network diagram, Applications of CPM and PERT techniques in Project planning and control; crashing of operations; resource allocation.

Books and References:

10. Operations Research, by Panneerselvam, PHI, India
Unit-I
Psychrometry of Air Conditioning Processes, Design Conditions & Load Calculations
Psychrometric Processes in Air Conditioning Equipments, Analysis of Air Conditioning systems for summer & winter conditions, Inside & outside design conditions for comfort, Industrial Air Conditioning.
Cooling & Heating Load calculations- Heat transfer through building structures, solar heat gain, Infiltration & ventilation air, Internal heat gain, Occupancy & Product load, Room sensible heat factor, Effective sensible heat factor & Grand sensible heat factor, capacity of the plant.


Unit-II
Analysis of Complete Vapour Compression System – Design and Balancing of System Components
Type of Refrigerant Compressors, Condensers, Evaporators & Expansion devices used in Vapour Compression Refrigeration Cycles, Design and Selection of individual components and their performance characteristics, Use of P-H charts for different refrigerants in performance predication of the cycle.
Analysis of the complete vapour-compression-system and determination of ‘Balance Points’ using Graphical and Analytical methods, system simulation. Layout & selection of Refrigerant, water and Brine pipings for the designed system. Selection of Refrigeration and Air conditioning Controls for the system.

Unit-III

Unit-IV

Unit-V
Optimization of design of thermal systems like condenser, evaporator, cooling tower for minimum cost and maximum performance, Development of computer program for design, Environmental consideration in design of thermal systems, Analysis of thermal systems using FEM.
Books and References:
1. Thermal Environment Engg. by Kuhnen, Ramsey & Thelked.
3. Refrigeration & Air Conditioning - By Manohar Prasad, New Age
4. Heating, Ventilating and Air Conditioning - By Mc Quistion, Parker & Spitler
5. Refrigeration & Air Conditioning Data Book – Manohar Prasad, New Age
6. ASHRAE Hand Book of Fundamentals-ASHRAE
8. Design of High Efficiency Turbomachinery and Gas Turbine by Wilsonm and Korakianitis, PHI, India
11. Thermal System Design and Optimization by Balaji, Ane Books Pvt Ltd

NME-053: ADVANCE SYNTHESIS OF MECHANISMS

UNIT-I
Introduction:
Mechanisms: Classifications, Relative and absolute motion, degree of freedom, 4-bar Mechanisms, planar and spatial mechanisms, Inversion and equivalent linkage, Transmission angle.

Kinematic analysis of Planer motion: Relative velocity, Instantaneous centre, Poles and centrodes, Relative acceleration.

UNIT-II
Kinematic Synthesis: Type, number and dimensional synthesis, spacing of accuracy points, Chebyshev polynomials.

Four bar linkage, Equation of coupler curves, Double points and symmetry, Robert Chebyshev theorem, Approximate and exact straight line mechanisms.

UNIT-III
Graphical Synthesis of Mechanisms:
Poles and relative poles of four bar linkage, Poles and relative poles of slider crank Mechanism. Synthesis of four bar mechanisms.

UNIT IV
Analytical Synthesis:
Displacement equation of four bar linkage, Crank and follower synthesis with three accuracy points, Four bar function generator with three accuracy points, Crank and follower synthesis, angular velocities and accelerations.

UNIT-V
Analytical Synthesis:
Synthesis of slider crank mechanism with three accuracy points, Synthesis of slider crank mechanism with four accuracy points, cam and follower mechanism, Analysis of mechanical errors in linkage.

Books and References:
2. Kinematic and Linkage Design AS Hall Jr Prentice Hall India Ltd.
3. Mechanism and Machine Theory Amitabh Ghosh and AK Mallick
4. Mechanism Design: Analysis & Synthesis Erdman & Sandor Prentice Hall of India
5. Kinematics and Dynamics of machinery (SIE), by Norton, McGraw Hill

NME-054: INDUSTRIAL AUTOMATION –I

Unit-I:
Historical perspective of Industrial Automation
- Origin, Evolution and Need / Demand of automation in industries, Current and future Trends
- Components of Industrial Automation System and their functionalities, Layers and Types of Automation

Unit -II:
Automation Controllers
- Introduction of Industrial Controllers
- Programmable Logic Controller: Constructions, Types, Programming Units, Memory, I/O Modules.
- Programming methodology
- Ladder Logic programming for Industrial Applications, Timers and Counters
- Selection criteria of PLC
- Examples of PLC application

Unit-III:
Industrial Switching Elements
- Electronic Logic gates
- Relays, Solenoids
- Pneumatic Valves and Actuators
- Hydraulic valves and Actuators
- Interfacing: Control of Hydraulics and Pneumatics with Electric Signals
- Comparison between different switching elements

Unit-IV:
Visualization: Human Machine Interface (HMI), Supervisory Control and Data Acquisition (SCADA) Systems:
- Need for HMI
- Hardware based HMI panels
- PC based HMI Systems – SCADA
- Different Functionalities
- Benefits of implementing SCADA systems
- Case Studies of SCADA implementation.

Unit V:
Case Study
- Hydraulic / Pneumatic Press
- Material handling System
- Machine Tool: NC/CNC Machine

Books and References:

NME-055: ADVANCED WELDING TECHNOLOGY

UNIT-I

Introduction: Welding as compared with other fabrication processes, Importance and application of welding, classification of welding processes, Health & safety measures in welding.

Welding Power Sources: Physics of welding Arc, Basic characteristics of power sources for various arc welding processes, Transformer, rectifier and generators.

Physics of Welding Arc: Welding arc, arc initiation, voltage distribution along the arc, arc characteristics, arc efficiency, heat generation at cathode and anode, Effect of shielding gas on arc, isotherms of arcs and arc blow.

Metal Transfer: Mechanism and types of metal transfer in various arc welding processes.

**UNIT-III**

**Heat Flow Welding:** Calculation of peak temperature; Width of Heat Affected Zone (HAZ); cooling rate and solidification rates; weld thermal cycles; residual stresses and their measurement; weld distortion and its prevention.

**UNIT-IV**

**Repair & Maintenance Welding:** Hardfacing, Cladding, Surfacing, Metallizing processes and Reclamation welding.

**Weldability:** Effects of alloying elements on weld ability, welding of plain carbon steel, Cast Iron and aluminium. Micro & Macro structures in welding.

**UNIT-V**


**Books and References:**


**DEPARTMENT ELECTIVE-VI**

**NME- 061: EXPERIMENTAL STRESS ANALYSIS**

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**UNIT -I**

**Stress:** Introduction, Two-Dimensional State of Stress, Equations of Equilibrium, Stress Transformation relations, principal Stresses, Special States of Stress.

**Strain:** Introduction, Displacement and Strain, Strain Transformation relations, principal strains, Stress Strain Relations, for Two-Dimensional State of Stress.

**UNIT- II**

Brittle Coating Method: Introduction, Coating Stresses, Brittle Coating Crack Patterns, Resin and Ceramic Based Brittle Coating, Test Procedure, Analysis of Brittle Coating Data.

UNIT -III

Strain Gage Circuit: Potentiometer, Wheat-Stone Bridge, Bridge Sensitivity, Null Balance Bridges. Three Element Rectangular Rosette

UNIT- IV

UNIT -V

Books and References:
1. Experimental Stress Analysis, by U C Jindal, Pearson India
2. Experiment Stress Analysis, by James W. Dally and William F. Riley, McGraw-Hill International
3. Experiment Stress Analysis by Dr. Sadhu Singh, Khanna Publishers.

UNIT -II
Workstations, Unit Loads & Containers, Conveyors, Vehicles, Lifting Devices, Workstation Material Handling, Ethics in Facility Design
Facilities design procedure and planning strategies, Production, activity and materials flow analysis, Space requirements and personnel services design considerations.

UNIT -III
**Layout construction techniques:** systematic layout planning; activity relationship analysis, pairwise exchange, graph-based construction algorithmic.
**Material Handling:** Material handling principles; material handling equipment and material handling systems.

UNIT -IV
**Computerized Layout and Analytical Methods:** ALDEP, CORELAP, CRAFT, BLOCPLAN, etc. **Warehouse operations:** function, storage operations.
**Manufacturing operation:** JIT, TQM, AM, CIM, SCM, Facility systems,
**Quantitative models:** Layout model, waiting line, AS/RS, simulation model, etc.

UNIT -V
Assessment and evaluation of layout alternatives Projects, Use Spiral software to practice plant layout design, Apply mathematical and engineering techniques such as systematic layout planning approach, quantitative model, cost estimate to solve practical facility layout problem.

Books and References:

NME-063: ADDITIVE MANUFACTURING
L T P
3 1 0
UNIT-I
Introduction
History and Advantages of Additive Manufacturing, Distinction Between Additive Manufacturing and CNC Machining, Types of Additive Manufacturing Technologies, Nomenclature of AM Machines, Direct and Indirect Processes; Prototyping, Manufacturing and Tooling.

Layer Manufacturing Processes; Polymerization, Sintering and Melting, Extrusion, Powder-Binder Bonding, Layer Laminate Manufacturing, Other Processes; Aerosolprinting and Bioplotter.

UNIT-II
Development of Additive Manufacturing Technology
Computer Aided Design Technology, Other Associated Technology, Metal and Hybrid Systems.

Generalized Additive Manufacturing Process Chain; The Eight Steps in Additive Manufacturing, Variation from one AM Machine to Another, Metal System, Maintenance of Equipment, Material Handling Issue, Design of AM.

UNIT-III
Additive Manufacturing Processes

UNIT-IV
Design & Software Issues
Additive Manufacturing Design and Strategies; Potentials and Resulting Perspectives, AM based New Strategies, Material Design and Quality Aspects for Additive Manufacturing; Material for AM, Engineering Design Rules for AM.

Software Issue for Additive Manufacturing; Introduction, Preperation of CAD Models: The STL file, Problem with STL file, STL file Manipulation, Beyond the STL file, Additional Software to Assist AM.

UNIT-V
Material Design & Quality Aspects
Applications
Aerospace, Automotive, Manufacturing, Architectural Engineering, Art, Jewelry, Toys, Medical, Biomedical, Dental, Bio-printing, Tissue & Organ Engineering and many others.

Books and References:


NME-064: COMPUTER AIDED PROCESS PLANNING

UNIT-I
Introduction to CAPP: Principles, scope and information requirement for CAPP, Role of process planning, Manual and experienced based process planning, Advantages of CAPP over conventional process planning, Decision table and decision trees, process capability analysis, Tolerance analysis, Variant process planning, Generative approach, Forward and Backward planning.

UNIT-II
Computer Aided Process Planning: Logical design of process planning systems, Implementation considerations, Computer based process monitoring and control, Computer and process interfacing, Totally integrated process planning systems, Process planning for rotational and prismatic parts, Machining of curves and surfaces, Five axis machining, Process planning of freedom surfaces, Development of NC codes, Computer aided design of fixtures, Inspection policies and inspection planning, Expert systems and their use in developing process planning systems.

UNIT-III

UNIT-IV
Determination of machining parameters: Reasons for optimal selection of machining parameters, effect of parameters on production, cost and surface quality, different approaches, advantages of mathematical approach over conventional approach, solving optimization models of machining processes, design and manufacturing tolerances, methods of tolerance allocation, sequential approach, integration of design and manufacturing tolerances.
UNIT-V
**Generation of tool path:** Simulation of machining processes, NC tool path generation, graphical implementation, determination of optimal index positions for executing fixed sequence, quantitative methods. Implementation techniques for CAPP: MIPLAN system, Computer programming languages for CAPP, criteria for selecting a CAPP system and benefits of CAPP. Computer integrated planning systems, and Capacity planning system.

**Books and References:**

NME-065: NON-DESTRUCTIVE TESTING  

**Unit-I**  
**Introduction**  
Scope and advantages of NDT, Comparison of NDT with Destructive Testing, Some common NDT methods used since ages, Terminology, Flaws and Defects, Visual inspection, Equipment used for visual inspection. Ringing test, chalk test (oil whitening test). Uses of visual inspection tests in detecting surface defects and their interpretation, advantages & limitations of visual inspection.

**Unit-II**  
Die penetrate test (liquid penetrate inspection), Principle, scope. Equipment & techniques, Tests stations, Advantages, types of penetrants and developers, Zyglo test, Illustrative examples and interpretation of defects.

Magnetic particle Inspection – scope and working principle, Ferro Magnetic and Non-ferromagnetic materials, equipment & testing. Advantages, limitations Interpretation of results, DC & AC magnetization, Skin Effect, use of dye & wet powders for magna glow testing, different methods to generate magnetic fields, Applications.

**Unit-III**  
**Radiographic methods**  
Introduction to electromagnetic waves and radioactivity, various decays, Attenuation of electromagnetic radiations, Photo electric effect, Rayleigh’s scattering (coherent scattering), Compton’s scattering (Incoherent scattering), Pair production, Beam geometry and Scattering factor.

Unit-IV
Ultrasonic testing methods

Unit-V
Special NDT Techniques

Books and References: