APPROVED BY BOS CHAIRMAN

GOA UNIVERSITY

FINAL AND/ FOURTH YEAR OF BACHELORS DEGREE COURSE IN
ENGINEERING
(Revised in 2007-08)
SCHEME OF INSTRUCTION AND EXAMINATION

SEMESTER VII

Sub Code	Subject	Scheme of instruction (hours/week)			Scheme of examination					
		L	T	P	Th Dur (hrs)	Marks Th	S	P	O	Total
7.1	CAD-CAM	3	1	2	3	100	25	25	25	175
7.2	Refrigeration & Air Conditioning	3	1	2	3	100	25	25	25	175
7.3	Manufacturing Technology III	3	1	-	3	100	25	-	-	125
7.4	Elective I	3	1	2*	3	100	25	-	25	150
7.5	Elective II	3	1	2*	3	100	25	-	25	150
7.6	Project	-	-	4	3	-	25**	-	50	75
	Total	**15**	**05**	**12**	**-**	**500**	**150**	**50**	**150**	**850**

*Practical slots for Electives subjects are to be decided based on nature of subjects offered and explicitly specified in the Elective list.
A journal containing assignments such as design exercises/or experiments conducted and results obtained to be submitted for assessment.

** Progress Seminar of PROJECT

Elective 4- major groups (thermal, design, manufacturing and industrial) and I-non departmental like computer, IT and management.

L: Lecture, T: Tutorial, P: Practical
Th.Dur: Duration of theory paper
Th: Theory, S: Sessional, P: Practical, O:Oral

Revised Course (Revised in 2007-08) sem VII (Mech) Electives to be introduced from I term of 2010-2011

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5-10-2010

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ME 7.1 CAD/CAM

	L+T+P
Lectures/Tutorial/Practical per week	3+1+2
Max. Marks for theory paper	100
Max. Marks for Sessionals	25
Max Marks for Practicals	25
Max Marks for Orals	25
Total number of modules	4
Total number of questions from each module	2
Duration of theory paper	3 hours
Total number of questions to be answered	5 (at least one question from each module)

OBJECTIVES

- To provide an overview of hardware, software, concepts of geometrical modeling & FEM and artificial intelligence in design & manufacturing.
- To introduce the student to the basic fundamentals of Computer Graphics, which can help him to visualize the graphic images/geometric model on the screen.
- To learn the basics of NC, CNC & DNC machine tools & also explain the concepts of NC part programming & computer assisted programming language. Suitable illustrations will enable the student to write his her own programs.
- To provide a glimpse of robot technology & rapid Prototyping.
- To understand the basic concepts of automation in FMS & CIM & how it can be implemented in modern factories.

INSTRUCTIONAL OBJECTIVES

- The student should be able to use the method of geometric construction for solid modeling with CAD softwares like CATIA, SOLIDWORKS, PRO- E etc.
- The student should be able to apply the concepts of FEM in mechanical engineering analysis using softwares like ANSYS, NASTRAN, ABACUS etc.
- Concepts like scan conversion, algorithms for line and circle drawing, clipping & geometric transformations can provide a platform for developing CAD/CAM software.
- The student should be able to write CNC programs independently for any specific CNC machine.
- The concepts of robotics and FMS should prepare the student for further work and research on these topics.

MODULE-I

Fundamentals of CAD/CAM, CIM and automation, CAD/CAM Hardware, CAD/CAM Software, Geometric modeling – Geometric models and construction methods, Finite element analysis procedure, FEM software, Concurrent engineering, CAD standards, Introduction to CAD CAM data exchange.

(14 Hours)

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9. Radhakrishnan P. Subramanyan S, CAD/CAM/CIM, New Age International publishers, 1994
10. Tien Chien Chang, Rolland Wyst, HSU Pin Wang, Computer aided manufacturing, Pearson Education

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MODULE II

(12+3)

2.1 Vapour Compression System

Limitations of air refrigeration system, development of vapour compression cycle (VCC), use of p-h charts, Second Law Analysis, actual vapour compression cycle. Introduction to multistage compression systems Two stage compression with flash gas removal, liquid intercooler, flash cooling, flash sub-cooling. Introduction to CASCAD refrigeration system, Numericals and solution procedure.

2.2 Vapour absorption system

Introduction, simple vapour absorption system, practical vapour absorption system, COP of an ideal vapour absorption mixture, water ammonia system(problems), Electrolux refrigerator, lithium bromide absorption system(descriptive treatment only)

MODULE III

(11+2)

3.1 Refrigerants and Components of refrigeration and air conditioning system

Desirable properties of refrigerants classification of refrigeration, secondary refrigerants, alternative refrigerants for CFC's and HCFC's ozone depletion potential (ODP) Global warming potential (GWP) total equivalent warming impact (TEWI), Montreal protocol, Kyoto protocol, Clean Development Mechanism.

Compressors, condensers, evaporators, expansion devices such as capillary tubes, automatic expansion valves, thermostatic expansion valves, Condensing Units and Cooling Towers, Pressure and Temperature controls. (Descriptive treatment only)

3.2 Psychrometry

Introduction, Psychrometry terms,use of Psychrometric chart, Psychrometric processes, adiabatic saturation temp. Evaporative cooling, bypass factor of coil, efficiency of coil, Air washers, Thermodynamics of human body with environment, effective t4empcomfort chart.

MODULE IV

(12+4)

4.1 Air Conditioning and Selection of air- conditioning Systems

Defination, factors, equipment used, classifications, all air system, all water air water system, unitary and central air conditioning systems, auditorium air conditioning system, Numericals on air conditioning systems using Psychrometric chart.Introduction to thermal distribution systems and their function, Selection criteria for air- conditioning systems. (Elementary treatment only)

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REFRIGERATION AND CONDITIONONG LABORATORY

Practical hours per week: 2
Maximum Marks for Practical Examination : 25

The term work shall consist of minimum five experiments from the following:

List of Practicals

1. Performance test on vapour compression test rig.
2. Performance test on air conditioning test rig.
3. Performance test on ice plant test rig.
4. Performance test on Heat Pump Trainer
5. Study of compressiors
6. Study of vapour absorption / Electrolux system
7. Determinations of cooling load of air conditioning system (case study)
8. Study of installation / operation / maintenance practices for refrigeration systems
9. Visit to any refrigeration or air conditioning plant.

TEXT BOOKS

1. Refrigeration and Air conditioning – Arora S. C. & Domkundwar S., Dhanpatrai & Sons, New Delhi.

REFERENCEBOOKS:-

1. Refrigeration and Air conditioning – C. P. Arora S. C. & Domkundwar S., Dhanpatri & Sons, New Delhi
2. Refrigeration and Air conditioning – Manohar Prasad, Wiley Eastern Limited
3. Refrigeration and Air conditioning-Anantanrayan, Tata McGraw Hills Co.,New Delhi
4. Refrigeration and Air conditioning – Dossat Ray J, Wiley Eastern Limited.

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MODULE III (12)

a) Form tool design
b) Milling cutters and its classification, elements of plain milling cutter, influence of tooth angles on cutter performance.
c) Broach tool design, theory of broaching.
d) Twist drill geometry and its design aspects.
e) Grinding wheel nomenclature, selection of grinding wheel.

MODULE IV

a) Surface finishing processes: lapping, honing, super finishing and burnishing.
b) Powder metallurgy: manufacturing of metal powders, mixing and blending Compacting, sintering and secondary operations. Advantages, limitations and applications of powder metallurgy. Recent trends in powder metallurgy.
c) Wear mechanisms of H. SS and carbide tools.
d) Machinability of magnesium, aluminum, copper, iron and steel.

TEXT BOOKS

1. Eary and Reid- Techniques of pressworking sheet metal-Prentice Hall Inc.
2. Joshi P.H. – Jigs and fixtures-TMH
3. Arsihnov-Tool Design MIR Publication.
4. ASTME- Tool Design
5. Trent E.M. – Metal Cutting – Butterworths.

REFERENCEBOOKS:-

1. HMT – Production Technology.
2. Kempster – Introduction to jigs and fixtures – ELBS
3. Juneja B.L. and Sekhon G. S. – Fundamentals of metal maching and machine tools Wiley Eastern LTD.
4. Donaldson – Tool Design.

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ME 7. 4. 2 TOOL ENGINEERING AND DESIGN

	L.T.P
Lectures/Tutorials/Practicals per week:	3+1+2
Max. marks for theory paper:	100
Max. marks for sessionals	25
Max. marks for orals	25
Total No. of questions from each module	2
Total No. of questions to be answered	5 (At least one question from each module)

Course Objective: To prepare mechanical Engineer to be specialised in Tool Design aspects of various types of tools required in various machine processes and various types of form tools.

Instructional Objectives: The study of various types of tools required for machinery processes and forming tools including plastic tooling, and tools required for N C Machine tools should be dealt in detail, give brief about processes before giving to design aspects.

MODULE 1 **(06 Hrs)**

1. **Tool Design Method and Tool Materials**: Introduction, the design procedure, properties of cutting tool material. Ferrous tooling materials such as Tool steels cast iron, Mild or low carbon steels. Nonmetallic, Non Ferrous tooling materials. Heat treating. Factors effecting heat treating. Heat treatment and tool design.

(06 Hrs)

2. **Design of Single Point Cutting Tools:** Basic requirement of cutting tools. Single point tools. Tools nomenclature, geometry of single point cutting tool, design of shank dimension using strength and rigidity consideration and selection of geometry for the cutting tool point. Boring tool, types of boring tools. Boring – bar and cutting adjustment. Design features of shaper. Planner, and slotter tools. Selection of carbide cutting tools. Determining shank size for single point carbide tools Determining the insert thickness for carbide tools.

MODULE II **(06 Hrs)**

3. **Design of Drill:** Geometry of drill, type of drill, effect of various factor on axial thrust and torque in drilling. Design of basic element of drill. Problem on drill body and flute of drills and selection of geometry.

(06 Hrs)

4. **Design of Milling Cutters:** profile sharpened milling cutters, profile sharpened plain milling cutters, profile sharpened face-milling cutter, profile sharpened side milling cutter, circulars saws, profile sharpened end- milling cutter, profile sharpened form milling cutter, and form relieved milling cutter. Design problems.

MODULE III **(6 Hrs)**

5. **Design of Form Tools:** Form tools for turning application, Flat form tools, Graphical profiling of flat form tools, Circular form tools, Correction of angles, Correction of Circular arcs, Comatibility of Tool angles, Tangential form tool.

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ME 7. 4. 3 CRYOGENICS

	L T P
Number of Lectures/Tutorials/Practicals per week	3+1+2
Question paper Duration	3 Hrs
Maximum Sessional Marks	25
Maximum oral Marks	25
Maximum Marks (theory)	100
No. of question for each module	02
Total number of questions to be answered	5 (at least one question from each module)

Course Objectives:

Use the information described in the course description to properly model and design very low temperature (cryogenics) systems.

Instructional Objective:

1. To build a solid foundation in the fundamentals of cryogenics
2. To encourage a "hands-on" approach to solving cryogenic problems
3. To define and demonstrate " what's different" at low temperatures
4. To provide up-to-date cryogenic solution of open-ended, client-based design problems.

MODULE I

(12+4)

Introduction : - Historical review, application areas, Temperature and temperature scales. First, Second and Third laws of Thermodynamics. Properties of state. Reversible and irreversible process. Heat engines and phase transitions. Review of solid and fluid properties at low temperatures

MODULE II

(12+4)

Liquefaction systems: Liquefaction Open and closed cycles; Effect of Component efficiencies as performance; Simulation of performance of different cycles

Cryogenic Refrigerators: Recuperative and Regenerative cycles – Effect of Irreversibility on system performanc

MODULE III

(12+4)

Micro-miniature cryocoolers for space and defence applications

Design criteria for equipment associated with low temperature systems: heat exchangers, compressors,expanders.

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MODULE IV

(12+4)

ME 7. 4. 4 ENGINEERING TRIBOLOGY

	L T P
Number of Lectures/Tutorials/Practicals per week	3+1+2
Question paper Duration	3 Hrs
Maximum Sessional Marks	25
Maximum oral Marks	25
Maximum Marks for Theory	100
No. of question for each module	02
Total number of questions to be answered	5 (at least one question from each module)

Course Objectives: This is an interdisciplinary course with knowledge drawn from different disciplines of mechanical engineering, materials science, chemistry and physics. The interaction between these different fields will lead engineers to control wear and friction.

Instructional Objective: Tribology focuses on friction, wear and lubrication of interacting surfaces in relative motion. Tribological studies have economic benefits in improving reliability, ensuring maintenance and reducing wear.

MODULE I

Introduction: Meaning of Tribology, Lubrication and wear. (2)

Physical Properties of Lubricants: Oil viscosity & Viscosity Index, Viscosity Measurements, Viscosity of Mixtures, Oil Viscosity Classification, Thermal Properties of Lubricants, Lubricant impurities and Contaminants. (3)

Hydrostatic bearings: Hydrostatic Bearing Analysis, Flat circular Hydrostatic Bearing: Pressure Distribution, Lubricant Flow, Load Capacity, Friction Torque, Friction Power Loss, Generalized Approach to Hydrostatic Bearing (5)

MODULE –II

The Friction of Solids: Genesis of Solid Friction: physical basis of the laws of Friction, Adhesion, Junction Growth. Static and Kinetic Friction: Stick-Slip Effects & Measurement of Friction. Friction of Non Metallic Materials, Tribo-Monitoring of Friction,

(5)

Wear & surface damage: Introduction, Classification of Wear, Wear Maps Mechanism of Wear: Seizure, Melt wear, Oxidation Dominated Wear, Mechanical Wear Process, Running in Adhesive Wear, Abrasive Wear, Delamination Wear, Fatigue Wear in Rolling Contacts, Fretting and Corrosive wear, Erosive Wear, Third bodies & Wear: Interfacial Third Bodies, Debris Analysis. Tribo-Monitoring

(5)

MODULE – III

Hydrodynamic Bearings: Introduction, Reynolds Equation, Simplifying Assumptions, Equilibrium of an Element, Continuity of flow in a Column, Simplifications of Reynolds Equation, Bearing Parameters predicted from Reynolds Equation. Pad bearings: Infinite Liner Pad Bearings, Infinite Raylegih Step Bearing, Finite Pad Bearings,Pivoted Pad bearings. Converging Diverging Wedges: Bearing Geometry, Pressure Distribution, Load Capacity. Journal Bearings: Evaluation of Main

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ME 7.4.5 MANAGEMENT INFORMATION SYSTEMS

	L T P
Lectures per week:	3+1+2
Max. marks for theory paper	100
Max marks for sessionals	25
Max marks for orals	25
Total No. of questions from each module	2
Total No. of questions to be answered	5 (At least one question from each Module.)

This course is aimed at providing an understanding of the concepts of management information system, Decision Making, Information, Databases, Database Management Systems and tools and methodologies for structural analysis and design of information systems and other related concepts. The students are expected to acquire competence in design of MIS in various functional areas of Management through case discussions and Project Assignments.

MODULE I **(12+4)**

Introduction of Information Systems, Distinction between Data & Information, Growth of Hardware. Classification of hardware and software. Basics of networking topology. Basics and discussion of internet, internet and extranet. Discussion of the domain name classification systems in Internet.
Different storage media, Different file storages, different file organizations – sequential, hashed, indexed, file organizations to support multi-attribute search. Different database structures-hierarchical, network, relational and object oriented.

MODULE II **(12+4)**

Concepts of decision making – Simons model of decision making, decision making under certainty, risk and uncertainty, Maxinin and minimax criteria, payoff matrices, decision trees, utiles, ranking, weighing and elimination of aspects.
Concepts of System-classification, Coupling and decoupling, Negative entropy, handling of system stress.
Concepts of Data & information-Value of Information, Value of perfect information, Data Independence – Physical and logical. Data dictionary.

MODULE III **(12+4)**

Logocal & Physical modeling of Data. Data Flow Diagrams – context diagrams and leveling
Tools for analysis and modeling of process – Flow charts, structured English, pseudocode, Decision Tables, LEDT & EEDT, Karnaugh Maps.
Concepts of databases, Graphical tools in logical modeling – Entity Relationship Diagrams (ER diagrams)
Introduction to Gnu/Linux O.S., Comparison free and open source software with proprietary software.
Relational Database Management Systems (RDBMS)); Data Defination, Data Manipulation and Query – Structured Query Language (SQL). Relating between tables. Comparison of popular RDBMS packages.

MODULE IV **(12+4)**

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M.E. 7.4.6 6- Sigma Management

	L T P
Lectures/Tutorials/Practical per week:	**3+1+2**
Max marks for theory paper:	**100**
Max. marks for sessionals	**25**
Max. marks for orals:	**25**
Total no. of questions from each module:	**2**
Total no of question to be answered:	**5 (At 1east one question from each module.)**

Course Objectives:
The primary objectives of this course is exposing students to the fundamentals of Six Sigma methodology, tools and techniques, and building in confidence and capability amongst students in mapping the organizational activities and problems in terms of Six Sigma framework,

Instructional Objectives:
The course will address the following main issues:
i) Introduction of Six-sigma
ii) Tools used in Six-sigma.
iii) QFD, FMEA, DOE and Taguchi Methods
iv) DMAIC and DFSS process

MODULE I

(12+4)

Overview of Six Sigma Management
Successful applications of Six Sigma Management, Timeline for Six Sigma Management, Benefits of Six Sigma Management, Voice of the Process, Voice of the Customer, Definitions(Non-technical and Technical) of Six Sigma.
Six Sigma Roles, Responsibilities: Champion, Master Black Belt, Black Belt, Green Belt, Process Owner. Terminologies in Six Sigma Management.

Tools used in Six Sigma
Frequency distribution and Histogram, Run charts, Stem-and-leaf plots, Pareto diagrams, Cause and Effect Diagrams, Box Plots, Normal probability plots.
Measures of Central Tendency, Measures of Variation.

MODULE II

(12+4)

Techniques used in Six Sigma: (At least two case studies each to understand concepts)
Quality Function Deployment (QFD) Failure Mode and Effects Analysis (FMEA).

MODULE III

(12+4)

Techniques used in Six Sigma: (At least two case studies each to understand concepts)
Design of Experiments (DOE): Factorial designs: Introduction, Two-Factor factorial design, ANOVA. 2^k Factorial Design: 2^2 and 2^3 designs only, ANOVA.
Taguchi Method:
Taguchi philosophy, Loss functions, Signal-to-Noise ratio, experimental design in Taguchi Method, Parameter design.

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ME 7. 4. 7 ANALYSIS & SYNTHESIS OF MECHANISMS

	L T P
Lectures/Tutorials/Practical per week:	3+1+2
Max marks for theory paper:	100
Max. marks for sessionals	25
Max. marks for orals:	25
Total no. of questions from each module:	2
Total no of question to be answered:	5 (At 1east one question from each module.)

MODULE I

(12+4)

1.1 Review of the Basics of Kinematics.

1.2 Kinematic Analysis of Plane Mechanisms: Displacement, Velocity and acceleration analysis of simple and complex mechanisms by analytical and graphical methods.

MODULE II

(12+4)

Curvature theory: Fixed and moving centrodes, envelops – velocity and acceleration inflection points and inflection circle. Euler – Savary equation, Bobillier's theorem, Hartmans's construction, return circle, cusp points, cubic of stationary curvature, Ball's point, Application in dwell mechanisms.

MODULE III

(12+4)

Kinematic synthesis of plane mechanisms: Type, number and dimensional synthesis, branch and order defects, Function generation and path generation, rigid body guidance. Chebychev spacing, three, four and five position synthesis, Burmerster point theory, synthesis by analytical methods.

MODULE IV

(12+4)

4.1 Computer – aided kinematic analysis of planar mechanisms.

4.2 Spatial Mechanisms: Position, velocity and acceleration analysis of RGGR mechanisms, Eulerian angles theorm on angular velocities and acceleration, DH parameters, DH matrix method, application of spatial mechanisms in robotics, Kinematic analysis of industrial robots.

Books Recommended:

1) Theory of Machines and Mechanisms, Shigley & Uicker.
2) Mechanism Design-Analysis and synthesis, Erdman And Sendor.
3) Theory of Mechanisms and Machines, Ghosh & Malik
4) Kinematic & linkage Design, Hall
5) Kinematic synthesis of Linkages, Hartenberg & Denavit.
6) Machines & Mechanisms, Myszka.
7) Computer – Aided Analysis of Mechanical systems, Nikravesh

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MODULE III

6. Game playing with min-max search, adding alpha beta cut offs. (04)
7. Planning an example domain, the blocks world, components of a planning system, goal stack planning, non linear planning, hierarchical planning (04)
8. Natural language processing: Introduction, syntactic, semantic, discourse and pragmatic processing. (04)

MODULE IV

9. Learning: Definition, rote learning, learning by taking advice, learning in problem solving, learning from examples. (04)
10. Expert system: definition, components, expert system shell, application, knowledge acquisition. (04)

8. Introduction to Artificial Neural Networks: History and development of ANN, ANN topology. Basic learning laws, supervised and unsupervised learning, stability and convergence, perceptron learning, three layered perceptron, back propagation learning. (08)

Text Books

1. Luger, Artificial Intelligence
2. Rich & Knight, "Artificial Intelligence".

Reference Books

1. Russell, Norving, Artificial Intelligence, A Modern Approach, Pearson Education..
2. Char nick "Introduction to Artificial Intelligence", Addision Wesley.
3. Marcellous, "Expert Systems Programming", PHI.
4. Elamie, "artificial Intelligence", Academic Press.
   Yegnarayana, Artificial Neural Networks

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Silicon carbide fibers, Quartz and silica fibers, Multiphase fibers, Whiskers, Flakes etc., Mechanical properties of fibers.
Metal matrix, Ceramic matrix, Carbon Matrix, Glass Matrix etc.
Interfaces: Wettability, Interactions at the interface, types of bonding at the interface, tests for measuring the interfacial strength.

Module III **(12+4)**

5. Processing of Composite Materials
   Processing of MMC: Solid state, Liquid state, deposition and Instu methods
   Processing of CMC: Conventional mixing and pressing. Techniques involving slurries, Liquid state, sol-gel, vapour deposition Lanxide and Insitu Techniques
   Processing of PMC: Hand lay-up and spray-up, filament winding, pultrusion, resin transfer moulding, SMC and compression moulding.

6. **Applications of composites:** Functional requirements and applications of composites in automotive, aerospace, sports and other engineering fields

Module IV **(12+4)**

7. **Smart materials:** Overview of Smart Materials and Structures, Physical Properties, Piezoelectric Materials, Electrostrictive Materials, Magnetostrictive Materials Magnetoelectric Materials, Magnetorheological fluids, Electrorheological Fluids and Shape Memory Materials.
8. **Nanomaterials:** Overview of nanoscience, Theory, definition and history – Properties at nanoscale, Societal implications of nanoscience – nanotoxicology Materials, structure, nanosurface, Energy at nanoscale, OD, ID,2D and 3D nanomaterials, Carbon based nanomaterials.
   Synthes of Nanomaterials : "Top-down" approach, "Bottom up" approach, Structure and properties; Characterization of nanomaterials: Diffraction techniques, spectroscopy and modeling, Imaging techniques.

Text Books

1) A text book of Polymers – M.S. Bhatnagar-S.Chand & Co., New Delhi
2) Fundamentals of Ceramics – Michel Darsoum, McGraw Hill, NY
3) Composite Materials – F.L.Mathews and R.D. Rawlings, CRC Press, Woodhead Publishing LTD
4) Composite Materials- F.L. Mathews and R.D. Rawlings, CRC Press, Woodhead Publishing LTD
5) Nano Materials- A.K. Bandyopadhyay, New Age Publishers.

References

1. Principles of Polymer Processing – Zehev Tadmor & Costas G. Gogov, Wiley International
2. Handbook of Ceramics, Glasses and Diamonds- Charles a. Harper, McGraw Hill
3. Introduction to Nanotechnology – Charles P. Poole Jr. and Franks. J. Qwens
4. Springer Handbook of Nanotechnology-Bharat Bhusan

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FUSION DEPOSITION MODELLING: Principle, Process parameter, Path generation. Applications.

SOLID GROUND CURING: Principle of operation, Machine details, Applications.

LAMINATED OBJECT MANUFACTURING: Principle of operation, LOM materials. Process details, application.

MODULE 3

(12 hours)

CONCEPTS MODELERS: Principle, Thermal jet printer, Sander's model maker, JP systems5, Object Quadra systems.

RAPID TOOLING: Silicone rubber tooling, Aluminium filled epoxy tooling, 3D Keltool process, Direct AIM, Copper polyamide, DTM rapid tool process.

RAPID MANUFACTURING PROCESS OPTIMIZATION: Factors influencing accuracy, Data preparation errors, Part building errors, Error in finishing, Influence of build orientation.

MODULE 4

(11 hours)

DESIGN MODELLING FOR RP: The STL File. The SLC Format, Model Slicing, Choosing a System

SOFTWARE FOR RP: Overview of Solid view, magics, imics, magic communicator, etc. Internet based software, Collaboration tools.

REVERSE ENGINEERING: 3D scanning, 3D digitizing and Data fitting, Surface generation from point cloud, Surface modification-data transfer to solid models, Overview of digitizing software's, Case studies.

Text Books

1. Stereo Lithography and other RP & M Technologies, Paul F. Jacobs: SME, NY 1996.
2. Rapid Manufacturing, Flham D.T & Dinjoy S. S, Springer- Verlog London 2001.
3. Computer Aided Manufacturing, Tien Chien Chang, Richard A. Wysk, Hsu Pin Wang, Pearson Education 2011

References Books

1. Rapid Prototyping, Terry Wohler's Report 2000" Wohlers Association 2000.
2. Rapid Prototyping Materials, Gurumurthi, Hsc Banglore
3. Rapid Automated, Lament wood. Indus press New York.

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Shell and tube heat exchanger- Tinkers, Kern's and Bell Delaware's method, design methodology, Methodology for thermal design of heat exchanges; rating and sizing problems, Pressure drop calculations.

MODULE III **(12+4)**

Design of Condenser

Estimation of heat transfer coefficient, Fouling factor, Friction factor, Design procedures, Wilson plots, Designing, different types of condensers BIS standers, Optimisation studies.

Design of Evaporator

Different types of evaporators, Design procedure, Selection procedure, Thermal stress calculations, matching of components, Design of evaporative condensers.

MODULE IV **(12+4)**

Design of Cooling Tower

Types of cooling towers, Analytical and graphical design procedures, Tower characteristics, Parametric analysis, Packaging, Water treatment, Selection of pumps and fans, Energy conservation.

Waste heat recovery systems, applications & techno economics

Recuperators – Regenerators – economizers – Plate Heat Exchangers – Waste Heat Boilers – classification, Location, Service conditions, Design Considerations, Unfired combined cycle – supplementary fired combined cycle – fired combined cycle applications in Industries – fluidized bed heat exchangers – heat pipe exchangers – heat pumps – thermic fluid heaters selection of waste heat recovery technologies – financial considerations – operations and investment costs of waste heat recovery.

Text Books

1. A. P. Frass and M. N. Ozisik, "Heat Exchanger Design", McGraw Hill, 1984.
2. D.C.Kern, "Process Heat Transfer", McGraw Hill 1950
3. Ozisik M.N., Heat transfer, McGraw-Hill,1988

References Books

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Final Drive: Differentials, rear axles, propeller shafts, couplings. **(2+1)**

Suspension: Various suspension systems, Independent front and rear suspension, shock absorbers, pitching, bouncing and rolling. **(2+1)**

Vehicle performance: Resistance to the motion og vehicles-air rolling, gradient resistances power requirement for acceleration and grade ability, selection of suitable rear axle & gear ratio. **(6+2)**

Electrical system: Lead Acid Battery, Types of ignition system, Engine starting system, Automobile Air conditioning. **(2+1)**

MODULE –IV

Automobile safety: Preventive safety design and design consideration of an automobile to minimize injury in case of accidents. **(2+1)**

Automobile Pollution control: Emission standards, Pollutants emitted by automobile and methods to control pollution. **(2+1)**

Recent advances in automobiles: Variable valve timing, Electronic fuel injection, Adaptive suspension system, Active roll control system, hybrid vehicles, Fuel cells, heavy haulage vehicles. **(3+1)**

Basic features two wheelers and three wheelers
Transmission system, Suspension system, Brake system. **(2+1)**

TEXT BOOKS

1. Heitner, Automotive Mechanics
2. Kirpal singh, Vol I&II ,Automobile Engineering.

REFERENCE BOOKS

1. Newton Steads, Motor Vehicle.
2. Crouse, Automotive Mechanics.
3. Automotive Mechanics ED May Vol II

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comb-drive and micromotor, Magnetic micro relay, Shap-memory-alloy based actuator, *Electro-thermal actuator System:* Micro gas turbine, Portable clinical analyzer, Active noise control in a helicopter cabin Introduction to RF-MEMS, BIO-MEMS, high temperature MEMS and optical MEMS (Basic concept only) **(11 hours)**

Surface-acoustic-wave based wireless strain sensor, actuators: silicon micro mirror arrays, Piezo-electric based inkjet print-head, Electrostatic comb-drive and micromotor, Magnetic micro relay, shape-memory-alloy based actuator, Electro-thermal actuator Systems: Micro gas turbine, Portable clinical analyzer, Active noise control in a helicopter cabin
Introduction to RF-MEMS, BIO-MEMS, high temperature MEMS and optical MEMS (Basic concepts only) (11 hours)

MODULE-3

Modeling: Scaling issues, Elastic deformation and stress analysis of beams and plates, Residential stresses and stress gradients, Thermal loading, Heat transfer issues, Basic fluid issues Electrostatics. Coupled electromechanics. Electromagnatic actuation. Capillary electro-phoresis. Pieszoresistive modeling. Piezoelectric modeling. Megntostrictive actuators.
Microsystem Design:Thermomechnical stress analysis, Dynamic analysis, Design of a Silicon die for micropressure sensor, design of microfluidic network system: Fluid resistance in microchannels **(12 Hours)**

MODULE-4

Integration and Packaging of Micro electro Mechanical Systems: Integration of microelectronics and micro devices at wafer and chip levels. Microelectronic packaging: wire and ball bounding, flip-chip, Low-temperature-cofired-ceramic(LTCC) multi-chip-module technology,Microsystem packaging examples.
Case Studies: BEL pressure sensor, thermal cycler for DNA amplification, and active vibration control of a beam. **(10 Hours)**

TEXT BOOKs:

1. MEMS & Microsystems: Design and Manufacture, Tai-Ran Tsu, Tata Mc- Graw-Hill
2. MEMS- Nitaigour Premchand Mahalik, TMH 2007
3. MEMS and MOEMS Technology & Applications, P. Rai Choudary, PHI learning Pvt Ltd, New Delhi, 2009.

REFERENCE BOOKS

1. Microsystem Design, S.D. Senturia, 2001, Kluwer Academic Publishers, Boston. USA.ISBN 0-7923-7246-8.
2. Analysis and Design Principles of MEMS Devices, Minhang Bao, Elsevier, Amsterdam, the Netherlands, ISBN 0-444-51616-6.
3. Design and Development Methodologies, Smart Material System and MEMS: V Varadan, K.J. Vinoy, S. Gopalkrishnan, Wiley.
4. Fundamentals of mocro fabrication, the science of miniaturization – Max J. Madou, Nanogen corporation, USA, CRC press, March 2002.

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M.E. 7.5.6 APPLIED OPERATIONS RESEARCH

	L	T	P
Lectures per week	: (3	1	2)
Max. marks for theory paper	: 100		
Max. marks for session	: 25		
Max. marks for oral	: 25		
Duration of paper	: 3 hours		
Total no. of modules	: 4		
Total no. Of question from each module	: 2		
Total no. Of questions to be answered	: 5(At least on question from each module with two compulsory question from any one module)		

COURSE OVERVIEW: - This course provides a comprehensive insight into various quantitative models available in Operations Research.The focus of the course in on LP models ,Transportation Model, Assignment model and IP model. In addition ,the course also discusses Decision Theory,Game Theory, DP models,Network Model and Queuing Theory.Simulation is also discussed with in troduction to GPSS.

INSTRUCTIONAL OBJECTIVES: - This course will enable the students to understand the difference between various prescriptive as well as descriptive models, their limitations. The students would learn the solution methodology of each model. The course would introduce GPSS to model simple real life situations with queuing background.

MODULE I

Operations Research:Origin and development,Feature or OR, Methodology of OR,
Linear Programming Model:Formulation of real life situations, Solutions methodology: Graphical method,simplex method.Special cases:- Unbounded, In-feasible, Alternate and Degenerate solution
Two phase method,Duality Theory,Dual simplex method,Post Optimal Analysis

MODULE II

Transportation Model:Formulation, Transportation algorithm Developing initial BFS using North West corner Rule,Leat cost cell method,VAM,.Testing the solution and improving using stepping Stone method and MODI method.Resolving unbalance, degeneracy,Transshipment

MODULE III

Assignment Model: Formulation,Hungarian Algorithm,Tackling Unbalance

Integer Programming: Classification,Introduction to Branch and Bound method, Gomory's Cutting Plane Algorithm for pur and mixed IP.

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M.E. 7.5.6 APPLIED OPERATIONS RESEARCH

	L	T	P
Lectures per week	: (3	1	2)
Max. marks for theory paper	: 100		
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Operations Research:Origin and development,Feature or OR, Methodology of OR,
Linear Programming Model:Formulation of real life situations, Solutions methodology: Graphical method,simplex method.Special cases:- Unbounded, In-feasible, Alternate and Degenerate solution
Two phase method,Duality Theory,Dual simplex method,Post Optimal Analysis

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GOA UNIVERSITY

FINAL AND/ FOURTH YEAR OF BACHELORS DEGREE COURSE IN ENGINEERING
(Revised in 2007-08)
SCHEME OF INSTRUCTION AND EXAMINATION

SEMESTER VIII

Sub Code	Subject	Scheme of instruction (hours/week)			Scheme of examination					
		L	T	P	Th Dur (hrs)	Marks Th	S	P	O	Total
8.1	Reliability based Design	3	1	-	3	100	25	-	50	175
8.2	Power Plant Enginerring	3	1	-	3	100	25	-	50	175
8.3	Elective III	3	1	2*	3	100	25	-	50	175
8.4	Elective IV	3	1	2*	3	100	25	-	50	175
8.5	Project	-	-	8	-	-	50	-	100**	150
Total		**15**	**04**	**12***	**-**	**400**	**150**		**300**	**850**

L: Lecture, T: Tutorial, P: Practical
Th.Dur: Duration of theory paper
Th: Theory, S: Sessional, P: Practical, O:Oral

*Practical slots for Electives subjects are to be decided based on nature of subjects offered and explicitly specified in the Elective list.
A journal containing assignments such as design exercises/or experiments conducted and results obtained to be submitted for assessment during oral examination.

** Seminar, demonstration & Oral

Elective 4- major groups (thermal, design, manufacturing and industrial) and I-non departmental like computer, IT and management.

BE(M)-Semester VIII

Elective III	
Code	Title
8.3.1	Finite element methods
8.3.2.	Industrial Robotics
8.3.3	Computational Fluid Mechanics
8.3.4	Maintenance Engineering and Management
8.3.5	System simulation
8.3.6	Control System Engineering
8.3.7	Energy management

BE(M)-Semester VIII

Elective IV	
Code	Title
8.4.1	Precision engineering
8.4.2.	Advanced metal forming
8.4.3	Supply chain management
8.4.4	Low cost automation
8.4.5	Fluid power control
8.4.6	Nano Technology

ME 8.1: RELIABILITY BASED DESIGN

	L +T+P
Lectures/Tutorials/Practical's per week	: 3+1+0
Question Paper Duration	: 3 Hrs
Max marks for theory paper	: 100
Max. marks for sessionals	: 25
Max. marks for orals	: 50
Total no. of questions from each module	: 2
Total no of questions to be answered	: 5 (At 1east one question from each module.)

Course Objectives:

Students will be able to understand the importance of reliability and quality in the design and manufacture of engineering products, components and systems. Probabilistic design methodology which deals with real-life cases is also dealt in this course. Optimization and its application to reliability in design, is explained with different types of methods of optimization.

Instructional Objectives:

The course begins with introduction to reliability and various failures density functions. Different optimization methods are covered with emphasis on solving numericals and understanding concepts behind each method. The course concludes with probabilistic design methodology.

MODULE 1 (12+4)

Need for Reliability based design, definition of reliability and its various measure, analysis of standard failure density function like Exponential Normal. Log Normal Gamma and Weibull distribution. Various methods to improve reliability, Redundancy, calculation of system reliability for series, parallel and Complex s Allocation and Optimization of system reliability., Formulation of reliability Optimization problem as NLP

MODULE 2 (12+4)

NON LINEAR OPTIMIZATION: Optimization in design, need. Concept of adequate. Optimum and Robust design. Formulation of design problem. Classification of design problems, Classification of Optimization in methods, Condition of optimality, Classical techniques, Single variable optimization techniques. Unrestricted search, Dichotomous search, Interval halving method, Golden Section method. Fibonacci search method, Bisection method, Secant method, Newton Ralph a method.

MODULE 3

(12+4)

Multi-variables optimization techniques without constraints: Random search method, Univariate method, Patten search method, Powell's Conjugate Gradient method. Simplex method for NLP.

Multi-variables optimization techniques with constraints; KTC conditions,

Variable elimination method, Lagrange's method, Cutting Plane method.

Introduction to Unconventional optimization techniques like Genetic Algorithm, Simulated Annealing, Tabu Search.

MODULE 4

(12+4)

Probabilistic design methodology: Interference theory, calculation of reliability of with stress and strength having exponential, normal, lognormal, gamma and weibull distribution.

Design of mechanical components.

Concepts of maintainability, Availibility, serviceability.

TEXT BOOKS

1. Kalyanmoi Deb: Optimisation for engineering Design Prentice Hall India.

2. Ashok Belegundi, T Chandrauptala: Optimisation concepts and applications in engineering, Pearson Education.

3. Rao S. S., Reliability Based Design, McGraw Hill

REFERENCES:

1. Rao S.S.: Optimisation theory and applications. Wiley Eastern Ltd.

2. Kapur K.C: Reliability in Engineering design.

3. Arora J. S. Introduction to optimum Design, Elsevier academic Press

ME 8.2: POWER PLANT ENGINEERING

	L +T+P
Lectures/Tutorials/Practical's per week	: 3+1+0
Question Paper Duration	: 3 Hrs
Max marks for theory paper	: 100
Max. marks for sessionals	: 25
Max. marks for orals	: 50
Total no. of questions from each module	: 2
Total no of questions to be answered	: 5 (At 1east one question from each module.)

Couse Objectives

To provide and deliver the highest quality course in Power Plant Engineering with the highest standards and continuously encouraging and inspiring students to strive for excellence and perfection in all their endeavors.

Instructional Objectives

1. To understand the Principles of Operations and Applications of Thermal Power Plants. (Steam Turbines, Gas Turbines and Combined Cycle Plants).
2. To understand the factors which affect the performance characteristics of Thermal Power Plants and their components.
3. To understand working principle and technologies used in Non-conventional Power generation and Direct Energy Conversion.
4. To understand economics of power generation.

MODULE I

1.1 Introduction (12+4)

Power Plants: Factors affecting Selection of site, Principal types of the power plants and combustion of fuel, Schematic Diagrams and relative merits of Steam ,Gas Diesel ,Hydro Power Plants, Present status of Power generation in India.

1.2 Economics Power Generation

Load curves, load duration curves, Connected load , maximum load , peak load, base load, and peak load power plants. load factor, plant capacity factor, plant use factor, demand factor, diversity factor. Performance at variable load of power plants, heat rate and incremental heat rate curves, load sharing among generators and prime movers, load shading between power stations, cost analysis, unit energy cost. Cost analysis, selection of type of generation, economics in plant selection and Economic load shearing.

MODULE II

(12+4)

Improved Rankine Cycles

Rankine cycle, Rankine Cycle with Reheating and Regeneration. Binary Vapour Cycle, Steam Power Plants with Process Heating, cogeneration, Numerical.

Thermal Power Plants

Introduction to thermal power plants, detailed layout, Fuel for thermal power plants, selection of thermal power plants, Handling , storage preparation & feeding, burning of fuels, Ash handling & dust collection, Draught system, Principle of Fluidized bed combustion.

MODULE III

(12+4)

Nuclear Power Plants.

Classification, Site Selection, Types of Various Reactors with working of various Components. Nuclear Power plants In India. Pressurized water reactor, Boiling water reactor, Gas cooled reactor, Heavy water reactor, Nuclear Waste Disposal.

Gas Turbine Power Plants

General Aspects, Gas turbine fuels, Modified gas turbine cycles for power generation, Effect of operating variables on Thermal Efficiency, Combined cycle power plant: Gas turbine and steam and Gas turbine diesel power plant, various arrangements of Gas turbine power plants, Numericals.

MODULE IV

(12+4)

Non-conventional Power generation and Direct Energy Conversion

Introduction, Wind power plants, wind electricity economics, Tidal power plants, Solar Power plants, Geothermal power plants, Biogas plants, Thermoelectric conversion systems, Thermionic conversion system, Photovoltaic power system, Magneto hydrodynamics (MHD), Fuel cells, Nuclear batteries.

Pollution and Its control

Introduction, Pollution from Thermal Power Plant, Gaseous emission and its control, particulate emission and its control, solid waste disposal, thermal pollution, pollution from nuclear power plants, pollution from hydro-electric power plants and solar power generating stations.

Text Books

1. Nag P.K.: Power Plant Engineering, TMH
2. Domkiundwar V.S.: Power Plant Engineering. Dhanpat Rai & Sons
3. Rao G.D.: Non Conventional Energy Sources. Dhanpat Rai & Sons.

Reference Books

1. Sukhatme S.P. Solar Energy, TMH
2. Leon Freris, David Infield, Renewable Energy in Power Systems. John Wiley
3. Power station Engineering and Economy by Bernhardt G.A. skrotzki and William A. Vopat – Tata Mc Graw Hill Publishing Campany Ltd., New Delhi
4. Power Plant Engg. : M.M. El-Wakil McGraw Hill 1985.

ME 8. 3.1: FINITE ELEMENT METHODS

	L +T+P
Lectures/Tutorials/Practical's per week	: 3+1+0
Question Paper Duration	: 3 Hrs
Max marks for theory paper	: 100
Max. marks for sessionals	: 25
Max. marks for orals	: 50
Total no. of questions from each module	: 2
Total no of questions to be answered	: 5 (At 1east one question from each module.)

Module I (12+4)

Introduction: Brief history of the development of the subject of FEM. Overview of the method, range of applications.

Basic Equations from linear theory of elasticity: Stress and strain tensors and their properties, Generalised Hooke"s law, Elastic constants for isotropic materials, Equilibrium equations, Compatibility equations, Caushy's equations, Plane stress and plane strain problems, A problem of theory of elasticity, Bi-harmonic equation. Airy's stress function.

Energy Method to solve problems in Mechanics of solids: Strain Energy at a point under the given state of stress, Maxwell-Betti's reciprocal theorem Castigliano's theorems. Virtual work principle, Rayleigh-Ritz method. Applications

Module II (12+4)

Basic Equations from Fluid Mechanics

Basic Equations from Heat Transfer

Variational Calculus: Introduction, Functional and it's minima

Analysis of Truss by matrix methods,

Module III (12+4)

Mathematical Approach: Variational approach, FEM and Ritz method element equations from Variational Principle, Finding variational principles for the problem, Methods of Weighted resaidue, Gelarkin, Collocation techniques, least square methods to solve the differential equations.

Elements and interpolation functions stiffness matrix and the equilibrium equations: Formulation based on generalized co-ordinates. Convergence requirements. Natural Co-ordinates, Numerical integration. Newton-Cotes and Gauss Legendre quadrature.

Assembly of global stiffness matrix and inserting boundry conditions and solution of linear system of equation: Gauss elimination. Gauss-Siedel. Cholesky's decomposition. Crout's factorization to solve the liner system of equation, Nature of the stiffness matrix

Module IV **(12+4)**

Application of FEM to Problems: Structural dynamics. General field problems such as torsioa, heat condition. Irritation, irrotational flow.

Subject project(To be presented at the time of oral exam): Formulation and development of FEM code to solve problem from the topics such as stress analysis Dynamics, Heat transfer etc.. Exposure to FEM software such as ANSYS.

Text Books:

1) Reddy J.N. an Introduction to the Finite Element Method MeGraw-Hill Book Company.
2) Belegundu and Chandraupatla, Introduction to Finite Elements in Engineering. Second Edition. Prentice hall of India Pvt. Ltd. New-Delhi
3) Desai and Abel FEM

References:

1) Batha K. J. Finite Element Procedures. Prntice-Hall of India, Pvt Ltd, New Delhi
2) Finite element analysis, Krishnamoorthy

ME 8.3.2: INDUSTRIAL ROBOTICS

	L +T+P
Lectures/Tutorials/Practical's per week	: 3+1+2
Question Paper Duration	: 3 Hrs
Max marks for theory paper	: 100
Max. marks for sessionals	: 25
Max. marks for orals	: 50
Total no. of questions from each module	: 2
Total no of questions to be answered	: 5 (At 1east one question from each module.)

Course Objectives

- To understand the structure ,classification & performance characteristics of a robot
- To study control systems and sensors used in robotics
- To introduce students to the forward & inverse kinematics of robots
- To provide a glimpse of robot dynamics
- To throw light on programming in robotics
- To learn the concepts in mobile robots & machine vision

Instructional Objectives

- The student should be able to apply the concepts learnt in design of robots.
- The study of programming languages should help the student to program robots for specific tasks and path.
- The concepts learnt should help the student to develop algorithms for robot motion and for frame transformations

MODULE I

Basic Concepts in (Fundamentals of) robotics: Automation and robotics, robot anatomy, Basic structure of robots, D O F. & degree of motion, joints & symbols, Work volume & envelope, Robot motions, resolution, accuracy and repeatability.

Classification and structure of robotic systems: Point to point and continuous path systems, Grippers, Design of grippers.

Drives and Control systems: Hydraulic and pneumatic systems, Control loop of robotic systems, Control approaches utilizing current and voltage amplifiers, Robot joint control design

MODULE II

Robot arm kinematics: The direct kinematics problem, Denavit Hartenberg convention and its applications, Generation of motion commands, Trajectory planning, the inverse kinematics solution for 2 axis planar mechanisms, 3 axis spherical, and 6 axis manipulators.

Introduction to robot dynamics: Stiffness control of robot end effector, Dynamic equations for robots.

MODULE III

Sensors in Robotics: Touch sensors, Force and torque sensors, Acoustic sensors, Slip sensors, Proximity & Range sensors

Robot Programming: Lead through programming methods, Robot program as a path in space, Motion interpolation, WAIT, SIGNAL and DELAY commands., Branching, Programming the maker robot- The teach pendant, Moving the robot, Teaching Points, Teaching programs.

Robot Language : Robot language structure, constants, variables & other data objects, Motion commands, End effectors and sensor commands, Computations & operations, Program control and subroutines, Communications & data processing, Monitor mode commands, VAL II.

MODULE IV

Machine Vision: Introduction, Sensing & digitizing function, Imaging devices, Lighting techniques, Image storage, Image processing and analysis , Image data reduction, segmentation, Feature extraction, Object recognition, Training the vision system , Robotic applications

Mobile robots: Introduction, Key issues for locomotion, Legged mobile robots, Leg configuration and stability, Types, Wheeled mobile robots, Wheel design, , Path planning – configuration space, Road map path planning, Cell decomposition path planning, Obstacle avoidance- bug algorithm, Vector field histogram

Text Books

1. Yoram Korean: Robotics for engineers, McGrew Hill Co.
2. M.P.Groover, M.Weiss, R.N.Nagel, N.G.Odrey Industrial Robotics Technology, programming and Applications.
3. K.S.Fu, R.C.Gonzalex, C.S.G.Lee: Robotics Control Sensing, Vision and Intelligence, McGraw Hill Book co.

References

1. Hartenberg and Denavit: Kinematics and Synthesis of linkages, McGraw Hill Book Co.
2. Roland Siegwart & Illah R. Nourbakhsh: Introduction to Autonomous Mobile Robots, Prentice hall of India.
3. Sabrie Solomon: Sensors & control systems in manufacturing, McGraw Hill Professional Publishing.
4. John J. Craig: Introduction to Robotics, Mechanics & Control, Pearson Education Inc.
5. Mittal: Robotics, John Wiley

ME 8.3.3: COMPUTATIONAL FLUID MECHANICS

	L +T+P
Lectures/Tutorials/Practical's per week	: 3+1+2
Question Paper Duration	: 3 Hrs
Max marks for theory paper	: 100
Max. marks for sessionals	: 25
Max. marks for orals	: 50
Total no. of questions from each module	: 2
Total no of questions to be answered	: 5 (At 1east one question from each module.)

MODULE I (12+4)

Introduction: Philosophy of CFD, CFD as research tool. CFD as a design tool, Impact of CFD

The Governing Equations of Fluid Dynamics: Models of flow, Substantial Derivative. Divergence of the velocity, Continuity equation, Momentum equation, Energy equation, Physical boundary conditions.

MODULE II (12+4)

Mathematical behavior of partially differential equations: Quasi liner differential equations, Eigen Value Method, General behavior of different classes of partial differential equations.

Basic Aspects of Discretization: Introduction to finite differences. Explicit and Implicit approaches, Errors and analysis of stability.

MODULE III (12+4)

Grids with appropriate transformation: General transformation of equations, Matrices and Jacobians, From of governing equations, Compressed grids, Boundry fitted co-ordinate systems, adaptive grids, modern developments in grid generation and In finite volume mesh.

MODULE IV (12+4)

Computational Fluid Dynamic techniques: Comments on Viseous flows. Conservation from and space marching. Relaxation techniques and its use with low speed inviseid flow, Aspects of numerical dissipation and dispersion. Alternating direction Implicit Pressure correction technique. Computer graphic techniques used in CFD.

TEXT BOOK

1. JOHN D. ANDERSON: Computational fluid dynamics, McGraw Hill International Edition.

ME8.3.4: MAINTENANCE ENGINEERING & MANAGEMENT

	L +T+P
Lectures/Tutorials/Practical's per week	: 3+1+2
Question Paper Duration	: 3 Hrs
Max marks for theory paper	: 100
Max. marks for sessionals	: 25
Max. marks for orals	: 50
Total no. of questions from each module	: 2
Total no of questions to be answered	: 5 (At 1east one question from each module.)

MODULE I

(12+4)

Necessity of Maintenance Management, Objectives, Importance & Functions of Maintenance, Types of Maintenance, Condition Based Maintenance. Economic Aspects of in Maintenance, Organization of Maintenance Department, Categories of Maintenance Selective control, Evaluation of Maintenance Performance, TPM, Management Techniques used in Plant Maintenance, Inspection & Lubrication, Computers in Maintenance, Maintenance budget. New trends in Maintenance.

MODULE II

(12+4)

Fundamentals of Reliability, Failure Distribution, Reliability Measures. Constant Failure Rate Model (Exponential), Time Dependent Failure Models (Normal, Lognormal, Weibull), Reliability of Systems (Series, Parallel, Complex), Stand-by Systems.

MODULE III

(12+4)

State dependent systems, Reliability allocation, Fault tree analysis in Maintainability, Analysis of Downtime, Repair Time Distribution, Reliability under Preventive Maintenance, State Dependent system with Repair, Standby system with Repair.

MODULE IV

(12+4)

Replacement Policies, Maintenance Requirements, Maintainability Design Methods, Maintainability Prediction & Demonstration, Maintainability Allocation.

Availability, it's Concepts & Definitions, Availability in odds, System Availability, Standby System Availability, Steady State Availability.

TEXT BOOK:

1. Charles E. Ebeling: "An Introduction to Reliability and Maintainability Engineering" Tata Mc Graw Hill Publication.
2. Anthony Kelly: "Maintenance Planning and Control" East West Press.

REFERENCE:

1. Srinath L.S. "Reliability Engineering" East West Press.

E 8. 3. 5: SYSTEM SIMULATION

	L +T+P
Lectures/Tutorials/Practical's per week	: 3+1+2
Question Paper Duration	: 3 Hrs
Max marks for theory paper	: 100
Max. marks for sessionals	: 25
Max. marks for orals	: 50
Total no. of questions from each module	: 2
Total no of questions to be answered	: 5 (At 1east one question from each module.)

MODULE I (12+4)

Defination, need modeling concepts. Types of system studies.
Random numbers:Need, Importance and desirable properties
Generation of random numbers with Bernoullis Trial, Binomial, Geometric, Pascal Exponential, Uniform, Normal, Erlang distribution.
Next event approach, Fixed time increment approach and process oriented approach for system simulation.

MODULE II (12+4)

Simulation of inventory system, queuing system, project network
Application of simulation for solving deterministic model like evaluation of definite integral, finding value of rot, area of circle.
Application of simulation in simple simulation of simple games.

MODULE III (12+4)

GPSS: Introduction to various block statements and control statements. GENERATE, ADVANCE, SEIZE, RELEASE, QUEUE,DEPART, ENTER, DEPART, TRANSFER, MARK, TABULATE, TERMINATE, SAVEVALUE, PRIORITY, ASSIGN, GATE, LOGIC, FUNCTION, START, RESET, JOB, SIMULATE
Various Standard Numeric attributes
Modeling of various systems using GPSS

MODULE IV (12+4)

Testing the random numbers for the various distributions.
Estimation of parameters
Analysis of simulation output determining the length of simulation, effect of initial bias, effect of auto-correlation, Variance Reduction techniques. Introduction to continuous simulation and CSMF

TEXT BOOKS

1. System Simulation, Geoffrey Gorden, Prentice Hall of India, New Delhi
2. Digital Computer Simulation, Fred J Maryanski, CBS Publishers & Distributors
3. Digital simulation by Narsingh Deo, PHI

ME 8. 3. 6: CONTROL SYSTEM ENGINEERING

	L +T+P
Lectures/Tutorials/Practical's per week	: 3+1+2
Question Paper Duration	: 3 Hrs
Max marks for theory paper	: 100
Max. marks for sessionals	: 25
Max. marks for orals	: 50
Total no. of questions from each module	: 2
Total no of questions to be answered	: 5 (At 1east one question from each module.)

MODULE I (12+4)

Feed back control systems. Historical development, System representation, modern control systems.

Representation of control components: Operational notations. Mechanical components, electrical components, series & Parallel law analogies, scale factors.

Thermal systems, fluid systems.

Representation of control systems: Linearisation of non liner functions, Linearisation of operating curves, hydraulic systems, pneumatic systems, DC motors, AC motors, Block-diagram algebra, speed control systems.

MODULE II (12+4)

Steady state operations: Steady state analysis, equilibrium, proportional control systems, integral control systems & their combination.

Laplace transforms: Classical methods, Laplace transform method, transforms properties, initial conditions, general procedures, convolution integral, error coefficients.

MODULE III (12+4)

Transient response: transformations. Complex conjugate zeros damping ratio & natural frequency. Computer solution transient response specification, general form of transient response to an external disturbance. Rouths stability criterion.

The Root – Locus Method: Significance of root loci. Construction of loci general procedure. Loci equations of parameters.

MODULE-IV (12+4)

System representation, signal flow graph. Solution of state spare equations transfer functions, multi variable system

Frequency response method: Logarithmic representation. Evaluation of gain. Polar plots. Correction between transient & frequency response.

Text Books :

1. Benjamic C Kuoi- Automatic Control Systems. PHI
2. Ogata Modern control Engineering PHI

Reference:

1. Raven F. H.- Automatic Control Systems. Engineering MGH

ME 8.3.7: ENERGY MANAGEMENT

L

	L+T+P
Lectures/Tutorials/Practical's per week	: 3+1+2
Question Paper Duration	: 3 Hrs
Max marks for theory paper	: 100
Max. marks for sessionals	: 25
Max. marks for orals	: 50
Total no. of questions from each module	: 2
Total no of questions to be answered	: 5 (At 1east one question from each module.)

Course Objectives:

This course will help students acquire the basic knowledge required to implement energy management. The course also includes tutorials to help students understand the concepts involved.

Instructional Objective:

1. To build a solid foundation in the fundamentals of Energy Management
2. To encourage a "hands-on" approach to solving Energy saving and efficiency problems
3. To provide up-to-date energy efficiency solutions to thermal and electrical utilities.

MODULE I

(12+4)

Introduction : energy and environment, need for renewable and energy efficiency, need and importance of energy conservation and management.

Energy consumption patterns and energy conservation opportunities in Indian industry, agriculture, commercial and residential sectors.

Energy Auditing - methodology, analysis and reporting. Portable and on-line instruments used for energy auditing.

MODULE II

(12+4)

Costing of utilities : Determination of cost of steam, compress air and electricity. Methods of financial analysis :

1) Simple payback period
2) Time value of money (future value, net present value)
3) Return on investment (ROI)
4) Internal rate of return (IRR)

Cogeneration: Definition, Need, Application, Advantages, Classification, Saving potentials

MODULE III

(12+4)

Energy conservation in refrigeration and air conditioning system, compressed air system. Energy conservation in steam generation and supply system. Boiler performance, Boiler efficiency

Waste Heat Recovery: Classification, Advantages and applications, Commercially viable waste heat recovery devices, Saving potential

MODULE IV

(12+4)

Insulation : Materials of insulations, form of insulations, desirable properties of insulations, economic thickness of insulation. Refractories.

Electrical systems : energy conservation in motors, energy efficient motors, power factor improvement, , variable speed drive.

Lighting : Illumination levels, fixtures, timers, energy-efficient illumination.

Text Books:

1) Energy Conservation - related booklets published by National Productivity Council (NPC), New Delhi
2) Petroleum Conservation Research Association (PCRA), New Delhi..

References:

1) IGC Dryden, editor : The Efficient use of Energy (Butterworths).
2) W.S. Turner, Editor : 2) Energy Management Handbook (Wiley).
3) Patrick Steven R., Patric Dale R., Fordo Stephen : Energy Conservation Guide Book, The Fairmont Press Inc.

ME 8.4.1: PRECISION ENGINEERING

	L +T+P
Lectures/Tutorials/Practical's per week	: 3+1+2
Question Paper Duration	: 3 Hrs
Max marks for theory paper	: 100
Max. marks for sessionals	: 25
Max. marks for orals	: 50
Total no. of questions from each module	: 2
Total no of questions to be answered	: 5 (At 1east one question from each module.)

MODULE I (12+4)

Design of precision machines and instruments: Basic in the design of precision machines and instruments, Mechanical design v/s Precision engineering design, Design process, Source of error in instruments, Error compensation, signal flow diagram and four quadrant diagram for instruments, precision design consideration in machine frames, Sliding and rolling element bearings.

MODULE II (12+4)

Precision manufacturing: revew of non conventional production techniques-spark erosion, electrochemical operation: ultrasonic and abrasive. Introduction to Micro & Nano machining, Precision manufacturing processes v/s Extrude honing: Magnetic abrasive machining; Water jet machining, electrochemical machining, Etching and joining technique for electrical components, Sensors and Controls in manufacturing.

MODULE III (12+4)

Precision Metrology; Analog and digital measuring techniques, Laser Interferometry, Application of machine vision in measurements, Coordinate measurement machines (CMM), Abbe's principle, Types of CMM. Components of CMM, Measurements on CMM.

MODULE IV (12+4)

Micro engineering; Introduction to micro electro mechanical systems MEMS), Micro system technology(MST), Design of microsystem, Micro sensors and micro actuators, piezo electric actuators, magneto strictive actuators shape memory alloys (SMA)

TEXTBOOKS

1. Alexander H. Slocum, Precision Machine Design. Prentice Hall, 1992
2. Raman R: Elements of Precision Engineering.

REFERENCE

1. Davidson A: Handbook on Precision Engineering

ME 8. 4. 2: ADVANCED METAL FORMING

	L +T+P
Lectures/Tutorials/Practical's per week	: 3+1+2
Question Paper Duration	: 3 Hrs
Max marks for theory paper	: 100
Max. marks for sessionals	: 25
Max. marks for orals	: 50
Total no. of questions from each module	: 2
Total no of questions to be answered	: 5 (At 1east one question from each module.)

MODULE –1 (15+5)

Introduction to analysis of metal forming process and its usefulness in the industry. Introduction to the theory of plasticity, Stress and its components, Stress-Strain and Stress-strain analysis, Plane strain and Plane-Stress analysis and its application. Axisymmetric compression.

MODULE – 2 (12+4)

Introduction to metal forming Processes. Cold and Hot forming

Rolling: Layout of tropical rolling mills, Sequences of operations, time cycles, Productivity, Economical indices, Defect in rolling, Main parameters in rolling. Rolling mills equipments.

MODULE – 3 (9+3)

Forging: Forging operations are the technology of hammer forging presses. Inspection and tolerances in forging. Forging equipments.

MODULE – 4 (12+4)

Extrusion: Parameters in hot and cold extrusion, metal flow, selection of presses, extraction equipment.

Wire Drawing: Principals and parameters, Technology of various operations.

TEXT BOOKS

1. Rawe G.W, introduction to the principle of Metal working, Edwarded Arnold Publishers, London.
2. Avitzur B, Metal forming Processor and analysis, McGraw Hill, New York, 1958.

REFERENCE

1. Johnson W and Mellor P b, Plasticity for Mechanical engineers, Van Nostrant, London, 1972.

ME 8.4.3: Supply Chain Management

	L +T+P
Lectures/Tutorials/Practical's per week	: 3+1+2
Question Paper Duration	: 3 Hrs
Max marks for theory paper	: 100
Max. marks for sessionals	: 25
Max. marks for orals	: 50
Total no. of questions from each module	: 2
Total no of questions to be answered	: 5 (At 1east one question from each module.)

Course Objectives:

Supply Chain Management (SCM) is about the management of material and information flows in multi-stage production distribution networks. Intense and fierce global competition and advances in information Technology have motivated companies to take initiatives to reduce costs and increase responsiveness to changes in the marketplace.

Instructional Objectives:

This course will provide students with the knowledge and tools necessary to develop, implement and sustain strategies for managing supply chains.

MODULE I.

(12+4)

Introduction to Supply Chain Management (SCM), Classification of Inventory Systems. Basics of SCM,. Managing Supply Chain inventory - pitfalls and opportunities. Planning demand and supply in Supply Chains, Managing economy of scale and uncertainty in Supply Chains, Lead times, Understanding impact of uncertainty of demand and supply on supply chains.

MODULEII

(12+4)

Supply Chain design appropriate for mass customization. Design for localization and Design for customization. Managing transportation in Supply Chains, links between transportation and inventory costs in the design of transportation networks, Issues in facility location in Supply Chains.

MODULE III (12+4)

Network Design in Supply Chains, framework for facility location decisions. Operational issues in Supply Chains, effect of demand and lead time uncertainty on the total costs of the Supply Chains. Playing the Beer Distribution game of the Supply Chain of the retailer, distributor, wholesaler and the manufacturer of a beer distribution Supply Chain. Information Distortion / Bullwhip Effect in Supply Chains. Different performance measures of Supply Chains.

MODULE IV (12+4)

Information technology and E-business in Supply Chain Management. Impact on sourcing of raw materials, distribution etc.

Studying and analyzing the supply chains of local industries like mining, tourism etc. and identifying the strong and weak points of each. Case studies of supply chains of the UP DeskJet, Dell Computers or any other major companies and one or two local industries.

TEXT BOOKS

1. Sunil Chopra, Peter Meindl,: Supply Chain Management - Strategy, Planning and Operations, Pearson Education Asia.

2. Simchi-Levi, Kaminsky, Simchi-Levi :Designing and Managing the Supply Chain, , McGraw Hill International edition.

3. Alterkar: Supply Chain Management , Concepts and Cases, Prentice Hall of India

REFERENCES:

1. G. Raghuram and N.Rangaraj (Ed.): Logistics and Supply Chain Management - Cases and Concepts, McMillan India Ltd, New Delhi.

2. Harvey M. Wagner: Principles of Operations Research - with applications to managerial decisions, Prentice Hall India Ltd., New Delhi.

3. Douglas Lambert, James Stock and Lisa Ellram, Irwin :Logistics Management -McGraw Hill International edition

ME 8. 4. 4: LOW COST AUTOMATION

	L +T+P
Lectures/Tutorials/Practical's per week	: 3+1+2
Question Paper Duration	: 3 Hrs
Max marks for theory paper	: 100
Max. marks for sessionals	: 25
Max. marks for orals	: 50
Total no. of questions from each module	: 2
Total no of questions to be answered	: 5 (At 1east one question from each module.)

Course Objectives: To know various low cost automation System and it application in industry. The student as mechanical Engineer should be able to design, Hydraulic, Pneumatic circuits and to control them.

Instructional Objectives: Student is required to be exposed to basics of Hydraulic, Pneumatics and PLC's microprocessor before entering in to design of Pneumatic, hydraulic circuits and to use this in various application in Industry.

MODULE – I

(12+4)

Automation

Introduction, Mechanization vs Automation, Application of Automation, Goals of automation social issues of Automation Low cost Automation. Types of Automation, current emphasis on automation, Reasons for automation, Issues for automation in factory operation. Ten strategies for automation.

Synthesis of Automatic systems- Basic concepts. Types of system comparison

Planning for Low Cost Automation, Mechanism for Low Cost Automation, Mechanical system for working cycle.

MODULE – II

(12+4)

Pneumatics – Elements, Pneumatic circuits, Electropneumatics.

Advantages and disadvantages of Pneumatic

Application of Pneumatics

Pneumatic Logic Circuits.

Hydraulic system Elements, Synthesis or circuits, Baisc Hydraulic system and Hydraulic system Design, some typical applications, Hydraulic servosystem.

Advantages & disadvantages if Hydraulics fluids used in Hydraulics rules for working with Hydraulics

MODULE – III

(12+4)

Fluidics:

Introduction Boolean Algebra, Laws of Boolean Algebra, Truth Table, Logic Gates, Origin and Development of fluidics, Coanda's Effact, Fluid Devices, Fluidic Sensors, Fluidic Amplifier, Advantages of fluidics.

Electrical and Electronic controls:

Sensors and Transducers, Senior Terminology, selection of a Transducer Photoelectric sensors LVDT/RVDT, Photoresistors, Microphone/speaker, piezoelectric devices ,Magnetostrictive Transducer, Pressure Transducer Strain gauges.

MODULE IV

(12+4)

Introduction to Microprocessor, Its design and Architecture Components of a microprocessor, How Microprocessor works, Classification of Microprocessor, Application of Microprocessor Programmable Logic Controller(PLC)

Control programme, Advantages of PLC,

Control program, Advantages of PLC, working of PLC, PLC Programming,

Transfer Devices and Feeders

Introduction fundamentals of production line, types of Assembly lines, Transfer systems, Mechanisms Transfer devices/Machines. Types of Transfer Devices. Transfer Devices used in Transfer machines. Advantages and Disadvantages of Transfer Machines.

Classification of feeders, Criteria for material selection of feeder, Parts feeding Devices, Types of Feeders

TEXT BOOKS

1. Industrial Automation and Robotics by A. K. Gupta & S. K. Arora
2. Low Cost Automation – Report on short term course on Low Cost Automation by IIT Bombay, 1986

REFERENCE:

Mechatronics by Prof C. R. Venkatramana, Sapna Book House Banglore.

ME 8.4.5: FLUID POWER CONTROL

	L +T+P
Lectures/Tutorials/Practical's per week	: 3+1+2
Question Paper Duration	: 3 Hrs
Max marks for theory paper	: 100
Max. marks for sessionals	: 25
Max. marks for orals	: 50
Total no. of questions from each module	: 2
Total no of questions to be answered	: 5 (At 1east one question from each module.)

Course Objectives:

This is an interdisciplinary course with application of knowledge from the basic subjects of applied mechanics, fluid mechanics, turbo machineries and mechatronics. This course meets the basic requirement of industry who require engineers to implement low cost automation.

Instructional Objectives:

Fluid Power control focuses on analyses applied to hydraulics and pneumatics. Components of hydraulics. Components of hydraulics and pneumatics are then discussed prior to application circuits. Programming circuits. Programmable logic controllers are also discussed in brief.

MODULE I

Introduction to fluid Power: advantages & application of fluid Power systems, Components of fluid power system, Types of fluid power control system, Environmental Issues. (2+0)

Physical Properties of Hydraulic Fluids – Pascal's law, Bulk Modulus, viscosity & Viscosity Index. (2+1)

Energy and Power in Hydraulic Systems: Application of Pascal's Law, Conservation of Energy, The Continuity Equation, Bernoulli's Equation, Torricelli's theorem. (4+1)

Hydraulic Conductors and Fittings: Conductor Sizing for Flow Rate Requirements, Pressure Rating of Conductors, Steel Pipes, Steel Tubing, Plastic Tubing, Flexible Hoses, Metric Steel Tubing. (4+2)

MODULE II

Basics of Hydraulic Flow in Pipelines : Frictional losses in Laminar and Turbulent Flow, Losses in Valves and Fittings, Equivalent Length technique, Hydraulic Circuit Analysis. (3+1)

Hydraulic Pumps: Pumping theory, Classification of pumps, Gear pumps, Vane pumps, Piston pumps, Pump Performance, Pump Selection, Pump Noise. (3+0)

Hydraulic Actuators and Motors: Linear Hydraulic Actuators, Mechanics of Hydraulic Cylinders loadings, Limited Rotation Hydraulic Actuators, Gear Motors, Vane Motors, Piston Motors, Hydraulic Motor Performance, Hydrostatic Transmissions. (3+1)

Hydraulic Direction Control: Check Valves, Shuttle Valves, 2 Way, 3 Way and 4 Way Direction Control Valves, Direction Control Valve Actuation, Hydraulic Circuits, Specifications. (3+2)

MODULE III

Hydraulic Pressure Control: Pressure Relief Valves, Unloading Valves, Pressure Reducing Valves, Sequence Valves, Counterbalance Valves, Brake Valves, Pressure Compensated Pumps, Specifications. (3+2)

Hydraulic Flow Control : Flow Valve Control Valve types, Flow Coefficient, Circuits, Cushioned Cylinders, Flow Dividers, Specifications. (3+0)

Ancillary Hydraulic Components : Accumulators, Intensifiers, Reservoirs, Filters, Seals and Bearing. (3+2)

Electronic Controls for Fluid Power: Solenoid Valves, Proportional and Servo Valves, Pump Controls. (3+0)

MODULE IV

Pneumatics : Introduction, Gas laws, Gas Flow, Vacuum , Pneumatic Systems. (2+0)

Pneumatic Power Supply : Compressor Types, Compressor Sizing, Vacuum Pumps. (2+1)

Pneumatic Components: Pneumatic Cylinders, Pneumatic Motors, Pneumatic Direction Control Valves, Pneumatic Flow Valve Control Valves, Air Preparation, Air Distribution.
(4+1)

Fluid Logic Control Systems: Moving Part Logic Control Systems, Principles of Fluidic Logic Control, Basic Fluidic Devices, Fluidic Sensors, Fluidic Control of Fluid Power Systems, Introduction to Boolean Algebra, Examples using Boolean Algebra.
(4+2)

TEXT BOOKS :

1. Anthony Esposito : Fluid Power with Applications, Prentice Hall.
2. James L. Johnson : Introduction to Fluid Power, Delmar Thomson Learning.
3. S. Illango , V Soundararajan Introduction to Fluid Power , Prentice Hall of India.

REFERENCES :

1. Peter Rohner : Fluid Power Logic Circuit Design, McMillan Press.
2. John Pippenger, Tyler Hicks: Industrial Hydraulics, McGraw Hill Industrial Editions.
3. Bolton W., Pneumatic and Hydraulic Systems, Butterworth-Heinemann.

ME 8.4.6: NANOTECHNOLOGY

	L +T+P
Lectures/Tutorials/Practical's per week	: 3+1+2
Question Paper Duration	: 3 Hrs
Max marks for theory paper	: 100
Max. marks for sessionals	: 25
Max. marks for orals	: 50
Total no. of questions from each module	: 2
Total no of questions to be answered	: 5 (At 1east one question from each module.)

Course Objectives:

This course explores the basic principles associated with nanoscience and nanotechnology including the fabrications & synthesis, size dependent properties, characterization and application of materials at nanometer length scales with an emphasis on recent technological breakthroughs in the field.

Instructional Objectives:

- To describe method for fabricating nanoparticles, nanotubes, nanowires, and nanostructured thin films.
- To understand the physical properties of nanomaterials.
- To understand tools for structure and property characterization of nanostructures.
- Be knowledge in the various modern technologies used in nanotechnology to grow bulk crystals, thin films, and nanoscale structures.
- To understand applications for nanomaterials.
- To use literature resources for further self-guided learning about nanoscale materials.

MODULE I (12+4)

1. Introduction: Background and Defination of Nanotechnology, Emergence of Nanotechnology, Bottom-Up and Top-Down Approaches, Challenges in Nanotechnology, Applications in Different Fields, Reliability Issues of MEMS/NEMS

2. Zero-Dimensional Nanostructures – Nanoparticles: Introduction, Nanoparticles through Homogeneous Nucleation, Nanoparticles through Heterogeneous

MODULE II (12+4)

3. **One-dimensional Nanostructres – Nanowires and Nanorods: Introduction, Spontaneous Growth, Template-Based synthesis, Electrospinning. Lithography.**
4. **Two-dimensional Nanostructures – thin Films: fundamentals of Film Growth vacuum Science, Physical Vapor Deposition(PVD), Chemical Vapor Deposition (CVD), Atomic Layer Deposition(ALD), Superlattices, Self Assembly, Langmuir – Blodgett Films, electrochemical Deposition, Sol-Gel Films**

MODULE III (12+4)

5. **Special Nanomaterials: Introduction, Carbon Fullerenes and Nanotubes, Micro and Mesoporous Materials, Core-Shell Structures, Organic-Inorganic Hybrids, Intercalation Compounds, Nanocomposites and Nanograined Materials**
6. **Nanostructures Fabricated by Physical Techniques: Introduction, Lithography, Nanomanipulation and Nanolothography, Soft lithography, assembly of Nanoparticles and Nanowires, Other methods for microfabrication.**

MODULE IV (12+4)

7. **Characterization and Properties of Nanomaterials: Introduction, Structural Characterization, chemical Characterization, physical Properties of Nanomaterials-Electrical conductivity, Ferroelectrics and dielectrics, Superparamagnetism.**
8. **Application of Nanomaterials: Introduction, Molecular electronics and Nanoparticles, Nanobots, Biological applications of Nanoparticles, Catalysis by Gold Nanoparticles, Band Gap Engineered Quantum Devices, Nanomechanics, Carbon Nanotube Emitters, Photoelectrochemical Cells, Photonic Crystals and Plasmon Waveguides**

Text Books:

1. Nanostructures and nanomaterials Synthesis, properties & applications Guozhong Gao, Imperial College Press London
2. Introduction to Nanotechnology – Charles P. Poole Jr. and Franks. J. Qwe4ns, John Wiley & Sons, Inc., New Jersey
3. Nano Materials A. K. Bandyopadhyay, New Age Publishers
4. Springer Handbook of Nanotechnology – Bharat Bhusan. Springer-Verlag Berlin Germany

References:

1. Hand book of Nano science, Engineering and Technology- Willam A Goddard Donald W. Brenner, Sergy E. Leshevsky. Gerald j. Jafrate, CRC Press, New York
2. Nanomaterials: Mechanics and Mechanisms – K. T. Ramesh, Springer science+Business Media, New York.