College of Engineering, Pune

(An Autonomous Institute of Govt. of Maharashtra, Permanently Affiliated to S.P. Pune University)

Department of Mechanical Engineering

Curriculum Structure & Detailed Syllabus (UG Program)

Final Year B. Tech.

(Revision: A.Y. 2017-18, Effective from: A.Y. 2018-19

Final Year B Tech Mechanical

Semester VII [M-Group]

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1.	MLC		Intellectual Property rights	1	0	0	0
2.	LLC		Liberal Learning Course	1	0	0	1
3.	PCC		Computer Aided Design/Computer Aided Manufacturing	2	0	0	2
4.	PCC		Refrigeration and Air Conditioning	2	1	0	3
5.	PCC		Mechanical Measurement and Automatic Control	3	0	0	3
6.	DEC		Department Elective-II [Option among minimum 3 courses]	3	0	0	3
7.	OEC		Institute level Open Elective [Science/Technology/Engg.] [To be offered to other Departments]	3	0	0	3
8.	LC		Computer Aided Design/Computer Aided Manufacturing Lab	0	0	2	1
9.	LC		Refrigeration and Air Conditioning Lab	0	0	2	1
10.	LC		Mechanical Measurement and Automatic Control Lab	0	0	2	1
11.	SBC		Project Stage-I	0	0	4	2
				15	1	10	20
			Total Academic Engagement and Credits	**Max. 26**			**20**

Minor course: Manufacturing Technology

Honour Course: Thermal Stream: Advance Heat Transfer

Honour Course: Design Stream: Stress Analysis

Semester VIII [M-Group]

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1	LLC		Liberal Learning Course	1	0	0	1
	PCC/HSMC		Metrology and Quality Control	3	0	0	3
2	DEC		Department Elective-III	3	0	0	3
3	DEC		Department Elective-IV	3	0	0	3
4	SBC		Project Stage-II	0	0	16	8
				10	0	16	18
			Total Academic Engagement and Credits	**Max. 10 Project 16 =26**			**18**

List of Open Electives-II

- Operation Research
- Robotics
- Air Conditioning
- Product Design

Minor course: CAD and CAM
Honour Course: Thermal Stream: Modeling of I C Engine
Honour Course: Design Stream: Advanced Vibrations and Acoustics

Details of the departmental electives to be offered by Mechanical Engineering Department

Stream	DE-I	DE-II	DE-III	DE-IV
Thermal	1. Non Conventional Energy Sources 2. Steam Technology 3. Hydraulic Embedded Systems	1. Computational Fluid Dynamics 2. Power plant engineering 3. Intelligent Hydraulic Systems	1. Energy Conservation and Management 2. Air conditioning systems design	1. Design of Heat Exchanger 2. Introduction to Nuclear Engineering
Design	1. Analysis and Synthesis of Mechanisms 2. Mechatronics	1. Finite Element Analysis 2. Integrated Product Design	1. Introduction to Optimum Design 2. Mechanics of Composite Materials	1. Fracture Mechanics 2. Tribology 3. Mechanical Vibrations and Acoustics
Manufacturing and Management	1. Advanced Manufacturing Technology 2. Operation Research	1. Machine Tool Design 2. Industrial Engineering	1. Robotics and Automation 2. Project Management	1. Advanced CAD/CAM 2. World Class Manufacturing

Note: Students are encouraged to take up the electives in stream-wise directions as they go to next level

Semester VII [M-Group]

Intellectual Property Rights

(ME) Computer Aided Design /Computer Aided Manufacturing

Teaching Scheme:
Lectures : 2 Hrs/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Course Outcomes

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

1. Recall the fundamentals of CAD/CAM
2. Compare and Represent 2-D and 3-D entities
3. Apply transform techniques on 2-D and 3-D entities
4. Examine CNC program for production of components
5. Express the principles and methods of Rapid Prototyping

Unit I: Fundamentals of CAD/CAM

Product cycle and scope of CAD/CAM/CIM in product cycle, Features of CAD/CAM Hardware and software, selection of software. CAD workstation configurations **[3hrs**]

Unit II: Representation of Curves and surfaces

Introduction to Analytic Curves, Synthetic Curves: Hermite Cubic Spline, Bezier Curve, B-Spline curve. Surface Representation: Synthetic Surfaces **[5 hrs]**

Unit III: Solid Modeling

2D Vs 3D modeling, Comparison of Wireframe, surface and solid modeling techniques, Geometry Vs Topology, Requirements of Solid Modeling, Solid Modeling Methods: Constructive Solid Geometry (CSG), Boundary Representation (B-rep), etc. **[4 hrs]**

Unit IV: Geometric Transformation

2D geometric transformations, Homogeneous co-ordinate representation, Composite transformations, 3D transformations, Inverse transformations, geometric mapping **[5 hrs]**

Unit V: Computer Numerical Control and Part Programming

Introduction to NC/CNC/DNC machines, Classification of NC systems, Axis nomenclature, Interpolation, features of CNC controllers, Types of CNC machines, Construction features of CNC machines, Manual Part Programming, , NC word format, Details of G and M codes, Canned cycles, subroutines and Do loops, Tool radius and length compensations **[6 hrs]**

Unit VI: Rapid Prototyping and Manufacturing

Introduction to Rapid Prototyping, rapid tooling and rapid manufacturing. Process of rapid prototyping. Different techniques of Rapid prototyping and their applications. **[3 hrs]**

Text Books:

- Ibrahim Zeid ,CAD/CAM Theory and Practice, , Tata McGraw-Hill Publishing Company Ltd., New Delhi,2012
- Dacid F. Rogers, J Alan Adams, Mathematical Elements for Computer Graphics, McGraw-Hill publishing Company Ltd.,2001
- Chougule N.K., CAD/CAM/CAE, Scitech Publications Ltd, 2017

Reference Books:

- M.E. Mortenson, Geometric Modelling , Wiley, 2016
- Bedworth, Wolfe & Henderson Computer Aided Design & Manufacturing , McGraw Hill, 2003

(ME) Refrigeration and Air Conditioning

Teaching Scheme:	**Examination Scheme:**
Lectures : 2 Hrs/week	T1 and T2: 20 Marks each
Tutorial: 1Hr/week	End-Sem Exam: 60 Marks

Course Outcomes:

Students will be able to

1. Interpret the working of Vapour Compression refrigeration system
2. Design the Vapour Compression refrigeration system for various applications.
3. Develop the knowledge of HVAC for multi-pressure systems.
4. Illustrate and apply the Psychrometry for air conditioning applications.
5. Design the duct for various air conditioning systems.

Unit I : Vapour Compression refrigeration system:

A Refrigerating Machine, Types of refrigeration system, Vapour Compression refrigeration system and thermodynamic cycle, Standard Rating Cycle and effect of Operating Conditions,

effect of Evaporator Pressure, effect of Condenser Pressure, effect of Suction Vapour Superheat, effect of Liquid Sub cooling, Actual Vapour Compression Cycle (Numerical treatment).
Vapour Absorption Refrigeration Systems: Types, working principle, aqua-ammonia, Lithium-bromide and Electrolux Systems.
Multipressure systems: Multi-evaporator Systems, Multistage Systems, Choice of Intermediate Pressure, Multi-evaporator Systems, Cascade Systems, Practices for Multistage Systems (Numerical treatment) **[12 hrs]**

Unit II : Refrigerants:
A Survey of Refrigerants, Designation of Refrigerants, Selection of a Refrigerant, Thermodynamic, Chemical, Physical, and safety Requirements, Secondary Refrigerants, Ozone depletion, Global warming, green house effect, Environment friendly refrigerant R134a, R410a, R600a, R290, R32. (Theoretical only) **[3 hrs]**

Unit III: Refrigerant Compressors:
Types of Compressors, Thermodynamic Processes during Compression, Principal Dimensions of a Reciprocating Compressor, Performance Characteristics of a Reciprocating Compressor, Capacity Control of Reciprocating Compressors, Rotary Compressors, Screw Compressors, Centrifugal Compressors, Digital scroll compressors **[5 hrs]**

Unit IV: Condensers, Evaporators and Expansion Devices:
Construction and working, Types of condensers, evaporators and expansion devices, Capillary Tube and Its Sizing, pumps, heat exchangers etc. Work done and heat transfer during steady flow processes. **[6 hrs]**

Unit V: Psychometrics of Air – Conditioning Processes:
Properties of moist Air, Working Substance in Air Conditioning, Psychometric Properties, Psychometric Chart, Mixing Process, Basic Processes in Conditioning of Air Psychometric Processes in Air – conditioning Equipment comfort conditions, (Numerical Treatment). **[6 hrs]**

Unit VI: Load Calculation and Applied Psychrometrics:
Preliminary Considerations, Internal Heat Gains, System Heat Gains, Break-up of ventilation Load and Effective Sensible Heat Factor, Cooling-load Estimate, Heating – load Estimate, Psychometric Calculations for Cooling, Design of air conditioning equipment, Numerical examples, Introduction to duct design by equal friction method. **[6 hrs]**

Text Books

- R.J.Dossat, “Principles of Refrigeration”, Pearson Education Asia, 2014
- C.P.Arora, “Refrigeration and Air-conditioning”, Tata McGraw-Hill, 2017
- Stoecker & Jones, “Refrigeration and Air-conditioning”, McGraw Hill Book Company, New York, 1983.
- S.N. Sapali “Refrigeration and Air-conditioning”, PHI (Second Edition) 2016

Reference Books

- J.L.Threlkeld, "Thermal Environmental Engineering", Prentice Hall, 1970.
- W.F.Stoecker, "Industrial Refrigeration Handbook", McGraw-Hill, 1998.
- P.C.Koelet, "Industrial Refrigeration: Principles, Design and Applications", Macmillan, 1992
- ASHRAE HANDBOOKS four volume Index 2014-2017
- "Handbook of air-conditioning system design", Carrier Incorporation, McGraw Hill Book Co.,U.S.A, 1965.
- Jones W.P., "Air Conditioning Engineering", Edward Arnold Publishers Ltd., London, 1985.
- Hainer R.W., "Control Systems for Heating, Ventilation and Air-Conditioning", Van Nostrand Reinhold Co., New York, 1984

(ME) Mechanical Measurement and Automatic Control

Teaching Scheme:
Lectures : 3Hrs/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Course Outcomes:

Students will be able to

1. Apply the basic concepts of mechanical measurement for industrial applications.
2. Describe methods of measurement for various quantities like force, torque, power, displacement, velocity/seed and acceleration e.
3. Describe the basic features and configurations of control systems.
4. Find the transfer function for linear, time-invariant translational mechanical systems and produce analogues electrical and mechanical circuits.
5. Describe quantitatively the transient response of 1^{st} order systems.
6. Apply frequency response techniques for stability analysis.

Unit I: Introduction to Mechanical Measurements

Importance of Measurements, Classification of measuring instruments, generalized measurement system , types of inputs for measurements. Concepts such as Accuracy, Precision, Calibration, Linearity, Sensitivity, Accuracy, Static error, Precision, Reproducibility, Threshold, Resolution, Hysteresis, Drift, Span & Range etc. Errors in Measurements, Classification of errors in measurements, Effect of component errors, Probable errors. **[6 hrs]**

Unit II: Displacement, Velocity & Pressure Measurement

Displacement Measurement: Transducers for displacement measurement, potentiometer, LVDT, Capacitance Types, Digital Transducers (optical encoder), Nozzle Flapper Transducer. Velocity Measurement: Tachometers, Tacho generators, Digital tachometers and Stroboscopic Methods. Pressure Measurement: Elastic pressure transducers viz. Bourdon tubes, diaphragm, bellows and piezoelectric pressure sensors, High Pressure Measurements, Bridge man gauge. Vacuum measurement: Vacuum gauges viz. McLeod gauge, Ionization and Thermal Conductivity gauges. **[6 hrs]**

Unit III: Temperature, Strain & Acceleration Measurement

Temperature Measurement: Thermocouple, Resistance thermometers, Thermistors, Pyrometers. Liquid in glass Thermometers, Bimetallic strip. Calibration of temperature measuring devices, Strain Measurement: Theory of Strain Gauges, gauge factor, temperature Compensation, Bridge circuit, orientation of strain gauges for force and torque, Strain gauge based load cells and torque sensors Acceleration Measurement, theory of accelerometer and vibrometers, practical accelerometers, strain gauge based and piezoelectric accelerometers. [**6 hrs]**

Unit IV: Introduction and Mathematical modelling of systems

Basic concepts of control systems, Classification of control systems, open loop and closed loop control system, Transfer Function & its significance. Block diagram representation of physical systems along with rules, properties, comparison and limitations. **[6 hrs]**

Unit V: Representation of Control System Components and Time Response Analysis

Introduction, Study of Mechanical and Electrical components employed in construction of control systems and mathematical equations for the same. Standard test signals along with examples of their usage, analysis of first order systems, Transient and steady state response of first order and second order systems when subjected to standard input signals **[6 hrs]**

Unit VI: Analysis of Frequency Response

Introduction, Characteristics of frequency response of different functions (up to second order systems), Graphical method of analyzing frequency response, Frequency response plots (Bode Plot), Concept of Stability, Routh's stability criteria. **[6 hrs]**

Text Books:

- Ernest Doebelin and Dhanesh Manik, "Measurement Systems" , McGraw-Hill, 6th Edition, 2017.
- Katsuhiko Ogata, "Modern Control Engineering", Prentice Hall of India,5thEdition, 2010.

Reference Books

- Francis H. Raven, "Automatic Control Engineering", TMH, 5th edition, 1994.

- Benjamin and C.Kuo, Farid Golnaraghi, "Automatic Control Systems" , John Wiley & Sons, 9th Edition, 2014.
- Norman S. Nise, "Control Systems Engineering", John Wiley & Sons, 6th Edition, 2010.

(ME) Computational Fluid Dynamics and Heat Transfers

Teaching Scheme:
Lectures : 3Hrs/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Course Outcomes:

Students will be able to :

1. develop an understanding for the major theories, approaches and methodologies used in CFD;
2. build up the skills in the actual implementation of CFD methods (e.g. boundary conditions, methodology etc.) by using programming language;
3. gain experience in the application of CFD analysis to real engineering designs.

Unit I: Introduction to CFD
Computational approach to Fluid Dynamics and its comparison with experimental and analytical methods, Basics of PDE: Elliptic, Parabolic and Hyperbolic Equations. **[6 hrs]**

Unit II: Governing Equations
Review of Navier-Stokes Equation and simplified forms, Solution Methodology: FDM and FVM with special emphasis on FVM, Stability, Convergence and Accuracy. **[6 hrs]**

Unit III: Finite Volume Method
Domain discretization, types of mesh and quality of mesh, SIMPLE, pressure velocity coupling, Checkerboard pressure field and staggered grid approach **[6 hrs]**

Unit IV: Geometry Modeling and Grid Generation
Practical aspects of computational modeling of flow domains, Grid Generation, Types of mesh and selection criteria, Mesh quality, Key parameters and their importance. **[6 hrs]**

Unit V: Methodology of CFDHT
Objectives and importance of CFDHT, CFDHT for Diffusion Equation, Convection Equation and Convection-Diffusion Equation **[6 hrs]**

UNIT VI: Solution of N-S Equations for Incompressible Flows
Semi-Explicit and Semi-Implicit Algorithms for Staggered Grid system and Non-staggered Grid System of N-S Equations for Incompressible Flows **[7 hrs]**

Text Books:

- by H.K. Versteeg, W.Malalasekera , An Introduction to Computational Fluid Flow (Finite Volume Method), 2nd Edition, Printice Hall 2009.
- Murlidhar and Sundarrajan ,Computational Fluid Flow & Heat Transfer by, Narosa Publication, Reprint, 2017.
- Atul Sharma, Introduction to Computational Fluid dynamics: Development, Application and Analysis, Wiley Publications, 2016.

Reference Books:

- John A. Anderson, Computational Fluid Dynamics, The Basic with applications., McGraw Hill International editions, Mechanical Engineering series,2017.
- Dr. Suhas Patankar, Numerical Heat Transfer Fluid Flow , CRC Press, 1980 .
- Ferziger and Peric, Computational Methods for Fluid Dynamics by, Springer Publication, 3rd Edition, 2002.
- Sedat Biringen, Chuen-Yen Chow, An Introduction to Computational Fluid Mechanics by Example, Wiley Publication, 2nd Edition, 2011.

(ME) Power Plant Engineering

Teaching Scheme:
Lectures : 3Hrs/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Course Outcomes

After completing this course the students will be able to:

1. Explain the basic working principles of steam, hydel, Diesel, as turbine power plant and boilers
2. Evaluate performance of thermal power plant, hydel power plant, diesel power plant gas turbine power plant
3. Illustrate working principle of different types of nuclear power plant
4. Describe working and significance of various non-conventional power plants
5. Evaluate cycle efficiency and performance of these power plants
6. Know the costs associated with power generation
7. Evaluate economics of plant selection and generation

8. Appraise safety aspects of power plants

Unit I : Introduction to Power Plants & Boilers

Layout of Steam , Hydel , Diesel , MHD, Nuclear and Gas turbine Power Plants Combined Power cycles – comparison and selection , Load duration Curves, Steam boilers and cycles – High pressure and Super Critical Boilers – Fluidised Bed Boilers. **[6 hrs]**

Unit II: Steam Power Plant

Fuel and ash handling , Combustion Equipment for burning coal, Mechanical Stokers. Pulveriser, Electrostatic Precipitator, Draught- Different Types, Surface condenser types, cooling Towers **[6 hrs]**

Unit III : Hydel Power Plants

Hydel Power plant- Essential elements, Selection of turbines, governing of Turbines- Micro hydel developments **[6 hrs]**

Unit IV : Diesel and Gas Turbine

Types of diesel plants, components , Selection of Engine type, applications-Gas turbine power plant- Fuels- Gas turbine material – open and closed cycles- reheating – Regeneration and inter-cooling – combines cycle **[6 hrs]**

Unit V: Other Power Plants

Nuclear Energy-Fission, Fusion Reaction, Types of Reactors, Pressurized water reactor, Boiling water reactor, Waste disposal and safety. Geo thermal- OTEC- tidal- Pumped storage –Solar central receiver system **[6 hrs]**

Unit VI: Economics of Power Plants

Cost of electric Energy- Fixed and operating costs-Energy rates- Types tariffs- Economics of load sharing, comparison of various power plants. **[6 hrs]**

Text Books:

- Arora S.C and Domkundwar S, “A Course in Power Plant Engineering”, Dhanpat Rai, 2016
- Nag P.K ,”Power Plant Engineering”. Third edition Tata McGraw- Hill ,2014

Reference Books:

- EI-Wakil M.M ,Power “Plant Technology,” Tata McGraw-Hill 2017
- K.K.Ramalingam , “ Power Plant Engineering “, Scitech Publications, 2015
- G.R,Nagpal , “Power Plant Engineering”, Khanna Publishers 2011
- G.D.Rai, “Introduction to Power Plant Technology” Khanna Publishers,2015
- Black & Veatch, “Power Plant Engineering”, Springer Science & Business Media, Inc 1996

(ME -) Finite Element Analysis

Teaching Scheme:
Lectures : 3Hrs/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Course Outcomes:

The students will be able to:

1. develop system level matrix equations from a given mathematical model of a problem following the Galerkin weighted residual method or Principle of Stationary Total Potential.
2. implement FEM, for problems of bars and beams, to obtain the values of the field variable at the global nodes,
3. implement FEM, for a 2-dimensional and axi-symmetric problems from structural mechanics to find displacements, stresses and strains, using triangular and quadrilateral elements.
4. summarize the sources of errors in implementing FEM and suggest remedies to minimize them,
5. determine, using FEM, parameters of interest for a potential field problem, using triangular and quadrilateral elements
6. apply FEM to estimate the fundamental frequency of natural vibration of bars and beams using the methods mentioned in the curriculum.

Unit I: Introduction

Introduction, An overview of engineering problems and methods for solving them, demonstration by an example – Physical system – Physical model – Mathematical model – Methods for solution – Solution. Need for using numerical methods to solve engineering problems **[4 hrs]**

Unit II: Introduction to FEM and 'BAR' Problems

Introduction to steps of FEM for the problem of finding elongation of an axially loaded bar as an example of a 1-D problem. Step-by-step development of the procedure of Galerkin weighted residual FEM for the bar problem - residual error, weighting function, discretization, elements and nodes, local variables, approximation functions (or shape functions), need for numerical integration and co-ordinate transformation, Gauss-Legendre integration scheme. Process of assembly of local matrix equations into global, solution to the equations, equation solvers **[8 hrs]**

Unit III: FEM for 'BEAMs'

FE formulation for beams, Governing differential equation, Characteristics of formulation for problems demanding C^1 continuity, Hermitian polynomials and shape functions based on them, BEAM element, FEM procedure followed for the beam problems.

Computation of derived quantities like strains and stresses from the nodal values of the field variables, Result post-processing.
Finite element formulation using variational and virtual work methods, demonstration for bar and beam problems. **[6 hrs]**

Unit IV: 2-D Problem from Structural Mechanics
Introduction to 2-dimensional problem from structural mechanics static analysis, Lagrangian as a starting point for FEM. Triangular and quadrilateral elements, Evaluating force vectors for traction at the edges and surfaces of elements, Substitution of boundary conditions, Obtaining derived quantities from basic solution from FEM, e.g. stress. Higher order elements, iso-parametric formulation. **[6 hrs]**

Unit V: Potential Field Problems
Introduction to potential field problems, examples from structural mechanics - of torsion of non-circular prismatic bars, 2-D steady state heat transfer with convection from surface. Sources of errors, error analysis, remedies to minimize the errors. Application of FEM to Axisymmetric problems, Axisymmetric solids under rotation, computation of force vector due to body forces **[6 hrs]**

Unit VI: Eigen-value problems
FEM for Eigen-value problems, Mass and stiffness matrices, Consistent and lumped mass matrices, lumping schemes, Methods for obtaining eigen-values and eigen-vectors – Power iteration and inverse power iteration methods, matrix transformation method – Jacobi's method. **[6 hrs]**

Text Books:

- Chandrupatla and Belegundu "Introduction to finite elements in Engineering", Prentice Hall of India Pvt. Ltd. New Delhi, 2012.
- Logan Deryl L., "A First Course in Finite Element Method", Thomson Brook/Cole, 3rd ed. 2012
- Reddy J N, "Finite element Method", Tata McGraw Hill publishing Co Ltd, New Delhi, Ed. 2, 2006

Reference Books :

- Cook R.D. "Concepts and applications of finite element analysis" Wiley, New York, 2007.
- Bathe K.J., Cliffs, N.J. "Finite Element Procedures in Engineering Analysis", Englewood. Prentice Hall, 1981.
- Zienkiewicz O. C. and Taylor R L, "Finite Element Method", Vol. 1 – The Basis, 5th Ed., Butterworth and Heinemann, New Delhi, 2000
- Zienkiewicz O. C. and Taylor R L, "Finite Element Method", Vol. 2 – Solid Mechanics, 5th Ed., Butterworth and Heinemann, New Delhi, 2000

(ME) - Integrated Product Design

Teaching Scheme:
Lectures : 3Hrs/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Course Outcomes:

Students will be able to

1. Identify the needs of the customer while designing a new product or while modifying existing design of a product in the highly competitive, dynamic and customer centered market.
2. Convert the needs of customers in technical specifications and constraints of a product.
3. Design the products after realizing the importance of creativity.
4. Apply the learning of various rapid prototyping methods and reverse engineering methods for generating and testing the new product designs.
5. Understand the importance of design for manufacture and assembly, maintenance, reliability and statistical considerations in design.
6. Apply the learning of the industrial design aspects such as design for emotions, eco design and retrofit design.

Unit I

Need Identification and problem definition, product specification, concept generation and selection, evaluation, creativity methods, Concept testing **[12 hrs]**

Unit II

Design for manufacture and assembly, robust design and , design for manufacturing processes such as casting, forging **[6 hrs]**

Unit III

Rapid prototyping and reverse engineering **[8 hrs]**

Unit IV

Statistical considerations in design and Reliability, Strength based reliability, parallel and series systems **[6 hrs]**

Unit V

Industrial design: Design for Emotion and experience, Introduction to retrofit and Eco design, Human behavior in design **[6 hrs]**

Text Books:

- Prashant Kumar, Product Design, Creativity, Concepts and Usability, PHI Learning Pvt. Ltd. New Delhi, 2012
- George E Dieter, "Engineering Design", McGraw Hill Company, 2000.
- Reverse Engineering an Industrial perspective, Editors: Vinesh Raja, Kiran J.Fernandes, Springer , 2008

Reference Books:

- Pahl, G.and W.Beitz, Engineering Design–A Systematic Approach – Springer, 2nd Ed., 1996.
- Rapid Prototyping: Laser-Based and Other Technologies Patri K. Venuvinod, Weiyin MaSpringer, 30-Nov-2003

(ME) Machine Tool Design

Teaching Scheme:
Lectures : 3Hrs/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Course Outcome:

After completion of the course student will be able to

1. Design gear box. And Design different machine tools considering static and dynamic loads.
2. Understand effect of vibrations on life of machine tools.
3. Understand design considerations for Special features in Machine tools

Unit I: Drives
Design considerations for drives based on continuous and intermittent requirement of power, Types and selection of motor for the drive, Regulation and range of speed based on preferred number series, geometric progression. Design of speed gear box for spindle drive and feed gear box. **[6 hrs]**

Unit II: Design of Machine Tool Structure
Analysis of forces on machine tool structure, static and dynamic stiffness. Design of beds, columns, housings, bases and tables. **[6 hrs]**

Unit III: Design of Guide-ways
Functions and types of guide-ways, design criteria and calculation for slide-ways, design of hydrodynamic, hydrostatic and aerostatic slide-ways, Stick-Slip motion in slide-ways. **[6 hrs]**

Unit IV:Design of Spindles, Spindle Supports and Power Screws

Design of spindle and spindle support using deflection and rigidity analysis, analysis of antifriction bearings, preloading of antifriction bearing.Design of power screws: Distribution of load and rigidity analysis. **[6 hrs]**

Unit V: Dynamics of Machine Tools

Dynamic characteristic of the cutting process, Stability analysis, vibrations of machine tools. Control Systems, Mechanical and Electrical, Adaptive Control System, relays, push button control, electrical brakes, drum control. **[6 hrs]**

Unit VI:Special features in Machine Tool Design

Design considerations for SPM, NC/CNC, and micro machining, Retrofitting, Recent trends in machine tools, Design Layout of machine tool using matrices. Step-less drives Design considerations of Step-less drives, electromechanical system of regulation, friction, and ball aviators, PIV drive, Epicyclic drive, principle of self locking. **[6 hrs]**

Text Books

- N.K. Mehta, "Machine Tool Design", Tata McGraw Hill, ISBN 0-07-451775-9. Edition 3 , 2012
- Bhattacharya and S. G. Sen., "Principles of Machine Tool", New central book agency Calcutta, ISBN 81-7381-1555.
- D. K Pal, S. K. Basu, "Design of Machine Tool", 4th Edition. Oxford IBH 2005, ISBN 81-204-0968 edition 5 , 2005

Reference Books

- N. S. Acherkan, "Machine Tool Vol. I, II, III and IV", MIR publications, 1965
- F. Koenigsberger, "Design Principles of Metal Cutting Machine Tools" - The Macmillan Company New York 1964

(ME) Industrial Engineering

Teaching Scheme:
Lectures : 3Hrs/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Course Outcomes:

After completion of the course student will be able to

1. Apply the Industrial Engineering concept in the industrial environment.
2. Manage and implement different concepts involved in methods study and understanding of work content in different situations.
3. Undertake project work based on the course content.

4. Describe different aspects of work system design and facilities design pertinent to manufacturing industries.
5. Identify various cost accounting and financial management practices widely applied in industries.
6. Develop capability in integrating knowledge of design along with other aspects of value addition in the conceptualization and manufacturing stage of various products.

Unit I: Introduction to Industrial Engineering and Productivity

Introduction: Definition and Role of Industrial Engineering, Contribution of Taylor and Gilbreth, Organisation : Concept of organisation, characteristics of organisation, elements of organisation, organisational structure, organisation charts; Types of organisation- formal line, military organisation, functional organization, line & staff organisation; Introduction to management principles, authority and responsibility, span of control, delegation of authority. Productivity : Definition of productivity, Productivity of materials, land, building, machine and power. Measurement of productivity: factors affecting the productivity, Productivity Models and Index (Numerical), productivity improvement programmers. **[6 hrs]**

Unit II: Method Study

Work Study : Definition, objective and scope of work-study. Human factors in work-study. Method Study : Definition, objective and scope of method study, activity recording and exam aids, Charts to record moments in shop - operation process charts, flow process charts, travel chart, two handed chart and multiple activity charts. Charts to record movement at work place - principles of motion economy, classification of moments, SIMO chart, and micro motion study. Definition and installation of the improved method, brief concept about synthetic motion studies.(Numerical); Introduction to Value Engineering and Value Analysis **[6 hrs]**

Unit III: Work Measurements

Work Measurements: Definition, objectives and uses; Work measurement techniques. Work sampling - need, confidence levels, sample size determinations, random observation, conducting study with the simple problems. Savitribai Phule Pune University, Pune 2012 Course BOS Mechanical Engineering SPPU Page 42 Time study: Definition, time study equipment, selection of job, steps in time study. Breaking jobs into elements, recording information. Rating and standard rating, standard performance, scales of rating, factors affecting rate of working, allowances and standard time determination; Introduction to PMTS and MTM. (Numerical), Introduction to MOST. **[6 hrs]**

Unit IV: Production Planning and Control

Introduction: Types of production systems, Need and functions of PPC, Aggregate production planning, Capacity Planning, ERP: Modules, Master Production Schedule; MRP and MRP-II; Forecasting techniques: Causal and time series models, moving average, exponential smoothing, trend and seasonality; (Numerical) Supply Chain Management: Concept, Strategies, Supply Chain Network, Push and Pull Systems, Logistics, Distribution; Order Control strategies: MTO, MTA, MTS. **[6 hrs]**

Unit V: Facility Design

Facility Location Factors and Evaluation of Alternate Locations; Types of Plant Layout; Computer Aided Layout Design Techniques; Assembly Line Balancing (Numerical); Material Handling: Principles, Types of Material Handling Devices; Stores Management Inventory Control: Functions, costs, classifications- deterministic and probabilistic inventory models, Concept of EOQ, purchase model without shortages (Numerical); ABC and VED Analysis. **[6 hrs]**

Unit VI: Engineering Economy, Human Resource and Industrial Safety

Engineering Economy and Costing: Elementary Cost Accounting and Methods of Depreciation; BreakEven Analysis (Numerical); Introduction to Debit and Credit Note, Financial Statements (Profit and Loss Account and Balance Sheet), Techniques for Evaluation of Capital Investments. Human Resource Development: Functions: Manpower Planning, Recruitment, Selection, Training; Concept of KRA (Key Result Areas); Performance Appraisal (Self, Superior, Peer, 3600). Industrial Safety: Safety Organisation, Safety Programme, General Safety Rules. **[6 hrs]**

Text Books

- M Mahajan, "Industrial Engineering and Production Management", Dhanpat Rai and Co,2015.
- O. P. Khanna, "Industrial engineering and managemen"t, Dhanpat Rai publication, ISBN no 13-978-8189928353, 2010
- Martend Telsang, "Industrial Engineering", S. Chand Publication, ISBN no 13-978-8121917735,2006.
- Banga and Sharma, "Industrial Organisation & Engineering Economics", Khanna publication, ISBN no 13- 978-8174090782,2003.

Reference Books

- Introduction to Work Study by ILO, Oxford & IBH Publishing Company, New Delhi, Second Indian Adaptation, 2008.
- H.B. Maynard, K Jell, "Maynard's Industrial Engineering Hand Book", McGraw Hill Education.
- Askin, "Design and Analysis of Lean Production System", Wiley, India
- Zandin K.B., "Most Work Measurement Systems", CRC Press,2002
- Martin Murry, "SAP ERP: Functionality and Technical Configuration", SAP Press; 3rd New edition (2010).
- Barnes, "Motion and time Study design and Measurement of Work", Wiley India

(ILOE) Operations Research

Teaching scheme
Lectures: 3 Hrs/Week

Examination scheme
T1 and T2: 20 marks each
End Sem. Exam: 60 marks

Course outcomes:

Student will able to

1. Illustrate the need to optimally utilize the resources in various types of industries
2. Apply and analyze mathematical optimization to various applications.
3. Demonstrate cost effective strategies in various applications in industry.

Unit I: Introduction to operations research

Scope, applications of operations research, phases and models of operations research, advantages and limitations of operations research and applications of operations research.

Linear Programming Problem (LPP): Formulation of LPP, graphical method of solution, simplex method, artificial variable technique- Big M method, two phase method, duality in LPP, sensitivity analysis **[6 hrs]**

Unit II: Transportation, assignment and sequencing model

Transportation Problem (TP): Mathematical formulation of TP, methods to obtain initial basic feasible solution, TP without degeneracy and with degeneracy

Assignment Problem (AP): Mathematical formulation of AP, variations of AP, travelling salesman problem

Sequencing Problem: Assumptions in sequencing, processing of n jobs on two machines, processing of n jobs on three machines and processing of n jobs on m machines. **[6 hrs]**

Unit III: Replacement and queuing model

Replacement model: Introduction, replacement of items that detoriates- replacement of items whose maintenance and repair cost increases with time ignoring value of money and replacement of items whose maintenance and repair cost increases with time considering value of money, replacement of items that fail suddenly- group replacement

Queuing Model: Kendall's notation for representing queue, single channel Poisson arrivals with exponential service times, infinite populations. **[6 hrs.]**

Unit IV : Games theory

Minimax (Maxmin) criterion for optimality, characteristics of game, dominance principles, 2X2 game-arithmetic and algebraic method, 2Xn and mX2 game-graphical method and method of sub-games, 3X3 game-method of matrices, iteration method and applications of games theory **[6 hrs]**

Unit V: Inventory control and simulation

Inventory control: Need and types of inventory, inventory associated costs, Economic Order Quantity (EOQ), Classical EOQ model with uniform demand rate and infinite replenishment, EOQ model with multiple price breaks

Simulation: Monte Carlo simulation, advantages and limitations of simulation, applications of simulation **[6 hrs]**

Unit VI: Network analysis

Network construction, identification of critical path, various types of floats and their computations, Programme Evaluation and Review Technique (PERT) time calculations, crashing of network, resource scheduling and network updating. **[6 hrs]**

Text Books:

- S. D. Sharma, Himanshu Sharma, "Operations research: Theory, Methods and Applications", Fifteenth edition, Kedar Nath Ram Nath, Meerut
- Premkumar Gupta, D. S. Hira, "Operations research", revised edition, S. Chand & Company Pvt. Ltd

Reference Books:

- Hamdy A Taha, "Operations research-An introduction", Nineth edition;2011, Pearson
- Maurice Saseini, Arhur Yaspan and Lawrence Friedman, "Operations research: methods and problems", Literary Licensing

(ILOE) Robotics

Teaching Scheme:
Lectures : 3 Hrs/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Course Outcomes:

Student will be able to

1. learn basic terminologies and concepts associated with Robotics & Automation
2. study various Robotic sub-systems and innovations in Robotics
3. understand hardwares and softwares of robotics to understand working of robots
4. study the associated aspects in Robotics and allied sciences.

Unit I: Introduction

Robot Definitions , three laws, DOF, Misunderstood devices…..etc. , Elements of Robotic Systems i.e. Robot anatomy, Classification, Associated parameters i.e. resolution, accuracy, repeatability, dexterity, compliance, RCC device, ..etc,

Automation :- Concept, Need, Principles and Strategies of Automation, Basic Elements of an Automated System

Innovative Robotic Apllications :- Biomimetic Robots, Swarm Robots, Micro & Nano Robots, Surgery Robots, Assisting Robots, Androids & Geminoids….etc. **[5 hrs]**

Unit II: Robot Grippers, Sensors for Robots, Vision Sensors

Robot Grippers:- Types of Grippers , Design aspect for gripper, Force analysis for various basic gripper system.

Sensors for Robots:- Characteristics of sensing devices, Selections of sensors, Classification and applications of sensors. Types of Sensors, Need for sensors and vision system in the working and control of a robot.

Vision Sensors :- Vision System Devices, Image acquisition, Masking, Sampling and quantisation, Image Processing Techniques , Noise reduction methods, Edge detection, Segmentation. **[5 hrs]**

Unit III: Drives, Control Systems

Drives:- Types of Drives, Actuators and its selection while designing a robot system. Types of transmission systems,

Control Systems :- Types of Controllers, Introduction to closed loop control

Control Technologies in Automation :- Industrial Control Systems, Process Industries Verses Discrete-Manufacturing Industries, Continuous Verses Discrete Control, Computer Process and its Forms. **[6 hrs]**

Unit IV: Kinematics, Dynamics

Kinematics :- Transformation matrices and their arithmetic, link and joint description, Denavit - Hartenberg parameters, frame assignment to links, direct kinematics, kinematics redundancy, kinematics calibration, inverse kinematics, solvability, algebraic and geometrical methods.

Dynamics: - Introduction to Dynamics , Trajectory generations & planning **[7 hrs]**

Unit V : Robot Programming, Programming Languages

Robot Programming :- Methods of robot programming, lead through programming, motion interpolation, branching capabilities, WAIT, SIGNAL and DELAY commands, subroutines,

Programming Languages: Introduction to various types such as RAIL and VAL II …etc, Features of each type and development of languages for recent robot systems.

Artificial Intelligence: - Introduction to Artificial Intelligence, AI techniques, Need and application of AI. **[7 hrs]**

Unit VI: Modeling and Simulation

Modeling and Simulation :- Introduction, need for system Modeling, Building Mathematical Model of a manufacturing Plant, Modern Tools- Artificial neural networks in manufacturing

automation, AI in manufacturing, Fuzzy decision and control, robots and application of robots for automation.
Allied Topics in Robotics:- Socio-Economic aspect of robotisation. Economical aspects for robot design, Safety for robot and associated mass, New Trends & recent updates in robotics. Trend of robotisation in industry. **[6 hrs]**

Text Books:

- John J. Craig, "Introduction to Robotics (Mechanics and Control)", Addison-Wesley, 2nd Edition, 2004
- Mikell P. Groover et. Al., "Industrial Robotics : Technology, Programming and Applications", McGraw – Hill International, 1986.
- Shimon Y. Nof ," Handbook of Industrial Robotics" , John Wiley Co, 2001.
- Automation, "Production Systems and Computer Integrated Manufacturing", M.P. Groover, Pearson Education.
- W.P. David, "Industrial Automation", John Wiley and Sons.

Reference Books:

- Richard D. Klafter , Thomas A. Chemielewski, Michael Negin, "Robotic Engineering : An Integrated Approach" , Prentice Hall India, 2002.
- : R.C. Dorf, "Handbook of design, manufacturing & Automation", John Wiley and Sons.

(IOLE) Air Conditioning

Teaching Scheme:
Lectures : 3 Hrs/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Course Outcome :

At the end of course student should be able to:

1. Interpret the concepts of Psychrometry.
2. Demonstrate and select Air-conditioning systems for various applications.
3. Estimate cooling load for various applications.
4. Design the Air conditioning systems.
   Analyze duct system for a central Air-conditioning system

Unit I: Psychrometry

Introduction, Applications of Air conditioning, Psychrometry, Psychrometry chart, Typical Air-conditioning process, Adiabatic cooling, Sensible heating, Cooling with humidification Process, Heating and Humidification, Adiabatic mixing of air streams, Air washer, Chemical dehumidification (Numerical Treatment). **[10 hrs]**

Unit II: Air-conditioning systems

Introduction ,Classification of Air-conditioning systems, Unitary systems, Central Classification of Air-conditioning systems, Reheat system, Multizone system, Dual Duct system, Variable Air Volume system (VAV) system, All – air and water systems, Unitary Vs Central systems**.** **[6 hrs]**

Unit III: Cooling Load Estimation

Introduction, Comfort, Human comfort chart, Outside Design conditions, Sources of heat load ,conduction through Exterior structures, Heat gain through glass , infiltration, ventilation, outside air load , heat load from people, Lightning, heat gain from equipment, System heat gain room cooling loads, cooling coil load. **[8 hrs]**

Unit IV : Designing the Air-Conditioning Systems

Psychometric analysis of Air-conditioning systems, Summer air-condition systems provided with Ventilation air, Room sensible heat factor (RSHF). **[6 hrs]**

Unit V : Air-conditioning Components

Cooling coil, Heating coils, Air cleaning devices, Humidifiers, Fan, Air distribution systems. **[5 hrs]**

Unit VI: Duct Design

Introduction , classification ,Duct materials, Continuity equation , Energy equation for pipe flow, total static velocity pressure , Static region , Pressure loss in duct Rectangular sections equivalent to circular duct. Dynamic losses in duct, Methods of duct design, Duct arrangement systems. **[5 hrs]**

Text Books

- R.J.Dossat, “Principles of Refrigeration”, Pearson Education Asia, 2002
- C.P.Arora, “Refrigeration and Air-conditioning”, Tata McGraw-Hill, 2017
- Stoecker & Jones, “Refrigeration and Air-conditioning”, McGraw Hill Book Company, New York, 1983.
- S.N. Sapali “Refrigeration and Air-conditioning”, PHI, 2016

Reference Books

- J.L.Threlkeld, “Thermal Environmental Engineering”, Prentice Hall, 1970.
- W.F.Stoecker, “Industrial Refrigeration Handbook”, McGraw-Hill, 1998.
- P.C.Koelet, “Industrial Refrigeration: Principles, Design and Applications”, Macmillan, 1992

- ASHRAE HANDBOOKS four volume Index 2014-2017
- "Handbook of air-conditioning system design", Carrier Incorporation, McGraw Hill Book Co.,U.S.A, 1965.
- Jones W.P., "Air Conditioning Engineering", Edward Arnold Publishers Ltd., London, 1985.
- Hainer R.W., "Control Systems for Heating, Ventilation and Air-Conditioning", Van Nostrand Reinhold Co., New York, 1984

(ME) Product Design

Teaching Scheme:
Lectures : 3Hrs/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Course Outcomes:

Students will be able to

1. Put into practice various steps involved in the design of new product.
2. Realize strategies involved in Industrial design.
3. Understand the importance of economic factors in the product design.
4. Apply principles of value engineering to new product development.
5. Understand Product development cycle, especially Booz Allen & Hamilton new product development cycle & A T A R model in financial analysis
6. To implement principles important from environment conservation point of view in product design

Unit I

Introduction, definition, design by innovation, evolution, essential factors of product design, production consumption cycle (pcc), flow and value addition in pcc, morphology of design, primary phases of design, role of allowances, process capability and tolerances in design and assembly **[8 hrs]**

Unit II

Product design strategies in industry , pricing, quality, utility, luxiriousness, product analysis, simplification, designer and his role, Industrial design considerations, procedures, problems, types of models, role of aesthetics, functional design practices **[6 hrs]**

Unit III

Economic factors influencing design, product value, economic analysis, profit , competitiveness, break even **[6 hrs]**

Unit IV

Value engineering & product design, value, value analysis job plan, creativity, value analysis tests **[8 hrs]**

Unit V

New product development and product management- defining product by nature and demand, New product strategy, product classification, product development & management, product life cycle, Booz Allen & Hamilton new product development cycle, A T A R model applied to financial analysis in business. **[8 hrs]**

Unit VI

Product design for environment, introduction, importance, factors, scope of impact, global & local issues, guidelines for design, life cycle assessment **[6 hrs]**

Text Books:

- K. Chitale, R. C. Gupta, "Product Design and Manufacturing" , PHI Publication, 2013

Reference Books:

- Karl T. Ulrich, Stephen Eppinger, "Product Design and Development", McGraw Hill Publication, 2012

(ME) CAD/CAM Laboratory

Teaching Scheme:
Practical : 2 Hrs/week

Examination Scheme:
Term Work: 50 Marks
Oral Exam: 50 Marks

Course Outcomes:

Students will be able to:

1. Design a product and assembly using CAD software
2. Prepare CNC program and simulate.
3. Distinguish various 3D printers and able to operate them.

List of experiments:

1. Describe typical CAD/CAM laboratory – Workstation specifications, networking layouts, CNC machines, 3D printer, Scanner specifications, typical layout of CAD/CAM lab.

2. Use of CAD software to create 3-D models.
3. Use of CAD software to create assembly of components.
4. Generate part and Assembly drawings
5. Manual part programming for CNC lathe machine.
6. Manual part programming for CNC milling machine.
7. Write a program to generate a curve/surface
8. Demonstration of 3D printers and scanners.

(ME) Refrigeration and Air Conditioning Lab

Teaching Scheme:
Practical : 2 Hrs/week

Examination Scheme:
Term work: 50 marks
Practical/oral: 50 Marks

Course Outcome:

At the end of course student should be able to:

1. Demonstrate the working of domestic refrigerator and Split Air-conditioning systems.
2. Estimate and analyze the cooling capacity, COP, Power of a VCR system.
3. Determine the RSHF using Psychrometric chart.
4. Analyze performance of Expansion devices in VCR system
5. Estimate the cooling capacity of a evaporative air cooler

List of experiments

1. Demonstration of a domestic refrigerator along with different auxiliary systems associated with a refrigerator.
2. Trial on Vapour Compression Refrigeration System to determine cooling capacity and coefficient of performance.
3. Trial on Vapour Compression Refrigeration System with R290 as a refrigerant (Application: Water Cooler)
4. Trial on Air conditioning test rig to determine cooling capacity and COP of VCR system with R22 as a refrigerant.
5. Trial on Air conditioning test rig to study the psychrometric processes.
6. Trial on an Evaporative Air Cooler
7. Trial on Ice Plant, to determine Coefficient of Performance for ice plant test rig
8. Trial on VCR System to study the performance analysis of expansion devices

(ME) Mechanical measurement and Automatic Control Lab

Teaching Scheme:

Lab : 2Hrs/week

Examination Scheme:

Term Work: 50 Marks

Viva voce: 50 marks

Course Outcomes:

Students will be able to

1. Understand the basic concepts of mechanical measurement.
2. Describe methods of measurement for various quantities like force, torque, power, displacement, velocity/seed and acceleration e.
3. Describe the basic features and configurations of control systems.
4. Understand the basic control actions.
5. Find the transfer function of a physical system and represent in block diagram form.

List of Experiments: (Any eight)

1. To study about mechanical measurements and control.
2. Measurement of displacement using LVDT.
   To study a Linear Variable Differential Transformer (LVDT) and use it in a simple experimental set up to measure a small displacement.
3. Measurement of Temperature: Thermocouple, Thermistor& RTD and comparative analysis
   a. To study the characteristics of RTD.
   b. To study the characteristics of J, K and PT100 type of thermocouples.
4. Measurement of Pressure using Bourdon pressure gauge.
   To study the working of Bourdon Pressure Gauge and to check the calibration of the gauge in a deadweight pressure gauge calibration set up.
5. Measurement of speed using non-contact type device.
   To measure the speed of a motor shaft with the help of non-contact type pick-ups
6. Study of control system components
7. An experiment on speed control of stepper motor
8. An experiment on level control system
9. An experiment on ON-OFF temperature control
10. An experiment on various models of control I, P, P+I, P+D & P+I+D.

PROJECT STAGE –I

Teaching Scheme	**Examination Scheme**
Practical – 4 hrs/week	Term work - 50 marks
	Practical/Oral- 50 marks

The students in a group of not more than FOUR will work under the guidance of the faculty member on the project work undertaken by them. The completion of work, the submission of the report and assessment should be done at the end of Part I (1st Semester).

The project work may consist of,

1. A comprehensive and up-to-date survey of literature related to study of a phenomenon or product.

2. Design of any equipment and / or its fabrication and testing.

3. Critical Analysis of any design or process for optimizing the same.

4. Experimental verification of principles used in applications related to Production Engineering.

5. Software development for particular applications.

6. A combination of the above.

The objective is to prepare the students to examine any design or process or phenomenon from all angles, to encourage the process of independent thinking and working and to expose them to industry. The students may preferably select the project works from their opted elective subjects.

A synopsis of the selected project work (two to three pages typed on A4 size sheets) certified by the project guide, should be submitted before the month of June of year. The synopsis shall be a part of the final project report.

The students should submit the report in a prescribed format, at the end of 1st semester. The report shall be comprehensive and presented in duplicate, typed on A4 size sheets and bound.

1. Term work will be assessed by the project guide along with one colleague appointed by the Head of Department.

2. The students will be examined orally by the external examiner and the project guide, as the internal examiner. Marks will be awarded on the basis of the work done and performance in the oral examination

Minor course
(ME) Manufacturing Technology

Teaching Scheme
Lectures: 3 hrs/Week

Examination Scheme
Test (I & II) - 40 marks
End Sem. Exam - 60 marks

Course Outcomes:

1. Analyze the need of manufacturing processes and develop a holistic approach to meet requirements of manufacturing industries.
2. Evaluate various surface finishing techniques and apply as needed in real time industry scenario.
3. Apply the knowledge of computer aided manufacturing.

Unit I: Metal Casting Processes
Types of casting processes, Sand Casting : Sand Mould terminology, Steps and operations involved, Type of patterns, Pattern Materials, allowances, Moulding sand Properties Cores, Castings: Cleaning and finishing; Inspection and testing, Principle of special casting processes, applications and Defects in Sand casting **[6 hrs]**

Unit II: Joining Processes
Operating principle, basic equipment, merits, types and applications of Gas welding, electric arc welding, resistance welding, miscellaneous welding processes, Weldability, Weld defects: types, causes and cure, Brazing and soldering **[7 hrs]**

Unit III: Mechanical Working of Metals
Hot working and cold working of metals, Forging: types and characteristics; Forging Machines; typical forging operations, Rolling: Principle of operation; Types of Rolling mills; Defects in rolled parts, Drawing of wire, rod and tube, Principles of Extrusion, Types of Extrusion, Hot and Cold extrusion **[6 hrs]**

Unit IV: Sheet Metal Processes
Sheet metal working, shearing, bending and drawing operations: working principle and applications, Stretch forming operations, Formability of sheet metal, Test methods, Special forming processes: Working principle and applications **[6 hrs]**

Unit V: Surface Finishing Operations

Introduction and need of surface finishing operations, Principle of operation and application: Grinding, Lapping Honing, Powder coating, polishing **[6 hrs]**

Unit VI: Fundamentals of Computer Aided Manufacturing

Working and Classification NC machines, Basics of Part Programming, Adaptive Control, Computer Numerical Control (CNC), Direct Numerical Control (DNC), Machining Centre, Advantages, Disadvantages and Applications of NC, CND, DNC systems **[5 hrs]**

Text Books:

- Sharma, P.C., "A Text book of production Technology", S.Chand and Co. Ltd., 2006
- Amitabha Ghosh and Ashok Kumar Mallik, “Manufacturing Science”, Affiliated East-West Press Private limited, 2010
- Hajra Chouldhary S.K and Hajra Choudhury. AK., "Elements of workshop Technology", volume I and II, Media promoters and Publishers Private Limited, Mumbai, 2017

Reference Books:

- Kalpakjian. S, “Manufacturing Engineering and Technology”, Pearson Education India Edition Gowri P. Hariharan, A.Suresh Babu, "Manufacturing Technology I", Pearson Education, 2008
- Rao, P.N. "Manufacturing Technology Foundry, Forming and Welding", 2003
- CAD/CAM: Computer Aided design and Manufacturing by Mikell Groover and Zimmer, Pearson Education

Honour course Thermal Stream

(ME) Advance Heat Transfer

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
T1, T2 – 20 marks each,
End-Sem Exam - 60

Course Outcomes:

At the end of the course:

1. The students are expected to understand the subject of Heat Transfer in detail with capability to solve Industrial Problems. This will also create the base and interest among the students to carry out the Future Research

Unit I: Conduction- one and two dimensional

Unit II: Fins, conduction with heat source, unsteady state heat transfer

Unit III: Natural and forced convection, integral equation, analysis and analogies

Unit IV: Transpiration cooling, ablation heat transfer, boiling, condensation and two phase flow mass transfer, cooling, fluidized bed combustion

Unit V: Heat pipes, Radiation, shape factor, analogy, shields

Unit VI: Radiation of gases & vapours

References:

- J.P. Holman, "Heat Transfer", McGraw Hill Book Company, New York, 1990.
- Incropera and Dewitt, "Fundamentals of Heat and Mass Transfer", John Wiley and Sons, NewYork, 2000.
- Frank Kreith, "Principles of Heat Transfer", Harper and Row Publishers, New York, 1973.
- Donald Q. Kern "Process Heat Transfer", Tata McGraw Hill Publishing Company Ltd., New Delhi, 1975.
- Gupta and Prakash, "Engineering Heat Transfer", New Chand and Bros, Roorkee (U.P.) India, 1996.
- R.C. Sachdeva "Fundamentals of Engineering Heat and Mass Transfer", Wiley Eastern Ltd., India

Honour course Design Stream

(ME) Stress Analysis

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
T1, T2 – 20 marks each,
End-Sem Exam – 60

Course Outcomes:

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

1. Apply the tensorial approach of continuum mechanics for complex analysis and comprehend modern research material.
2. Synthesis the basic field equations such as equilibrium equations, compatibility and constitutive relationship.
3. Evaluate torsion, bending and two dimensional problems employing basic field equations, energy methods and plastic hinges.
4. Estimate any complex analysis using proficient FEM software packages with framing correct boundary conditions.

Unit I: Tensors:
Tensor, transformation of tensorial components, dot and cross product of vectors, eigenvalue problems, Gradient of a scalar, Gauss theorem. Stress Analysis; traction vector, Stress tensor, stress components at a point of a free surface, Principal stresses and principal directions, Mohr circle, theories of yielding. **[6 hrs]**

Unit II: Deformation and strain:
Deformation gradient, polar decomposition theorem, Cauchy-Green tensor, Green strain tensor, small displacement strain tensor, engineering and tensorial strains, transformation of strain components in cylindrical coordinates. Compatibility relations in strain components and in stress components, conservation laws; conservation of linear momentum and angular momentum, equilibrium equations in Cartesian and cylindrical coordinates. **[6 hrs]**

Unit III: Constitutive relations and Linear Elasticity:
Uniaxial stress tension test, true stress and true strain, strain energy density, generalized Hooks law, Isotropic materials, boundary conditions, principle of superposition, uniqueness, Saint-Venant's principle, Dislocations in crystalline materials, Bauschinger effect. **[6 hrs]**

Unit IV: Two dimensional problems and Energy methods:
Plane stress, Plane strain, Biharmonic equation and Airy's stress function, Biharmonic equation in cylindrical coordinates, concentrated load on half space, Energy methods; strain energy and complimentary energy, principle of virtual work, principle of minimum potential energy, Rayleigh Ritz methods, Castiglione's theorems. **[6 hrs]**

Unit V: Torsion:
Polar rotation, Prandlt stress approach, torsion of non-circular cross-sections, Prandlt membrane analogy, torsion of thin plates and thin wall tubes. **[6 hrs]**

Unit VI: Bending and Shearing:
Short beam, bending of asymmetrical sections, shear stress on a thin wall open section **[6 hrs]**

Text Books:

- Arbind kumar Singh, "Mechanics of solids", Prentice Hall of India Pvt. Ltd, New Delhi, 2007.
- Srinath L.S, "Advanced Mechanics of Solids", Tata McGraw Hill Education, New Delhi, 2009.

Reference Books:

- Sadd Martin H., "Elasticity: Theory, Applications and Numerics", Elsevier, 2014.
- Boresi A.P. and K. P. Chong, "Elasticity in Engineering Mechanics", Second Edition, John Wiley & Sons, 2000.

- Budynas R. G., “Advance strength and Applied Stress Analysis”, Second Edition, McGraw Hill, 1999.
- Dally J. W. and Riley W.F., “Experimental Stress Analysis”, McGraw Hill International, 2005.

Semester VIII

(ME) Metrology and Quality Control

Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/week	T1, T2 – 20 marks each, End-Sem Exam – 60

Course Outcomes

After completion of the course student will be able to

1. An ability to apply knowledge of various tools and techniques used to determine geometry and dimensions of components in engineering applications.
2. An ability to perform experiments, as well as to analyze and interpret data.
3. An ability to design gauges to meet desired needs within realistic constraints.
4. An understanding of Quality Control Techniques and its applications in engineering industries

Unit I: Measurement standards and comparators

Principles of Engineering metrology, Measurement standards, Types and sources of errors, Accuracy and Precision, introduction to uncertainty in measurement, linear and angular measuring instruments and their applications. Calibration: Concept and procedure, traceability, Gauge R&R Comparators: Mechanical, Pneumatic, Optical, Electrical (LVDT).Checking all geometrical forms. **[6 hrs]**

Unit II : Design of gauges, Interferometers and Surface Roughness measurements

Design of Gauges: Tolerances, Limits and Fits, Taylors principle, Types of gauges and gauge design (numerical). Interferometer: Principle, NPL Interferometer, Laser Interferometer and their applications. Surface Roughness Measurement: Surface texture, Parameters for measuring surface roughness, Contact & non-contact type surface roughness measuring instruments.

[8 hrs]

Unit III: Metrology of Thread, Gears and Advance Metrology

Measurement of Thread form: Thread form errors, Measurement of Minor, Major and Effective diameter (Three Wire Method), Flank angle, pitch, Floating Carriage Micrometer (Numerical). Gear Metrology: Types of errors, Gear tooth Vernier, Constant chord, Base tangent (Numerical), Gear Rolling Tester. Profile Projector, Tool makers microscope and their applications. Advancements in Metrology: Introduction & applications of: Co-ordinate Measuring Machine, Universal Measuring Machine, Laser in Metrology, Automatic inspection system, Machine vision for online-offline inspection. **[6 hrs]**

Unit IV : Introduction to Quality and Quality Tools

Quality: Dimensions, Statements, Cost of quality & value of quality, Deming‟s cycles & 14 Points, Juran Trilogy approach, Seven Quality Tools, Introduction to N Seven Tools, Quality Circle, Criteria for Quality Award (National & International). University of Pune. **[6 hrs]**

Unit V: Statistical quality control

Statistical quality control: Statistical concept, Frequency diagram, Concept of variance analysis, Control Chart for Variable (X & R Chart) & Attribute (P & C Chart), Process capability(Indices: cp, cpk, ppk), Statistical Process Control (Numerical). Production Part Approval Method (PPAP). **[8 hrs]**

Unit VI

Acceptance Sampling: Sampling Inspection, OC Curve and its characteristics, sampling methods, Sampling Plan: Single, Double (Numerical), Multiple, Comparison of Plan, calculation of sample size, AOQ, Probability of Acceptance (Numerical). **[6 hrs]**

Text Books

- Hume K.J., “Engineering Metrology”, Macdonald Publications, ISBN no13-978-81-7409-153-X,1984.
- Jain R.K.,“Engineering Metrology”, Khanna Publication, ISBN no 13-978-81-7409-153-X,1984
- Juran J. M., “Quality Handbook”, McGraw Hill Publications,1951.
- Grant S.P., “Statistical Quality Control”, Tata McGraw hill Publication,1988.
- Kulkarni V. A. and Bewoor A. K.,” Quality Control”, John Wiley Publication, ISBN no 13-978-8126519071,2009.

Reference Books

- Galyer J.F & Shotbolt C.R., “Metrology for engineers”, ISBN no 13-978-0304318445, Edition 5,1990
- Gupta I.C., “Engineering Metrology”, Dhanpatrai Publiartions, ISBN no 8189928457, Edition 7,2012
- Judge A.W.,” Engineering Precision Measurements”, Chapman and Hall,1944.

- Francis T. Farago, Mark A. Curtis, “Handbook of dimensional measurement”, Edition 2,1982.
- ASTME, “Handbook of Industrial Metrology”, Prentice Hall of India Ltd,1967.
- Basterfield, “Quality control”, ISBN no 13-978-0135000953, Edition 8.
- Harrison M. Wordsworth, Stefeen Godfrey, “Modern Methods for Quality control and Improvement”, Willy publication.

(ME) Energy Conservation and Management

Teaching Scheme:
Lectures : 3Hrs/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Course Outcomes:

Student will be able to:

1. Explain the importance of energy conservation
2. Calculate energy losses in process, equipment and plat etc.
3. Showcase energy conservation opportunities in various mechanical systems and suggest methods for energy savings
4. Analyze the energy data of industries and utilize the technical skills attained in carrying out energy accounting and balancing
5. Perform energy audit and use energy management tools
6. Apply practices of energy conservation in various sectors like domestic, Industry and commercial

Unit I : Introduction:
Global Energy Scenario and Indian Energy Scenario in various sectors and Indian economy. Concerns of Energy Security in India
Basics – Revision of basics of Electrical and Mechanical Engineering relevant to Energy conservation and Management, Definitions of units, conversions in commercial practices Sankey Diagrams, Specific Energy consumption **[6 hrs]**

Unit II: Economic Analysis
Simple Payback Period, Return on Investment, Dynamic value of money, Discount Rate Cash flows, Time value of money, Formulae relating present and future cash flows - single amount, uniform series; Payback period; Return on Investment (ROI); Life Cycle cost.
Costing of Utilities- specific costs of uyilities like; all fuels stream, compressed air, electricity, water etc. **[6 hrs]**

Unit III: Energy Auditing

Elements and concepts, Types of energy audits, methodology, Instruments used in energy auditing; Portable and On-line instruments; Role of Non-Conventional Energy Sources in Energy Conservation; Need and Kyoto Protocol, Carbon Credits and Clean Development Mechanism (CDM). **[6 hrs]**

Unit IV: Fuels, Boilers, Steam Systems

Fuels– Solid, Liquid and gaseous, Combustion, Excess air requirements, Flue gas monitoring

Boilers–Performance testing, efficiencies, and energy conservation opportunities

Steam Systems– Aspects of steam distribution, Steam Traps, Condensate and Flash-steam utilization, Energy conservation opportunities, Thermal Insulation **[6 hrs]**

Unit V: Mechanical systems

Energy Conservation Opportunities in compressed air systems, Refrigeration and air-conditioning system and water systems, Elementary coverage of Energy conservation in pumps and fans Cogeneration-concept, options(steam/gas, turbine/DCT-based), Selection criteria, Trigeneration **[6 hrs]**

Unit VI: Electric System

Demand control, Demand Side Management (DSM), Power Factor Improvement, benefits and ways of improvement, Load scheduling, Electric motors, losses, efficiency, energy-efficient motors, motor speed control, variable speed drive. Lighting: Illumination levels, fixtures, timers, energy- efficient illumination. **[6 hrs]**

Text Books:

- Energy Manager Training Manual (4 Volumes) available at a website administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India.
- S Rao and B B Parulekar ," Energy Technology" Khanna Publishers, 2012
- K. V. Sharma, P. Venkataseshaiah, "Energy Management and Conservation", I.K. International Publishing House Pvt. Limited, 2011

Reference Books

- Witte. L.C., P.S. Schmidt, D.R. Brown, "Industrial Energy Management and Utilization" Hemisphere Publication, Washington, 1988
- D.A. Reay, "Industrial Energy conservation: A handbook for engineers and managers", Pergamon Press, 1979
- Patrick Steven R., Patric Dale R. and Fordo Stephen : Energy conservation Guide book, The Fairmont Press Inc.7, 1993

- Albert Thumann, “Plant Engineers and managers Guide to Energy conservation”, The Fairmont Press, 2010
- WR Murphy and G McKay, “Energy Management”, Butterworth Heinemann, Elsevier, 1982

(ME) Air Conditioning System Design

Teaching Scheme:
Lectures : 3 Hrs/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Course Outcome:

At the end of course student should be able:

1. Interpret the concepts of Psychrometry.
2. Demonstrate and select Air-conditioning systems for various applications.
3. Estimate cooling load for various applications.
4. Design the Air conditioning systems.
5. Analyze duct system for a central A.C. systems.

Unit I: Psychrometry:

Introduction, applications of Air conditioning, Psychrometry, Psychrometry chart, Typical Air-conditioning process, Adiabatic cooling, Sensible heating, Cooling with humidification Process, Heating and Humidification, Adiabatic mixing of air streams, Air washer, Chemical dehumidification. (Numerical Treatment) **[8 hrs]**

Unit II: Air-conditioning systems:

Introduction ,Classification of Air-conditioning systems, Unitary systems, Central Classification of Air-conditioning systems, Reheat system, Multizone system, Dual Duct system, Variable Air Volume system (VAV) system, All – air and water systems, Unitary Vs Central systems. **[6 hrs]**

Unit III : Cooling Load:

Introduction, Thermodynamics of human body and mathematical model, Effective temperature, Human comfort chart, Outside Design conditions, Sources of heat load ,conduction through Exterior structures, Heat gain through glass , infiltration, ventilation, outside air load , heat load from people, Lightning, heat gain from equipment, System heat gain room cooling loads, cooling coil load. **[10 hrs]**

Unit IV :Designing the Air-Conditioning Systems:

Psychometric analysis of air-conditioning systems, summer air conditioner systems provided with ventilation air, Room sensible heat factor (RSHF) **[6 hrs]**

Unit V : Selection of Air-conditioning Components:
Cooling coil, Heating coils, Air cleaning devices, Humidifiers, Fan, Air distribution systems.
[5 hrs]

Unit VI: Duct Design:
Introduction , classification ,Duct materials, Continuity equation , Energy equation for pipe flow, total static velocity pressure , Static region , Pressure loss in duct Rectangular sections equivalent to circular duct. Dynamic losses in duct, Methods of duct design, Duct arrangement systems. **[5 hrs]**

Text books:

- S.N. Sapali "Refrigeration and Air-conditioning", PHI (Second Edition) 2016
- R.J.Dossat, "Principles of Refrigeration", Pearson Education Asia, (5th edition) 2014
- C.P.Arora, "Refrigeration and Air-conditioning", Tata McGraw-Hill, (3 rd Edition) 2017
  Stoecker & Jones, "Refrigeration and Air-conditioning", McGraw Hill Book Company, New York, (2nd edition) 1983

Reference Books

- J.L.Threlkeld, "Thermal Environmental Engineering", Prentice Hall, 1970.
- W.F.Stoecker, "Industrial Refrigeration Handbook", McGraw-Hill, 1998.
- P.C.Koelet, "Industrial Refrigeration: Principles, Design and Applications", Macmillan, 1992
- ASHRAE HANDBOOKS four volume Index 2014-2017
- "Handbook of air-conditioning system design", Carrier Incorporation, McGraw Hill Book Co.,U.S.A, 1965.
- Jones W.P., "Air Conditioning Engineering", Edward Arnold Publishers Ltd., London, 1985.
- Hainer R.W., "Control Systems for Heating, Ventilation and Air-Conditioning", Van Nostrand Reinhold Co., New York, 1984

(ME) Introduction to Optimum Design

Teaching Scheme:
Lectures : 3 Hrs/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Course outcomes:

After completion of the course students will be able to:

1. formulate an optimization problem
2. classify a problem
3. apply the algorithms for design optimization
4. test the optimality of an optimum solution

Unit I: Introduction to optimization
Basic principles, optimal problem formulation, classification of optimization problems, Differences between classical and modern optimization techniques **[4 hrs]**

Unit II: One dimensional minimization
Optimality criteria, bracketing methods, direct search methods, gradient based search methods **[8 hrs]**

Unit III: Multivariable Unconstrained Optimization
Optimality criteria, direct search methods, gradient based search methods, applications **[8 hrs]**

Unit IV: Constrained optimization
KKT conditions, direct search methods, gradient based search methods, applications **[8 hrs]**

Unit V: Linear programming
Linear problem formulation, simplex method and duality in linear programming, sensitivity or post-optimality analysis, Karmarkar's method **[4 hrs]**

Unit VI: Introduction to Genetic Algorithms
Operators, method, applications like optimum design of spring, gear box, etc. **[4 hrs]**

Test Books

- Kalyanmoy Deb, "Optimization for Engineering Design", Prentice Hall of India, New Delhi, 2016
- J. S. Arora, "Introduction to Optimum Design", McGraw Hill, New York, 2014

Reference Books

- R.C. Johnson, "Optimum Design of Mechanical Elements" , Willey, New York, 2011
- L.C.W. Dixon, Birkhauser, "Non-Linear Optimization - Theory and Algorithms" , Boston, 2005

(ME) Mechanics of Composite Materials

Teaching Scheme: **Examination Scheme:**

Lectures : 3 Hrs/week

T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Course Outcomes:

The student should be able to

1. Differentiate between composite materials and conventional materials using basic concepts.
2. Determine role of constituent materials in defining the average properties and response of composite materials on macroscopic level.
3. Apply knowledge for finding failure envelopes and stress-strain plots of laminates.
4. Develop a clear understanding to utilize subject knowledge using computer programs to solve problems at structural level.

Unit I : Introduction

Definition and characteristics, overview of advantage and limitations of compositr materials, Significance and objectives of composite materials, Science and technology, current status and future prospectus. **[4 hrs]**

Unit II. Basic Concepts and Characteristics

Structural performance of conventional material, Geometric and physical definition, Material response, Classification of composite materials, Scale of analysis; Micromechanics, Macromechanics, Basic lamina properties, Constituent materials and properties, Properties of typical composite materials **[5 hrs]**

Unit III. Processing of FRP Composites

Contact moulding, Compression moulding, Pultrusion, Filament winding, Resin transfer moulding and Autoclave processing **[5 hrs]**

Unit IV. Elastic Behavior of Unidirectional Lamina

Stress-strain relations, Relation between mathematical and engineering constants, transformation of stress, strain and elastic parameters **[6 hrs]**

Unit V. Strength of Unidirectional Lamina

Micromechanics of failure; failure mechanisms, Macromechanical strength parameters, Macromechanical failure theories, Applicability of various failure theories **[7 hrs]**

Unit VI. Elastic Behavior of Laminate

Basic assumptions, Strain-displacement relations, Stress-strain relation of layer within a laminate, Force and moment resultant, General load–deformation relations, Analysis of different types of laminates, Hygrothermal effects on mechanical behavior, Hygrothermal stress-strain relations, Hygro-thermoelastic stress analysis of laminates, Residual stresses, Warpage **[8 hrs]**

Text Books:

- Isaac M. Daniels and Ori Ishai, “Engineering Mechaincs of Composite Materials”, Oxford University Press, 1994.

Reference Books

- Bhagwan D. Agarwal and Lawrence J. Broutman, “Analysis and Performance of fiber composites”, John Wiley and Sons, Inc. 1990.
- Mathews F. L. and Rawlings R. D., “Composite Materials: Engineering and Science”, CRC Press, Boca Raton, 2003.
- Madhujit Mukhopadhyay, “Mechanics of Composite Materials and Structures”, University Press, 2004.
- Mazumdar S. K., “Composite Manufacturing – Materials, Product and Process Engineering”, CRC Press, Boca Raton, 2002.
- Robert M. Jones,” Mechanics of Composite Materials”, Taylor and Francis, Inc., 1999.

(ME) Robotics and Automation

Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/week	Test I and II – 20 each End Sem. Exam – 60 marks

Course Outcomes:

Student will be able to

1. To understand basic terminologies and concepts associated with Robotics & Automation
2. To study various Robotic sub-systems and Automation systems
3. To study kinematics and dynamics to understand exact working pattern of robots
4. To study the associated recent updates in Robotics and Automation

Unit I

Introduction:- Basic Concepts such as Definition , three laws, DOF, Misunderstood devices…..etc. , Elements of Robotic Systems i.e. Robot anatomy, Classification, Associated parameters i.e. resolution, accuracy, repeatability, dexterity, compliance, RCC device, ..etc,

Automation :- Concept, Need, Automation in Production System, Principles and Strategies of Automation, Basic Elements of an Automated System, Advanced Automation Functions, Levels of Automations, introduction to automation productivity. **[5 hrs]**

Unit II

Robot Grippers:- Classification of Grippers , Design aspect and design guidelines for robot gripper design, Force analysis for various basic gripper system.

Sensors for Robots:- Characteristics of sensing devices, Selections of sensors, Classification and applications of sensors. Types of Sensors, Need for sensors and vision system in the working and control of a robot. Machine Vision System :- Vision System Devices, Image acquisition, Masking, Sampling and quantisation, Image Processing Techniques , Noise reduction methods, Edge detection, Segmentation. **[5 hrs]**

Unit III

Drives:- Types of Drives, Actuators and its selection while designing a robot system. Types of transmission systems,

Control Systems :- Types of Controllers, Introduction to closed loop control

Control Technologies in Automation :- Industrial Control Systems, Process Industries Verses Discrete-Manufacturing Industries, Continuous Verses Discrete Control, Computer Process and its Forms. Control System Components such as Sensors, Actuators and others. **[6 hrs]**

Unit IV

Kinematics :- Transformation matrices and their arithmetic, link and joint description, Denavit - Hartenberg parameters, frame assignment to links, direct kinematics, kinematics redundancy, kinematics calibration, inverse kinematics, solvability, algebraic and geometrical methods.

Velocities and Static forces in manipulators:- Jacobians, singularities, static forces, Jacobian in force domain.

Dynamics :- Introduction to Dynamics , Trajectory generations **[7 hrs]**

Unit V

Robot Programming :- Methods of robot programming, lead through programming, motion interpolation, branching capabilities, WAIT, SIGNAL and DELAY commands, subroutines,

Programming Languages : Introduction to various types such as RAIL and VAL II …etc, Features of each type and development of languages for recent robot systems.

Artificial Intelligence:- Introduction to Artificial Intelligence, AI techniques, Need and application of AI. **[7 hrs]**

Unit VI

Modeling and Simulation for manufacturing Plant Automation:- Introduction, need for system Modeling, Building Mathematical Model of a manufacturing Plant, Modern Tools- Artificial

neural networks in manufacturing automation, AI in manufacturing, Fuzzy decision and control, robots and application of robots for automation.
Other Topics in Robotics:- Socio-Economic aspect of robotisation. Economical aspects for robot design, Safety for robot and associated mass, New Trends & recent updates in robotics **[6 hrs]**

Text Books:

- John J. Craig, "Introduction to Robotics (Mechanics and Control)", Addison-Wesley, 2nd Edition, 2004
- Mikell P. Groover et. Al., "Industrial Robotics : Technology, Programming and Applications", McGraw – Hill International, 1986.
- Shimon Y. Nof ," Handbook of Industrial Robotics" , John Wiley Co, 2001.
- Automation, "Production Systems and Computer Integrated Manufacturing", M.P. Groover, Pearson Education.
- W.P. David, "Industrial Automation", John Wiley and Sons.

Reference Books:

- Richard D. Klafter , "Thomas A. Chemielewski, Michael Negin, Robotic Engineering : An Integrated Approach" , Prentice Hall India, 2002.
- R.C. Dorf, "Handbook of design, manufacturing & Automation", John Wiley and Sons.
- Shimon Y. Nof , "Handbook of Industrial Robotics" , John Wiley Co, 2001.
- Niku, Saeed B. , "Introduction to Robotics Analysis, Systems Applications", Pearson Ed. Inc. New Delhi.

(ME) Project Management

Teaching Scheme:
Lectures : 3Hrs/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Course Outcomes

After completion of the course student will be able to

1. Manage the scope, cost, timing, and quality of the project, at all times focused on project success as defined by project stakeholders.
2. Align the project to the organization's strategic plans and business justification throughout its lifecycle.
3. Identify project goals, constraints, deliverables, performance criteria, control needs, and resource requirements in consultation with stakeholders.

4. Implement project management knowledge, processes, lifecycle and the embodied concepts, tools and techniques in order to achieve project success.
5. Utilize technology tools for communication, collaboration, information management, and decision support.
6. Implement general business concepts, practices, and tools to facilitate project success.
7. Apply appropriate legal and ethical standards.

Unit I: Project Integration & Structures

Project and Importance of Project Management, Project Life Cycle, Role and Responsibilities of Project Manager, Project Integration Management.

Project Management Structures, Right Project Management Structure, Organization Culture **[6 hrs]**

Unit II: Project Appraisal & Selection

Organization Strategy: Strategic Management Process, Need for Portfolio Management, Selection Criteria: Financial and Non-Financial **[6 hrs]**

Unit III: Project Planning, scheduling & Control

Defining the Project: Project Scope, Creating Work Breakdown Structure, Responsibility Matrix and Communication Plan.

Quality of Estimates and Guidelines, Methods for Estimating Project Times and Costs, Type of Costs **[6 hrs]**

Unit IV : Managing Risk & People

Risk Management Process, Contingency Plans, Change Control Management, Managing Vs. Leading A Project

Managing Project Stakeholders, Influence as Exchange, Managing Project Teams: Team Development, Establishing Team identitiy, Managing Conflicts, Project Team Pitfalls **[6 hrs]**

Unit V: Project Planning, Scheduling & Control problems CPM & PERT

Developing a project plan and project network, AOA and AON diagram, CPM calculations, problem solving, PERT model, pert calculations, time scale network, problem solving , network scheduling with limited resources, heuristic programs, resource allocation & spar model, problem solving, precedence diagramming, decision networks, Pert network, problem solving, reducing project duration, project cost – duration graph, crashing of activities, project monitoring information system, developing status report, earned value analysis. **[6 hrs]**

Unit VI: Project Audit, Closure

Project audit, project closure, retrospectives **[6 hrs]**

Text Book(s)

- Clifford F. Grey, Erik W. Larson, Gautam V. Desai “Project Management The Managerial Process”, McGraw Hill Education(India) Private Limited, New Delhi, Sixth Edition, 2014

- Jerome D Wiest & Ferdinand K Levy, "A Management Guide to PERT/ CPM with GERT/PDM/DCPM and other Networks", PHI Learning Private Limited, 2nd Edition 2009

Reference Book(s)

- Kerzner Harold," Project Management: A Systems Approach to Planning, Scheduling and Controlling", Wiley Student Edition 10th Ed., 2013

(ME) - Design of Heat Exchanger

Teaching Scheme:
Lectures : 3Hrs/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Course Outcomes:

Student will be able to:

1. Demonstrate a basic understanding of several types of heat exchangers and its performance
2. Design and analyze various heat exchangers using heat exchanger design standards and codes
3. Appreciate the consequences of fouling on performance of heat exchangers and determine fouling resistance
4. Carry out Thermal and Hydraulic design and analysis of heat exchangers for various real time problems including heat transfer coefficient enhancement and fouling effect
   Use simulation and optimization tools in heat exchanger design

Unit I :
Heat Exchangers – Classification according to transfer process, flow arrangement, number of fluids, surface compactness, and construction features. Tubular heat exchanger, plate type heat exchangers, extended surface heat exchangers, heat pipe, Regenerators. **[6 hrs]**

Unit II:
Heat exchanger design methodology, assumption for heat transfer analysis, problem formulation, ϵ-NTU method, P-NTU method, Mean temperature difference method. **[6 hrs]**

Unit III:
Fouling of heat exchanger, effects of fouling, categories of fouling, fundamental processes of fouling, determination of fouling resistance and consequences of fouling on performance of heat exchangers. **[6 hrs]**

Unit IV:
Double Pipe Heat Exchangers: Thermal and Hydraulic design of inner tube, Thermal and hydraulic analysis of Annulus, Pressure drop analysis
Compact Heat Exchangers: Thermal and Hydraulic design of compact heat exchanger **[6 hrs]**

Unit V:
Shell and Tube heat exchangers – Tinker's, kern's, and Bell Delaware's methods, for thermal and hydraulic design of Shell and Tube heat exchanger **[6 hrs]**

Unit VI:
Mechanical Design of Heat Exchangers – design standards and codes, key terms in heat exchanger design, and thickness calculation for major components such as tube sheet, shell, tubes etc. **[6 hrs]**

Text Books:

- Ramesh K. Shah and Dusan P. Sekulic, "Fundamentals of Heat Exchanger Design" John Wiley & sons Inc., 2013

Reference Books

- D.C. Kern, "Process Heat Transfer", McGraw Hill, 1950.
- Sadik Kakac and Hongton Liu, "Heat Exchangers: Selection, Rating and Thermal Design" CRC Press, 1998
- Geoffrey F. Hewitt, "Hand Book of Heat Exchanger Design",Begell House, 1992.
- "T.E.M.A. Standard", New York, 1999.
- Kuppan Thulukkanam, "Heat Exchanger Design Handbook", CRC Press, 2nd Edition, 2013

(ME) Introduction to Nuclear Reactor Engineering

Teaching Scheme:
Lectures : 3Hrs/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Course Outcomes:

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

1. The basic concepts and processes taking place inside a nuclear reactor, such as nuclear fission, neutron production, scattering, diffusion, slowing down and absorption.

2. The student will also be familiar with concepts of reactor criticality, the relationship between the dimension and fissile material concentration in a critical geometry.
3. Time dependent (transient) behavior of power reactor in non-steady state operation and the means to control the reactor.
4. It will also familiarize the student with concepts of heat removal from reactor core, reactor safety and radiation protection.

Unit I : Basics of nuclear fission and power from fission
Radioactivity, nuclear reactions, cross sections, nuclear fission, power from fission, conversion and breeding **[6 hrs]**

Unit II : Neutron transport and diffusion
Neutron transport equation, diffusion theory approximation, Fick's law, solutions to diffusion equation for point source, planar source, etc., energy loss in elastic collisions, neutron slowing down **[9 hrs]**

Unit III : Multigroup, multiregion diffusion equation, concept of criticality
Solution of multigroup diffusion equations in one region and multiregion reactors, concept of criticality of thermal reactors **[9 hrs]**

Unit IV : Reactor kinetics and control
Derivation of point kinetics equations, inhour equation, solutions for simple cases of reactivity additions, fission product poison, reactivity coefficients **[6 hrs]**

Unit V : Heat removal from reactor core
Solution of heat transfer equation in reactor core, temperature distribution, critical heat flux **[3 hrs]**

Unit VI : Reactor safety, radiation protection
Reactor safety philosophy, defence in depth, units of radioactivity exposure, radiation protection standards **[3 hrs]**

Text Books:

- John R. Lamarsh, Anthony J. Barrata, "Introduction to Nuclear Engineering" (3rd Edition) Prentice Hall, (2001)
- John R. Lamarsh, "Introduction to Nuclear Reactor Theory", Addison-Wesley, (1966)

Reference Books :

- James J. Duderstadt and Lewis J. Hamilton, "Nuclear Reactor Analysis", John Wiley (1976)

(ME) - Fracture Mechanics

Teaching Scheme:
Lectures : 3Hrs/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Course Outcomes:

Students will be able to

1. Predict different modes of failure and differentiate between brittle fracture and ductile fracture.
2. Interpret the damage tolerance of a component with a crack by analyzing the problem by methods of energy release rate and stress intensity factor.
3. Explore the test methods for determining critical energy release rate, critical stress intensity factor.
4. Analyze stress and displacement fields at the tip of edge crack and embedded crack.
5. Analyze variable amplitude fatigue in a component when a crack is present in it.
6. Estimate crack propagation, and environment assisted cracking along with various crack detection techniques.

Unit I: Energy Release Rate:
Kinds of failure, Brittle and ductile fracture, Modes of fracture failure, Damage tolerance, Griffith's Dilemma, Surface energy, Griffith's realization, Griffith's Analysis, Energy release rate, crack resistance, stable and unstable crack growth, R-curve for Brittle Cracks, Critical Energy Release Rate. **[6 hrs]**

Unit II: Stress Intensity Factor:
Introduction, Stress and Displacement Fields in Isotropic Elastic Materials ,Stress intensity factor, Background for Mathematical Analysis, Westergaard's Approach, Application of the Principle of Superposition , Crack in a Plate of Finite Dimensions, edge cracks, embedded cracks , The Relation between G_I and K_I , critical stress intensity factor, Bending and Twisting of Cracked Plates. **[6 hrs]**

Unit III: Crack tip plasticity:
Shape and size of plastic zone, effective crack length, effect of plate thickness, Crack tip opening displacement, Definition of the J-Integral, Path Independence, Stress-Strain Relation, Relationship between CTOD, K_I and G_I for Small Scale Yielding, Equivalence between CTOD and J. **[6 hrs]**

Unit IV : Test Methods:
Introduction, Test methods for determining critical energy release rate, Test Methods to Determine J_{Ic}, Test Methods to Determine G_{IC} and G_{IIC}, Determination of Critical CTOD. **[6 hrs]**

Unit V: Fatigue Failure and Environment-assisted fracture:
Introduction, Terminology, S-N Curve, Crack Initiation, Fatigue failure: Crack propagation, effect of an overload, crack closure, variable amplitude fatigue load, Micro mechanisms, Environment-assisted fracture, Environment-assisted Fatigue Failure, Major Factors Influencing Environment-assisted Fracture, Test Methods. **[6 hrs]**

Unit VI: crack detection techniques:
Introduction, , various crack detection techniques, Examination through Human Senses, Liquid Penetration Inspection, Ultrasonic Testing, Radiographic Imaging, Magnetic Particle Inspection. **[6 hrs]**

Text Books:

- Kumar Prashant, "Elements of Fracture Mechanics", Tata McGraw-Hill, 2009.
- Maiti S K, "Fracture Mechanics: Fundamentals and Applications", Cambridge University Press, 2015.

Reference Books:

- Brook D, "Elementary engineering fracture mechanics', Springer, 2012.
- Liebowitz H.," Fracture" Volume I to VII, Academic Press Inc., Nov. 1972.
- Nadai A and Hemp W. S., "Theory of flow and fracture of solids", McGraw Hill Book Company, 1950.

(ME) - Tribology

Teaching Scheme:
Lectures : 3Hrs/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Course Outcomes:

Students will be able to

1. Understand various theories of friction and wear and will be able to apply them to various practical situations.
2. Understand the various surface measurement techniques and effect of surface texture on Tribological behavior of a surface.
3. Select materials and lubricants to suggest a tribological solution to a particular situation.
4. Apply learning of the basics of hydrodynamic bearings and hydrostatic bearings.
5. Use Raimondi and Boyd charts to design hydrodynamic journal bearing, pivoted pad and slider shoe bearing.

Unit I
Friction, theories of friction, Friction control **[6 hrs]**

Unit II
Surface texture and measurement **[6 hrs]**

Unit III
Wear, types of wear, theories of wear, wear prevention. **[6 hrs]**

Unit IV
Tribological properties of bearing materials and lubricants. **[6 hrs]**

Unit V
Lubrication Regimes, Hydrodynamic Journal Bearing, Hydrostatic bearings, their applications **[6 hrs]**

Text Books:

- Principles in Tribology, Edited by J. Halling, 1975
- Bernard J. Hamrock, "Fundamentals of Fluid Film Lubrication", McGraw Hill Publication

Reference Books:

- S.K. Basu, B. B. Ahuja, S. N. Sengupta , "Fundamentals of Tribology", EEE, PHI Pvt. Publications Ltd.
- A. Cameron, "Basic Lubrication Theory", Ellis Horwood Ltd, 1981.

(ME) Mechanical Vibrations and Acoustics

Teaching Scheme:
Lectures : 3Hrs/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Course Outcomes:
The students will be able to

1. model a given vibratory system as SDOF or MDOF system, with or without damping, and with base or force excitation as periodic or aperiodic
2. evaluate natural frequencies and mode shapes of MDOF and continuous systems using modal analysis and computational methods such as Rayleigh-Ritz method and Holzer method.

3. explain various terminologies used in acoustics and acoustic wave transmission.
4. estimate sound pressure level at a given distance from a simple sound source of known strength.
5. summarize the mechanism of hearing by human and principles of Psychoacoustics and noise control.

Unit I: SDOF Systems – Arbitrary Excitation

One degree of freedom systems- harmonic excitation – An Overview; Transient Vibrations, Response of a single degree of freedom system to step and any arbitrary excitation, convolution (Duhamel's) integral, impulse response function **[6 hrs]**

Unit II: MDOF Systems – Free and Forced Vibrations

Multi degree of freedom systems, Free, damped and forced vibrations of two degree of freedom systems, Eigen values and Eigen vectors, normal modes and their properties, mode summation method. **[6 hrs]**

Unit III: Vibrations of Continuous Systems and Numerical Methods

Continuous Systems, Introduction to vibrations of strings, bars, shafts and beams; Mathematical model for vibration of Euler beam and its solution – natural and forced vibration, Mode shapes and natural frequencies, forced vibration of beams carrying concentrated harmonic forces. Numerical and computer methods in vibrations: Rayleigh, Rayleigh-Ritz and Holzer's method. **[6 hrs]**

Unit IV Plane Acoustic Waves

Plane acoustic waves, derivation of plane wave equation, relationships between acoustic pressure, particle displacement and velocity, velocity of plane acoustic waves, specific acoustic impedance, Sound power, sound intensity, sound pressure and sound intensity levels.
Transmission Phenomena, transmission from one fluid medium to another, normal incidence, reflection at the surface of a solid, standing wave patterns. (No analytical treatment to this topic) **[6 hrs]**

Unit V Spherical Acoustic Waves

Spherical acoustic waves, Spherical wave equation, Spherical acoustic impedance, Spherical radiation from a simple source, Only description of pressure and sound intensity in case of sources like piston (no analytical treatment) – Near and far field, Beam width and directivity index, Reaction on a vibrating body, Radiation impedance. **[8 hrs]**

Unit VI Psychoacoustics

Speech, Hearing and Noise, anatomy of the ear, mechanism of hearing, thresholds of the ear, loudness, pitch and timbre. **[4 hrs]**

Text Books:

- Thomson W.T., "Theory of vibrations with applications", CBS Publishers, Delhi, 2008.
- Rao S.S., "Mechanical Vibrations", Wiley Publishing Co., 2003.

- Inmann Daniel J. ,"Engineering Vibration", 4th Edition, Pearson,2014
- Kinsler Lawrence E. and Frey Austin R. "Fundamentals of Acoustics", Wiley Eastern Ltd., 2000

Reference Books:

- Timoshenko S, "Vibration problems in Engineering", Wiley, 1990.
- Shriniwasan P., "Mechanical Vibration Analysis", Tata McGraw Hill, 1982.
- Rettinger Michael, "Acoustic Design and Noise Control", Vol. I & II. , Chemical Publishing Co., New York, 1977.
- Meirovitch Leonard, "Fundamentals of vibrations", McGraw Hill International Edition, 2003.
- Malik Asok Kumar, "Principles of Vibration Control", Affiliated East-West Press,1999.

(ME) Advanced CAD/CAM

Teaching Scheme:
Lectures : 3 Hrs/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Course Outcomes:

Students will be able to

1. Develop an ability to create automated solid model using CAD Customization.
2. understand CAD/CAM data exchange formats
3. apply theory of FEA method to generate FE equations of basic 1D and 2D finite elements for structural applications
4. understand applications of CAD for computer aided Advanced Manufacturing Methods
5. understand concept of Product Life Cycle Management (PLM)

Unit I: CAD Customization

Need of Cad customization. OLE interfaces in CAD/CAM software; Use of General programming interfaces like VB, VBS, VC++, Open GL programming and System dependent programming interfaces like Visual LISP (AutoCAD), GRIP (Unigraphics), Pro-Programming (Pro/Engineer). Creating automated Solid modeling using Customization through API **[6 hrs]**

Unit II: Data Exchange Formats

Introduction to CAD/Cam data exchange formats. Direct and Indirect translators. Neutral file formats: Data Exchange format (DXF), Standard Triangular Languages (STL), Initial Graphics Exchange Specification (IGES). **[5 hrs]**

Unit III: Fundamentals of FEM

Introduction to Finite Element Method of solving field problems, Historical background, Steps in FEM, Applications, Advantages and Disadvantages, Commercial FEM Softwares. Theoretical Approaches of FEM Sources of errors in FEM, FEM convergence requirement. **[4 hrs]**

Unit IV: Finite Element Analysis of 1D and 2D Problems

Analysis of 1D bar element. Effect of temperature on the elements. Analysis of 2D plane Truss element. Plane stress and plane strain condition. Analysis of 2D Constant Strain Triangular Element (CST) **[8 hrs]**

Unit V: Advanced Manufacturing Methods

Computer Aided Manufacturing: Computer Aided CNC part programming. Features of Professional CAM softwares. Steps in CAM programming. CL file and Post processing.

Additive Manufacturing Processes: Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies of following:Solid-based Rapid Prototyping Systems: Fused Deposition Modeling (FDM), Laminated Object Manufacturing (LOM). Liquid-based Rapid Prototyping Systems:

Stereo lithography Apparatus (SLA). Powder Based Rapid Prototyping Systems: Selective laser sintering (SLS) **[10 hrs]**

Unit VI : Introduction to Product Life Cycle Management

Background, Overview, Need, Benefits, and Concept of Product Life Cycle, Components / Elements of PLM, Emergence of PLM, Significance of PLM, Customer Involvement,. Threads of PLM- computer aided design (CAD), engineering data management (EDM), Product data management (PDM), computer integrated manufacturing (CIM, comparison of PLM to Engineering resource planning (ERP). **[8 hrs]**

Text Books

1. Martti Mantilya, “Solid Modelling”, Computer Science Press,2014
2. Tirupathi R Chandrupatla and Ashok. D. Belegundu, “Introduction of Finite Element in Engineering”, Prentice Hall of India,2016
3. Chua C.K., Leong K.F. and LIM C.S,” Rapid prototyping: Principles and Applications” - World Scientific publications , Third Edition, 2010

Reference Books

1. Manuals of Professional CAD software such as Creo Parametric, NX, CATIA
2. A. J. Baker; “Finite Element Method 1-2-3”; McGraw Hill International Editions, 2014
3. Gibson, Ian, Rosen, David, Stucker, Brent, “Additive Manufacturing Technologies, 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing”, 2013

(ME) World Class Manufacturing

Teaching Scheme:
Lectures : 3Hrs/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Course outcomes

After completion of the course student will be able to

1. Understand the various manufacturing philosophies for the excellence.
2. Demonstration of professional and ethical responsibility in the chosen field.
3. Realization of the significance of internal and external customer needs and wants.
4. Understanding the role of leader in manufacturing and services

Unit I: Introduction to World Class Manufacturing
Manufacturing excellence and competition frame work of WCM- Hall's, Schonberger's Gunn's, Maskell.WCM and Indian manufacturing scenario. **[6 hrs]**

Unit II: Total Quality Management
Quality definition, Contribution of various quality guru, Customer satisfaction, Continuous improvement, Supplier partnership, performance measures of Quality. **[6 hrs]**

Unit III: Tools and Techniques of TQM
Matrix diagram, process decision program chart, Management tool- Force field analysis, affinity diagram, Pareto diagram, Histogram, Process flow diagram, why- why analysis, Cause and effect diagram, Benchmarking, Quality function deployment (QFD), ISO 9000, Malcom Baldrig Certificate, European Quality Award certification. **[6 hrs]**

Unit IV: JIT Philosophy
Just in time, seven waste, Basic element of JIT, KANBAN, PoKaYoKe, 5 S Theory, Implementation of JIT, Value engineering **[6 hrs]**

Unit V: Total Productive Maintenance
Introduction of maintenance, Learning and implementing TPM, Development Autonomous Group, Training pertaining to TPM, Calculation relation with availability of machine. **[6 hrs]**

Unit VI: Business Process Reengineering
Service Management, Introduction to concurrent engineering,Introduction to ERP and Supply chain management. **[6 hrs]**

Text books:

1. Barsterfield, “Total Quality Management”, Pearson Publication, ISBN no 13-978-9332534452,Edition 4,2015.

2. T.C. Cheng, S. Podolsky Springer “Science & Business Media”, 31-Jul-1996 - Business & Economics.

Reference Books:

- B. S. Sahay, K. B. C. Saxena ,”WCM- A strategic Perspective”, Macmillan Publication, ISBN no 13-978-0333934746,2013.
- Mart and Telsang. S ,”Industrial Engineering and Production Management”, Chand Publication, ISBN no 13-978-8121917735,2006.
- K.C. Arora. S.K ,”Total Quality Management”, Kataria and Sons Publication.
- Barsterfield ,”Total Quality Management”, Pearson Publication, ISBN no 13-978-8185749990,2010.

(ME) Project Stage-II

Teaching Scheme	**Examination Scheme**
Practical – 16 hrs/week	Term work - 50 marks
	Practical/Oral- 50 marks

The students in a group of not more than FOUR will work under the guidance of the faculty member on the project work undertaken by them. The completion of work, the submission of the report and assessment should be done at the end of Part II (2nd Semester).

The project work may consist of,

1. A comprehensive and up-to-date survey of literature related to study of a phenomenon or product.
2. Design of any equipment and / or its fabrication and testing.
3. Critical Analysis of any design or process for optimizing the same.
4. Experimental verification of principles used in applications related to Production Engineering.
5. Software development for particular applications.
6. A combination of the above.

The objective is to prepare the students to examine any design or process or phenomenon from all angles, to encourage the process of independent thinking and working and to expose them to industry. The students may preferably select the project works from their opted elective subjects.

A synopsis of the selected project work (two to three pages typed on A4 size sheets) certified by the project guide, should be submitted before the month of June of year. The synopsis shall be a part of the final project report.

The students should submit the report in a prescribed format, at the end of 2nd semester. The report shall be comprehensive and presented in duplicate, typed on A4 size sheets and bound.

1. Term work will be assessed by the project guide along with one colleague appointed by the Head of Department.

2. The students will be examined orally by the external examiner and the project guide, as the internal examiner. Marks will be awarded on the basis of the work done and performance in the oral examination

Minor courses:

(ME) Computer Aided Design /Computer Aided Manufacturing

Teaching Scheme:
Lectures : 3 Hrs/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Course Outcomes

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

1. Explain the fundamentals of CAD/CAM
2. Represent 2-D and 3-D entities
3. Transform 2-D and 3-D entities
4. write CNC program for production of components
5. Explain the principles and methods of Rapid Prototyping

Unit 1: Fundamentals of CAD/CAM
Product cycle and scope of CAD/CAM/CIM in product cycle, Features of CAD/CAM Hardware and software, selection of software. CAD workstation configurations **[3 hrs]**

Unit 2: Representation of Curves and surfaces
Introduction to Analytic Curves, Synthetic Curves: Hermite Cubic Spline, Bezier Curve, B-Spline curve. Surface Representation: Synthetic Surfaces. **[5 hrs]**

Unit 3: Solid Modeling
2D Vs 3D modeling, Comparison of Wireframe, surface and solid modeling techniques, Geometry Vs Topology, Requirements of Solid Modeling, Solid Modeling Methods: Constructive Solid Geometry (CSG), Boundary Representation (B-rep), etc. **[4 hrs]**

Unit 4: Geometric Transformation

2D geometric transformations, Homogeneous co-ordinate representation, Composite transformations, 3D transformations, Inverse transformations, geometric mapping **[5 hrs]**

Unit 5: Computer Numerical Control and Part Programming

Introduction to NC/CNC/DNC machines, Classification of NC systems, Axis nomenclature, Interpolation, features of CNC controllers, Types of CNC machines, Construction features of CNC machines, Manual Part Programming, , NC word format, Details of G and M codes, Canned cycles, subroutines and Do loops, Tool radius and length compensations **[6 hrs]**

Unit 6: Rapid Prototyping and Manufacturing

Introduction to Rapid Prototyping, rapid tooling and rapid manufacturing. Process of rapid prototyping. Different techniques of Rapid prototyping and their applications. **[3 hrs]**

Text Books:

- Ibrahim Zeid, "CAD/CAM Theory and Practice", Tata McGraw-Hill Publishing Company Ltd., New Delhi,2012
- Dacid F. Rogers, J Alan Adams, "Mathematical Elements for Computer Graphics", McGraw-Hill publishing Company Ltd,2001.
- P. Radhakrishnan ,"CAD/CAM/CIM", New Age International Ltd. Publishers New Delhi.2016

Reference Books:

- M.E. Mortenson, "Geometric Modelling" , Wiley
- Bedworth, Wolfe & Henderson,"Computer Aided Design & Manufacturing" , McGraw Hill

Honour course Thermal Stream

(ME) Modeling of IC Engine

Teaching Scheme:
Lectures : 3 Hrs/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Course Outcomes:

Students will be able to

1. Develop and calibrate engine models
2. Develop and calibrate single and double zone combustion models
3. Analyse zero dimensional Models

Unit I: Fundamentals

Governing equations, Equilibrium charts of combustion chemistry, chemical reaction rates, and approaches of modeling, model building and integration methods, gas exchange through valves, engine and porting geometry, exhaust gas recirculation, valve lift curves. **[8 hrs]**

Unit II: Thermodynamic Combustion Models of CI Engines

Single zone models, premixed and diffusive combustion models, combustion heat release using wiebe function, wall heat transfer correlations, ignition delay, internal energy estimations, two zone model, application of heat release analysis. **[10 hrs]**

Unit III: Fuel spray behavior:

Fuel injection, spray structure, fuel atomization, droplet turbulence interactions, droplet impingement on walls. **[5 hrs]**

Unit IV: Modeling of charging system:

Constant pressure and pulse turbo charging, compressor and turbine maps, charge air cooler. **[5 hrs]**

Unit V: Mathematical models of SI Engines:

Simulation of Otto cycle at full throttle, part throttle and supercharged conditions. Progressive combustion, Autoignition modeling, single zone models, mass burning rate estimation, SI Engine with stratified charge. Friction in pumping, piston assembly, bearings and valve train etc. friction estimation for warm and warm up engines. **[8 hrs]**

References:

- Haywood, "I.C. Engines", Mc Graw Hill,2017.
- Ramos J, "Internal Combustion Engine Modeling"**.** CRC Press,1989
- C. D. Rakopoulos and E. G. Giakoumis, Evangelos G. "Diesel Engine Transient Operations, Springer ,2009.
- V. Ganeshan, "Computer simulation of spark engine processes", Universities Press, 1996.
- P.A. Lakshminarayanan and Y. V. Aghav, " Modelling Diesel Combustion" Springer, 2010
- Bernard Challen and Rodica Baranescu, "Diesel Engine Reference Book" Butterworth-Heinemann, 1999.

Honour course Design Stream:

(ME) Advanced Vibrations and Acoustics

Teaching Scheme:
Lectures : 3 Hrs/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Course Outcomes:

At the end of the course:

1. The students will be able to model a given vibratory system as SDOF or MDOF system, with or without damping. He would also identify the type of given base or force excitation as periodic or aperiodic. He would be able to write, mathematically, the excitations of the types such as impulse, step, ramp, half sinusoidal, or such simple arbitrary excitations.
2. The student will be able to predict response of a SDOF system, damped or undamped, subjected to simple arbitrary base or force excitations mentioned above using convolution integral; They will be able to obtain Shock Response Spectrum of SDOF systems for such excitations and understand use of the SRS.
3. The students will be able to write differential equations of motion for MDOF systems, and through the technique of decoupling and orthogonal properties of natural modes, should be able to obtain the eigen-values and mode shapes of natural vibrations and response to harmonic and arbitrary excitations.
4. The students will be able to obtain the eigen-values and mode shapes of natural vibrations and response to harmonic excitations using orthogonal properties of natural modes.
5. Student will be able to obtain natural frequencies and mode shapes of MDOF and continuous systems using computational methods such as Rayleigh-Ritz method, Holzer method, Dunckerley's method, and Stodola's method.
6. The student should be able to obtain natural frequencies and mode shapes of MDOF and continuous systems and their response to harmonic excitation using MATLAB
7. Student will know various terminologies used in acoustics and acoustic wave transmission.
8. The student will able to derive plane and spherical wave equations, and will be able to obtain sound pressure level at a given distance from a simple sound source of known strength.
9. Students will be able to understand the mechanism of hearing by human and principles of Psychoacoustics and noise control.
10. The student will be able to measure and analyze signals received from vibrating and/or noise radiating structure by use of accelerometers, microphones and signal analyzer. They should be able to carry out FFT analysis and know the dominant frequency components in the signal and their correlation with the vibration of the structure. They should be able to identify correlation between two signals being received from two sources.

Unit I

Transient Vibrations, Response of a single degree of freedom system to step and any arbitrary excitation, convolution (Duhamel's) integral, impulse response function. **[6 hrs]**

Unit II

Multi degree of freedom systems, Free, damped and forced vibrations of two degree of freedom systems, Eigen values and Eigen vectors, normal modes and their properties, mode summation method, use of Lagrange's equations to derive the equations of motion. **[6 hrs]**

Unit III

Continuous Systems, Vibrations of strings, bars, shafts and beams, discretised models of continuous systems and their solutions using Rayleigh – Ritz method, Mode summation method. **[6 hrs]**

Unit IV

Vibration Control, Methods of vibration control, Non-linear vibrations, Systems with non-linear elastic properties, principle of superposition, Numerical and computer methods in vibrations: Rayleigh, Rayleigh-Ritz and Dunkerley's methods, matrix iteration method for eigen-value calculations, Holzer's method. **[6 hrs]**

Unit V

Plane and Spherical acoustic waves, Transmission Phenomena, transmission from one fluid medium to another, normal incidence, reflection at the surface of a solid, standing wave patterns, transmission through three media, Resonators and filters, Absorption of sound waves in fluids : Phase log between pressure and condensation, viscous absorption of plane waves, heat conduction as a source of acoustic attenuation. **[6 hrs]**

Unit VI

Speech, Hearing and Noise, The voice mechanism, acoustic power output of a speech, anatomy of the ear, mechanism of hearing, thresholds of the ear, loudness, pitch and timbre, beats, aural harmonics and combination tones, masking by pure tones, masking by noise.

[6 hrs]

References:

- Thomson W.T., "Theory of Vibrations with applications", George Allen and Unwh Ltd. London, 1981.
- S.S. Rao, Addison, "Mechanical Vibrations", Wesley Publishing Co., 1990.
- Leonard Meirovitch, "Fundamentals of vibrations", McGraw Hill International Edition.
- S. Timoshenko, "Vibration problems in Engineering", Wiley, 1974.
- Lawrence E. Kinsler and Austin R.Frey, "Fundamentals of acoustics", Wiley Eastern Ltd., 1987.

  Michael Rettinger, "Acoustic Design and Noise Control", Vol. I & II. , Chemical Publishing Co., New York, 1977.