BIJU PATNAIK UNIVERSITY OF TECHNOLOGY, ORISSA

MECHANICAL ENGINEERING

7th Semester

Code	Theory Subjects	L-T-P	Credit
PCME4401	Product Design and Production Tooling	3-0-0	3
PCME4402	Refrigeration & Air Conditioning	3-0-0	3
PCME4403	Mechanical Measurement and Control	3-0-0	3
	Professional Elective - III	3-0-0	3
PEME5401	Mechanical Vibration		
PEME5402	Advanced Fluid Mechanics		
PEME5403	Fluid Power & Control		
PEME5404	Computational Fluid Dynamics		
	Professional Elective-IV	3-0-0	3
PEME5405	Metrology, Quality Control & Reliability		
PEME5406	Simulation Modeling and Control		
PEME5407	Mechatronics		
PEME5408	Composite Materials		
	Free Elective-IV (Any one)	3-0-0	3
FEME6401	Human Resource Managements		
PEEE5407	Industrial Automation & Control		
PEEE5406	Soft Computing		
HSSM3401	Entrepreneurship Development		
	Theory Credits		18
	Practical/Sessional		
PCME7402	Project	0-0-3	3
PCME7403	Seminar - I	0-0-3	2
PCME7401	Refrigeration & Air Conditioning & Mechanical Measurement Lab	0-0-3	2
	Practical/Sessional Credits		**07**
	TOTAL SEMESTER CREDITS		**25**

8th Semester

Code	Theory Subjects	L-T-P	Credit
HSSM3402	Environmental Engineering	3-0-0	3
PCME4404	Production and Operation Management	3-0-0	3
	Professional Elective-V (Any one)	3-0-0	3
PEME5409	Power Plant Engineering		
PEME5410	Fatigue, Creep & Fracture		
PEME5411	Experimental Stress Analysis		
PEME5412	Smart Materials & Structures		
PEME5413	Machinery Fault Diagnostics & Condition Monitoring.		
	Free Elective-V (Any one)	3-0-0	3
PETX5412	Management Information System		
HSSM3403	Marketing Managements		
PECS5407	Wireless Sensor Networks		
PEEI5405	Micro Electro Mechanical Systems(MEMS)		
	Theory Credits		12
	Practical/Sessional		
PCME7404	Project	0-0-3	4
PCME7405	Seminar - II	0-0-3	2
PCME7406	Enterprenurship Project	0-0-3	2
PCME7407	Comprehensive Viva-Voce	0-0-3	2
	Practical/Sessional Credits		**10**
	TOTAL SEMESTER CREDITS		**22**
	TOTAL CUMULATIVE CREDITS		**204**

PRODUCTION DESIGN & PRODUCTION TOOLING

Module I **(8 hours)**

Product design considerations, product planning, product development, value analysis, product specification. Role of computer in product design.

Product design for sand casting: design of gating system and risering.

Module II **(12 hours)**

Forging design: allowances, die design for drop forging, design of flash and gutter, upset forging die design.

Sheet metal working: Design consideration for shearing, blanking piercing, deep drawing operation, Die design for sheet metal operations, progressive and compound die, strippers , stops, strip layout.

Module III **(16 hours)**

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

Process Planning – selection of processes, machines and tools. Design of sequence of operations, Time & cost estimation, Tooling design for turret lathe and automats.

Text Books:

1. Fundamentals of Tool Engineering design, S.K. Basu, S.N. Mukherjee, R. Mishra, Oxford & IBH Publishing co.
2. Manufacturing Technology, P.N. Rao , Tata McGraw Hill
3. A Textbook of Production Engineering, P.C. Sharma, S. Chand & Co

Reference Books:

1. Product Design & Manufacturing, A K Chitale, R C Gupta, Eastern Economy Edition, PHI.
2. Product Design & Development, Karl T Ulrich, Steven D Eppinger, Anita Goyal, Mc Graw Hill
3. Technology of Machine Tools, Krar, Gill, Smid, Tata Mc Graw Hill
4. Jigs & Fixture Design, Edwrd G Hoffman, Cengae Learning.

REFRIGERATION & AIR CONDITIONING

Module I (14 hours)

1. Air Refrigeration System : Introduction, Unit of refrigeration, Coefficient of performance, Reversed Carnot Cycle, Temperature limitations, maximum COP, Bell Coleman air cycle, Simple Air Cycle System for Air-craft with problems.
2. Vapour Compression System : Analysis of theoretical vapour compression cycle, Representation of cycle on T - S and p - h diagram, Simple saturation cycle, sub-cooled cycle and super-heated cycle, Effect of suction and discharge pressure on performance, Actual vapour compression cycle. Problem illustration and solution.
3. Multi-stage compression and Multi-evaporator systems : Different arrangements of compressors and inter-cooling, Multistage compression with inter-cooling, Multi-evaporator system, Dual compression system. Simple problems

Module II **(** 13 hours)

4. Vapour Absorption System : Simple Ammonia - absorption system, Improved absorption system, Analysis of vapour absorption system (Specifically of analyzing coloumn and rectifier), Electrolux / Three fluid system, Lithium-bromide-water vapour absorption system, comparison of absorption system with vapour compression system. Simple Problems and solution.
5. Thermoelectric Refrigeration: Basics and Principle. Defining the figure of Merit. (No Problem)
6. Refrigerants ; Classification of refrigerants and its degignation- Halocarbon (compounds, Hydrocarbons, Inorganic compounds, Azeotropes, Properties of refrigerants, comparison of common refrigerants, uses of important refrigerants, Brines. Alternative refrigerants (Organic and inorganic compounds).

Module III (13 hours)

Psychrometrics : Properties of air-vapour mixture, Law of water vapour-air mixture, Enthalpy of moisture, Psychrometric chart, simple heating and cooling, Humidification, De-humidification, Mixture of air streams. Review question and discussions

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

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

Text Books :

1. Refrigeration and Air Conditioning by R.C. Arora , PHI Publication
2. Refrigeration and Air Conditioning by S.C. Arora and S. Domkundwar, Dhanpat Rai & Sons. Chapters ; 3,4,5,6,7,11,16,17,19,20
3. Refrigeration and Airconditioning Data book by Manohar Prasad

Reference Books :

1. Refrigeration and Air conditioning by P.L. Balloney, Khanna Publishers.
2. Refrigeration and Air conditioning by Manohar Prasad,New Age international publishers.
3. Refrigeration and Air conditioning by C.P. Arora, Tata McGraw Hill.

MECHANICAL MEASUREMENT & CONTROL

Module I **(14 hours)**

Introduction to Instruments and their Representation:

Typical Applications of Instrument Systems, Functional Elements of a Measurement System, Brief Description of the Functional Elements of the Instruments, Classification of Instruments, Microprocessor -Based Instrumentation, Standards and Calibration.

Static and Dynamic Characteristics of Instruments:

Static Performance Parameters, Impedance Loading and Matching, Selection and Specifications of Instruments, Dynamic Response, Compensation.

Transducer Elements:

Analog Transducers, Digital Transducers,

Basic detector transducer elements : Electrical transducer, Sliding Contract devices, Variable-inductance transducer elements, the differential transformer, Variable-reluctance transducers, Capacitive transducers. The piezoelectric effect, photo-electric transducer, electronic transducer element.

Intermediate Elements:

Amplifier, Operational Amplifier, Diffential and Integrating Elements, Filters, A-D and D-A Converters

The simple current sensitive circuit, the ballast circuit, The voltage-dividing potentiometer circuit, The voltage balancing potentiometer circuit, Resistance bridges.

Indicating, Recording and Display Elements:

Meter Indicators. The vacuum tube voltmeter, CRO, Electronic Switch, CRO recording techniques, Oscillographs. Digital Recorders

Module II **(12 hours)**

Strain Measurement

The electrical resistance strain gauge. The metallic resistance strain gauge, Selection and Installation factors for metallic strain gauge, Circuitry, metallic strain gauge. The strain gauge ballast circuit, the staring gauge bridge circuit, Temperature compensation.

Measurement of Pressure

Pressure measurement systems, Pressure measurement transducers, Elastic diaphragms, strain gauge pressure cells, measurement of high pressure, Measurement of low pressures, dynamic characteristics of pressure measuring systems.

Measurement of Fluid Flow

Flow characteristics obstruction meters, Obstruction meter for compressible fluids- Orifice, Venturi meter and Pitot tube, The variable-area meter, Turbine Flow meters.

Temperature Measurement

Use of bimetals pressure thermometers, Thermocouples, Pyrometry, Calibration of temperature measuring devices.

Force, Power, Speed and Torque Measurement :

Load Cell, Dynamometers, Tachometer and Tacho-generator, Stroboscope, The seismic instrument.- Vibrometers and accelerometers

Module III **(12 hours)**

Description of open and closed loop control systems and their block diagrams. Use of block diagram and signal flow graph to find overall transfer function.

1^{st} and 2^{nd} order systems and their response to step and sinusoidal input, error analysis, static and dynamic error coefficients.

Routh's stability criterion. The Root-Locus method, Bode Plot and Nyquist plot, Gain margin and phase margin.

Textbooks

1. Instrumentation Measurement and Analysis, B.C.Nakra and KK.Chaudhry, Tata Mc Graw Hill, Third Edition.

Reference :

1. Mechanical Measurements, T.G. Beckwith and N. Lewis Buck, Oxford and IBH Publishing Co.
2. Modern Control Engineering, K.K. Ogata, prentice Hall India

MECHANICAL VIBRATION

Module – I **[12]**

1. INTRODUCTION & IMPORTANCE OF MECHANICAL VIBRATION: Brief history of Mechanical Vibration, Types of Vibration, Simple Harmonic Motion (S.H.M.), Principle of superposition applied to S.H.M., Beats, Fourier Analysis, Concept of degree of freedom for different vibrating systems.
2. UNDAMPED FREE VIBRATION OF SINGLE DEGREE FREEDOM SYSTEMS: Modeling of Vibrating Systems, Evaluation of natural frequency – differential equation, Energy & Rayleigh's methods, Equivalent systems.
3. DAMPED FREE VIBRATION OF SINGLE DEGREE FREEDOM SYSTEMS: Different types of damping, Equivalent viscous damping, structural damping, Evaluation of damping using free and forced Vibration technique, Concept of critical damping and its importance, study of vibration response of viscous damped systems for cases of under damping, critical damping and over damping, Logarithmic decrement.

Module – II **[15]**

4. FORCED VIBRATION OF SINGLE DEGREE FREEDOM SYSTEMS: Steady state solution with viscous damping due to harmonic force, reciprocating and rotating unbalance mass, vibration isolation and transmissibility due to harmonic force excitation and support motion. Vibration measuring instruments – vibrometer and accelerometer. Whirling of shaft with single disc and withour damping, Concept of critical speed and its effect on the rotating shaft.
5. UNDAMPED VIBRATION OF TWO DEGREE FREEDOM SYSTEMS: Free vibration of spring coupled and mass coupled systems, Longitudial, Torsional and transverse vibration of two degree freedom systems, influence coefficient technique, Un-damped vibration Absorber.

Module – III **[13]**

6. INTRODUCTION TO MULTI-DEGREE FREEDOM SYSTEMS: Normal mode vibration, Co-ordinate coupling-close coupled and far coupled systems, Orthogonality of mode shapes, Methods of matrix iteration, Holzer's method and Stodola method. Torsinal vibration of two, three and multi-rotor systems. Dunkerley's lower bound approximate method.
7. CONTINOUS SYSTEMS: Vibration of strings, longitudinal vibration of rods, torsional vibration of rods, transverse vibration of Euler-beams.

Text Books:

1. Theory of vibration with Applications: W.T. Thomson and Marie Dillon Dahleh, Pearson Education 5th ed. 2007.
2. Introductory Course on theory and Practice of Mechanical Vibrations. J.S. Rao & K. Gupta, New Age International Publication, New Delhi, 2007.

Deference Books:

1. Mechanical Vibrations: S.S. Rao, Prarson Education Inc, 4th ed. 2003
2. Mechanical Vibrations: S. Graham Kelly, Schaum's outline series, Tata McGraw Hill, Special Indian ed., 2007
3. Mechanical Vibrations: V.P. Singh, Dhanpat Rai & company Pvt. Ltd. 3rd ed., 2006
4. Elements of vibration Analysis: Leonard Meirovitch, Tata McGraw Hill, Special Indian ed., 2007

ADVANCED FLUID MECHANICS

Module I

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

Module II

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

Module III

Theory of hydrodynamic lubrication. Boundary layer: derivation, exact solutions, Blasius, Falkner Skan, series solution and numerical solutions. Approximate methods. Momentum integral method. Two dimensional and axisymmetric jets. Description of turbulent flow, velocity correlations, Reynold's stresses, Prandtl's Mixing Length Theory, Karman's velocity defect law, universal velocity distribution.

Text Book:

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

Reference Books:

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

FLUID POWER & CONTROL

Module – I (12 hrs)

Fluid Power

Introduction, History, Basic Law, types and Advantages of Fluid Power.

Hydraulic fluids and properties: Various types of hydraulic fluids (water, petroleum oil, Water glycols, water oil emulsion, phosphate esters and silicones), properties of Fluids and their comparison.

Basic Principles of Hydraulic Flow: Laminar and Turbulent Flow, Reynolds Number, Darcy-Weisbach Equation, Losses in Valves and Fittings and Circuit Calculations.

Hydraulic Pumps and Actuators:

Pumps: Basic Elements of an Oil Hydraulic System, Hydrodynamic and Hydrostatic Pumps, Classification of Positive Displacement Pumps, Gear Pumps, vane pumps and piston pumps, types, principles and application, Pump performance

Hydraulic Actuators: Hydraulic Motors; Types Hydraulic Motor Efficiencies, Semi-rotary Actuators, Vane Type Actuators, Piston Type Semi-rotary Actuator, Helical Screw Semi-rotary Actuator, different types of Hydraulic Cylinders Mounting Configurations, Methods of applying Linear Motion.

Module – II (12 hrs)

Hydraulic Valves: different types of Pressure Controls, Pressure Relief and Direction Control Valves, Flow dividers and other special purpose valves.

Selection of hydraulic components

Seals and Filters, Conditions Affecting the Selection of Sealing Devices Fluid Contamination Cleanliness Standards

Filtration of Fluids Strainers, Filter Media, Types of Filters, Filter Location Accumulators: Types and their operation, Accumulator Circuits

Servo Valves and Proportional Valves: Types, Principles and applications, comparison between servo and proportional valves.

Pneumatic valves: Types and applications, comparison of hydraulic and Pneumatic valves.

Pneumatic actuators, common pneumatic systems, Selection of pneumatic components.

Hydro – Pneumatic: Air-oil Reservoir: Air-oil Cylinder, Air-oil Intensifier, Comparison of hydro-pneumatic and Pneumatic Systems

Module III (12hrs)

Different hydraulic and pneumatic circuits, Electrical and microelectronic control of fluid power Examples of different industrial hydraulic and pneumatic systems applications, installation, maintenance and trouble shooting, Pneumatic Logic Controls

Text book :

Hydraulic and Pneumatic controls by R. Srinivasan, TMH (2nd Edition)

REFERENCE BOOK:

1. Fluid Power Control by J.F. Blackburn, G. Reethof & J.L. Shearer, John Wiley & Son Inc.

2. Fluid Power with microprocessor control: An Introduction by E.W. Reed and I.S. Larman. Prentice Hall International, N.D.

COMPUTATIONAL FLUID DYNAMICS

Module-I

Basics of Computational Fluid Dynamics (CFD)- Introduction to One dimensional computation: Finite difference methods (FDM)-Finite element method(FEM)-Finite volume method(FVM). Solution of Discretised Equations: The tri-diagonal matrix algorithm (Thomas Algorithm for one dimensional case)

The Finite Volume Method for Diffusion Problems-Introduction -Finite volume method for one-dimensional steady state diffusion -Worked examples: one-dimensional steady state diffusion

Module-II

The Finite Volume Method for Convection-Diffusion Problems – Introduction - Steady one-dimensional convection and diffusion - The central differencing scheme - Assessment of the central differencing scheme for convection-diffusion problems - The upwind differencing scheme - Assessment of the upwind differencing scheme - The hybrid differencing scheme - Assessment of the hybrid differencing scheme - The power-law scheme - Higher order differencing schemes for convection-diffusion problems - Quadratic upwind differencing scheme: the QUICK scheme

Module-III

The Finite Volume Method for Unsteady Flows - Introduction - One-dimensional unsteady heat conduction - Explicit scheme - Crank-Nicolson scheme - The filly implicit scheme - Illustrative examples - Implicit method for two- and three-dimensional problems - Discretisation of transient convection-diffusion equation - Worked example of transient convection-diffusion using QUICK differencing.

Text Book

1. Versteeg, H. K. , Malalasekera W , An Introduction to Computational Fluid Dynamics-The Finite Volume Method, Longman Scientific & Technical.

Reference Books

1. Patenkar V. Subas, Numerical Heat Transfer & Fluid Flow, Taylor & Francis
2. Muralidhar, K. and Sundararajan, T., Computational Fluid Flow and Heat Transfer, Norosa Publishing House, N. Delhi.
3. Ozisik, M. N. , Finite Difference Method, CRC Press.
4. Anderson, D. A. Jr, Computational Fluid Mechanics and Heat Transfer, McGraw-Hill Education.

METROLOGY, QUALITY CONTROL & REALIABILITY

Module I (12 hours)

Principles of Measurements, Line and End & optical Standards, Calibration, accuracy and Precision, Random error and systemic error.

Measurement of Surface Roughness, Screw Thread and Gears.

Limits, Fits and Gauges, Assembly by full, partial and group interchangeability, geometric tolerances.

Measurement of straightness, Flatness and circularity.

Module II (14 hours)

Some useful Probability Distribution, Testing of hypothesis, type I and type II errors, control limit theorem.

Causes of Variation, standard error of mean, process capability, PCR, RPI, Natural tolerance Limits, Specification Limits, Trial and Revised control Limits, Rational subgroups, Control charts for variable (X,R,S, CUSUM, EWMA), Control charts for fraction, non-conforming control charts for non-conformation.

Design of single sampling plan. Double, multiple and sequential sampling plans, O.C. curve, AOQ, AOQL,

Taguchi's Loss function, Orthogonal Arrays, Linear Graphs, parametric design, signal-to noise Ratio, ANOVA, TQM, Taguchi, ISO 9000, ZIT, Quality circle.

Module-III (10 hours)

Definition, bath-tub-curve, system reliability, reliability improvement, maintainability and availability, Availability of single repairable system using Markov model, Life tests, acceptance sampling plan based on life tests, Sequential acceptance sampling plan based on MTTF & MTBF.

Test Books

1. Engineering Metrology,R.K. Jain, Khanna Publisher, Delhi
2. Quality control and Application ,B.L. Hansen and P.M. Ghare, Prentice Hall of India.
3. Reliability Engg. And Terotechnology , A.K. Gupta, Macmillan India.
4. Taguchi methods Explained Practical steps to Robust design T.P. Bagchi, PHI

Reference Books

1. A text book of Engineering Metrology I.C. Gupta, Dhanpat Rai & sons, Delhi.
2. E.L. Grant and R.S. Leveaworth, Statistical quality Control", 7e, mc-Graw Hill.
3. Introduction to Statistical Quality control, D.C. Montgonery, John Wiley & sons.
4. Introduction to /reliability and Maitainability Engg E. Ebeling, MC-Graw Hill.
5. Statistical Quality Control, M. Mahajan, Dhanpat Rai & Sons.
6. Statistical Process Control and Improvement, A. Mitra, Pearson.

SIMULATION MODELLING & CONTROL

Module I **14 hours**

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

Statistical models in simulation, Discrete and continuous distributions, Poisson process, Empirical distribution, Generation of pseudo random numbers, Analysis of simulation data, Parameter estimation, Goodness-of-fit tests, Multivariable time series models.

Module II **12 hours**

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

Modules III **10 hours**

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

Text Books :

1. Discrete-Event system simulation by Jerry Banks, J.S. Carson, B.L. Nelson and D.M. Nicol (Pearson Publications).

2. Feedback control of dynamic systems by G.F. Franklin, J.D. Powell, A-Naeini, Pearson Publications.

3. Simulation modeling and analysis by A.M. Law, W.D. Kelton, Tata McGrawHill Publications.

MECHATRONICS

Module 1 **(10 hours)**

Evolution of Mechatronics, components of mechatronic system, types of mechatronic products, Signal theory, signal analysis and processing, Laplace transformation, Z-transformation modulation and de-modulation.

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

Module II **(10 hours)**

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

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

Module III **(16 hours)**

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

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

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

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

Text Books

1. A Text Books of Mechatronics, R.K.Rajput, S.Chand & company
2. Mechatronics, N.G. P.C Mahalik, Tata McGraw Hill
3. Mechatronics, D.G. Alciator, M.B. Histand, Tata McGraw Hill

Reference Books :

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

COMPOSITE MATERIALS

Module – I (14 hours)

1. **Introduction :**

Classification and characteristics of composite materials, mechanical behaviour of composites, constituents, Reinforcements, Matrices, Fillers, Additives, Applications and advantages of composites.

2. **Processing :**

Initial form of constituent materials, Manufacturing procedures for fibre-reinforced plastics, quality control.

3. **Macromechanical Behaviour :**

Stress strain relations of anisotropic materials - Engineering constants for orthotropic materials, Stress strain relations for specially orthotropic lamina. Transformation relationships for a lamina of arbitrary fibre orientation.

Module – II (12 hours)

Testing of Composites, Evaluation of Engineering Constants and Strengths.
Micromechanical Analyses of orthotropic lamina, Evaluation of Engineering Constants using Micromechanical principles, Rules of Mixtures, Kelly Davis Model for Minimum and Critical Volume Fractions.

Module – III (10 hours)

FRP Composite Laminate designation and codes, Macromechanical Behaviour of FRP Composite Laminates, Classical Lamination Theory.
General Design Consideration and Suitable laminating Scheme.

Text Book

1. Mechanics of Composite Materials, R.M. Jones, Mc. Graw Hill Book Co.

Reference Book :

1. Fibre - Reinforced composites :- Materials, manufacturing and Design by P.K. Mallick, CRC Press.
2. Engineering Mechanics of Composite Materials, I.M.Danel, O.Issai, Oxord University Press
3. Composite materials, Broutman & Crock,
4. Principles of Composite Material Mechanics, R.F.Gibson, CRC Press

HUMAN RESOURCE MANAGEMENT

Module I:

Concept scope and objectives of HRM. Relationship between HRM and HRD. The challenges for HRM – Environmental, organizational and Individual. Role and functions of HR managers in the changing business scenario.

Human Resources Planning – overview, Recruitment – concept, objectives, legal framework regulating recruitment in India, Selection – Objectives and methods, Test and interviews, Induction and orientation, validity and reliability of Tests and interviews.

Module II:

Career Planning – concept, objectives. Different stages of career and its implications, Methods of career planning and development, Promotion – types and process, Transfer – types. Separations including lay off and retrenchment.

Performance Management – concept and objectives. Performance Appraisal – concept objectives and methods – management by objectives (MBO), Assessment centre, 360 degree feedback. Appraisal errors. Competency mapping – concept, objectives and the process.

Module III:

Compensation Management – objectives and principles. wage & salary. Wage concept – minimum wage, Fair wage, living wage. nominal wage and real wage. Components of wages, methods of wage determination, job evaluation – methods wage differentials and its functions.

Training and Development – Training need Assessment, Types of Training Programs – on the job and off the job training programs, Evaluation of effectiveness of training programs.

Books Recommended

1. Personnel & HRM – P. subha Rao, Himalaya Publishing House.
2. HRM - Text and cases – Aswathappa, THM
3. Managing Human Resources – Gomez, Belkin & Cardy, PHI.
   HRM – Snell, Bohlander, Vohra – Cengage Publication

INDUSTERIAL AUTOMATION & CONTROL

Module I: (12 Hours)
Process Control: Introduction: Process Definition, Feedback Control, PID Control, Multivariable Control. (Chapter 1 of Text Book 1)
PID Controller Tuning: Introduction, Zeigler-Nichols Tuning Method (Based on Ultimate Gain and Period, and Process Reaction Curve), Digital PID Controllers. (Chapter 13 of Text Book 2)

Module II: (15 Hours)
Special Control Structures: Cascade Control, Feedfroward Control, Feedfroward-Feedback Control Configuration, Ratio Control, Selective Control, Adaptive Control, Adaptive Control Configuration. (Chapter 10 and 11 of Text book 3)
Actuators: Introduction, Pneumatic Actuation, Hydraulic Actuation, Electric Actuation, Motor Actuators and Control Valves. (Chapter 8 of Text Book 1)

Module III: (10 Hours)
Industrial Automation: Programmable Logic Controllers: Introduction, Principles of operation, Architecture, Programming (Programming Languages, Ladder Diagram, Boolean Mnemonics) (Chapter 5 of Text Book 1)
Distributed Control: Distributed vs. Centralized, Advantages, Functional Requirements, System Architecture, Distributed Control Systems (DCS), Communication options in DCS. (Chapter 6 of Text Book 1)
Real-time Programming: Multi-tasking, Task Management, Inter-task Communication, Real-time Operating System. (Chapter 9 of Text Book 1)

Text Books:
1. Krishna Kant, “Computer-Based Industrial Control”, PHI, 2009.
2. M. Gopal, “Digital Control and State Variable Methods” Tata McGraw Hill, 2003.
3. Surekha Bhanot, Process Control: Principles and Applications, Oxford university Press, 2010
Reference Books:

1. Smith Carlos and Corripio, “Principles and Practice of Automatic Process Control”, John Wiley & Sons, 2006.
2. Jon Stenerson, “Industrial Automation and Process Control”, Prentice Hall, 2003.
3. C. Johnson, “Process Control Instrumentation Technology”, PHI, New Delhi
4. D.R. Coughnowr, “Process System analysis and Control”, McGraw Hill.

SOFT COMPUTING

MODULE-I (12 Lectures)

Introduction: Soft Computing Constituents and Conventional Artificial Intelligence, Neuro-Fuzzy and Soft Computing Characteristics.

Fuzzy Sets: Introduction, Basic Definitions and Terminology, Set Theoretic Operations, MF Formulation and Parameterization.

Fuzzy Rules & Fuzzy Reasoning: Extension Principle and Fuzzy Relations, Fuzzy If-Then Rules, Fuzzy Reasoning.

Fuzzy Inference Systems: Mamdani Fuzzy Models, Sugeno Fuzzy Models, Tsukamoto Fuzzy Models, Other Considerations.

(BOOK-1:- Chap-1: 1.1 to 1.3, Chap-2: 2.1 to 2.4, Chap-3: 3.2 to 3.4 & Chap-4: 4.2 to 4.5)

MODULE-II (14 Lectures)

Neural Networks: Neuron Abstraction, Neuron Signal Functions, Mathematical Preliminaries, Neural Networks Defined, Architectures: Feed forward and Feedback, Salient Properties and Application Domains of Neural Networks, Multi-layered Network Architectures, Back-propagation Learning Algorithm, Practical Considerations in Implementing the BP Algorithm, Structure Growing Algorithms, Universal Function Approximation and Neural Networks, Applications of Feed Forward Neural Networks, Reinforcement Learning, Radial Basis Function Networks, Regularization Theory Route to RBFNs, Generalized Radial Basis Function Network, Learning in RBFNs, Associative Learning, Hopfield Network, Content Addressable Memory, Bidirectional Associative Memory, Self Organizing Feature Maps, Applications of the Self Organizing Map.

(BOOK-2:-Chap-3: 3.1 to 3.6, Chap-6: 6.1 to 6.2, 6.5 to 6.6 & 6.8 to 6.10, Chap-8: 8.4 to 8.7,

Chap-10: 10.2 & 10.5 to 10.6 & 10.16 and Chap-12: 12.8 to 12.9)

MODULE-III (08 Lectures)

Regression & Optimization: System Identification: an Introduction, Least Squares Estimator, Geometric Interpretation of LSE, Recursive Least Squares Estimator.

Derivative-Free Optimization: Genetic Algorithms, Simulated Annealing, random Search, Downhill Simplex Search.

Adaptive Neuro-Fuzzy Inference Systems (ANFIS): ANFIS Architecture, Hybrid Learning Algorithm.

(BOOK-1:- Chap-5: 5.1, 5.3 to 5.5, Chap-7: 7.2 to 7.5 and Chap-12: 12.2 to 12.3)

TEXT BOOK:

1. "***Neuro-Fuzzy and Soft Computing***" By J.-S.R.Jang, C.-T.Sun & E. Mizutani, PHI

2. "***Neural Networks: A Classroom Approach***" By Satish Kumar, TMH Education

Reference Book:

1. "***Neural Networks Fuzzy Logic & Genetic Algorithms; Synthesis & Applications,*** *S.Rajasekaran & G.A. VijayaLaxmi Pai, Prentice Hall, India, May'2006- LakshmiPai*
2. Principle of Soft Computing, S.N. Sivanandan & S.N. Deepa, Wiley India Edition,2010.

ENTREPRENEURSHIP DEVELOPMENT (3-0-0)

Module I: Understanding Entrepreneurship

Concept of Entrepreneurship, Motivation for Economic Development and Entrepreneurial Achievement, Enterprise and Society

Why and how to start Business – Entrepreneurial traits and skills, Mind Vrs Money in Commencing New Ventures, Entrepreneurial success and failures, Environmental dynamics and change.

Entrepreneurial Process

Step by step approach to entrepreneurial start up

Decision for Entrepreneurial start up.

Module II: Setting up of a small Business Enterprise.

Identifying the Business opportunity - Business opportunities in various sectors, formalities for setting up small enterprises in manufacturing and services, Environmental pollution and allied regulatory and non-regulatory clearances for new venture promotion in SME sector.

Writing a Business plan, components of a B-Plan, determining Bankability of the project.

Module III: Institutional Support for SME.

Central / State level Institution promoting SME.

Financial Management in small business.

Marketing Management, problems & strategies

Problems of HRM – Relevant Labour – laws.

Sickness in Small Enterprises.

Causes and symptoms of sickness – cures of sickness.

Govt. policies on revival of sickness and remedial measures.

Reference Books:

1. Entrepreneurship Development, Small Business Enterprises, Chavantimath, Pearson.
2. Entrepreneurial Development, S.S. Khanka, S Chand
3. Entrepreneurship, Barringer BR, Ireland R.D., Pearson
4. Entrepreneurship, David H Holt, PHI
5. Entrepreneurship, Kurilko, D.F. and Attodgets RM, Cengage
6. The Dynamics of Entrepreneurial Development & Management, Vasant Desai, HPH.
7. Entrepreneurship, Roy, Oxford
8. Entrepreneurship, Hisrich, Peters, Shepherd, TMH

REFRIGERATION & AIR CONDITIONING AND MECHANICAL MEASUREMENT LABORATORY

Refrigeration & Air Conditioning Lab (Minimum 05 experiments)

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

Mechanical Measurement Lab (Minimum 05 experiments**)**

1. Calibration of LVDT using indicator / CRO
2. Calibration of load cell using electrical resistance strain gauge
3. Calibration of a Rotameter for fluid flow measurement
4. Calibration of thermo couples
5. Calibration of Bourden Tube Pressure Gauge and measurement of pressure using manometer
6. Experiment on Pneumatic trainer
7. Experiment on Hydraulic trainer
8. Determination of damping coefficient of vibration absorbing materials using vibration measuring equipment.
9. Strain measurement using resistant strain gauge

Experimental stress analysis through Photo-elasticity.

ENVIRONMENTAL ENGINEERING (3-0-0)

Objective: This course introduces the students to the environmental consequences of Industries, development actions etc. and the methods of minimizing their impact through technology and legal systems.

Module – I

Ecological Concepts and Natural Resources: Ecological perspective and value of environment. Environmental auditing, Biotic components, Ecosystem Process: Energy, Food Chain, Water cycle, Oxygen cycle, Nitrogen cycle etc., Environmental gradients, Tolerance levels of environment factor, EU, US and Indian Environmental Law, Global Perspective.

Chemistry in Environmental Engineering: Atmospheric chemistry, Soil chemistry, Material balances and Reactor configurations.

Module – II

Water Pollution: water quality standards and parameters, Assessment of water quality, Aquatic pollution, Estuarine water quality, Marine pollution, Organic content parameters, Ground water Contamination, Water table and Aquifer, Ground water recharge. Water quality parameter and standards.

Water Treatment: Water treatment processes, Pre-treatment of water, Conventional process, Advanced water treatment process.

Waste Water Treatment: DO and BOD of Waste water treatment process, pretreatment, primary and secondary treatment of waste water, Activated sludge treatment: Anaerobic digestion and its microbiology, Reactor configurations and methane production.

Application of anaerobic digestion.

Air Pollution : Air pollution and pollutants, criteria pollutants, Acid deposition, Global climate change –green house gases, non-criteria pollutants, emission standard form industrial sources, air pollution metereology, Atmospheric dispersion.

Industrial Air Emission Control:

Characterization of air stream, Equipment selection, Equipment design, Special Methods: Flue gas desulphurization, NOx removal, Fugitive emissions.

Module – III

Solid Waste Management Source classification and composition of MSW: properties and separation, storage and transportation, MSW Management, Waste minimization of MSW, Reuse and recycling,

Hazardous Waste Management, Hazardous waste and their generation, Transportation and treatment of hazardous waste: Incinerators, Inorganic waste treatment, handling of treatment plant residue. Waste minimization techniques.

Noise Pollution: Physical Properties of sound, Noise criteria, Noise Standards, Noise measurement, Noise control.

Environment impact Assessment, Origin and procedure of EIA, Project Screening for EIA, Scope studies, Preparation and review of EIS.

Text Book

1. Environmental Engineering Irwin/ McGraw Hill International Edition, 1997, G. Kiely,
2.Environmental Engineering & Safety by Prof B.K. Mohapatra, Seven Seas Publication,Cuttack

Reference Books

1. Environmental Engineering by Arcadio P. Sincero & Gergoria A.Sincero PHI Publication
2. Principles of Environmental Engineering and Science, M. L. Davis and S. J. Masen, McGraw Hill International Edition, 2004
3. Environmental Science, Curringham & Saigo, TMH,
4. Man and Environment by Dash & Mishra
5. An Introduction to Environmental Engineering and Science by Gilbert M. Masters & Wendell P. Ela - PHI Publication.

PRODUCTION & OPERATION MANAGEMENT

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

Module I

1. Operations Function in an Organization, Manufacturing Vrs Service Operations, System view of Operations, Strategic Role of Operations, Operations Strategies for Competitive Advantage, Operations Quality and Productivity Focus, Meeting Global Challenges of Production and Operations Imperatives. **(3 Hours)**

2. Designing Products, Services and Processes: New Product Design- Product Life Cycle, Product Development Process, Process Technology : Project, Jobshop, Batch, Assembly Line, Continuous Manufacturing; Process Technology Life Cycle, Process Technology Trends, FMS, CIM, CAD, CAM; Design for Services, Services Process Technology. **(4 Hours)**

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

Module II

4. Location and Layout Planning : Factor Influencing Plant and Warehouse Locations, Impact of Location on cost and revenues. Facility Location Procedure and Models : Qualitative Models, Breakeven Analysis, location Model, centroid method.
Layout Planning: Layout Types : Process Layout, Product Layout, Fixed Position Layout Planning, block diagramming, line balancing, computerized layout planning- overview.
Group Technology **(4 Hours)**

5. Forecasting : Principles and Method, Moving Average, weighted Moving Average, Exponential Smoothing, Winter's Method for Seasonal Demand, Forecasting Error.**(4 Hours)**

6. Manufacturing Planning and Control : The Framework and Components : Aggregate Planning, Master Production Scheduling, Rough-cut-Capacity Planning, Material Requirements Planning, Capacity Requirements Planning. **(5 Hours)**

Module III

7. Sequencing and Scheduling : Single Machine Sequencing : Basics and Performance Evaluation Criteria, Methods for Minimizing Mean Flow Time, Parallel Machines : Minimization of Makespan, Flowshop sequencing : 2 and 3 machines cases : Johnson's Rule and Jobshop Scheduling : Priority dispatching Rules. **(3 Hours)**

8. Inventory Control : Relevant Costs, Basic EOQ Model, Model with Quantity discount, Economic Batch Quantity, Periodic and Continuous Review Systems, Safety Stock, Reorder Point and Order Quantity Calculations. ABC Analysis. **(4 Hours)**

9. Modern Trends in Manufacturing : Just in Time (JIT) System : Shop Floor Control By Kanbans, Total Quality Management, Total Productive Maintenance, ISO 9000, Quality Circle, Kaizen, Poka Yoke, Supply Chain Management. **(4 Hours)**

Reference Book:

1. S.N.Chary, "Production and Operations Management", Tata McGraw Hill.
2. R. Paneerselvam, "Production and Operations Management, Prentice Hall of India.
3. Aswathappa & Bhatt – Production & Operations Management, HPH.
4. Gaither & Frazier - Operations Management, Cengage Publication
5. Russell & Taylor - Operations Management, PHI Publication
6. Chase, Aquilanno, Jacob & Agarwal - Operations Management, TMH Publication.
7. E.E. Adam and R.J. Ebert "Production and Operations Management", Prentice Hall of India

POWER PLANT ENGINEERING

Module- I (13Hrs)

INTRODUCTION

Different sources (Conventional and nonconventional) of energy and the principle of power generation only, Types of power plant and site selection, overall view of a steam power plant.

STEAM GENERATOR

Fossil fuel steam generators, classification, circulation in water tube boilers, Modern high pressure water tube boilers(both sub critical and super critical), Boiler mounting and accessories, Combustion equipment: air supply systems (Natural and Mechanical Draught Systems). Pulverized coal burning systems and Basics of Fluidized bed combustion, Feed water treatment (Necessity & general consideration only). Boiler performance calculations.

FLOW THROUGH NOZZLES

Types of nozzles and their area of application & related calculation, critical pressure & chocked flow, super saturated flow. Effect of friction and nozzle efficiency

Module – II **13Hrs**

STEAM TURBINES

Turbine types, Variation of Pressure and Velocity in different types of turbines, Simple impulse Turbines, Flow through turbine blades and velocity diagram, Pressure - compounded impulse turbines and Velocity compounded impulse turbines. Turbine power and related calculations.

REACTION TURBINES

Reaction turbines Flow through blades and velocity diagram, degrees of reaction, Parsons turbine, power and related calculations, Blade height calculations, Losses in steam turbines, Reheat factor & condition line, Governing of turbines.

Module III 14 Hrs

STEAM CONDENSER & CIRCULATING WATER SYSTEMS

Types, Surface condenser, Performance calculation, Air removal methods, Vacuum & vacuum efficiency. Cooling towers.(types, principle of operation and performance)

NUCLEAR POWER PLANT

Introduction, Nuclear fuels, Nuclear fission, Reactor components, & materials and classification,, Boiling Water Reactor (BWR), Pressurized water Reactor (PWR), CANDU Reactor, Gas cooled Reactors, Liquid metal fast breeder Reactor. Heavy water Reactors .Waste disposal and Safety of Nuclear power plant

ECONOMICS OF POWER PLANT

Basic definitions, cost of electrical energy(Fixed cost and operating cost), Types of tariff, Types of loads(typical load curves), Economic Load sharing

Books recommended

1. Power plant Engineering ; - By P.K. Nag (2nd edition) TMH
2. Power Plant Engineering by Arora and Domkundwar, Dhanpat Rai publications

Reference:

1.. Power Plant Engineering by Yadav
2. Power Plant Engineering by Rajput
3. Power plant technology : By E.I. Wakil TMH
4. Power Plant Engineering by C.Elanchezhian, Sarvanakumar, Vijayramnath, IK International Publishing house Pvt Ltd

FATIGUE, CREEP AND FRACTURE

Module – I : (12 hours)

Design philosophy : (i) Infinite life, (ii) Safe life, (iii) Fail safe and (iv) Damage tolerant design concepts.

Fatigue Design : Cyclic stress and stress reversals, Fatigue and progressive fracture, Endurance limit, Fatigue Tests : Cantilever and Beam type of Fatigue Tests, Axial Fatigue Tests. Influence of mean stress on fatigue : Gerber, Goodman and soderberg's criteria. Effect of compressive cyclic stress on fatigue. Fatigue design formula for axial, bending, torsional and combined loading.

Fatigue controlling factors: Effect of frequency, Temperature, size, form, stress concentration factors, Notch, sensitivity & surface conditions, residual stresses.

Module – II : (12 hours)

Improvement of fatigue strength' by chemical/metallurgical processes such as ritriding, flame hardening, case carburizing. Fatigue strength enhancement by mechanical work : cold rolling, peening, shot peening.

Effect of environment : Corrosion Fatigue, Concept of cumulative fatigue damage

Fracture Mechanics : Ductile and brittle fracture Theoretical cohesive strength of metasl, Griffith Theory of brittle Fracture, Oruron's modification to Griffith Theory.

Module – III (14 hours)

Modes of fracture : Mode I, II and III, fatigue creek growth Behaviour of metals, Linear Elastic Fracture Mechanics (LEFM), Stress Intensity Factor(SIF), Stress field near the crack tip, Critical SIF and Fracture Toughness, Experimental determination of fracture toughness K_{IC}, COD gauges and standard ASTM Tests.

Strain Energy Release Rates (SERR), Elasto-Plastic Fracture Mechanics (EPFM), Plastic zone size and its evaluation, J-Integral Method.

Creep Analysis :

Definition, Constant stress and constant, strain creep tests. Uniaxial creep tests : Baily's Power Law, Creep relaxation : strain hardening and time hardening creep relaxation. Introduction to Creep bending and deflection of simple problems.

Text Books:

1. George E. Dieter, Mechanical Metallurgy, - Mc Graw Hill, NY, 1988
2. Joseph Marin, Mechanical Behaviour of Engg. Materials, - Prentice Hall of India, 1966
3. Stephens, R.I. and Fuchs, H.O., Metal Fatigue in Engg. ,- Wiley, NY 2001
4. Finnie, I. and Heller, W.R., Creep of Engg. Materials, - Mc Graw Hill Book Co., 1959
5. Prasant Kumar, Fracture Mechanics

Reference Books:

1. L.S. Srinath, Advanced Mechanics of Materials, - Tata Mc Graw Hill Ltd., ND, 2009.
2. Norman E, Dowling, Mechanical Behaviour of Materials, - Prentice Hall, NJ, 1999.
3. Lessells, J.M., strength and resistance of materials, - John wiley & sons, 1954
4. Peterson, R.E., Stress Concentration Design Factors,- John Wiley & Sons, 1953
5. Meguid, S.A., Fracture Mechanics,- John Wiley & Sons, 1996
6. Kare Hellan, Introduction to Fracture Mechanics, - Mc Graw Hill Book Co., 1985

EXPERIMENTAL STRESS ANALYSIS

Module – I (12 hours)

Elementary Elasticity :

Stress at a point, Principal Stresses in 2D and 3D stress systems, strain and stress-strain velations, principal strains, plane stress and plane strain problems.

Theory of Photo elasticity: Photo elasticity methods- Light and optics as related to photoelasticity, polarization of light, plane and circularly polarized light, plane polariscopes. The stress-optic law, effects of a stressed model in plane and civculor polariscopes. Dark field and light field arrangements.

Module – II (12 hours)

Photoelestic model materials for two-dimensional applications, calibration methods. Analysis techniques, Isochromatic and Isoclinic fringe Patterns, Compensation techniques, stress separation techniques, scaling model to prototype stresses. Birefringent coatings and scattered light in Photo-elasticity, reflection polariscope.

Module – III (14 hours)

Strain-measurement methods and related instrumentation

Electrical resistance strain gauges, Gage construction, gage factor, selection, temperature compensation, semiconductor strain gauges.

Strain gage circuits, Wheatstone and Potentiometer bridge circuits, Rosette Analysis, recording instruments, Dynamic strain measurements.

Brittle coating methods, Behaviour of stress coats and its application.

Grid Technique of displacement/strain analysis.

Text Books:

1. Experimental Stress Analysis by James W. Dally and William F. Riley, Mc Graw Hill Pub. Co., 1965
2. Experimental stress Analysis and Motion Measurements by Dove and Adams Prentice Hall of India (P) Ltd.

References :

1. Timoshenko, S. P. and Goodier, J.N., Theory of Elasticity, Mc Graw Hill Book Co., NY, 1951
2. Durelli, A.J., Phillips, E. and Tsao, C.H., Introduction to the Theoretical and Experimental Analysis of Stress and Strain, Mc Graw Hill Book Co., NY, 1958.
3. Frocht, M.M., Photoelasticity, John Wiley and Sons, Inc., NY, 1948. (vol I & II).
4. Durelli, A.J. Applied stress Analysis, Prentice Hall of India (P) Ltd.

SMART MATERIALS AND STRUCTURES

Module I **14 hours**

1. **Overview** of Smart Materials, Structures and Products Technologies.
2. **Smart Materials (Physical Properties)**
   Piezoelectric Materials, Electrostrictive Materials, Magnetostrictive Materials, Magnetoelectric Materials.
   Magnetorheological Fluids, Electrorheological Fluids, Shape Memory Materials, Fiber-Optic Sensors.
3. **Smart Sensor, Actuator and Transducer Technologies**
   Smart Sensors: Accelerometers; Force Sensors; Load Cells; Torque Sensors; Pressure Sensors;
   Microphones; Impact Hammers; MEMS Sensors; Sensor Arrays
   Smart Actuators: Displacement Actuators; Force Actuators; Power Actuators; Vibration Dampers;
   Shakers; Fluidic Pumps; Motors
   Smart Transducers: Ultrasonic Transducers; Sonic Transducers; Air Transducers

Module II **13 hours**

4. **Measurement, Signal Processing, Drive and Control Techniques**
   Quasi-Static and Dynamic Measurement Methods; Signal-Conditioning Devices; Constant Voltage, Constant Current and Pulse Drive Methods; Calibration Methods; Structural Dynamics and Identification Techniques; Passive, Semi-Active and Active Control; Feedback and Feed forward Control Strategies

Module III **13 hours**

5. **Design, Analysis, Manufacturing and Applications of Engineering Smart Structures and Products**
   Case studies incorporating design, analysis, manufacturing and application issues involved in integrating smart materials and devices with signal processing and control capabilities to engineering smart structures and products. Emphasis on structures, automation and precision manufacturing equipment, automotives, consumer products, sporting products, computer and telecommunications products, as well as medical and dental tools and equipment.

TEXT BOOKS:

1. M. V. Gandhi and B. S. Thompson, Smart Materials and Structures, Chapman & Hall, London; New York, 1992 (ISBN: 0412370107).
2. B. Culshaw, Smart Structures and Materials, Artech House, Boston, 1996 (ISBN:0890066817).

REFERENCE BOOKS

1. A. V. Srinivasan, Smart Structures: Analysis and Design, Cambridge University Press, Cambridge; New York, 2001 (ISBN: 0521650267).
2. H.Thomas.Banks, Ralph Charles Smith, Yun Wang, Smart material structures: modeling, estimation and control, Wiley, 1996, ISBN: 9780471970248
3. Mel M. Schwartz, Smart materials, CRC Press, 2009, ISBN: 9781420043723
4. G. Gautschi, Piezoelectric Sensorics: Force, Strain, Pressure, Acceleration and Acoustic Emission Sensors. Materials and Amplifiers, Springer, Berlin; New York, 2002 (ISBN: 3540422595).
5. K. Uchino, Piezoelectric Actuators and Ultrasonic Motors, Kluwer Academic Publishers, Boston, 1997 (ISBN: 0792398114).
6. K. Otsuka and C. M. Wayman, Shape Memory Materials, Cambridge University Press,. Cambridge; New York, 1998 (ISBN: 052144487X).
7. Andre Preumont, Vibration Control of Active Structures: An Introduction, 2nd Edition, Kluwer Academic Publishers, Dordrecht; Boston, 2002 (ISBN: 1402004966).
8. Peter L. Reece, Smart materials and structures: new research, Nova Publishers, 2007, ISBN: 9781600211072.

MACHINERY FAULT DIAGNOSTICS AND CONDITION MONITORING

Module – I **13 hours**

Principles of Maintenance, Fault analysis planning and system availability: Failure modes, effects and criticality analysis (FMECA), Failure effects assessment (FEA), Critical areas assessment, Fault tree method, Availability concepts, Failure prediction/reliability assessment

Data Processing and Signal Analysis: Computer-Aided Data Acquisition, Time Domain Analysis, Frequency Domain Analysis - Fast Fourier Transform

Performance trend monitoring: Primary monitoring – performance, Primary and secondary performance parameters, Performance trend analysis

Module – II **12 hours**

Vibration Analysis: Vibration monitoring equipment, System monitors and vibration limit detectors, vibration monitoring experience

Discrete frequencies: Introduction, Simple vibrations, Gear excitation, Rolling element bearings, Blade vibration, Fans and Pumps and Case Studies on Vibration Monitoring

Contaminant analysis: Contaminants in used lubricating oils, Carrier fluid degradation, Contaminant monitoring techniques (Wear processes), Oil degradation analysis, Abrasive particles in lubrication oil, Abrasive particle in bearings, Abrasive particle in hydraulic systems, Dissolved gas fault monitoring

Module – III **11 hours**

Electric Motor Current and Signature Analysis

Non-Destructive Test and Evaluation technology: Overview:

Radiography, Ultrasonics: Principle, transducers, equipments and testing

Liquid Penetrant Test, Magnetic Particle Test, Eddy Current Test.

Other Topics: Thermal Infrared Imaging, Acoustic Emission, Leak Testing

Industrial Applications of NDE

Text Books

1. Mechanical Fault Diagnosis and Condition Monitoring by Ralph Albert Collacott, Wiley (or Chapman and Hall, 1977)

Reference Books

1. Condition Based Maintenance and Machine Diagnostics, John W Williams, Alan Davies, Paul R Drake, Springer, 2006
2. Rotating Machinery Vibration; From Analysis to Troubleshooting, Maurice L. Adams, Jr., CRC Press
3. Lubrication and Maintenance of Industrial Machinery; Best Practices and Reliability, R.M.Gresam and G.E.Totten, CRC Press
4. Vibration, Monitoring and Diagnosis: Techniques for Cost-effective Plant Maintenance by Ralph Albert Collacott, 1979, Wiley
5. Handbook on Condition Monitoring, B.K.N. Rao, Elsevier Science 1998
6. Handbook of Condition Monitoring Techniques and Methodology, M.Davies, Springer 2006
7. Vibratory Condition Monitoring of Machines", J.S.Rao, *CRC Press*, 2000
8. Vibration Monitoring, Testing, and Instrumentation, Editor(s)**:** Clarence W. de Silva, *University of British Columbia, Vancouver, Canada*, Series: Mechanical Engineering Series, CRC Press (Taylor & Francis)
9. Non-destructive Test and Evaluation of Materials, J.Prasad and C.G.K.Nair, Tata-McGraw-Hill
10. Machinery Condition Monitoring and Trouble Shooting, John S. Mitchell

MANAGEMENT INFORMATION SYSTEM

Module – I (12 hours)

Overview: Definition of MIS, Data processing and MIS, Characteristics of MIS, Need / importance of MIS in organization, Limitations of MIS; MIS and other disciplines
Data and Information; Characteristics of Information; Types of Information – Operational, Tactical and Strategic information; Managers as Information Processors;
System Approach: MIS as a system, Sub-systems of MIS – Activity sub-systems, Functional sub-system
Decision Making: Decision-making under certainty, risk and uncertainty; Phases of Decision-making Process; Decision Models - Classical Economic Model, Administrative Model; Organizational Decision-making
Planning for development of MIS: Feasibility Analysis – Technical, Economic, Motivational, Schedule and Operational Feasibility; MIS development as a project;

Module – II (12 hours)
Overview of System Life Cycle Models – Waterfall model, Prototyping model and Spiral model
System Analysis and Design (SAD): Purpose, Requirement engineering, Typical content of System Requirement Specification (SRS), System Design – high level design and low level design, Characteristics of good design – coupling and cohesion
Overview of tools used in SAD – Context diagram, Data Flow Diagram (DFD), Data Dictionary, ER diagram, Structure charts, HIPO documentation, Decision Table, Decision Tree, Pseudocode

Module – III (12 hours)
MIS in Organization: MIS in Marketing; Manufacturing; HRM; Accounting and Finance, Enterprise Resource Planning (ERP) System.
Business Intelligence (BI): Role of BI in marketing, finance, human resource, and manufacturing; Overview of DSS, Data Mining and Data Warehouse
Implementation of MIS: Critical Success Factor
Information System Security, Privacy, Social and Ethical issues

Books:

1. Management Information Systems, M Jaiswal & M Mital, Oxford Univ. Press
2. Information Systems for Modern Management, Murdick, Ross & Claggett, PHI
3. Management Information System, Launden & Launden, Pearson
4. Management Information System, James O Brian, TMH
5. Management Information Systems, A K Gupta, Sultan Chand & Sons
6. Management Information System, Jawadekar, McGraw Hill

MARKETING MANAGEMENT (3-0-0)

Objective of the Course: The course aims at introducing the basic concepts of marketing to the undergraduate students in engineering. The learning shall help the students in better designing, manufacturing and selling product/ service packages keeping competitive market, customers and cost in view.

Module – I (10 hours)

Marketing Management: Concept, Process, Functions and relevance in the current context.

Marketing Environment: Elements of micro and macro environment

Competition Analysis: Factors contributing to competition, porter's five forces model, Identifying and analyzing competitors.

Marketing Planning : Exploring Opportunity, Product –market selection, Marketing Planning Process.

Market Research and Information Systems: Research Process, The Internet and World Wide Web based Information collection and processing, Database, Data Warehouses and Data Mining, Global Market Research.

Consumer Behavior: Factors influencing consumer behavior, consumer decision process. Organizational buying behavior.

Module II (10 hours)

Market Segmentation, Targeting and Positioning: Definition, Bases of segmenting consumer and Industrial markets. Target Market strategies: Market Positioning.

Market Demand Forecasting: Key Terms, Forecasting Tools: Short term tools: Moving average and Exponential smoothing methods, Long-term forecasting Tools: Time series analysis, Econometrics methods, Qualitative tools : Buying Intention Survey, Sales Force Opinion and Delphi Techniques.

Product Planning : Product Life Cycle, New Product Development Process, Branding Strategy, Positioning a Brand, Brand Equity, Packaging and Labeling, Product-mix and Product Line, Planned Obsolescence.

Module – III (10 hours)

Pricing Decision: Objectives and Factors influencing pricing, Pricing method and strategies.

Integrated Marketing Communication(IMC)- Concept of IMC, the marketing communication process, Promotion Mix, elements of promotion mix, Direct marketing.

Channels of Distributions: Types of intermediaries, functions of distribution channels, channel levels, Designing Distribution Channels, Physical Distribution, Supply Chain Management (Basic only).

Trends in Marketing: Green Marketing, Customer Relationship Management, E-marketing, Rural Marketing and Service Marketing (concepts only)

Text Book:

1. Etzel , Walker ,Stanton and Pandit, Marketing, 14/e, Tata McGraw Hill.

2. Saxena, "Marketing Management" Tata McGraw Hill, 4/e.

Reference

1. Grewal, Levy, 'Marketing' Tata McGraw Hill, special Indian edition.

2. Karunakaran "Marketing Management", Himalaya Publishing House, 2010/e.

3. Kotler, Keller,Koshy and Jha, "Marketing Management", 13/e, Pearson Education.

WIRELESS SENSOR NETWORKS

Unit I 8Hrs

Sensor Network Concept: Introduction, Networked wireless sensor devices, Advantages of Sensor networks, Applications, Key design challenges.

Network deployment: Structured versus randomized deployment, Network topology, Connectivity, Connectivity using power control, Coverage metrics, Mobile deployment.

Unit II 8Hrs

Localization and Tracking: Issues and approaches, Problem formulations: Sensing model, collaborative localization. Coarse-grained and Fine-grained node localization. Tracking multiple objects: State space decomposition.

Synchronization: Issues and Traditional approaches, Fine-grained clock synchronization, and Coarse-grained data synchronization.

Unit III 14Hrs

Wireless Communications: Link quality, shadowing and fading effects

Medium-access and sleep scheduling: Traditional MAC protocols, Energy efficiency in MAC protocols, Asynchronous sleep techniques, Sleep-scheduled techniques, and Contention-free protocols.

Routing: Metric-based approaches, Multi-path routing, Lifetime-maximizing energy-aware routing techniques, Geographic routing.

Sensor network Databases: Data-centric routing, Data-gathering with compression, Querying, Data-centric storage and retrieval, the database perspective on sensor networks.

Security: Privacy issues, Attacks and countermeasures.

Text Books:

1. Wireless Sensor Networks: An Information Processing Approach- by Feng Zhao, Leonidas Guibas , Morgan Kaufmann Series in Networking 2004.

References Books:

1. Networking Wireless Sensors: Bhaskar Krismachari, Cambridge University Press
2. Wireless Sensor Networks: Edited by C.S Raghavendra, Krishna M, Sivalingam, Taieb Znati , Springer.
3. Wireless Sensor Networks: Technology, Protocols, and Applications: Kazem Sohraby, Daniel Minoli, Taieb Znati , Wiley Inter Science.

MICRO-ELECTRO-MECHANICAL SYSTEMS (MEMS)

Module-I 14 Lectures
Overview of MEMS and Microsystems. (Chapter 1 of Text Book 1)
Micromachining Techniques: Silicon as material for micromachining, Photolithography, thin film deposition, doping, wet and dry etching, surface and bulk micromachining, Wafer bonding, packaging. (Chapter 3 and Section 8.2 of Text Book 1, Chapter 2 of Text Book 2)

Module II 10 lectures
Microsystem Modeling and Design: Mechanics of deformable bodies, Energy method, Estimation of stiffness and damping for different micro-structures, Modeling of electromechanical systems, Pull-in voltage. (Section 4.1 to 4.3 and 6.2.2 of Text Book 1, Section 3.4 of Text Book 2)

Module III 15 Lectures
MEMS Applications: Mechanical sensors and actuators: Piezoresistive pressure sensors, MEMS capacitive accelerometer, Gyroscopes, Piezoelectric actuators. (Section 8.3 of Text Book 1 and Section 5.3 and 5.11 of Text Book 2)
Optical: Micro-lens, Micro-mirror, Optical switch (Section 7.5 to 7.7 of Text Book 2)
Radio frequency MEMS: Inductor, Varactor, Filter, Resonator. (Section 9.3 to 9.7 of Text Book 2)
Microfluidics: Capillary action, Micropumping, Electrowetting, Lab-on-a-chip. (Section 10.1 to 10.8 of Text Book 2)

Text Books:

1. G.K. Ananthsuresh, K.J. Vinoy, S. Gopalakrishnan, K.N. Bhat and V.K. Atre: Micro and Smart Systems, Wiley India, New Delhi, 2010.
2. N.P. Mahalik: MEMS, Tata McGraw-Hill, New Delhi, 2007.
Reference Book:

1. T. Hsu: MEMS and Microsystems: Design and Manufacture, Tata McGraw-Hill, New Delhi, 2002.