



JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA - VIZIANAGARAM
VIZIANAGARAM – 535 003 Andhra Pradesh (India)
 (Established by Andhra Pradesh Act No.22 of 2021)

B.Tech. – IV Year I Semester

S.No.	Category	Title	L	T	P	Credits
1	PC	CAD/CAM	3	0	0	3
2	Management Course- II	Operations Research	2	0	0	2
3	PE – IV	Professional Elective-IV	3	0	0	3
4	PE - V	Professional Elective-V	3	0	0	3
5	OE - III	1. Digital marketing management 2. Product design and development 3. Introduction to Mechatronics 4. Condition Monitoring 5. Operations Management	3	0	0	3
6	OE - IV	1. Statistical Quality Control 2. Nano Materials 3. Entrepreneurship 4. Product Design & Development 5. Optimization Techniques	3	0	0	3
7	Skill Enhancement Course	Renewable Energy Simulation Lab Instrumentation and control systems lab	0	1	2	2
8	Audit Course	Constitution of India	2	0	0	-
9	Internship	Evaluation of Industry Internship	-	-	-	2
Total			19	01	02	21

Professional Elective-IV

1. Production Planning & Control
2. Nondestructive evaluation
3. Smart materials
4. Hydrogen and fuel cell technology
5. Power Plant Engineering

Professional Elective-V

1. Electric and Hybrid vehicles
2. Cryogenics
3. Automation in Manufacturing
4. Industrial Hydraulics and Pneumatics
5. Noise Control



JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA - VIZIANAGARAM
VIZIANAGARAM – 535 003 Andhra Pradesh (India)
 (Established by Andhra Pradesh Act No.22 of 2021)

B.Tech. – IV Year II Semester

S.No	Category	Title	L	T	P	C
1	Internship & Project Work	Full semester Internship & Project Work	0	0	24	12

For Minor degree: (18 Credits)

1. Industrial Engineering and Management
2. Materials Science
3. Design of Machine Elements
4. Manufacturing Technologies
5. Basics of Thermal Engineering
6. Material Science Lab
7. Manufacturing Technologies Lab

For Honor's degree:

1. Machine Design (18 Credits)

1. Advanced Mechanics of Solids
2. Advanced Finite Element Methods
3. Advanced Mechanisms & Robotics
4. Advanced Machine Design
5. Design for Manufacturing & Assembly
6. Computational Lab
7. Mechanisms and Robotics Lab

2. CAD/CAM (18 Credits)

1. Advanced CAD
2. Computer Integrated Manufacturing
3. Modeling & Simulation of Manufacturing systems
4. Advanced Manufacturing Processes
5. Quality & Reliability
6. Advanced CAD Lab
7. Modeling & Simulation of Manufacturing systems Lab



JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA - VIZIANAGARAM
VIZIANAGARAM – 535 003 Andhra Pradesh (India)
(Established by Andhra Pradesh Act No.22 of 2021)

3. Thermal Engineering (18 Credits)

1. Advanced Thermodynamics
2. Advanced Fluid Mechanics
3. Advanced Heat Transfer
4. Advanced CFD
5. Design of Heat Transfer Equipment
6. Computational laboratory
7. Computational Fluid Dynamics Lab

4. Robotics and Automation (18 Credits)

- 1) Robotic Engineering
- 2) Basic Control system for robots
- 3) Fluid Power System for Automation
- 4) Industrial IoT and Cloud Computing
- 5) Autonomous Navigation and Path Planning
- 6) Robot Design Lab
- 7) IoT and Cloud Computing Lab

5. Industrial Engineering (18 Credits)

- 1) Operations Planning and Control
- 2) Work System Design
- 3) Facilities Planning
- 4) Advanced Operation Research
- 5) Productivity Engineering & Management
- 6) Industrial Engineering Lab-I
- 7) Industrial Engineering Lab-II

IV Year-I Semester	Professional Course	L	T	P	C
		3	0	0	3
CAD/CAM					

Course Objectives:

The students will acquire the knowledge

1. To interpret the basic fundamentals of computer aided design and manufacturing.
2. To analyze 2D & 3D transformations of the basic entities like line, circle, ellipse etc
3. To interpret the different geometric modeling techniques like solid modeling, surface modeling, feature based modeling etc. and to visualize how the components look like before its manufacturing or fabrication.
4. To interpret the part programming, importance of group technology, computer aided process planning, computer aided quality control
5. To illustrate the overall configuration and elements of computer integrated manufacturing systems.

UNIT – I

Computers in industrial manufacturing, product cycle, CAD / CAM Hardware, basic structure, CPU, memory types, input devices, display devices, hard copy devices, storage devices.

COMPUTER GRAPHICS: Raster scan graphics coordinate system, database structure for graphics modeling, transformation of geometry, 3D transformations, mathematics of projections, clipping, hidden surface removal.

UNIT – II

GEOMETRIC MODELING: Requirements, geometric models, geometric construction models, curve representation methods, surface representation methods, modeling facilities desired.

DRAFTING AND MODELING SYSTEMS: Basic geometric commands, layers, display control commands, editing, dimensioning, solid modelling.

UNIT – III

PART PROGRAMMING FOR NC MACHINES: NC, NC modes, NC elements, CNC machine tools, structure of CNC machine tools, features of Machining center, turning center, CNC Part Programming: fundamentals, manual part programming methods, Computer Aided Part Programming. Direct Numerical Control, Adaptive Control

UNIT – IV

GROUP TECHNOLOGY: Part family, coding and classification, production flow analysis, types and advantages. Computer aided processes planning – importance, types. FMS- Introduction, Equipment, Tool management systems, Layouts, FMS Control.

UNIT – V

COMPUTER AIDED QUALITY CONTROL: Terminology used in quality control, use of computers in Quality control. Inspection methods- contact and noncontact types, computer aided testing, integration of CAQC with CAD/CAM.

COMPUTER INTEGRATED MANUFACTURING SYSTEMS: Types of manufacturing systems, machine tools and related equipment, material handling systems, material requirement planning, computer control systems, human labor in manufacturing systems, CIMS benefits.

Text Books:

1. CAD / CAM Principles and Applications/PN Rao / McGraw-Hill
2. Automation, Production systems & Computer integrated Manufacturing/ M.P. Groover/Pearson Education

References:

1. Mastering CAD / CAM / Ibrahim Zeid / McGraw-Hill
2. Principles of Computer Aided Design and Manufacturing / Farid Amirouche / Pearson
3. Computer Numerical Control Concepts and programming / Warren S Seames / Thomson learning, Inc
4. Product manufacturing and cost estimation using CAD/CAE/ Kuang Hua Chang/Elsevier Publishers

Course Outcome:

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

1. Interpret the basic fundamentals of computer aided design and manufacturing.
2. Analyze 2D & 3D transformations of the basic entities like line, circle, ellipse etc
3. Interpret the different geometric modeling techniques like solid modeling, surface modeling, feature based modeling etc. and to visualize how the components look like before its manufacturing or fabrication.
4. Interpret the part programming, importance of group technology, computer aided process planning, computer aided quality control
5. Illustrate the overall configuration and elements of computer integrated manufacturing systems.

IV Year-I Semester	Professional Course	L	T	P	C
		3	0	0	3
Operations Research					

Course Objectives: The students will acquire the knowledge

1. To Analyze Linear Programming models
2. To Interpret Transportation and sequencing problems
3. To Solve replacement problems and analyze queuing models
4. To Analyze game theory and inventory problems
5. To Interpret dynamic programming and simulation.

UNIT – I

Development – definition– characteristics and phases – types of operation research models – applications. ALLOCATION: Linear programming problem formulation – graphical solution – simplex method – artificial variables techniques -two–phase method, big-M method – duality principle.

UNIT – II

TRANSPORTATION PROBLEM: Formulation – optimal solution, unbalanced transportation problem – degeneracy, assignment problem – formulation – optimal solution - variants of assignment problem- travelling salesman problem. SEQUENCING – Introduction – flow –shop sequencing – n jobs through two machines – n jobs through three machines – job shop sequencing – two jobs through ‘m’ machines.

UNIT – III

REPLACEMENT: Introduction – replacement of items that deteriorate with time – when money value is not counted and counted – replacement of items that fail completely, group replacement. THEORY OF GAMES: Introduction – mini. max (max. mini) – criterion and optimal strategy – solution of games with saddle points – rectangular games without saddle points – 2 x 2 games – dominance principle – m x 2 & 2 x n games -graphical method.

UNIT – IV

WAITING LINES: Introduction – single channel – poisson arrivals – exponential service times – with infinite population and finite population models– multichannel – poisson arrivals – exponential service times with infinite population single channel poisson arrivals.

INVENTORY: Introduction – single item – deterministic models – purchase inventory models with one price break and multiple price breaks – shortages are not allowed – stochastic models – demand may be

discrete variable or continuous variable – instantaneous production. Instantaneous demand and continuous demand and no set up cost. ABC & VED Analysis.

UNIT – V

DYNAMIC PROGRAMMING: Introduction – Bellman's principle of optimality – applications of dynamic programming- capital budgeting problem – shortest path problem – linear programming problem

SIMULATION: Definition – types of simulation models – phases of simulation– applications of simulation – inventory and queuing problems – advantages and disadvantages – simulation languages.

Text Books:

1. Operations Research-An Introduction/Hamdy A Taha/Pearson publishers
2. Operations Research –Theory & publications / S.D.Sharma-Kedarnath/McMillan publishers India Ltd

References:

1. Introduction to O.R/Hiller & Libermann/TMH
2. Operations Research /A.M. Natarajan, P. Balasubramani, A. Tamilarasi /Pearson Education.
3. Operations Research: Methods & Problems / Maurice Saseini, Arhur Yaspan & Lawrence Friedman/Wiley
4. Operations Research / R.Pannerselvam/ PHI Publications.
5. Operations Research / Wagner/ PHI Publications.
6. Operation Research /J.K.Sharma/MacMilan Publ.
7. Operations Research/ Pai/ Oxford Publications
8. Operations Research/S Kalavathy / Vikas Publishers
9. Operations Research / DS Cheema/University Science Press 10. Operations Research / Ravindran, Philips, Solberg / Wiley publishers

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

1. Analyze Linear Programming models
2. Interpret Transportation and sequencing problems
3. Solve replacement problems and analyze queuing models
4. Analyze game theory and inventory problems
5. Interpret dynamic programming and simulation.

IV Year-I Semester	Professional Elective - IV	L	T	P	C
		3	0	0	3
PRODUCTION PLANNING AND CONTROL					

Course objectives:

The students will acquire the knowledge:

1. To Illustrate the different types of production systems and the internal organization of production planning and control
2. To estimate forecasts in the manufacturing and service sectors using selected quantitative and qualitative techniques
3. To Analyze the importance and function of inventory and to be able to apply for its control and management
4. To apply routing procedures and differentiate schedule and loading and interpret scheduling policies and aggregate planning
5. To interpret dispatching procedure and applications of computers in production planning and control

UNIT – I

Introduction: Definition – objectives and functions of production planning and control – elements of production control – types of production – organization of production planning and control department – internal organization of department.

UNIT – II

Forecasting – Importance of forecasting –types of forecasting, their uses – general principles of forecasting – forecasting techniques – qualitative methods and quantitative methods.

UNIT – III

Inventory management – functions of inventories – relevant inventory costs – ABC analysis – VED analysis – EOQ model – Inventory control systems – P-Systems and Q-Systems
Introduction to MRP I, MRP II, ERP, LOB (Line of Balance), JIT and KANBAN system.

UNIT – IV

Routing –definition – routing procedure –route sheets – bill of material – factors affecting routing procedure, schedule –definition – difference with loading. Scheduling policies – techniques, standard scheduling methods.

Line Balancing, aggregate planning, chase planning, expediting, controlling aspects.

UNIT – V

Dispatching – activities of dispatcher – dispatching procedure – follow up – definition – reason for existence of functions – types of follow up, applications of computer in production planning and control.

Text Books:

1. Elements of Production Planning and Control / Samuel Eilon/Universal Book Corp.
2. Manufacturing, Planning and Control/Partik Jonsson Stig- ArneMattsson/ TataMc GrawHill

References:

1. Inventory Control Theory and Practice / Martin K. Starr and David W.Miller/Prentice-Hall
2. Production Planning and Control/Mukhopadyay/PHI.
3. Production Control A Quantitative Approach / John E.Biegel/Prentice-Hall
4. Production Control / Franklin G Moore & Ronald Jablonski/Mc-GrawHill
5. Production and Operations Management/Shailendra Kale/McGraw-Hill
6. Production and Operations Management/Ajay K Garg/McGraw-Hill

.TEXT BOOKS:

1. Elements of Production Planning and Control / Samuel Eilon/Universal Book Corp.
2. Manufacturing, Planning and Control/Partik Jonsson Stig-Arne Mattsson/Tata McGraw Hill

REFERENCES:

1. Inventory Control Theory and Practice / Martin K. Starr and David W. Miller/Prentice-Hall
2. Production Planning and Control/Mukhopadyay/PHI.
3. Production Control A Quantitative Approach / John E. Biegel/Prentice-Hall
4. Production Control / Franklin G Moore & Ronald Jablonski/ Mc-Graw Hill

5. Production and Operations Management/Shailendra Kale/McGraw Hill
6. Production and Operations Management/Ajay K Garg/McGraw Hill

Course Outcomes:

1. Illustrate the different types of production systems and the internal organization of production planning and control
2. Estimate forecasts in the manufacturing and service sectors using selected quantitative and qualitative techniques
3. Analyze the importance and function of inventory and to be able to apply for its control and management
4. Apply routing procedures and differentiate schedule and loading and interpret scheduling policies and aggregate planning
5. Interpret dispatching procedure and applications of computers in production planning and control

IV Year-I Semester	Professional Elective - IV	L	T	P	C
		3	0	0	3
NON-DESTRUCTIVE EVALUATION					

Course Objectives:

The students will acquire the knowledge

1. To Illustrate basic concepts of non-destructive testing and industrial applications
 2. To analyze the elements of ultrasonic test and limitations of ultrasonic test
 3. To Illustrate the concepts involved in the liquid penetrant test and eddy current test
 4. To analyze the basic principles and operating procedures of magnetic particle testing
 5. To interpret the basic concepts involved in the infrared and thermal testing
- (At least, two equipment on Non-destructive evaluation process are to be demonstrated)

UNIT-I

Introduction to non-destructive testing and industrial Applications of NDE: Span of NDE Activities Railways, Nuclear, Non-nuclear and Chemical Industries, Aircraft and Aerospace Industries, Automotive Industries, Offshore Gas and Petroleum Projects, Coal Mining Industry, NDE of pressure vessels, castings, welded constructions.

Radiographic test, Sources of X and Gamma Rays and their interaction with Matter, Radiographic equipment, Radiographic Techniques, Safety Aspects of Industrial Radiography

UNIT-II

Ultrasonic test: Principle of Wave Propagation, Reflection, Refraction, Diffraction, Mode Conversion and Attenuation, Sound Field, Piezo-electric Effect, Ultrasonic Transducers and their Characteristics, Ultrasonic Equipment and Variables Affecting Ultrasonic Test, Ultrasonic Testing, Interpretations and Guidelines for Acceptance, Rejection - Effectiveness and Limitations of Ultrasonic Testing.

UNIT-III

Liquid Penetrant Test: Liquid Penetrant Test, Basic Concepts, Liquid Penetrant System, Test Procedure, Effectiveness and Limitations of Liquid Penetrant Testing,

Eddy Current Test: Principle of Eddy Current, Eddy Current Test System, Applications of Eddy Current Testing Effectiveness of Eddy Current Testing

UNIT-IV

Magnetic Particle Test: Magnetic Materials, Magnetization of Materials, Demagnetization of Materials, Principle of Magnetic Particle Test, Magnetic Particle Test Equipment, Magnetic Particle Test Procedure, Standardization and Calibration, Interpretation and Evaluation, Effective Applications and Limitations of the Magnetic Particle Test

UNIT-V

Infrared And Thermal Testing: Introduction and fundamentals to infrared and thermal testing–Heat transfer –Active and passive techniques –Lock in and pulse thermography–Contact and non-contact thermal inspection methods–Heat sensitive paints –Heat sensitive papers –thermally quenched phosphors liquid crystals –techniques for applying liquid crystals –other temperature sensitive coatings –Inspection methods –Infrared radiation and infrared detectors–thermo mechanical behaviour of materials–IR imaging in aerospace applications, electronic components, Honey comb and sandwich structures–Case studies.

Text Books:

1. Non destructive test and evaluation of Materials/J Prasad, GCK Nair/TMH Publishers
2. Ultrasonic testing of materials/ H Krautkramer/Springer
3. Non destructive testing/Warren, J Mc Gonnagle / Godan and Breach Science publishers
4. Nondestructive evaluation of materials by infrared thermography / X. P. V. Maldague, Springer-Verlag, 1st edition, (1993)

References:

1. Ultrasonic inspection training for NDT/E.A.Gingel/PrometheusPress,
2. ASTM Standards, Vol3.01, Metals and alloys
3. Non-destructive, Hand Book – R. Hamchand

Course Outcomes

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

1. Illustrate basic concepts of non-destructive testing and industrial applications
2. Analyze the elements of ultrasonic test and limitations of ultrasonic test
3. Illustrate the concepts involved in the liquid penetrant test and eddy current test
4. Analyze the basic principles and operating procedures of magnetic particle testing
5. Interpret the basic concepts involved in the infrared and thermal testing

IV Year-I Semester	Professional Elective - IV	L	T	P	C
		3	0	0	3
SMART MATERIALS					

Course Objectives

The students will acquire the knowledge:

1. To classify the composite materials and identify the applications
2. To illustrate manufacturing methods of PMC, MMC & CCC and their applications
3. To analyze macro-mechanical analysis of a lamina
4. To interpret the functionally graded materials and their properties
5. To analyze types of nano materials and their properties

UNIT-I

INTRODUCTION TO COMPOSITE MATERIALS: Introduction, classification: polymer matrix composites, metal matrix composites, ceramic matrix composites, carbon–carbon composites, fiber- reinforced composites and nature-made composites, and applications

REINFORCEMENTS: Fibres- glass, silica, kevlar, carbon, boron, silicon carbide, and boron carbide fibres.

UNIT-II

AEROSPACE MATERIALS: Metallic materials- super alloys, Aluminium, Magnesium, titanium and Nickel based alloys and intermetallics, High temperature polymers, Materials for cryogenic application, Materials for space environment, Evaluation of materials for extreme environment, Materials processing and manufacturing in zero gravity.

UNIT-III

MACROMECHANICAL ANALYSIS OF A LAMINA: Introduction, generalized Hooke's law, reduction of Hooke's law in three dimensions to two dimensions, relationship of compliance and stiffness matrix to engineering elastic constants of an orthotropic lamina, laminate-laminate code.

UNIT-IV

FUNCTIONALLY GRADED MATERIALS: Types of functionally graded materials-classification different systems-preparation-properties and applications of functionally graded materials.

SHAPE MEMORY ALLOYS: Introduction-shape memory effect-classification of shape memory alloys-composition-properties and applications of shape memory alloys.

UNIT-V

NANO MATERIALS: Introduction-properties at nano scales-advantages & disadvantages applications in comparison with bulk materials (nano – structure, wires, tubes, composites). state of art nano advanced- topic delivered by student.

Text Books:

1. Nano material /A.K. Bandyopadyay/New age Publishers
2. Material science and Technology: A comprehensive treatment/Robert W.Cahn,/VCH
3. Engineering Mechanics of Composite Materials / Isaac and M Daniel/Oxford University Press

References:

1. Mechanics of Composite Materials / R. M. Jones/ Mc Graw Hill Company, New York, 1975.
2. Analysis of Laminated Composite Structures / L. R. Calcote/Van Nostrand Rainfold,NY 1969
3. Analysis and performance of fibre Composites /B. D. Agarwal and L. J. Broutman /Wiley-Interscience, New York, 1980
4. Mechanics of Composite Materials - Second Edition (Mechanical Engineering) /Autar K.Kaw /CRC Press

Course Outcomes

After learning the course, the students should be able to

1. Classify the composite materials and identify the applications
2. Illustrate manufacturing methods of PMC, MMC & CCC and their applications
3. Analyze macro-mechanical analysis of a lamina
4. Interpret the functionally graded materials and their properties
5. Analyze types of nano materials and their properties

IV Year-I Semester	Professional Elective - IV	L	T	P	C
		3	0	0	3
HYDROGEN & FUEL CELL TECHNOLOGY					

Course Objective: To gain insight about hydrogen energy, fuel cells, their working principle, types of fuel cells and performance analysis.

UNIT-I

Introduction to hydrogen energy systems: Current scenario of hydrogen production, general introduction to infrastructure requirement for hydrogen production, dispensing and utilization. Hydrogen production pathways: Thermal: Steam reformation, Thermo chemical water splitting, Gasification, Pyrolysis and Partial oxidation methods. Electrochemical: Electrolysis, Photo-electro chemical. Biological: Anaerobic Digestion, Fermentative Micro-organisms

UNIT-II

Hydrogen Storage: General storage methods, compressed storage, Zeolites, Metal hydride storage, chemical hydride storage and cryogenic storage. Hydrogen Utilization: Overview of hydrogen utilization, I.C. Engines, gas turbines, hydrogen burners, power plant, refineries, domestic, marine applications, fuel cell.

UNIT-III

Introduction to Fuel Cell: A simple fuel cell, fuel cell advantages, fuel cell disadvantages, fuel cell types basic fuel cell operation, fuel cell performance characterization and modeling, fuel cell technology, fuel cells and the environment. Fuel Cell Thermodynamics: Thermodynamics review, Heat potential of a fuel: enthalpy of reaction, Work potential of a fuel: Gibbs Free Energy, Predicting reversible voltage of a fuel cell under non-Standard state conditions, fuel cell efficiency, Thermal and Mass balances in fuel cells, Thermodynamics of reversible fuel cells.

UNIT-IV

Fuel Cell Reaction Kinetics: Introduction to electrode kinetics, activation energy of charge transfer reactions, activation energy determines reaction rate, net rate of a reaction calculation, rate of reaction at equilibrium: exchange current density, potential of a reaction at equilibrium: Galvani potential, potential and rate: Butler–Volmer equation, exchange currents and electrocatalysis: Improving kinetic performance, simplified activation kinetics: Tafel equation.

UNIT-V

Fuel Cell Charge Transport: Charges move in response to forces, charge transport results in a voltage loss, characteristics of fuel cell charge transport resistance, physical meaning of

conductivity, review of fuel cell electrolyte classes. Fuel Cell Mass Transport: Transport in electrode versus flow structure, transport in electrode: diffusive transport, transport in flow Structures: convective transport. Overview of Fuel Cell Types: introduction, phosphoric acid fuel cell, polymer electrolyte membrane fuel cell, alkaline fuel cell, molten carbonate fuel cell, solid-oxide fuel cell, other fuel cells.

Text Books

- 1 O'Hayre, Ryan/ Colella, Whitney/ Cha, Suk-Won, Fuel Cell Fundamentals (3rd Ed.) by Wiley Publications. 2016 (B) Reference Books
2. James Larminie and Andrew Dicks, Fuel Cell Systems Explained, 2ndEd., John Wiley & Sons Inc. 2000
- 2 .Supramaniam Srinivasan, Fuel Cells: From Fundamentals to Applications, Springer. 2010
3. Frano Barbir, PEM Fuel Cells Theory and Practice, Elsevier Academic Press. 2005

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

- i. Gain knowledge on fuel cell working principle, types of fuel cell, voltage loss and its reason
- ii. Interpret the role of fluid dynamics, reaction kinetics and mass transfer principles in fuel cell operation.
- iii. Illustrate the stacking of fuel cell and fuel processing for fuel cell.

IV Year-I Semester	Professional Elective - IV	L	T	P	C
		3	0	0	3
POWER PLANT ENGINEERING					

Course Objectives:

The students will acquire the knowledge:

1. To illustrate the working of different circuits of the steam power plant.
2. To analyze the layout and auxiliaries of the diesel and gas power plants.
3. To interpret the different elements in the hydroelectric and nuclear power plants.
4. To illustrate the basic concepts for power production in combined plants and usage of different instrument to measure the operating parameters of the power plant.
5. To analyze the concepts of power plant economics and pollution standards to be observed in the power plants.

UNIT – I

Introduction to the sources of energy – resources and development of power in India.

STEAM POWER PLANT: Plant layout, working of different circuits, fuel and handling equipment, types of coals, coal handling, choice of handling equipment, coal storage, ash handling systems. Combustion: properties of coal – overfeed and underfeed fuel beds, traveling grate stokers, spreader stokers, retort stokers, pulverized fuel burning system and its components, combustion needs and draught system, cyclone furnace, design and construction, dust collectors, cooling towers and heat rejection. corrosion and feed water treatment.

UNIT – II

INTERNAL COMBUSTION AND GAS TURBINE POWER PLANTS:

DIESEL POWER PLANT: Plant layout with auxiliaries – fuel supply system, air starting equipment, super charging.

GAS TURBINE PLANT: Introduction – classification - construction – layout with auxiliaries, combined cycle power plants and comparison.

UNIT – III

HYDRO ELECTRIC POWER PLANT: Water power – hydrological cycle / flow measurement – drainage area characteristics – hydrographs – storage and pondage – classification of dams and spill ways.

HYDRO PROJECTS AND PLANT: Classification – typical layouts – plant auxiliaries – plant operation pumped storage plants.

NUCLEAR POWER STATION: Nuclear fuel – breeding and fertile materials – nuclear reactor – reactor operation.

TYPES OF REACTORS: Pressurized water reactor, boiling water reactor, sodium-graphite reactor, fast breeder reactor, homogeneous reactor, gas cooled reactor, radiation hazards and shielding – radioactive waste disposal.

UNIT – IV

COMBINED OPERATIONS OF DIFFERENT POWER PLANTS: Introduction, advantages of combined working, load division between power stations, storage type hydro-electric plant in combination with steam plant, run-of-river plant in combination with steam plant, pump storage plant in combination with steam or nuclear power plant, co-ordination of hydro-electric and gas turbine stations, co-ordination of hydro-electric and nuclear power stations, co-ordination of different types of power plants.

POWER PLANT INSTRUMENTATION AND CONTROL: Importance of measurement and instrumentation in power plant, measurement of water purity, gas analysis, O₂ and CO₂ measurements, measurement of smoke and dust, measurement of moisture in carbon dioxide circuit, nuclear measurements.

UNIT – V

POWER PLANT ECONOMICS AND ENVIRONMENTAL CONSIDERATIONS: Capital cost, investment of fixed charges, operating costs, general arrangement of power distribution, load curves, load duration curve, definitions of connected load, maximum demand, demand factor, average load, load factor, diversity factor – related exercises. effluents from power plants and Impact on environment – pollutants and pollution standards – methods of pollution control.

Text Books:

1. A course in Power Plant Engineering /Arora and Domkundwar/Dhanpatrai & Co.
2. Power Plant Engineering /P.C.Sharma / S.K.Kataria Pub

References:

1. Power Plant Engineering: P.K.Nag/ II Edition /TMH.
2. Power station Engineering – ElWakil / McGrawHill.
3. An Introduction to Power Plant Technology / G.D. Rai/Khanna Publishers

Course outcomes:

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

1. Illustrate the working of different circuits of the steam power plant.
2. Analyze the layout and auxiliaries of the diesel and gas power plants.
3. Interpret the different elements in the hydroelectric and nuclear power plants.
4. Illustrate the basic concepts for power production in combined plants and usage of different instrument to measure the operating parameters of the power plant.
5. Analyze the concepts of power plant economics and pollution standards to be observed in the power plants.

IV Year-I Semester	Professional Elective - V	L	T	P	C
		3	0	0	3
ELECTRIC AND HYBRID VEHICLES					

Course Objectives: To present a comprehensive overview of Electric and Hybrid Electric Vehicles.

UNIT – I

Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, and mathematical models to describe vehicle performance.

UNIT – II

Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis. Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis.

UNIT-III

Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives

Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Hybridization of different energy storage devices.

UNIT-IV

Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology.

UNIT-V

Communications, supporting subsystems: In vehicle networks- CAN, Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies.

Text Book:

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003

References:

1. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.
2. Mehrdad Ehsani, YimiGao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.

Course outcome:

The students will be able to

- i. Illustrate a suitable drive scheme for developing an electric hybrid vehicle depending on resources (BL-1)
- ii. Design and develop basic schemes of electric vehicles and hybrid electric vehicles. (BL-6)
- iii. Select proper energy storage systems for vehicle applications (BL-1)
- iv. Identify various communication protocols and technologies used in vehicle networks. (BL-1)

IV Year-I Semester	Professional Elective - V	L	T	P	C
		3	0	0	3
CRYOGENICS					

Course Objectives

- 1 To interpret the scope and history of cryogenics, the properties of materials at low temperature applying fundamental knowledge.
- 2 To apply the knowledge of low temperature production methods to interpret and analyse different liquefaction systems. To gain knowledge about the critical components involved in liquefaction.
- 3 To apply the knowledge of ideal refrigeration techniques, to interpret and analyse common cryogenic refrigeration systems. To apply some of the novel cryogenic refrigeration methods.
- 4 To illustrate various cryogenic fluid storage and transport systems and to evaluate their performance applying fundamental concepts
- 5 To interpret the different cryogenic instrumentation and to illustrate cryo pumping.

UNIT-I

Introduction to Cryogenic Systems: Historical development, Applications of Cryogenics (Space, Food Processing, Super conductivity, Electrical Power, Biology, Medicine, Electronics and Cutting Tool Industry). Low Temperature Properties: Properties of Engineering Materials (Mechanical properties, Thermal properties, Electric and Magnetic properties), Properties of Cryogenic fluids.

UNIT-II

Introduction to Liquefaction Systems: Ideal system, Joule Thomson expansion, Adiabatic expansion, Linde Hampson Cycle, Claude & Cascaded System. Introduction to Cryogenic Refrigeration Systems: Magnetic Cooling, Stirling Cycle Cryo Coolers.

UNIT-III

Gas Liquefaction Systems: General liquefaction systems. Liquefaction systems for Neon, Hydrogen and Helium. Critical components of liquefaction systems.

UNIT-IV

Cryogenic Refrigeration Systems: Ideal refrigeration systems, Refrigeration using liquids and gases as refrigerant, Refrigerators using solids as working media.

UNIT-V

Cryogenic Fluid Storage and Transfer Systems: Cryogenic storage vessels and transportation. Thermal insulation and their performance at cryogenic temperatures, Super insulations, Vacuum insulation, Powder insulation. Cryogenic fluid transfer systems. Cryogenic Instrumentation: Pressure, flow-rate, liquid-level and temperature measurements. Types of Heat Exchangers used in cryogenic systems (only description with figure). Cryo Pumping Applications.

Text books

1. J. H. Boll Jr, Cryogenic Engineering
2. R. B. Scott, Cryogenic Engineering, Van Nostrand Co., 1959

References

1. Randal F.Barron, Cryogenic systems, McGraw Hill, 1986 R1 Klaus D.Timmerhaus and Thomas M.Flynn, Cryogenic Process Engineering, Plenum Press, New York, 1989.

Course Outcomes

1. interpret the scope and history of cryogenics, the properties of materials at low temperature applying fundamental knowledge.
2. Apply the knowledge of low temperature production methods to interpret and analyse different liquefaction systems. To gain knowledge about the critical components involved in liquefaction.
3. Apply the knowledge of ideal refrigeration techniques, to analyse common cryogenic refrigeration systems. To interpret some of the novel cryogenic refrigeration methods.
4. Illustrate various cryogenic fluid storage and transport systems and to evaluate their performance applying fundamental concepts
5. Interpret the different cryogenic instrumentation and cryo pumping.

IV Year-I Semester	Professional Elective - V	L	T	P	C
		3	0	0	3
AUTOMATION IN MANUFACTURING					

Course Objectives:

The students will acquire the knowledge:

- 1.To analyze the types and strategies and various components in Automated Systems
- 2.To classify the types of automated flow lines and analyze automated flow lines
- 3.To solve the line balancing problems in the various flow line systems with and without buffer storage
4. To interpret different automated material handling systems, storage and retrieval systems and automated inspection systems
- 5.To illustrate the principles of Adaptive Control systems and recognize the types of automated inspection techniques and their applications

UNIT-I

INTRODUCTION: Types and strategies of automation, pneumatic and hydraulic components, circuits, automation in machine tools, mechanical feeding and tool changing and machine tool control.

UNIT – II

AUTOMATED FLOW LINES: Methods of part transport, transfer mechanism, buffer storage, control function, design and fabrication considerations. Analysis of automated flow lines - General terminology and analysis of transfer lines without and with buffer storage, partial automation, implementation of automated flow lines.

UNIT – III

ASSEMBLY SYSTEM AND LINE BALANCING: Assembly process and systems, assembly line, line balancing methods, ways of improving line balance, flexible assembly lines.

UNIT – IV

AUTOMATED MATERIAL HANDLING and STORAGE SYSTEMS:

Types of equipment, functions, analysis and design of material handling systems, conveyor systems, automated guided vehicle systems. Automated storage and retrieval systems; work in process storage, interfacing handling and storage with manufacturing.

UNIT – V

ADAPTIVE CONTROL SYSTEMS: Introduction, adaptive control with optimization, adaptive control with constraints, application of adaptive control in machining operations. Consideration of various parameters such as cutting force, temperatures, vibration and acoustic emission in the adaptive controls systems.

AUTOMATED INSPECTION: Fundamentals, types of inspection methods and equipment, Coordinate Measuring Machines, Machine Vision

TEXT BOOK:

1. Automation, Production Systems and Computer Integrated Manufacturing: M.P. Groover./ PE/PHI.

REFERENCES:

1. Computer Control of Manufacturing Systems by YoramCoren.
2. CAD / CAM/ CIM by Radhakrishnan.
3. Automation by W. Buekinsham.

Course outcomes:

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

1. Analyze the types and strategies and various components in Automated Systems
2. Classify the types of automated flow lines and analyze automated flow lines
3. Solve the line balancing problems in the various flow line systems with and without buffer storage
4. Interpret different automated material handling systems, storage and retrieval systems and automated inspection systems
5. Illustrate the principles of Adaptive Control systems and recognize the types of automated inspection techniques and their applications

IV Year-I Semester	Professional Elective - V	L	T	P	C
		3	0	0	3
INDUSTRIAL HYDRAULICS AND PNEUMATICS					

Course Objectives:

The students will acquire the knowledge:

1. To explain the basic concepts of fluid power
2. To illustrate the functions of elements of Hydraulic and Pneumatic systems
3. To analyze the functions of hydraulic and Pneumatic circuits
4. To illustrate the working of various hydraulic and pneumatic devices.
5. To interpret the procedure of installation, maintenance and troubleshooting of hydraulic and Pneumatic systems

UNIT – I:

Fluid Power: Power transmission modes, hydraulic systems, pneumatic systems, laws governing fluid flow: Pascal's law, continuity equation, Bernoulli's theorem, Boyle's, Charles', Gay-lussac' laws, flow through pipes - types, pressure drop in pipes, working fluids used in hydraulic and pneumatic systems- types, ISO/BIS standards and designations, properties.

UNIT– II:

Hydraulic and Pneumatic Elements:

Hydraulic pipes-Types, standards, designation methods and specifications, pressure ratings, applications and selection criteria, pumping theory, Hydraulic Pumps - types, construction, working principle, applications, selection criteria and comparison, hydraulic Actuators, Control valves, Accessories - their types, construction and working, pneumatic Pipes - materials, designations, standards, properties and piping layout, air compressors, Air receivers, air dryers, Air Filters, Regulators, Lubricators (FRL unit): their types, construction, working, specifications and selection criteria of following air preparation and conditioning elements, pneumatic Actuators and Control valves - types, construction, working, materials and specifications

UNIT– III:

Hydraulic and Pneumatic Circuits:

ISO symbols used in hydraulic and pneumatic circuit, basic Hydraulic Circuits – types (such as intensifier, regenerative, synchronizing, sequencing, speed control, safety), circuit diagram, components, working and applications, basic Pneumatic Circuits – types (such as speed control, two step feed control, automatic cylinder reciprocation, time delay, quick exhaust), circuit diagram, components, working and applications, pneumatic Logic circuit design - classic method, cascade method, step counter method, Karnaugh Veitch maps and combinational circuit design.

UNIT-IV

Hydraulic and Pneumatic Devices:

Hydraulic and Pneumatic devices – Concept and applications, construction, working principle, major elements, performance variables of: Automotive hydraulic brake, Industrial Fork lift, Hydraulic jack, Hydraulic press, Automotive power steering, Automotive pneumatic brake, Automotive air suspension, Pneumatic drill, Pneumatic gun.

UNIT-V

Installation, Maintenance and Trouble-Shooting:

Installation of hydraulic and pneumatic system causes and remedies for common troubles arising in hydraulic elements, maintenance of hydraulic systems, causes and remedies for troubles arising in pneumatic elements, maintenance of pneumatic systems.

Textbooks:

1. Majumdar, S.R. Oil Hydraulic Systems Tata Mcgraw-Hill Publication, New Delhi,3/e, 2013
2. Majumdar, S.R. Pneumatic Systems Tata Mcgraw-Hill Publication, New Delhi,3/e, 2013

References:

1. Srinivasan, R. Hydraulic and Pneumatic Controls Vijay Nicole Imprints Private, New Delhi, Limited, 2/e, 2008
2. Jagadeesha, T. Fluid Power Generation, Transmission and Control Universities Press (India) Private Limited, New Delhi,1/e, 2014
3. Jagadeesha, T. Pneumatics Concepts, Design And Applications Universities Press (India) Private Limited, New Delhi,1/e, 2014
4. Parr, Andrew Hydraulic And Pneumatics A Technician's and Engineer's Guide Jaico Publishing House, New Delhi,2/e, 2013
5. Shanmuga Sundaram, K . Hydraulic And Pneumatics Controls - Understanding Made Easy S. Chand Company Ltd., New Delhi, 1/e, 2006

Course outcomes:

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

1. Explain the basic concepts of fluid power
2. Illustrate the functions of elements of Hydraulic and Pneumatic systems

3. Analyze the functions of hydraulic and Pneumatic circuits
4. Illustrate the working of various hydraulic and pneumatic devices.
5. Interpret the procedure of installation, maintenance and troubleshooting of hydraulic and Pneumatic systems

IV Year-I Semester	Professional Elective - V	L	T	P	C
		3	0	0	3
NOISE CONTROL					

Course Objectives:

The students will acquire the knowledge:

1. To interpret the fundamental principles of sound and acoustics.
2. To measure and analyze noise and vibration signals.
3. To identify and characterize various noise sources.
4. To apply different noise control techniques to reduce noise at the source, along the path, or at the receiver.
5. To apply relevant noise standards and regulations.

Unit-1

Fundamentals of Acoustics:

Nature of Sound: Sound waves, propagation, frequency, wavelength, speed of sound, simple harmonic motion., **Sound Pressure, Power, and Intensity:** Definitions, units, and relationships., **Decibel Scale:** Sound pressure level (SPL), sound power level (SWL), sound intensity level (SIL), dB arithmetic, combining sound levels., **Frequency Analysis:** Octave bands, 1/3 octave bands, narrow band analysis, frequency weighting (A, C, etc.)., **Human Hearing:** Anatomy of the ear, hearing mechanisms, psychoacoustics, loudness, pitch, masking, human response to noise, hearing loss, noise-induced hearing loss., **Sound Fields:** Free field, reverberant field, near field, far field., **Acoustic Impedance and Admittance.**

UNIT II. Noise Measurement and Instrumentation:

Sound Level Meters: Types, components, standards, and usage., **Microphones:** Types, characteristics, and selection., **Noise Dosimeters:** Principles and applications for personal noise exposure assessment., **Frequency Analyzers:** Real-time analyzers (RTA), Fast Fourier Transform (FFT) analyzers., **Calibration and Measurement Techniques:** Standards and best practices for noise measurements in various environments., **Measurement of Sound Power Level:** Different methods (e.g., ISO standards), **Vibration Measurement:** Displacement, velocity, and acceleration; transducers.

UNIT III. Noise Sources and Characteristics:

Types of Noise Sources: Point, line, and area sources., **Noise from Machinery:** Motors, pumps, compressors, fans, HVAC systems, industrial equipment., **Flow-Induced Noise:** Turbulence, jet noise, cavitation, aerodynamic noise., **Noise from Vibrating Structures:** Sound radiation,

structural vibration as a noise source., **Transportation Noise:** Road traffic, railway, aircraft noise, **Environmental Noise Sources:** Construction, community noise., **Source Characterization:** Sound power estimation, directivity.

UNIT IV. Principles and Methods of Noise Control:

Source-Path-Receiver Model: Understanding the elements of noise problems., **Noise Control Strategies:** Control at the source, control along the path, protection of the receiver., **Passive Noise Control:** **Sound Absorption:** Materials, mechanisms, absorption coefficient, room acoustics treatment. **Sound Isolation/Transmission Loss:** Barriers, enclosures, walls, floors, transmission loss coefficient, mass law, coincidence effect, double-leaf partitions. **Vibration Isolation:** Isolators, resilient mounts, damping. **Damping Treatments:** Application and effectiveness. **Silencers and Mufflers:** Reactive and dissipative types, design principles.

Unit V. Environmental Noise and Regulations:

Outdoor Sound Propagation: Geometric spreading, ground effects, atmospheric absorption, meteorological effects, barriers. **Environmental Noise Standards and Regulations:** National and international guidelines, noise limits for different environments.

Course Out comes:

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

1. Interpret the fundamental principles of sound and acoustics.
2. Measure and analyze noise and vibration signals.
3. Identify and characterize various noise sources.
4. Apply different noise control techniques to reduce noise at the source, along the path, or at the receiver.
5. Apply relevant noise standards and regulations.

IV Year-I Semester	Open Elective - III	L	T	P	C
		3	0	0	3
DIGITAL MARKETING MANAGEMENT					

Course Objectives:

This course aims at enabling students,

1. To describe the basic concept of Digital Marketing.
2. To explain the basics of Mobile Marketing.
3. To summarize the concept of Online Marketing.
4. To illustrate with the knowledge of E-mail Marketing.

UNIT I

Introduction to Digital marketing

The Concept, Need & Evolution of Digital Marketing, Reason for growing importance of Digital Marketing in India, Digital Marketing: Types & Examples.

Case Study on Digital Marketing

UNIT II

Mobile Marketing

Meaning, types & Evolution, Mobile – market size and rate of growth, Mobile applications, Types of Mobile Marketing, Advantages and Disadvantages of Mobile marketing, Performance marketing: definition, benefits.

Case Study on Mobile Marketing

UNIT III

Online Marketing

The concept of Digital Marketing Mix, 7 P's of Online Marketing: Product, Price, Promotion, Place People, Process, Physical evidence, Methods of Online Marketing promotion.

Case Study on Online Marketing

UNIT IV

Email Marketing

Email Marketing: Need for Emails, Types of Emails, options in Email advertising, Do's and Don'ts of an email marketing campaign, Introduction to E-mail marketing tool- Mailchimp.

Case Study on Email Marketing

UNIT V

Social Media Marketing with Twitter and LinkedIn Twitter Usage Stats and Interesting Facts, Twitter Terminology and Account Security, Advertising on Twitter, Twitter for Marketing. LinkedIn for Business, LinkedIn for Advertising, LinkedIn for Recruiters

Text Books:

1. Damian Ryan & Calvin Jones. Understanding DIGITAL Marketing, 2009, ISBN 9780749453893
2. Vandana Ahuja, Digital Marketing, Oxford University Press, New Delhi, 2015, ISBN: 9780199455447.
3. Jodie the Mom (2023) Email Marketing Planner: Organize and Track Your Emails, 2023, ASIN :B0C5KNF1BM

Reference Books:

1. Dave Evans., Susan Bratton, Social Media Marketing: The Next Generation of Business Engagement. Wiley ,
2010, ISBN: 978-0-470-63403-5
2. George Pain(2019). Marketing Automation and Online Marketing: Automate Your Business through Marketing
Best Practices such as Email Marketing and Search Engine Optimization, 2019, ISBN-10 1922301132 :

E-sources:

1. <https://www.coursera.org/learn/foundations-of-digital-marketing-and-e-commerce>
2. <https://open.umn.edu/opentextbooks/textbooks/1602>

Course Outcomes:

After learning the course, the students should be able to:

1. Describe the core concepts of Digital Marketing. (BL-2)
2. Explain the basics of Mobile Marketing. (BL-2)
3. Summarize the core concepts of Online Marketing. (BL-2)
4. Discuss E-mail marketing techniques. (BL-6)

IV Year-I Semester	Open Elective - III	L	T	P	C
		3	0	0	3
PRODUCT DESIGN AND DEVELOPMENT					

COURSE OBJECTIVES:

The students will acquire the knowledge:

1. Apply the principles of generic development process; conduct customer need analysis; and set product specification for new product design and development.
2. Generate, select, screen, and test concepts for new product design and development.
3. Apply the principles of product architecture and industrial design to design and develop new products.
4. Apply the principles of DFMA and Prototyping to design and develop new product.
5. Apply the concepts of economics principles sustainable product development and life cycle assessment.

UNIT I

INTRODUCTION – A Generic Development Process – Adapting the Generic Product Development Process - Product Development Process Flows- Digital tools for product design– Identifying Customer Needs - Product Specifications: Establishing Target Specifications; Setting the Final Specifications.

UNIT II

CONCEPT GENERATION

Concept Generation: The Activity of Concept Generation - Concept Selection: Concept Screening; Concept Scoring – Concept Testing – Concept innovation using TRI

UNIT III

PRODUCT ARCHITECTURE

Implications of the Architecture; Establishing the Architecture; Delayed Differentiation;

Platform Planning; Related System-Level Design Issues – Industrial Design: Assessing the Need for Industrial Design; Impact of Industrial Design; The Industrial Design Process; Management of the Industrial Design Process; Assessing the Quality of Industrial Design.

UNIT IV

DFM AND PROTOTYPING

Design for Manufacturing: Estimate the Manufacturing Costs; Reduce the Costs of Components; Reduce the Costs of Assembly; Reduce the Costs of Supporting Production; Consider the Impact of DFMA– Prototyping: Type; Uses; Principles; Technologies; Planning for Prototypes.

UNIT V

PRODUCT DEVELOPMENT ECONOMICS

Elements of Economic Analysis; Economic Analysis Process – sustainable product development: framework and metrics – life cycle assessment of a product: stages and impact.

Text Books:

1. Jamnia, A., Introduction to Product Design and Development for Engineers, CRC Press, 2018.
2. Karl, T. Ulrich and Steven, D. Eppinger, “Product Design and Development”, McGraw Hill, 2003.

References:

1. Belz A., 36-Hour Course: “Product Development” McGraw-Hill, 2010.
2. Chitale, A. K. and Gupta, R. C., Product Design and Manufacturing, PHI Learning, 2013.
3. Pugh S., “Total Design – Integrated Methods for successful Product Engineering”, Addison Wesley Publishing, 1991.
4. Rosenthal S., “Effective Product Design and Development”, Business One, 1992.
5. Silva, A., Handbook of Research on Trends in Product Design and Development: Technological and Organizational Perspectives: Technological and Organizational Perspectives, IGI Global, 2010.
6. Devdas Shetty, “Product design for Engineers”, Cengage Learning

Course Outcomes:

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

1. Apply the principles of generic development process; conduct customer need analysis; and set product specification for new product design and development.
2. Select, screen, and test concepts for new product design and development.
3. Apply the principles of product architecture and industrial design to design and develop new products.
4. Apply the principles of DFMA and Prototyping to design and develop new product.
5. Apply the concepts of economics principles sustainable product development and life cycle assessment.

IV Year-I Semester	Open Elective - III	L	T	P	C
		3	0	0	3
INTRODUCTION TO MECHATRONICS					

Course Objectives:

The students will acquire the knowledge

1. To illustrate the use the various mechatronics systems, measurement systems, sensors and transducers.
2. To apply the concepts of solid-state electronic devices.
3. To identify the components in the design of electro mechanical systems.
4. To apply the concepts of digital electronics and applications of PLCs for control.
5. To analyze system interfacing, data acquisition and design of mechatronics systems.

UNIT-I

Mechatronics systems – elements & levels of mechatronics system, Mechatronics design process, system, measurement systems, control systems, microprocessor-based controllers, advantages and disadvantages of mechatronics systems. Sensors and transducers, types, displacement, position, proximity, velocity, motion, force, acceleration, torque, fluid pressure, liquid flow, liquid level, temperature and light sensors.

UNIT-II

Solid state electronic devices - PN junction diode, BJT, FET, DIAC, TRIAC and LEDs. Analog signal conditioning, operational amplifiers, noise reduction, filtering.

UNIT-III

Hydraulic and pneumatic actuating systems - Fluid systems, Hydraulic systems, and pneumatic systems, components, control valves, electro-pneumatic, hydro-pneumatic, electro-hydraulic servo systems. Mechanical actuating systems and electrical actuating systems – basic principles and elements.

UNIT-IV

Digital electronics and systems, digital logic control, microprocessors and micro controllers, programming, process controllers, programmable logic controllers, PLCs versus computers, application of PLCs for control.

UNIT-V

System and interfacing and data acquisition – Data Acquisition Systems, Analog to Digital and Digital to Analog conversions; Digital Signal Processing – data flow in DSPs, block diagrams, typical layouts, Interfacing motor drives. Design of mechatronics systems & future trends.

Text Books:

1. Mechatronics: Integrated Mechanical Electronics Systems/KP Ramachandran, GK Vijaya Raghavan & MS Balasundaram/WILEY India Edition

References

1. Mechatronics /Smaili A, Mrad F/ Oxford Higher Education, Oxford University Press
2. Mechatronics Source Book / Newton C Braga/Thomson Publications, Chennai.
3. Mechatronics – N. Shanmugam / Anuradha Agencies Publishers.
4. Mechatronics System Design / Devdasshetty/Richard/Thomson.
5. Mechatronics/M.D.Singh/J.G.Joshi/PHI.
6. Mechatronics – Electronic Control Systems in Mechanical and Electrical Engg. 4th Edition / W.Bolton/ Pearson, 2012
7. Mechatronics – Principles and Application / Godfrey C. Onwubolu/Elsevier, Indian print

Course Outcomes:

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

1. Illustrate the use of the various mechatronics systems, measurement systems, sensors and transducers.
2. Apply the concepts of solid-state electronic devices.
3. Identify the components in the design of electro mechanical systems.
4. Apply the concepts of digital electronics and applications of PLCs for control.
5. Analyze system interfacing, data acquisition and design of mechatronics systems.

IV Year-I Semester	Open Elective - III	L	T	P	C
		3	0	0	3
CONDITION MONITORING					

COURSE OBJECTIVE:

- Provide an overview of the fundamental principles of maintenance and condition monitoring techniques
- Acquire knowledge of data acquisition and signal processing techniques
- Explain about diagnosis of machinery faults and methods to correct faults
- Describe oil analysis and other NDT techniques

UNIT-I

Predictive Maintenance Techniques:

Basics, maintenance philosophies, Bath tub curve, Classification of maintenance, advantages and disadvantages of maintenance, plant machinery classifications and recommendations.

Condition Monitoring Techniques:

Introduction to Condition monitoring, definition, Types of condition monitoring, advantages and limitations of different condition monitoring techniques like wear debris monitoring, oil monitoring, performance monitoring, vibration monitoring, thermography, corrosion monitoring.

UNIT-II

Data Acquisition:

Introduction, collection of vibration signal, vibration transducers, characteristics and mountings, conversion of vibrations to electrical signal.

Signal Processing, Applications and Representations:

The Fast Fourier Transform (FFT) analysis, Time waveform analysis, Phase signal analysis, special signal processes.

UNIT-III

Machinery Fault Diagnosis Using Vibration Analysis:

Unbalance, bent shaft, Eccentricity, Misalignment, looseness, Belt drive problems, gear

defects, bearing defects, Electrical faults, Cavitation Shaft cracks, Rotor rubs, Resonance, Hydraulic and aerodynamic forces.

Correcting Faults That Cause Vibration:

Introduction, Balancing Alignment, Resonance vibration control with dynamic absorbers.

UNIT-IV

Oil and Practical Analysis:

Introduction, oil fundamentals, oil analysis sampling methods, lubricant properties, contaminants in lubricants, practical analysis techniques.

Other Predictive Maintenance Techniques:

Ultrasound, Infrared thermography applications of IR thermography, ISO 2372 standards for vibrations.

Text books

1. Machinery vibration Analysis & Predictive Maintenance by Paresh Girdhar, Elsevier publishers.
2. Mechanical Fault diagnosis and condition monitoring by R. A. Collacott.

References

1. Vibration monitoring and diagnosis by R. A. Collacott.
2. First course on condition monitoring in the process industries, by M.J.Neale, Nov 1979, Manchester.
3. Management of Industrial Maintenance by Newman-Butterworth, March 1978.
4. Condition Monitoring Manual by National Productivity council, New Delhi

Course Outcomes:

At the end of the course student can be able to

1. Apply maintenance and condition monitoring techniques to machineries and industries (BL-3)

2. Apply data acquisition and signal processing techniques to all mechanical components and plants
3. Illustrate Machinery faults and apply methods to correct faults
4. Analyze machinery faults and using oil analysis and other NDT techniques (BL-3)

IV Year-I Semester	Open Elective - III	L	T	P	C
		3	0	0	3
OPERATIONS MANAGEMENT					

Course Objectives:

The students will acquire the knowledge:

1. To identify types of forecasting techniques and their principles
2. To analyze plant and process layout
3. To interpret about material management and MRP logic
4. To apply the concepts of aggregate planning and scheduling
5. To analyze the concepts of inventory control, MRP-II, JIT, ERP and supply chain Management

UNIT-I

Forecasting: Introduction, types of forecasting and their uses, General principles of forecasting, forecasting techniques: qualitative and quantitative methods of Forecasting.

Production Systems: Types of production systems: job, batch, mass and flow type production.

UNIT-II

Plant Location: Factors affecting the plant location, comparison of rural and urban sites.

Plant Layout: Introduction, principles of plant layout, types of plant layouts

UNIT-III

Materials Management: Introduction, functions of materials management, inventory, inventory management, types of inventories, Selective inventory control techniques: ABC analysis, VED analysis. Material Requirement Planning: Introduction, Inputs, outputs and MRP logic

UNIT-IV

Aggregate Planning: Introduction, aggregate planning strategies, aggregate planning methods mathematical planning models, heuristic and computer search models, problems. Scheduling:

Introduction, difference with loading, scheduling policies, techniques, standard scheduling methods.

UNIT-V

Inventory Control: Deterministic models, safety stock inventory control systems Contemporary management techniques: Introduction to MRP-II, JIT, ERP and Supply chain management

TEXT BOOKS:

1. Operations Management /Joseph. G.Monks, International (3rd) Edition
2. Elements of Production Planning and Control / Samuel Eilon.
3. Modern Production/ operation managements / Baffa& Rakesh Sarin

REFERENCES:

1. Operations Management – S.N. Chary.
2. Inventory Control Theory and Practice / Martin K. Starr and David W. Miller.
3. Production And Operation Management / Martand Telsang
4. Production Control A Quantitative Approach / John E. Biegel.
5. Production Control / Moore.

Course Out comes:

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

1. Identify types of forecasting techniques and their principles
2. Analyze plant and process layout
3. Interpret about material management and MRP logic
4. Apply the concepts of aggregate planning and scheduling
5. Analyze the concepts of inventory control, MRP-II, JIT, ERP and supply chain Management

IV Year-I Semester	Open Elective - IV	L	T	P	C
		3	0	0	3
STATISTICAL QUALITY CONTROL					

Course objectives:

The students will acquire the knowledge:

1. To analyze the approaches and techniques of quality value and engineering
2. To interpret statistical process control with $\bar{X}$, R, p, c charts and other types of control charts.
3. To illustrate tolerance design and quality function deployment
4. To interpret techniques of modern reliability engineering tools.
5. To interpret the concepts of complex system and reliability techniques

UNIT-I

Quality value and engineering – quality systems – quality engineering in product design and production process – system design – parameter design – tolerance design, quality costs – quality improvement.

UNIT-II

Statistical process control $\bar{X}$, R, p, c charts, other types of control charts, process capability, process capability analysis, process capability index. (SQC tables can be used in the examination)

Acceptance sampling by variables and attributes, design of sampling plans, single, double, sequential and continuous sampling plans, design of various sampling plans

UNIT-III

Loss function, tolerance design – N type, L type, S type; determination of tolerance for these types. Online quality control – variable characteristics, attribute characteristics, parameter design.

Quality function deployment – house of quality, QFD matrix, total quality management concepts. Quality information systems, quality circles, introduction to ISO 9000 standards.

UNIT-IV

Reliability – Evaluation of design by tests - Hazard Models, Linear, Raleigh, Weibull. Failure Data Analysis, reliability prediction based on Weibull distribution, Reliability improvement.

UNIT-V

Complex system, reliability, reliability of series, parallel & standby systems & complex systems & reliability prediction and system effectiveness.

Maintainability, availability, economics of reliability engineering, replacement of items, maintenance costing and budgeting, reliability testing.

Text Books:

1. Quality Engineering in Production Systems / G Taguchi /McGraw Hill
2. Reliability Engineering/ E.Bala Guruswamy/Tata McGraw Hill,
3. Statistical Quality Control : A Modern Introduction/ Montgomery/Wiley

References:

1. Jurans Quality planning & Analysis/ Frank.M.Gryna Jr. / McGraw Hill.
2. Taguchi Techniques for Quality Engineering/ Philippos/ McGraw Hill,
3. Reliability Engineering / LS Srinath / Affiliated East West Pvt. Ltd.,
4. Statistical Process Control/ Eugene Grant, Richard Leavenworth / McGraw Hill.
5. Optimization & Variation Reduction in Quality / W.A. Taylor / Tata McGraw Hill
6. Quality and Performance Excellence/ James R Evans/ Cengage learning

Course Outcomes:

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

The students will acquire the knowledge:

1. Analyze the approaches and techniques of quality value and engineering
2. Interpret statistical process control with $\bar{X}$, R, p, c charts and other types of control charts.
3. Illustrate tolerance design and quality function deployment
4. Interpret techniques of modern reliability engineering tools.
5. Interpret the concepts of complex system and reliability techniques

IV Year-I Semester	Open Elective - IV	L	T	P	C
		3	0	0	3
NANO MATERIALS					

Course Objectives:

The students will acquire the knowledge:

1. To analyze historical development and classification of nano materials
2. To interpret structure and bonding in nano materials
3. To analyze the size dependence of properties
3. To illustrate nano material Synthesis techniques
5. To interpret nano material characterization techniques

UNIT-I

Introduction: Definitions, historical development of nano materials, classification of nano materials, Size & Scale Units Scaling Atoms, Molecules, Clusters and Supramolecules

UNIT-II

Structure and Bonding in Nano materials

Chemical Bonds (types and strength), intermolecular forces, molecular and crystalline structures, hierarchical structures, bulk to surface transition, surface reconstruction

UNIT-III

Properties and Size dependence of properties: Chemical Optical, vibrational, thermal, Electrical, Magnetic, Mechanical, Theoretical Aspects-e.g. density functional theory

UNIT-IV

Nano material Synthesis: Chemical routes, Electrochemical methods, Vapour growth, Thin films methods: chemical vapour deposition, physical vapor deposition (sputtering, laser ablation), Langmuir-Blodgett growth Mechanical methods: ball milling, mechanical attrition Sol-gel methods, Special nanomaterials: carbon nanotubes, fullerenes, nanowires, porous silicon, Bio-inspired synthesis, Nanocomposite fabrication, Nanolithography

UNIT-V

Nano material characterization techniques: Scanning and Transmission Electron Microscopy, Scanning Probe Microscopies: Atomic Force, scanning tunneling microscopy, Diffraction and scattering techniques, Vibrational spectroscopy, Surface techniques

Applications: Nano-electronics, Nano optics, Nanoscale chemical- and bio-sensing, Biological/bio-medical applications, Photovoltaic, fuel cells, batteries and energy-related applications, High strength nanocomposites, Nano energetic materials

Textbook

1.The Physics and Chemistry of Nanosolids by Frank J. Owens and Charles P. Poole Jr, Wiley-Interscience, 2008.

Reference Books

1.Nanomaterials- Synthesis, Properties and Applications, Edited by A.S. Edelstein and R.C. Cammarata, Institute of Physics Publishing, London, 1998 (paper back edition)

2.Nanochemistry: A Chemical Approach to Nanomaterials, by G. Ozin and A. Arsenault, RSC Publishing, 2005

3.Nanophysics and Nanotechnology: An Introduction to Modern Concepts in Nanoscience, Edward L. Wolf, Wiley-VCH, 2nd Reprint (2005)

Course Outcomes:

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

1. Analyze historical development and classification of nano materials
2. Interpret structure and bonding in nano materials
3. Analyze the size dependence of properties
4. Illustrate nano material Synthesis techniques
5. Interpret nano material characterization techniques

IV Year-I Semester	Open Elective - IV	L	T	P	C
		3	0	0	3
ENTREPRENEURSHIP					

COURSE OBJECTIVE:

The students will acquire the knowledge:

1. To analyze concept of entrepreneurship and its characteristics
2. To recognize entrepreneurial environment and policies
3. To illustrate business plan preparation
4. To interpret finance and Human Resource mobilization and operations planning
5. To analyze management of small business

UNIT- I **ENTREPRENEURIAL COMPETENCE**

Entrepreneurship concept – Entrepreneurship as a Career – Entrepreneurial Personality -

Characteristics of Successful, Entrepreneur – Knowledge and Skills of Entrepreneur.

UNIT- II **ENTREPRENEURIAL ENVIRONMENT AND POLICIES**

Business Environment - Role of Family and Society - Entrepreneurship Development Training and Other Support Organizational Services – Central and State Government Industrial Policies and Regulations - International Business.

UNIT- III **BUSINESS PLAN PREPARATION**

Sources of Product for Business - Prefeasibility Study - Criteria for Selection of Product -

Ownership - Capital - Budgeting Project Profile Preparation - Matching Entrepreneur with the Project - Feasibility Report Preparation and Evaluation Criteria.

UNIT- IV **LAUNCHING OF SMALL BUSINESS**

Finance and Human Resource Mobilization Operations Planning - Market and Channel Selection -Growth Strategies - Product Launching – Incubation, Venture capital, IT startups.

UNIT- V

MANAGEMENT OF SMALL BUSINESS

Monitoring and Evaluation of Business - Preventing Sickness and Rehabilitation of Business

Units- Effective Management of small Business.

Text Books:

1. Hisrich, Entrepreneurship, Tata McGraw Hill, New Delhi, 2001.
2. S.S.Khanka, Entrepreneurial Development, S.Chand and Company Limited, New Delhi, 2001.

References

1. Mathew Manimala, Entrepreneurship Theory at the Crossroads, Paradigms & Praxis, Biztrantra ,2nd Edition 2005
2. Prasanna Chandra, Projects – Planning, Analysis, Selection, Implementation and Reviews, Tata McGraw-Hill, 1996.
3. P.Saravanavel, Entrepreneurial Development, Ess Pee kay Publishing House, Chennai -1997.

Course Outcome:

Up on completing this course, students are able to

1. Analyze concept of entrepreneurship and its characteristics
2. Recognize entrepreneurial environment and policies
3. Illustrate business plan preparation
4. Interpret finance and Human Resource mobilization and operations planning
5. Analyze management of small business

IV Year-I Semester	Open Elective - IV	L	T	P	C
		3	0	0	3
PRODUCT DESIGN AND DEVELOPMENT					

COURSE OBJECTIVES:

The students will acquire the knowledge:

1. To interpret the principles of generic development process; conduct customer need analysis; and set product specification for new product design and development.
2. To generate, select, screen, and test concepts for new product design and development.
3. To interpret the principles of product architecture and industrial design to design and develop new products.
4. To apply the principles of DFMA and Prototyping to design and develop new product.
5. To apply the concepts of economics principles sustainable product development and life cycle assessment.

UNIT I

INTRODUCTION – A Generic Development Process – Adapting the Generic Product Development Process - Product Development Process Flows- Digital tools for product design– Identifying Customer Needs - Product Specifications: Establishing Target Specifications; Setting the Final Specifications.

UNIT II

CONCEPT GENERATION

Concept Generation: The Activity of Concept Generation - Concept Selection: Concept Screening; Concept Scoring – Concept Testing – Concept innovation using TRI

UNIT III

PRODUCT ARCHITECTURE

Implications of the Architecture; Establishing the Architecture; Delayed Differentiation;

Platform Planning; Related System-Level Design Issues – Industrial Design: Assessing the Need for Industrial Design; Impact of Industrial Design; The Industrial Design Process; Management of the Industrial Design Process; Assessing the Quality of Industrial Design.

UNIT IV

DFM AND PROTOTYPING

Design for Manufacturing: Estimate the Manufacturing Costs; Reduce the Costs of Components; Reduce the Costs of Assembly; Reduce the Costs of Supporting Production; Consider the Impact of DFMA– Prototyping: Type; Uses; Principles; Technologies; Planning for Prototypes.

UNIT V

PRODUCT DEVELOPMENT ECONOMICS

Elements of Economic Analysis; Economic Analysis Process – sustainable product development: framework and metrics – life cycle assessment of a product: stages and impact.

TEXT BOOK:

1. Jamnia, A., Introduction to Product Design and Development for Engineers, CRC Press, 2018.
2. Karl, T. Ulrich and Steven, D. Eppinger, “Product Design and Development”, McGraw Hill, 2003.

REFERENCES:

1. Belz A., 36-Hour Course: “Product Development” McGraw-Hill, 2010.
2. Chitale, A. K. and Gupta, R. C., Product Design and Manufacturing, PHI Learning, 2013.
3. Pugh S., “Total Design – Integrated Methods for successful Product Engineering”, Addison Wesley Publishing, 1991.
4. Rosenthal S., “Effective Product Design and Development”, Business One, 1992.
5. Silva, A., Handbook of Research on Trends in Product Design and Development: Technological and Organizational Perspectives: Technological and Organizational Perspectives, IGI Global, 2010.
6. Devdas Shetty, “Product design for Engineers”, Cengage Learning

Course Outcomes:

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

1. Interpret the principles of generic development process; conduct customer need analysis; and set product specification for new product design and development
2. Select, screen, and test concepts for new product design and development.
3. Interpret the principles of product architecture and industrial design to design and develop new products.
4. Apply the principles of DFMA and Prototyping to design and develop new product.
5. Apply the concepts of economics principles sustainable product development and life cycle assessment.

IV Year-I Semester	Open Elective - IV	L	T	P	C
		3	0	0	3
OPTIMIZATION TECHNIQUES					

Course Objectives:

The students will acquire the knowledge:

1. To classify of optimization problem and apply classical optimization techniques
2. To apply unconstrained optimization techniques using various methods
3. To analyze the characteristics and approaches of constrained optimization techniques
4. To illustrate optimized solutions using constrained and unconstrained geometric programming
5. To analyze integer programming methods

UNIT I

INTRODUCTION TO OPTIMIZATION: Engineering applications of optimization- statement of an optimization problem- classification of optimization problem- optimization techniques.

CLASSICAL OPTIMIZATION TECHNIQUES: Single variable optimization- multivariable optimization with equality constraints- multivariable optimization with inequality constraints.

UNIT-II

UNCONSTRAINED OPTIMIZATION TECHNIQUES: Pattern search method- Rosenbrock's method of rotating coordinates- Simplex method- Descent methods- Gradient of function- Steepest Descent method.

UNIT-III

CONSTRAINED OPTIMIZATION TECHNIQUES: Characteristics of constrained problem methods of feasible directions - basic approach in the penalty function method- interior penalty function method- convex programming problem- exterior penalty function method.

UNIT-IV

GEOMETRIC PROGRAMMING (G.P): Solution of an unconstrained geometric programming, differential calculus method and arithmetic method. primal dual relationship and sufficiency conditions.

Solution of a constrained geometric programming problem (G.P.P). Complimentary geometric programming (C.G.P)

UNIT-V

INTEGER PROGRAMMING (I.P): Graphical representation. Gomory's cutting plane method. Bala's algorithm for zero-one programming problem. Integer non linear programming.

Text Books:

1. Optimization Theory and Applications/ S.S.Rao/Wiley Eastern Limited, New Delhi.

References:

1. Engineering Optimization / Kalyanmanai Deb/Prentice Hall of India, New Delhi.

2. Optimization Techniques-Theory and applications/C.Mohan&Kusum Deep/New Age International

3. Operations Research /S.D.Sharma / MacMillan Publishers

Course Outcomes:

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

1. Classify of optimization problem and apply classical optimization techniques
2. Apply unconstrained optimization techniques using various methods
3. Analyze the characteristics and approaches of constrained optimization techniques
4. Illustrate optimized solutions using constrained and unconstrained geometric programming
5. Analyze integer programming methods

IV Year-I Semester	Skill oriented Course- III	L	T	P	C
		2	0	0	2
RENEWABLE ENERGY					

Course Objectives:

The students will acquire the knowledge:

1. To demonstrate the importance and solar radiation, solar energy collection and storage
2. To illustrate the energy sources and potential from wind energy, bio-mass, geothermal energy and ocean energy
3. To interpret energy efficient electrical and mechanical systems
4. To develop energy efficient processes
5. To analyze features and benefits of green buildings

UNIT-I

SOLAR RADIATION: Role and potential of new and renewable sources, the solar energy option, Environmental impact of solar power, structure of the sun, the solar constant, sun-earth relationships, coordinate systems and coordinates of the sun, extraterrestrial and terrestrial solar radiation, solar radiation on tilted surface, instruments for measuring solar radiation and sun shine, solar radiation data, numerical problems. Photo voltaic energy conversion – types of PV cells.

SOLAR ENERGY COLLECTION: Flat plate and concentrating collectors, classification of concentrating collectors, orientation.

SOLAR ENERGY STORAGE AND APPLICATIONS: Different methods, sensible, latent heat and stratified storage, solar ponds, solar applications- solar heating/cooling technique, solar distillation and drying, solar cookers, central power tower concept and solar chimney.

UNIT – II

WIND ENERGY: Sources and potentials, horizontal and vertical axis windmills, performance characteristics, betz criteria, types of winds, wind data measurement.

BIO-MASS: Principles of bio-conversion, anaerobic/aerobic digestion, types of bio-gas digesters, gas yield, utilization for cooking, bio fuels, I.C. engine operation and economic aspects.

GEOTHERMAL ENERGY: Resources, types of wells, methods of harnessing the energy.

OCEAN ENERGY: OTEC, Principles of utilization, setting of OTEC plants, thermodynamic cycles. Tidal and wave energy: Potential and conversion techniques.

UNIT –III

ENERGY EFFICIENT SYSTEMS:

(A) ELECTRICAL SYSTEMS: Energy efficient motors, energy efficient lighting and control, selection of luminaire, variable voltage variable frequency drives (adjustable speed drives), controls for HVAC (heating, ventilation and air conditioning), demand site management.

(B) MECHANICAL SYSTEMS: Fuel cells- principle, thermodynamic aspects, selection of fuels & working of various types of fuel cells, Environmental friendly and Energy efficient compressors and pumps.

UNIT-IV

ENERGY EFFICIENT PROCESSES: Environmental impact of the current manufacturing practices and systems, benefits of green manufacturing systems, selection of recyclable and environment friendly materials in manufacturing, design and implementation of efficient and sustainable green production systems with examples like environmental friendly machining, vegetable based cutting fluids, alternate casting and joining techniques, zero waste manufacturing.

UNIT – V

GREEN BUILDINGS: Definition, features and benefits. Sustainable site selection and planning of buildings for maximum comfort. Environmental friendly building materials like bamboo, timber, rammed earth, hollow blocks, lime & lime pozzolana cement, agro materials and industrial waste, Ferro cement and Ferro-concrete, alternate roofing systems, paints to reduce heat gain of the buildings. Energy management.

Text Books:

1. Solar Energy – Principles of Thermal Collection and Storage/Sukhatme S.P. and J.K.Nayak/TMH
2. Non-Conventional Energy Resources- Khan B.H/ Tata McGraw Hill, New Delhi, 2006

3. Green Manufacturing Processes and Systems - J. Paulo Davim/Springer 2013

References:

1. Alternative Building Materials and Technologies - K.S Jagadeesh, B.V Venkata Rama Reddy and K.S Nanjunda Rao/New age international
2. Principles of Solar Engineering - D.Yogi Goswami, Frank Krieth & John F Kreider / Taylor & Francis
3. Non-Conventional Energy - Ashok V Desai /New Age International (P) Ltd
4. Renewable Energy Technologies -Ramesh & Kumar /Narosa
5. Non conventional Energy Source- G.D Roy/Standard Publishers
6. Renewable Energy Resources-2nd Edition/ J.Twidell and T. Weir/ BSP Books Pvt.Ltd
7. Fuel Cell Technology -Hand Book / Gregor Hoogers / BSP Books Pvt. Ltd

Course Outcomes:

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

1. Demonstrate the importance and solar radiation, solar energy collection and storage
2. Illustrate the energy sources and potential from wind energy, bio-mass, geothermal energy and ocean energy
3. Interpret energy efficient electrical and mechanical systems
4. Develop energy efficient processes
5. Analyze features and benefits of green buildings

IV Year-I Semester	Skill oriented Course- III	L	T	P	C
		0	1	2	2
SIMULATION LAB					

Course Objectives:

The students will acquire the knowledge:

1. To impart the fundamental knowledge on using various analytical tools like ANSYS, FLUENT, etc., for Engineering Simulation
2. To know various fields of engineering where these tools can be effectively used to improve the output of a product.
3. To impart knowledge on how these tools are used in Industries by solving some real time problems using these tools.

1. PART MODELING: Generation of various 3D models through protrusion, revolve, shell sweep. creation of various features. study of parent child relation. feature based and Boolean based modelling surface and assembly modelling. study of various standard translators. design simple components.

2. ANALYSIS:

- a) Determination of deflection and stresses in 2D and 3D trusses and beams.
- b) Determination of deflections component and principal and Von-mises stresses in plane stress, plane strain and Axisymmetric components.
- c) Determination of stresses in 3D and shell structures (at least one example in each case)
- d) Estimation of natural frequencies and mode shapes, Harmonic response of 2D beam.
- e) Steady state heat transfer Analysis of plane and Axisymmetric components.

Packages to be provided to cater to drafting, modelling & analysis from the following:

CATIA, Pro-E, I-DEAS, ANSYS, NISA, etc

Course outcomes:

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

1. Explain the concepts of part drawings and assembly of various mechanical parts
2. Interpret the concepts of surface and assembly modeling
3. Solve displacements, stress and reactions in a the 2D bar, beam and truss elements
4. Solve displacements, stress and reactions in the 3D bar, beam and truss elements
5. Describe the steady state heat transfer analysis of plane and Axisymmetric components.

IV Year-I Semester	Skill oriented Course- III	L	T	P	C
		0	1	2	2
INSTRUMENTATION AND CONTROL SYSTEMS LAB					

Course Objectives:

To study and calibrate displacement, temperature, speed, capacitance and pressure measuring instruments

List of Experiments

1. Calibration of pressure gauge.
2. Calibration of transducer for temperature measurement.
3. Study and calibration of LVDT transducer for displacement measurement.
4. Calibration of strain gauge.
5. Calibration of thermocouple.
6. Calibration of capacitive transducer.
7. Study and calibration of photo and magnetic speed pickups.
8. Calibration of resistance temperature detector.
9. Study and calibration of a rotameter.
10. Study and use of a seismic pickup for the measurement of vibration amplitude of an engine bed at various loads.
11. Study and calibration of Mcleod gauge for low pressure.

Course Outcomes:

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

1. Explain the usage of pressure gauge, Mcleod gauge and temperature measurement transducer
2. Analyze the usage of LVDT transducer and strain gauge
3. Illustrate concept of applications of thermo couple and capacitive transducer
4. Explain the usage of photo and magnetic speed pickups and resistance temperature detector.
5. Interpret the calibration of Rotameter and seismic pickup for measurement of vibrational amplitude.

IV Year-I Semester	Audit Course- III	L	T	P	C
		2	0	0	-
CONSTITUTION OF INDIA					