JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India

DEPARTMENT OF MECHANICAL ENGINEERING

IV YEAR I SEMESTER

S. No.	Course Code	Course Title	L	T	P	Credits
1	HSIMS	Industrial Management	3	--	--	3
2	PCC-ME	Finite Element Methods	3	--	--	3
3	PEC-3	1.Mechanical Vibrations 2. Renewable Energy Sources 3.Production Planning & Control 4. Machine Tool Design 5. MOOCs (NPTEL/Swayam)	3	--	--	3
4	PEC-4	1.Industrial Automation and Robotics 2. Micro and Nano manufacturing 3. Power Plant Engineering 4.Optimization Techniques 5. MOOCs (NPTEL/Swayam)	3	--	--	3
5	OEC-1	**OPEN ELECTIVE -I**	3	--	--	3
6	PCC-ME Lab	Finite Element Simulation Lab	--	--	2	1
7	PROJ-I	Project-I	--	--	4	2
		Total Credits	**15**	--	**6**	**18**

OPEN ELECTIVE -I:
1. MEMS
2. Optimization Methods
3. Operations Management
4. Nano Technology
5. Finite Element Analysis

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		3	0	0	3
	INDUSTRIAL MANAGEMENT				

Course Objectives:

1. To impart fundamental knowledge and skill sets required in the Industrial Management and Engineering profession, which include the ability to apply basic knowledge of mathematics, probability and statistics, and the domain knowledge of Industrial Management and Engineering
2. To produce graduates with the ability to adopt a system approach to design, develop, implement and innovate integrated systems that include people, materials, information, equipment and energy.
3. To enable students to understand the interactions between engineering, business, technological and environmental spheres in the modern society.
4. To enable students to understand their role as engineers and their impact to society at the national and global context.

UNIT – I
INTRODUCTION: Definition of industrial engineering (I.E), development, applications, role of an industrial engineer, differences between production management and industrial engineering, quantitative tools of IE and productivity measurement. concepts of management, importance, functions of management, scientific management, Taylor's principles, theory X and theory Y, Fayol's principles of management.

UNIT – II
PLANT LAYOUT: Factors governing plant location, types of production layouts, advantages and disadvantages of process layout and product layout, applications, quantitative techniques for optimal design of layouts, plant maintenance, preventive and breakdown maintenance.

UNIT – III
WORK STUDY: Importance, types of production, applications, workstudy, method study and time study, work sampling, PMTS, micro-motion study, rating techniques, MTM, work factor system, principles of Ergonomics, flow process charts, string diagrams and Therbligs,

UNIT – IV
STATISTICAL QUALITY CONTROL: Quality control, Queing assurance and its importance, SQC, attribute sampling inspection with single and double sampling, Control charts $-\overline{X}$ and R – charts $\overline{X}$ and S charts and their applications, numerical examples.
TOTAL QUALITY MANAGEMENT: zero defect concept, quality circles, implementation, applications, ISO quality systems. six sigma – definition, basic concepts

UNIT – V
RESOURCE MANAGEMENT: Concept of human resource management, personnel management and industrial relations, functions of personnel management, Job-evaluation, its importance and types, merit rating, quantitative methods, wage incentive plans, types.

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VALUE ANALYSIS: Value engineering, implementation procedure, enterprise resource planning and supply chain management.

TEXT BOOKS:
1.Industrial Engineering and management / O.P Khanna/Khanna Publishers.
2.Industrial Engineering and Production Management/Martand Telsang/S.Chand & Company Ltd. New Delhi

Reference Books:
1.Industrial Management / Bhattacharya DK/Vikas publishers

2. Operations Management / J.G Monks/McGrawHill Publishers.

3.Industrial Engineering and Management Science/T.R. Banga,S.C.Sharma, N. K. Agarwal/Khanna Publishers

4. Principles of Management /Koontz O' Donnel/McGraw Hill Publishers.

5. Statistical Quality Control /Gupta/Khanna Publishers

6. Industrial Engineering and Management /NVS Raju/Cengage Publishers

Course outcome:
Upon successful completion of this course you should be able to:
1. Design and conduct experiments, analyse, interpret data and synthesize valid conclusions
2. Design a system, component, or process, and synthesize solutions to achieve desired needs
3. Use the techniques, skills, and modern engineering tools necessary for engineering practice with appropriate considerations for public health and safety, cultural, societal, and environmental constraints
4. Function effectively within multi-disciplinary teams and understand the fundamental precepts of effective project management

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		3	0	0	3
	FINITE ELEMENT METHODS				

Course Objectives:
1. To learn basic principles of finite element analysis procedure
2. To learn the theory and characteristics of finite elements that represent engineering structures
3. To learn and apply finite element solutions to structural, thermal and dynamic problems.
4. Learn to model complex geometry problems and solution techniques.

UNIT-I
Introduction to finite element method, stress and equilibrium, strain – displacement relations, stress – strain relations, plane stress and plane strain conditions, variational and weighted residual methods, concept of potential energy, one dimensional problems.
Discretization of domain, element shapes, discretization procedures, assembly of stiffness matrix, band width, node numbering, mesh generation, interpolation functions, local and global coordinates, convergence requirements, treatment of boundary conditions.

UNIT – II
Analysis of Trusses: Finite element modeling, coordinates and shape functions, assembly of global stiffness matrix and load vector, finite element equations, treatment of boundary conditions, stress, strain and support reaction calculations.
Analysis of Beams: Element stiffness matrix for Hermite beam element, derivation of load vector for concentrated and UDL, simple problems on beams.

UNIT – III
Finite element modeling of two dimensional stress analysis with constant strain triangles and treatment of boundary conditions, formulation of axisymmetric problems.

UNIT-IV
Higher order and isoparametric elements: One dimensional quadratic and cubic elements in natural coordinates, two dimensional four noded isoparametric elements and numerical integration.

UNIT – V
Steady state heat transfer analysis : one dimensional analysis of a fin and two dimensional analysis of thin plate, analysis of a uniform shaft subjected to torsion. Dynamic Analysis: Formulation of finite element model, element consistent and lumped mass matrices, evaluation of eigen values and eigen vectors, free vibration analysis.

Text Books:
 1.The Finite Element Methods in Engineering / SS Rao / Pergamon.
 2. Introduction to Finite Elements in Engineering/ Tirupathi R. Chandrupatla, Ashok D. Belegundu, Pearson Publishers.

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References:

1.Finite Element Method with applications in Engineering / YM Desai, Eldho & Shah /Pearson publishers

2.An introduction to Finite Element Method / JN Reddy / McGraw Hill

3.The Finite Element Method for Engineers – Kenneth H. Huebner, Donald L. Dewhirst, Douglas E. Smith and Ted G. Byrom / John Wiley & sons (ASIA) Pte Ltd.

Course outcomes:

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

1. Understand the concepts behind variational methods and weighted residual methods in FEM
2. Identify the application and characteristics of FEA elements such as bars, beams, plane and isoparametric elements, and 3-D element .
3. Develop element characteristic equation procedure and generate global equations.
4. Able to apply Suitable boundary conditions to global equations, and reduce it to a solvable form.
5. Able to apply the FE procedure to field problems like heat transfer.

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		3	0	0	3
	MECHANICAL VIBRATIONS				

Course Objectives:
- Analyze the various 1-D periodic and periodic responses of a vibrating system with and without damping
- To learn to derive the equations of motion and solution for Two and multi degree freedom systems by the application of analytical methods
- To understand the numerical methods for quick estimation of 1st natural frequency of multi degree freedom systems .
- Have the knowledge of the various physical vibration measuring instruments.
- Learn to solve vibrations problems of continuous systems.

Unit I

Single degree of Freedom systems: Undamped and damped free vibrations: forced vibrations ; coulomb damping; Response to harmonic excitation; rotating unbalance and support excitation, Vibration isolation and transmissibility,.

Unit II

Vibration Measurement: Vibrometers, velocity meters & accelerometers

Two degree of freedom systems: Principal modes – undamped and damped free and forced vibrations; undamped vibration absorbers.

UNIT-III

Multi degree of freedom systems: Matrix formulation, stiffness and flexibility influence coefficients; Eigen value problem; normal modes and their properties; Free and forced vibration by Modal analysis; Method of matrix inversion; Torsional vibrations of multi – rotor systems and geared systems; Discrete-Time systems.

Unit IV

Numerical Methods: Rayleigh's, stodola's, Matrix iteration, Rayleigh-Ritz Method and Holzer's methods.

Unit V

Application of concepts: Free vibration of strings – longitudinal oscillations of bars-transverse vibrations of beams- Torsional vibrations of shafts. Critical speeds without and with damping, secondary critical speed.

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TEXT BOOKS:
1. Elements of Vibration Analysis by Meirovitch.
2. Mechanical Vibrations by G.K. Groover.

REFERENCES:
1. Vibrations by W.T. Thomson
2. Mechanical Vibrations – Schaum series.
3. Vibration problems in Engineering by S.P. Timoshenko.

COURSE OUTCOMES:

➢ To Analyze the various 1-D periodic and periodic responses of an vibrating system with and without damping

➢ Able to derive equations of motion and solutions for two and multi degree freedom systems by the application of analytical methods

➢ Able to understand the numerical methods for quick estimation of 1st natural frequency of multi degree freedom systems.

➢ Apply the knowledge of the various physical vibration measuring instruments and their applications in real life vibration data acquisition.

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IV Year - I Semester		L	T	P	C
		3	0	0	3
	RENEWABLE ENERGY SOURCES				

Course Objective:

The course aims to highlight the significance of alternative sources of energy, green energy systems and processes and provides the theory and working principles of probable sources of renewable and green energy systems that are environmental friendly.

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 titled 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.

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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 outcome:
At the end of the course, the student will be able to:
(1) To understand the principles and working of solar, wind, biomass, geo thermal, ocean energies.
(2) To understand the principles and working and green energy systems and appreciate their significance in view of their importance in the current scenario and their potential future applications.

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		3	0	0	3
	PRODUCTION PLANNING & CONTROL				

Course objectives:

This subject provides students with

1. An understanding of the concepts of production and service systems;
2. The ability to apply principles and techniques in the design, planning and control of these systems to optimise/make best use of resources in achieving their objectives.
3. Identify different strategies employed in manufacturing and service industries to plan production and control inventory.
4. Measure the effectiveness, identify likely areas for improvement, develop and implement improved planning and control methods for production systems.

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 quantitive 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

UNIT – IV
Capacity planning, factors, measures of capacity, economies of scale, aggregate planning, long term and short term strategies, LPP models to solve Aggregate planning problems, Disaggregating

UNIT – V
Material Requirement Planning, Master Production Schedule, Bill of Materials, Lot sizing Methods, MRP-II, Introduction to ERP, Line balancing Methods
.
TEXT BOOKS:
  1. Elements of Production Planning and Control / Samuel Eilon/Universal Book Corp.
  2. Manufacturing, Planning and Control/Partik Jonsson Stig-Arne Mattsson/TataMcGrawHill

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

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Course Outcome:

CO1. Apply the systems concept for the design of production and service systems.

CO2. Make forecasts in the manufacturing and service sectors using selected quantitative and qualitative techniques.

CO3. Apply the principles and techniques for planning and control of the production and service systems to optimize/make best use of resources.

CO4. Understand the importance and function of inventory and to be able to apply selected techniques for its control and management under dependent and independent demand circumstances.

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IV Year - I Semester		L	T	P	C
		3	0	0	3
	MACHINE TOOL DESIGN				

Course Objectives:

- To learn and applications of the basics and working principles of different types of machine tools
- To grasp the knowledge of critical functional and operational requirements of different types of machine tools
- To learn the knowledge of design of different types of machine tools to meet varied functional and operational requirements.

Unit I:
Basic features: Classification of machine tools-Basic features of construction and fundamental kinematic mechanisms of general purpose, special purpose machine tools, transfer machines, Automatic and N.C. machines. Mechanisms used for converting rotary to linear motion: Mechanisms for intermittent motion.

Unit II:
Kinematics, Drives of Machine tools: Selection of range of speeds and feeds. Layout in G.P., A.P. and H.P, standardization of speeds and feeds. Productivity loss. Selection of highest and lowest speeds, range ratio. Design of ray diagram and structural diagrams for machine tool gear boxes. Sliding, clustered and clutched drives, support drive.

Unit III:
Feed gear boxes: Norton and Meander drives pre-selection of speed, stepped and stepless regulation. Strength, rigidity and design analysis: Analysis of beds, frames, columns. Materials for structures. Methods to improve the rigidity of structures. Types of Guide ways-overall compliance of machine tool. Thermal effects-functional accuracy of machine tool.

Unit IV:
Spindle units: Spindle units of lathe, drilling, milling and grinding machines, materials for spindles. Spindle design. Effect of clearance on the rigidity of spindle. Hydrodynamic, hydrostatic, rolling bearings. Selection of bearings.

Unit V:
Jigs & Fixtures: Principles of design of jigs and fixtures and uses, classification of jigs & fixtures, principles of location and clamping, types of clamping & work holding devices, typical examples of jigs and fixtures.

Text Books:

1. Sen G.S., & Battacharya, "Principles of Machine Tools", New Central Book Agency, Calcutta, 1986.
2. Machine Tool Design and Numerical Control/ NK Mehata / Tata MeGraw Hills, 2012

Reference Books:

1. Basu S.K., "Design of Machine Tools", Allied Publishers, 1980.
2. Russe W. Henke, "Introduction to Fluid Power Circuits and Systems", Addison Wesley, 1970.
3. Metal Cutting and Tool Design – Dr.B.J.Ranganath - Vikas Publishing House Pvt. Ltd.- 2nd Edition - 2018
4. A Textbook of Production Engineering – P.C.Sharma- S.Chand Publishers.

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Course Outcomes: Student will be able to

1. Understand the basic working principles of different machine tools with kinematic mechanisms.
2. Distinguish the functional and operational requirements of different machine tools
3. Design speed and feed gear boxes for a particular configuration.
4. Design machine tool structures for strength and rigidity
5. Understand various controls used in machine tools

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		3	0	0	3
	INDUSTRIAL AUTOMATION AND ROBOTICS				

Course Objectives:
1. The student will be exposed to the concepts of automation
2. The students will be exposed to the concepts of robot kinematics, Dynamics, Trajectory planning.
3. Mathematical approach to explain how the robotic arm motion can be described.
4. The students will understand the functioning of sensors and actuators and their applications
5. The student will be exposed to the applications of robotics in manufacturing.

UNIT-I
INTRODUCTION: Automation and Robotics, types of automation, assembly automation equipment, material handling systems, feed systems, Automated Guided Vehicles, Automated storage and retrieval systems, Flexible Manufacturing Systems, Computer Aided Process Planning Systems, Computer Aided manufacturing. CAD/CAM and Robotics – An over view of Robotics – present and future applications – classification by coordinate system and control system.
COMPONENTS OF THE INDUSTRIAL ROBOTICS: Function line diagram representation of robot arms, common types of arms. Components, Architecture, number of degrees of freedom – Requirements and challenges of end effectors, determination of the end effectors, comparison of Electric, Hydraulic and Pneumatic types of locomotion devices.

UNIT – II
MOTION ANALYSIS: Homogeneous transformations as applicable to rotation and translation – problems.
MANIPULATOR KINEMATICS: Specifications of matrices, D-H notation joint coordinates and world coordinates Forward and inverse kinematics – problems.

UNIT – III
Differential transformation and manipulators, Jacobians – problems
Dynamics: Lagrange – Euler and Newton – Euler formulations – Problems.

UNIT IV
General considerations in path description and generation. Trajectory planning and avoidance of obstacles, path planning, Skew motion, joint integrated motion –straight line motion – Robot programming, languages and software packages-description of paths with a robot programming language.

UNIT V
ROBOT ACTUATORS AND FEED BACK COMPONENTS:
Actuators: Pneumatic, Hydraulic actuators, electric & stepper motors.
 Feedback components: position sensors – potentiometers, resolvers, encoders – Velocity sensors.
ROBOT APPLICATIONS IN MANUFACTURING: Material Transfer - Material handling, loading and unloading- Processing - spot and continuous arc welding & spray painting - Assembly and Inspection.

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Text Books:
1. Industrial Robotics / Groover M P /Pearson Edu.
2. Robotics and Control / Mittal R K & Nagrath I J / TMH.

References:
1. Robotics / Fu K S/ McGraw Hill.
2. Robotic Engineering / Richard D. Klafter, Prentice Hall
3. Robot Analysis and Control / H. Asada and J.J.E. Slotine / BSP Books Pvt.Ltd.
4. Introduction to Robotics / John J Craig / Pearson Edu.

Course outcomes:
Upon successful completion of this course you should be able to:
1. Identify various robot configuration and components,
2. Select appropriate actuators and sensors for a robot based on specific application
3. Carry out kinematic and dynamic analysis for simple serial kinematic chains
4. Perform trajectory planning for a manipulator by avoiding obstacles.
5. Use knowledge of robotics for automation in manufacturing applications.

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		3	0	0	3
	MICRO AND NANO MANUFACTURING				

UNIT:I
Nanomaterials and their synthesis: Synthesis of Bulk poly crystalline samples, growth of single crystals, synthesis techniques- Bottom –Up approaches – Thin film growth, PVD and CVD. Top-Down approaches – Ball milling, Micro fabrication, Electron beam and Ion beam Lithography, Nano lithography.

UNIT:II
Thin films and Nanocomposites: Micro and Nano scale thin film fabrication techniques, Optical, electrical and magnetic properties of Nano structured thin films, Nano composites and their physical and optical properties, Etching- Wet etching and Dry etching, Diffusion and Ion implantation

UNIT III
Nano Scale Characterization Techniques: X Ray diffraction, Scanning electron microscopy, Transmission electron microscopy, Energy dispersive X-Ray analysis and Atomic force microscopy.

UNIT:IV
An Over view of Micro and Nano mechanical systems and their applications in mechanical engineering, Silicon micro machining methods, Crystal growing and wafer preparation, Films and Film deposition Materials Aspects of Micro Electro Mechanical Systems (MEMS) and Nano Electro Mechanical Systems (NEMS), Silicon, Germanium-Based Materials, Metals, Harsh Environment Semiconductors, GaAs, InP, and Related III-V Materials, Ferroelectric Materials and Polymer Materials,

UNIT:V
Micro machining of MEMS devices, MEMS Fabrication Techniques, Bulk Micromachining, Surface Micromachining, High Aspect-Ratio Micromachining, Silicon micro machining methods, Crystal growing and wafer preparation, Films and Film deposition
Nanofabrication Techniques, E-Beam and Nano-Imprint Fabrication, Epitaxy and Strain Engineering, Scanned Probe Techniques, Self-Assembly and Template Manufacturing

Text Books:
1. Nanoscience and Nanotechnology: Fundamentals to Frontiers/ M.S.Ramachandra Rao, Shubra Singh, Willey.

References:
1. Springer's Hand book of Nano-technology - Bharat Bhusan (Ed.)
2. Nanotechnology and nanoelectronics – WR Fahrner, Springer International
Course Outcomes: Upon successful completion of this course you should be able to:
1. get awareness of different techniques used in micro and nano manufacturing.
2. get in-depth idea of thin films and nano composites
3. get awareness on Characterization Techniques

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4. find different materials for Micro and Nano mechanical systems and their applications in mechanical engineering.
5. Explain different MEMS & Nano fabrication Techniques.

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	POWER PLANT ENGINEERING				

Course Objectives:
The course is aimed at providing knowledge of power generation through different prime movers viz steam, ICGT, Hydro, nuclear and hybrid systems along with their economics and environmental considerations.

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 equipments, 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 – plant operation and 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, 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,
POWER PLANT INSTRUMENTATION AND CONTROL: Importance of measurement and instrumentation in power plant, measurement of water purity, gas analysis, O_2 and CO_2 measurements, measurement of smoke and dust, measurement of moisture in carbon dioxide circuit, nuclear measurements.

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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:
After undergoing this course the student can
(1) Understand various conventional methods of power generation
(2) To understand the principle of operation and performance of respective prime movers along with their economics and their impact on environment.
(3) To understand the power plant instrumentation and control

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KAKINADA – 533 003, Andhra Pradesh, India

DEPARTMENT OF MECHANICAL ENGINEERING

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

COURSE OBJECTIVES:

To enable the students learn the latest non-linear optimization techniques such as classical optimization methods, integer programming etc. Provide basic knowledge and enough competence to formulate the optimization problems.

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 a 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 BOOK:

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 Out comes:

1. Students at the end of the course learn advanced optimization techniques to solve real-life problems
2. Students can able to formulate and solve various practical optimization problems in manufacturing and service organizations

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	MICRO ELECTRO MECHANICAL SYSTEMS				

UNIT – I
INTRODUCTION: Definition of MEMS, MEMS history and development, micro machining, lithography principles & methods, structural and sacrificial materials, thin film deposition, impurity doping, etching, surface micro machining, wafer bonding, LIGA.
MECHANICAL SENSORS AND ACTUATORS: Principles of sensing and actuation: beam and cantilever, capacitive, piezo electric, strain, pressure, flow, pressure measurement by micro phone, MEMS gyroscopes, shear mode piezo actuator, gripping piezo actuator, Inchworm technology.
UNIT – II
THERMAL SENSORS AND ACTUATORS: Thermal energy basics and heat transfer processes, thermisters, thermo devices, thermo couple, micro machined thermo couple probe, peltier effect heat pumps, thermal flow sensors, micro hot plate gas sensors, MEMS thermo vessels, pyro electricity, shape memory alloys (SMA), U-shaped horizontal and vertical electro thermal actuator, thermally activated MEMS relay, micro spring thermal actuator, data storage cantilever.
MAGNETIC SENSORS AND ACTUATORS: Magnetic materials for MEMS and properties, magnetic sensing and detection, magneto resistive sensor, more on hall effect, magneto diodes, magneto transistor, MEMS magnetic sensor, pressure sensor utilizing MOKE, magnetic MEMS actuators, by directional micro actuator, feedback circuit integrated magnetic actuator, large force reluctance actuator, magnetic probe based storage device.
UNIT – III
MICRO-OPTO-ELECTRO MECHANICAL SYSTEMS: Principle of MOEMS technology, properties of light, light modulators, beam splitter, micro lens, micro mirrors, digital micro mirror device (DMD), light detectors, grating light valve (GLV), optical switch, wave guide and tuning, shear stress measurement.
UNIT – IV
RADIO FREQUENCY (RF) MEMS: RF – based communication systems, RF MEMS, MEMS inductors, varactors, tuner/filter, resonator, clarification of tuner, filter, resonator, MEMS switches, phase shifter.
MICRO FLUIDIC SYSTEMS: Applications, considerations on micro scale fluid, fluid actuation methods, dielectro phoresis (DEP), electro wetting, electro thermal flow, thermo capillary effect, electro osmosis flow, opto electro wetting (OEW), tuning using micro fluidics, typical micro fluidic channel, microfluid dispenser, micro needle, molecular gate, micro pumps.
UNIT - V
CHEMICAL AND BIO MEDICAL MICRO SYSTEMS: Sensing mechanism & principle, membrane-transducer materials, chem.-lab-on-a-chip (CLOC) chemoresistors, chemocapacitors, chemotransistors, electronic nose (Enose), mass sensitive chemosensors, fluroscence detection, calorimetric spectroscopy.

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TEXT BOOK:
1. MEMS, Nitaigour Premchand Mahalik, TMH Publishing co.

REFERENCE BOOKS:
1. Foundation of MEMS, Chang Liu, Prentice Hall Ltd.
2. Bio-MEMS (Micro systems), Gerald Urban, Springer.
3. MEMS and Micro Systems: Design and Manufacture, Tai-Ran Hsu, TMH Publishers.

Course Outcomes: After completion of this course, the student shall be able to understand various micro electro mechanical system devices and components.

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IV Year - I Semester		L	T	P	C
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	OPTIMIZATION METHODS				

UNIT -I INTRODUCTION

Concept of optimization – classification of optimization – problems.

UNIT- II LINEAR PROGRAMMING

Examples of linear programming problems – formulation simplex methods variable with upper bounds – duality principle -dual simplex method - sensitivity analysis – revised simplex procedure – solution of the transportation problem – assignment – network minimization – shortest route problem – maximal two problem – L.P. representation of networks.

UNIT -III UNCONSTRAINED OPTIMIZATION

 Maximization and minimization of convex functions. Necessary and sufficient conditions for local minima – speed and order of convegence – unibariate search – steepest and desent methods- metcher reeves method -conjugate gradient method.

UNIT- IV CONSTRAINED OPTIMIZATION

 Necessary and sufficient condition – equality constraints, inequality constraints -kuhu – tucker conditions – gradient projection method – penalty function methods – cutting plane methods of sibel directions.

UNIT- V GENETIC ALGORITHMS (GA)

 Differences and similarities between conventional and evolutionary algorithms, working principle, reproduction, crossover, mutation, termination criteria, different reproduction and crossover operators, GA for constrained optimization, draw backs of GA,

TEXT BOOK(S):
 1.Rao S.S,"Optimization – Theory and applications", Wiley Easter Ltd., 1979.
 REFERENCE BOOKS:
 1. David G.Luerbeggan, "Introduction to Linear and Non Linear Programming", Addison Wesley Publishing Co. 1973.
 2. Hadley G. "Nonlinear and – dynamic programming" Addison Wesley Publishing Co. 1964.
 3. Cordan C.C. Beveridge and Robert S. Schedther, "Optimization, Theory and Practice" McGraw Hill Co.1970.

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4. HarndyA.Tahh. "operations Research, An Introduction", Macmillan Publishers Co.NewYork,1982.

5. Beightferand S. others, "Foundations of Optimization Pill", New Delhi, 1979

Course Outcomes:

1. Students at the end of the course learn advanced optimization techniques to solve real-life problems
2. Students can able to formulate and solve various practical optimization problems in manufacturing and service organizations

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IV Year - I Semester		L	T	P	C
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	OPERATIONS MANAGEMENT				

Course objectives:
1. To develop an understanding of how the operations, have strategic importance and can provide a competitive advantage in the workplace.
2. To understand the relationship between operations and other business functions
3. To understand techniques of location and facility planning; line balancing; job designing; and
4. capacity planning in operations 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.

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Course Outcomes: On completion of this course, the students will be able to
1. Identify the elements of operations management and various transformation processes to enhance productivity and competitiveness
2. Analyze plant and process layout
3. Develop aggregate capacity plans and MPS in operation environments.

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IV Year - I Semester		L	T	P	C
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	NANO TECHNOLOGY				

Course Objectives:
1. To make the students acquire an understanding the Nanoscience and Applications

UNIT-I
GENERAL INTRODUCTION: Basics of Quantum Mechanics, Harmonic oscillator, magnetic Phenomena, band structure in solids, Mossbauer and Spectroscopy, optical phenomena bonding in solids, Anisotropy.

UNIT-II
SILICON CARBIDE: Application of Silicon carbide, nano materials preparation, Sintering of SiC, X-ray Diffraction data, electron microscopy sintering of nano particles,
NANO PARTICLES OF ALUMINA AND ZIRCONIA: Nano materials preparation, Characterization, Wear materials and nano composites,

UNIT-III
MECHANICAL PROPERTIES: Strength of nano crystalline SiC, Preparation for strength measurements, Mechanical properties, Magnetic properties,

Unit -IV
ELECTRICAL PROPERTIES: Switching glasses with nanoparticles, Electronic conduction with nano particles
OPTICAL PROPERTIES: Optical properties, special properties and the coloured glasses

UNIT-V
Process of synthesis of nano powders, Electro deposition, Important Nano materials
INVESTIGAING AND MANIPULATING MATERIALS IN THE NANOSCALE:
Electron microscopics, scanning probe microscopics, optical microscopics for nano science and technology, X-ray diffraction.

TEXT BOOKS:
1. Nano Materials- A.K.Bandyopadhyay/ New Age Publishers.
2. Nano Essentials- T.Pradeep/TMH
Course Outcomes: After completing this course students will be able to:
1.Learn the basic concepts of nanotechnology
2.Understand the synthesis of nanomaterials and their application
3.Apply their learned knowledge to develop Nanomaterial's.

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	FINITE ELEMENT ANALYSIS				

Course Objectives:
1. To learn basic principles of finite element analysis procedure
2. To learn the theory and characteristics of finite elements that represent engineering structures
3. To learn and apply finite element solutions to structural, thermal and dynamic problems.
4. Learn to model complex geometry problems and solution techniques.

UNIT-I

Introduction to finite element method, stress and equilibrium, strain – displacement relations, stress – strain relations, plane stress and plane strain conditions, variational and weighted residual methods, concept of potential energy, one dimensional problems.

Discretization of domain, element shapes, discretization procedures, assembly of stiffness matrix, band width, node numbering, mesh generation, interpolation functions, local and global coordinates, convergence requirements, treatment of boundary conditions.

UNIT – II

Analysis of Trusses: Finite element modeling, coordinates and shape functions, assembly of global stiffness matrix and load vector, finite element equations, treatment of boundary conditions, stress, strain and support reaction calculations.

Analysis of Beams: Element stiffness matrix for Hermite beam element, derivation of load vector for concentrated and UDL, simple problems on beams.

UNIT – III

Finite element modeling of two dimensional stress analysis with constant strain triangles and treatment of boundary conditions, formulation of axisymmetric problems.

UNIT-IV

Higher order and isoparametric elements: One dimensional quadratic and cubic elements in natural coordinates, two dimensional four noded isoparametric elements and numerical integration.

UNIT – V

Dynamic Analysis: Formulation of finite element model, element consistent and lumped mass matrices, evaluation of eigen values and eigen vectors, free vibration analysis.

Text Books:

1.The Finite Element Methods in Engineering / SS Rao / Pergamon.

2. Introduction to Finite Elements in Engineering/ Tirupathi R. Chandrupatla, Ashok D.Belgundu, Pearson Publishers.

References:

1.Finite Element Method with applications in Engineering / YM Desai, Eldho & Shah/Pearson publishers

2.An introduction to Finite Element Method / JN Reddy / McGraw Hill

3.The Finite Element Method for Engineers – Kenneth H. Huebner, Donald L. Dewhirst, Douglas E. Smith and Ted G. Byrom / John Wiley & sons (ASIA) Pte Ltd.

Course outcomes:

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

1. Understand the concepts behind variational methods and weighted residual methods in FEM
2. Identify the application and characteristics of FEA elements such as bars, beams, plane and isoparametric elements, and 3-D element .
3. Develop element characteristic equation procedure and generate global equations.
4. Able to apply Suitable boundary conditions to global equations, and reduce it to a solvable form.
5. Able to apply the FE procedure to field problems like heat transfer.

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IV Year - I Semester		L	T	P	C
		0	0	2	1
	FINITE ELEMENT SIMULATION LAB				

The objective of this lab is to familiarize finite element simulation soft tools for the following applications:
1. Determination of deflection and stresses in 2D and 3D trusses and beams.
2. Determination of deflections component and principal and Von-mises stresses in plane
3. stress, plane strain and Axisymmetric components.
4. Determination of stresses in 3D and shell structures (at least one example in each case)
5. Estimation of natural frequencies and mode shapes, Harmonic response of 2D beam.
6. Casting processes - Study of Solidification, temperatures, Residual stresses, metallurgical phases etc.
7. Forging processes - Study of cold working and hot working processes for extrusion, drawing, rolling, etc.
8. Forming Processes – Study of blanking, bending, deep drawing, etc.
9. Steady state heat transfer Analysis of plane and Axisymmetric components.
10. Convective heat transfer – Internal flow (study both velocity and thermal boundary layers)
11. Convective heat transfer – External flow (study both velocity and thermal boundary layers)
12. Radiation heat transfer– Emissivity