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B.Tech. in Mechanical Engineering
V Semester Syllabus
ME521OE: Optimization Techniques

Course Objectives:

The objectives of the course is to make the students

- various optimization techniques i.e classical, linear programming, transportation problem, simplex algorithm, dynamic programming.
- understand the characteristics of simplex method and its procedure and transportation problems for optimality.
- constrained and unconstrained optimization techniques for solving and optimizing an electrical and electronic engineering circuits design problems in real world situations.
- understand penalty method and basic approaches of Interior and Exterior penalty function methods for various applications.
- the concept of Dynamic programming and its applications to project implementation.

Course Outcomes:

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

- explain the need of optimization of engineering systems
- understand optimization of electrical and electronics engineering problems
- apply classical optimization techniques, linear programming, simplex algorithm, transportation problem
- apply unconstrained optimization and constrained non-linear programming and dynamic programming
- formulate optimization problems

UNIT - I

Introduction and Classical Optimization Techniques

Statement of an Optimization problem — design vector — design constraints — constraint surface — objective function — objective function surfaces — classification of Optimization problems. Solution by method of Lagrange multipliers — Multivariable Optimization with inequality constraints — Kuhn — Tucker conditions.

UNIT - II

Linear Programming Problem (LPP) and Transportation Problem (TP)

Standard form of a LPP — geometry of linear programming problems — definitions and theorems — solution of a system of linear simultaneous equations — pivotal reduction of a general system of equations — motivation to the simplex method — simplex algorithm. Introduction to TP-Finding initial basic feasible solution by north — west corner rule, least cost method and Vogel's approximation method — testing for optimality of balanced transportation problems.

UNIT - III

Unconstrained Optimization Techniques

Unconstrained Nonlinear Programming- One dimensional minimization methods, Classification, Fibonacci method and Quadratic interpolation method

Unconstrained Optimization Techniques- Univariant method, Powell's method and steepest descent method.

UNIT - IV

Constrained Nonlinear Programming

Characteristics of a constrained problem - classification - Basic approach of Penalty Function method - Basic approach of Penalty Function method - Basic approaches of Interior and Exterior penalty function methods - Introduction to convex programming problem.

UNIT - V

Dynamic Programming

Dynamic programming multistage decision processes — types — concept of sub optimization and the principle of optimality — computational procedure in dynamic programming — examples illustrating the calculus method of solution - examples illustrating the tabular method of solution.

Text Books:

1. Singiresu S. Rao, Engineering Optimization: Theory and Practice by John Wiley andSons, 4° edition, 2009.
2. H. S. Kasene & K. D. Kumar, Introductory Operations Research, Springer (India),Pvt. Ltd., 2004

Reference Books:

1. George Bernard Dantzig, Mukund Narain Thapa, “Linear programming”, Springer series in operations research 3rd edition, 2003.
2. H.A. Taha, “Operations Research: An Introduction, 8'h Edition, Pearson/Prentice Hall, 2007.
3. Kalyanmoy Deb, “Optimization for Engineering Design — Algorithms and Examples”, PHI Learning Pvt. Ltd, New Delhi, 2005.

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B.Tech. in Mechanical Engineering
V Semester Syllabus
ME522OE: Fundamentals of Mechanical Engineering

Course Objectives:

To objectives of the course is to make the students

- Fundamentals of thermodynamics and energy resources,
- Properties of gases and steam and steam generators and its accessories and mountings
- Heat engine cycles and their thermal efficiencies
- Pumps, air compressors and cooling systems
- Power transmitting devices and engineering materials

Course Outcomes:

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

- Understand the heat energy resources and basics thermodynamics
- Understand the generation of steam and its properties and thermodynamic processes
- Know thermal efficiency of heat engine cycles and internal combustion engines
- Understand the working of pumps, air compressors and cooling systems
- Know engineering materials and power transmitting systems

UNIT - I

Introduction: Prime movers and its types, Concept of Force, Pressure, Energy, Work, Power, System, Heat, Temperature, Specific heat capacity, Change of state, Path, Process, Cycle, Internal energy, Enthalpy, Statements of Zeroth Law and First law.

Energy: Introduction and applications of Energy sources like Fossil fuels, Nuclear fuels, Hydel, Solar, wind, and biofuels, Environmental issues like Global warming and Ozone depletion.

UNIT – II

Properties of gases: Gas laws, Boyle's law, Charle's law, Combined gas law, Gas constant, Relation between Cp and Cv, Various non-flow processes like constant volume process, constant pressure process, Isothermal process, Adiabatic process, Poly-tropic process

Properties of Steam: Steam formation, Types of Steam, Enthalpy, Specific volume, Internal energy and dryness fraction of steam, use of Steam tables, steam calorimeters.

Steam Boilers: Introduction, Classification, Cochran, Lancashire and Babcock and Wilcox boiler, functioning of different mountings and accessories.

UNIT – III

Heat Engines: Heat Engine cycle and Heat Engine, working substances, Classification of heat engines, description, and thermal efficiency of Carnot; Rankine; Otto cycle and Dieselcycles.

Internal Combustion Engines: Introduction, Classification, Engine details, four- stroke/two-stroke cycle Petrol/Diesel engines, indicated power, Brake Power, Efficiencies.

UNIT – IV

Pumps: Types and operation of Reciprocating, Rotary and Centrifugal pumps, Priming
Air Compressors: Types and operation of Reciprocating and Rotary air compressors, significance of Multistage.
Refrigeration & Air Conditioning: Refrigerant, Vapor compression refrigeration system, vapor absorption refrigeration system, Domestic Refrigerator, Window, and split air conditioners.

UNIT – V

Couplings, Clutches and Brakes: Construction and applications of Couplings (Box; Flange; Pin type flexible; Universal and Oldham), Clutches (Disc and Centrifugal), and Brakes (Block; Shoe; Band and Disc).
Transmission of Motion and Power: Shaft and axle, Belt drive, Chain drive, Friction drive, Gear drive.
Engineering Materials: Types and applications of Ferrous & Nonferrous metals, Timber, Abrasive material, silica, ceramics, glass, graphite, diamond, plastic, and polymer.

TEXT BOOKS:
1. Basic Mechanical Engineering / Pravin Kumar/ Pearson
2. Introduction to Engineering Materials / B.K. Agrawal/ Mc Graw Hill

REFERENCE BOOKS:
1. Fundamental of Mechanical Engineering/ G.S. Sawhney/PHI
2. Thermal Science and Engineering / Dr. D.S. Kumar/Kataria

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B.Tech. in Mechanical Engineering
VI Semester Syllabus
ME621OE: Non-conventional Sources of Energy

Course Objectives

The objectives of the course is to make the students
- Explain the concepts of Non-renewable and renewable energy systems
- Outline utilization of renewable energy sources for domestic, commercial and industrial Applications
- Design the renewable energy-based energy systems and analyze their performance for domestic, commercialand industrial applications.
- Capability to carry out basic design of renewable energy systems
- Understand various direct energy conversion systems and their effective utilization

Course Outcomes:

At the end of the course, the student will be able to:
- Identify renewable energy sources and their utilization. Understand the basic concepts of solar radiation and analyze the working of solar and thermal systems.
- Understand the operation of various energy conversion systems
- Understand the concepts and applications of fuel cells, thermoelectric convertor and MHD generator.
- Identify methods of energy storage for specific applications
- Understand principles of energy conversion from alternate sources including wind, geothermal, ocean, biomass, biogas and hydrogen.

UNIT – I

Principles of Solar Radiation: Role and potential of new and renewable source, the solar energy option, Environmental impact of solar power - Physics of the sun, the solar constant, extra-terrestrial and terrestrial solar radiation, Solar radiation on titled surface, Instruments for measuring solar radiation and sun shine, solar radiation data.
Solar Energy Collection: Flat plate and concentrating collectors, classification of concentrating collectors, orientation and thermal analysis, advanced collectors.

UNIT – II

Solar Energy Storage and Applications: Different methods, sensible, latent heat and stratified storage, solar ponds. Solar applications - solar heating/cooling techniques, solar distillation and drying, photovoltaic energy conversion.
Wind Energy: Sources and potentials, horizontal and vertical axis windmills, performance characteristics, Betz criteria

UNIT – III

Bio-Mass: Principles of Bio-Conversion, Anaerobic /aerobic digestion, types of Bio-gas digesters, gas yield, combustion characteristics of biogas, utilization for cooking, I.C. Engine operation, and economic aspects.

UNIT – IV

Geothermal Energy: Resources, types of wells, methods of harnessing the energy, potential in India.
Ocean Energy – OTEC, Principles, utilization, setting of OTEC plants, thermodynamic cycles. Tidal and Wave energy: Potential and conversion techniques, mini-hydel power plants, their economics.

UNIT –V

Direct Energy Conversion: Need for DEC, Carnot cycle, limitations, Principles of DEC. Thermoelectric generators, Seebeck, Peltier and Joule Thompson effects, figure of merit, materials, applications, MHD generators, principles, dissociation and ionization, hall effect, magnetic flux, MHD accelerator, MHD engine, power generation systems, electron gas dynamic conversion, economic aspects. Fuel cells, principle, faraday's laws, thermodynamic aspects, selection of fuels and operating conditions.

TEXT BOOKS:

1. Renewable Energy Resources / Tiwari and Ghosal / Narosa
2. Non- conventional Energy Sources / G.D. Rai/ Khanna Publishers
3. Biological Energy Resources/ Malcolm Fleischer & Chris Lawis/ E&FN Spon.

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B.Tech. in Mechanical Engineering
VI Semester Syllabus
ME622OE: Fundamentals of Robotics

Course Objectives:

The objectives of the course is to make the students

- Understand the fundamental of robotics and robot anatomy
- Analyze the DH table and apply for serial manipulators
- Apply and analyze equations for dynamic control of a robot
- Understand the variations of robot programming and its advancement
- Understand the integration of all components of the robot

Course Outcomes:

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

- Explain the fundamentals of robotics and its components
- Illustrate the forward and Inverse kinematics of robots
- Predict the trajectory of the robot and dynamic control of robot
- Programme a robot to perform tasks in industrial applications.
- Integrate the robot to its actuators, sensors

UNIT – I

Robotics-Introduction-classification with respect to geometrical configuration (Anatomy), Controlled system & chain type: Serial manipulator & Parallel Manipulator. Components of Industrial robotics, Specifications of Robot, Wrist Configuration, Degree of Freedom.

UNIT – II

Grippers - Mechanical Gripper-Grasping force-Engelberger-g-factors-mechanisms for actuation, Magnetic gripper, Vaccume cup gripper-considerations in gripper selection & design, Selection based on the Application.

UNIT – III

Kinematics-Manipulators Kinematics, Rotation Matrix, Homogenous Transformation Matrix, D-H transformation matrix, D-H method of assignment of frames. Direct and Inverse Kinematics for industrial robots. Differential Kinematics for planar serial robots

UNIT IV

Trajectory planning: Types – Cartesian & Joint Space, Path planning vs. Trajectory Planning, Cubic Polynomial & Linear Trajectory Planning with parabolic blend without via points, 4-3-4 & 3-5-3 Trajectory Planning, Slew motion, joint interpolated motion, straight line motion – Problems.

Robot actuators and Feedback components:

Actuators: Pneumatic, Hydraulic actuators, electric & stepper motors, comparison of Actuators, Feedback components: position sensors – potentiometers, resolvers, encoders – Velocity sensors, Tactile and Range sensors, Force and Torque sensors.

UNIT V

Programming of Robots and Vision System-Lead through programming methods- Teach pendent- overview of various textual programming languages like VAL etc. Machine (robot) vision:

TEXT BOOKS:

1. Industrial Robotics / Groover M P /Mc Graw Hill
2. Robotics and its control / R. K. Mittal & I. J. Nagarath

REFERENCE BOOKS:

1. Robot Dynamics and Controls / Spony and Vidyasagar / John Wiley
2. Robot Analysis and control / Asada , Slotine / Wiley Inter-Science

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B.Tech. in Mechanical Engineering
VII Semester Syllabus
ME721OE: Industrial Management

Course Objectives:

At the end of this course students are expected:

- To learn the management concepts.
- To understand the application of Concepts in Practical aspects of business.
- To understand the various organizational structures available.
- To understand the various production systems, plant Layouts, value analysis.
- To understand work study, work sampling and statistical quality control.
- To learn the methods of Job evaluation and Project management

Course Outcomes:

After successful completion of the course:

- Student is able to understand the functions and applications of Management. Student is able to apply principles of management in his / her extra and co-curricular activity in college and in industrial in-plant training.
- Student is able to summarize the suitability of various organizational structures.
- Student is able to understand the purposes of various production systems, plant Layouts, value analysis.
- Student is able to understand various productivity management techniques like method study, work measurement for improved ways of doing work and statistical process control techniques. Student is able to apply these techniques in an organization where he undergoes for in-plant training.
- Student is able to demonstrate knowledge and understanding of various methods of Job Evaluation and Project management techniques and apply these to one's own work, as a member and leader in a team.

UNIT-I

Introduction to Management

Entrepreneurship and organization – Nature and Importance of Management, Functions of Management, Taylor's Scientific Management Theory, Fayol's Principles of Management, Maslow's Theory of Human Needs, Douglas McGregor's Theory X and Theory Y, Herzberg's Two-Factor Theory of Motivation, Systems Approach to Management, Leadership Styles, Social responsibilities of Management

UNIT-II

Designing Organizational Structures

Departmentalization and Decentralization, Types of Organization structures – Line organization, Line and staff organization, functional organization, Committee organization, matrix organization, Virtual Organization, Cellular Organization, team structure, boundary less organization, inverted pyramid structure, lean and flat organization structure and their merits, demerits and suitability.

UNIT-III

Operations Management

Objectives- product design process- Process Selection-Types of production system (Job, batch and Mass Production), Plant location-factors- Urban-Rural sites comparison- Types of Plant Layouts- Design of product layout- Line balancing (RPW method). Value analysis-Definition-types of values- Objectives- Phases of value analysis- Fast diagram

UNIT-IV

Productivity Management Techniques

Work Study: Introduction - definition - objectives - steps in work study - Method study - definition, objectives - steps of method study. Work Measurement - purpose - types of study - stop watch methods - steps - key rating - allowances - standard time calculations -work sampling. Statistical Quality Control: variables-attributes, Shewhart control charts for variables- X bar chart, R chart, – Attributes- Defective-Defect- Charts for attributes-p-chart -c chart (simple Problems), Acceptance Sampling- Single sampling- Double sampling plans-OC curves

UNIT-V

Job Evaluation and Project Management

Job Evaluation: Methods of job evaluation - simple routing objective systems - classification method factor comparison method, point method, benefits of job evaluation and limitations. Project Management (PERT/CPM): Network Analysis, Programme Evaluation and Review Technique (PERT), Critical Path Method (CPM), Identifying critical path, Probability of Completing the project within given time, Project Cost Analysis, Project Crashing. (Simple problems)

Text Books:

1. Khanna, O.P., Industrial Engineering and Management, DhanpatRai Publications, 17th Edition, 2018.
2. Sharma, S.C. and Banga, T.R., Industrial Engineering and Management, Khanna Publishers, First Edition, 2017.

Reference Books:

1. Ralph M Barnes, Motion and Time Study:Design and Measurement of Work, John Willey & Sons, Seventh Edition, 1980
2. Ernest J McCormick, Human factors in Engineering & Design, TMH, Seventh Edition,1992
3. PaneerSelvam, R., Production & Operation Management, PHI, Third Edition, 2012
4. NVS Raju, NVS., Industrial Engineering & Management,Cengage Learning, First Edition,2013
5. Maynard, Industrial Engineering Handbook, McGraw-Hill, Fifth Education, 2001.
6. Ravi Shankar, Industrial Engineering and Management, Galgotia Publications, Second Edition, 2000

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B.Tech. in Mechanical Engineering
VIII Semester Syllabus
ME722OE – Fundamentals of 3D Printing Technology

Course Objectives:

The objectives of the course is to make the students

- Impart fundamentals of 3D printing technology
- Learn how to convert part file into STL format
- Understand the method of manufacturing liquid based, powder based and solid based technologies
- Understand numerous applications of 3D printing technology in various field
- Learn the fundamentals of DFM in manufacturing and Technology

Course Outcomes:

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

- Apply 3D printing techniques for various Industrial needs
- Use software tools for 3D printing
- Know how to prepare 3D printed modules
- Learn how to construct products using LOM and FDM technologies
- Analyze various processes in 3D printing to properly choose for varied applications

UNIT- I

Introduction to 3D printing: History of 3D printing, Materials and costs involved, 3D printing eco system, future scope of 3D printing, 3D Printing, Generic 3D Printing Process, Benefits of 3D Printing, Distinction Between 3D Printing and CNC Machining, Other Related Technologies Development of 3D Printing Technology: Introduction, Computers, Computer-Aided Design Technology, Other Associated Technologies, Milestones in 3D Printing Development, 3D Printing around the World

UNIT- II

3D Printing Technologies I: Basics of various 3D printing technologies, types. Introduction to **Liquid** Based 3D Printing: Stereo lithography apparatus (SLA): Models and specifications, process, photopolymers, photo polymerization, layering technology, laser and laser scanning, applications, advantages and disadvantages

UNIT- III

3D Printing Technologies II: Introduction to Laminated object manufacturing (LOM): Models and specifications, Process, Applications, Advantages and disadvantages, Case studies. Fused Deposition Modeling (FDM): Models and specifications, Process, Working principle, Applications, Advantages and disadvantages

UNIT- IV

3D Printing Design and Required Tools

Design for 3D Printing - Design for Manufacturing and Assembly, basics of DFM for 3D Printing Concepts and Objectives, Design Tools for 3D Printing. Guidelines for Process Selection - Selection Methods for a Part, Challenges of Selection, Preliminary Selection, Production Planning and Control.

Overview of software related to 3D printing -Basics of 3D design sketching and types of softwares used. Introduction to sketching and sketchbook basics, expressing sketching in 3D, Fusion 360 Basics

Introduction to Fusion 360, navigating the user interface, working with primitives, sketch-based construction and creating components, Open SCAD, 3D scanning: Examples of 3D scanning, concept of post processing, creating digital designs into physical objects

UNIT- V

Applications & Future Directions for 3d Printing: Medical Applications for 3D Printing - Use of 3D Printing to Support Medical Applications, Software Support for Medical Applications, Limitations of 3D Printing for Medical Applications, Further Development of Medical 3D Printing Applications. Use of Multiple Materials in 3D Printing - Discrete Multiple Material Processes, Porous Multiple Material Processes, Blended Multiple Material Processes, Embedded Component 3D Printing, Commercial Applications Using Multiple Materials, Future Directions, Business Opportunities and Future Directions

REFERENCES BOOKS:

1. Ian Gibson, David W Rosen, Brent Stucker., "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010
2. Chua C.K., Leong K.F. and LIM C.S Rapid prototyping: Principles an Applications, World Scientific publications, 3rdEd., 2010
3. Terry Wohlers, " Wholers Report 2000", Wohlers Associates, 2000
4. Paul F. Jacobs, " Rapid Prototyping and Manufacturing"–, ASME Press, 1996
5. D.T. Pham, S.S. Dimov, Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling, Springer 2001.
6. Ali K. Kamrani, Emand Abouel Nasr, "Rapid Prototyping: Theory & Practice", Springer, 2006.