RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL

New Scheme Based On AICTE Flexible Curricula

Robotics & Mechatronics, V-Semester

RM 501- Design of Machine Elements

Course Outcomes:

After studying the subject, students will be able to ;

1. learn about various stresses induced in machine components during operation.
2. design components subjected to fatigue loading.
3. understand design concepts of shafts and springs used in automated mechanical systems and Robotic technology.
4. understand fundamentals of vibratory motion and different types of vibrations
5. Solve problems related to different types of vibrations, vibration isolation and transmissibility.

Unit 1 : Introduction to Stress in Machine Component: Stress concentration and fatigue: causes of stress concentration; stress concentration in tension, bending and torsion; reduction of stress concentration, theoretical stress concentration factor, notch sensitivity, fatigue stress concentration factor, cyclic loading, endurance limit, S-N Curve, loading factor, size factor, surface factor. Design consideration for fatigue, Goodman and modified Goodman's diagram, Soderberg equation, Gerber parabola, design for finite life, cumulative fatigue damage factor.

Unit 2 : Design of Shaft and Springs: Design of shaft under combined bending, twisting and axial loading, shock and fatigue factors, design for rigidity; design of shafts subjected to dynamic loading, design of keys and shaft couplings. Design of helical springs, design of leaf springs, Fatigue loading of springs, surging in springs.

Unit 3: Design of Mechanical Drives Introduction to power transmission and drives. Classification of gears, Terminology, Gear tooth proportions, Tooth forms, System of gear teeth, contact ratio, Standard proportions of gear systems, Interference in involute gears, Backlash, Selection of gear materials, Gear manufacturing methods, Failure of gear tooth, Design considerations, AGMA and Indian standards, Beam strength and wear strength of gear tooth, Design of spur and helical gears.

Unit 4: Dynamics of Engine Mechanisms: Displacement, velocity and acceleration of piston; turning moment on crankshaft, turning moment diagram; fluctuation of crankshaft speed, analysis of flywheel.

Balancing of Inertia Forces and Moments in Machines: Balancing of rotating masses, two plane balancing, determination of balancing masses (graphical and analytical methods),

balancing of rotors, balancing of internal combustion engines (single cylinder engines, in-line engines, V-twin engines)

Unit 5: Vibration Analysis :

Vibration, main causes; engineering applications of vibration and noise; vector method of representing harmonic motion; characteristics of vibration, harmonic analysis and beats phenomenon, Undamped Free Vibrations: Derivation of differential equation of motion: the energy method, the method based on Newton's second law of motion, and Rayleigh's method. Solution of differential equation of motion: Natural frequency of vibration,

Damped free vibrations; Viscous damping: coefficient of damping; damping ratio; under damped, over damped and critically damped systems; logarithmic decrement; frequency of damped free vibration; Harmonically excited Vibration: One degree of freedom- forced harmonic vibration; vector representation of forces; excitation due to rotating and reciprocating unbalance; vibration Isolation, force and motion transmissibility

EVALUATION

Evaluation will be continuous an integral part of the class as well through external assessment

References:

1. Shigley JE et al; Mechanical Engineering Design, TMH
2. Khurmi R.S. Machine Design, S Chand
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7. Dukikipati RV Srinivas J Text book of Mechanical Vibrations; PHI
8. Thomson , W.T., Theory of Vibration with Applications , C.B.S Pub & distributors .
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Suggested List of Experiments:

1. To determine endurance limit of a given specimen using Fatigue Testing Machine
2. Design of a shaft used in power transmission system.
3. To find out effect of load on natural frequency of vibrations of a lever pin supported at one end carrying adjustable load on a vertical screwed bar and spring supported at some intermediate point (i) When the dead weight of rods is neglected and (ii) when their dead weight is taken into account

4. To find out frequency of damped free vibration and rate of decay of vibration-amplitude in the system
5. To find out natural frequency and damped free frequency of a torsion pendulum and , hence to find out coefficient of damping of the oil ;
6. To observe the phenomenon of ‘whirl’ in a horizontal light shaft and to determine the critical speed of the shaft.
7. Study of various first order vibration systems

RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL

New Scheme Based On AICTE Flexible Curricula

Robotics & Mechatronics, V-Semester

RM 502- SENSORS TECHNOLOGY

Course Objectives:

1. Introduce students to the principle of various Transducers, their construction, applications and principles of operation, standards and units of measurements.
2. Provide students with opportunities to develop basic skills in the understanding the operation of electronic sensors based technology.

Unit 1 : Introduction to Electronics Measurement and Instrumentation: Transducers and sensors- Accuracy and precisions, types of errors, statistical analysis, probability of errors, limiting errors, sensitivity, linearity, hysteresis, resolution, reproducibility, transfer function. Sensors fundamentals and characteristics; sensors classification, performance,

Unit 2 : Temperature Sensors: Resistance Vs Temperature characteristics for different materials, Thermistors, Thermocouples - thermoelectric effects for thermocouples, thermocouple tables, RTD, Other Thermal Sensors

Unit 3 : Pressure, force, displacement and weight measurement: Capacitive and inductive transducers, Displacement Sensor (LVDT), Strain Sensors – strain gauges, its principle, applications, types of strain gauges, Load cells, Piezo-electric sensors, Motion sensors.

Unit 4: Flow measurement: Basic principle of flow meter, Differential pressure flow meters, Variable area flow meter, Volumetric flow meter, Hotwire anemometer, Magnetic and ultrasonic flow meter, Rota meter, Hall effect transducer working and measurement techniques

Unit 5: Radio Frequency Sensing: Basic principle of EM fields, Antenna, RFID, Near Field and Far Field Sensing, Radar and Navigation, EMI & EMC sensing.

EVALUATION

Evaluation will be continuous an integral part of the class as well through external assessment

REFERENCES:

1. Curtis D. Johnson, “Process Control Instrumentation Technology”, Prentice Hall India.

2. D.V.S. Murty, “Transducers and Instrumentation”, Prentice Hall India.

3. Helfrick Albert D. and Cooper W. D., "Modern Electronic Instrumentation and Measurement Techniques", Prentice Hall India.

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5. Shawhney A. K. "A Course In Electrical and Electronics Measurements and Instrumentation", Dhanpat Rai& Sons, 11th Ed., 1999.

6. Bell David A. "Electronic Instrumentation and Measurements", PHI / Pearson Education.

7. Mathew Sadiku, "Elements of Electromagnetic", PHI

Suggested List of Experiments:

1. Strain, Force, pressure, and torque measurement ;
   i. Strain measurement with Bridge Circuit
   ii. Beam force sensor using Strain Gauge Bridge
   iii. Beam deflection sensing with Strain Gauge Bridge
   iv. Diaphragm pressure sensor using Strain Gauge Bridge
2. Develop a displacement measurement system with the following sensors: i. Inductive transducer (LVDT) ii. Hall effect sensor
3. Develop a sensor system for force measurement using piezoelectric transducer
4. Develop a temperature measurement system for a particular application using the suitable sensor.
   i. Thermocouple principles
   ii. ii. Thermistor and linearization of NTC Thermistor
   iii. iii. Resistance Temperature Detector
   iv. iv. Semiconductor Temperature sensor
5. Evaluate performance characteristics of different types of sensors

RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL

New Scheme Based On AICTE Flexible Curricula

Robotics & Mechatronics, V-Semester

RM 503 (A)- Industrial Engineering and Supply Chain

Course Objectives:

1. To familiarize students about forecasting methods, project scheduling and project management techniques
2. To provide knowledge of inventory control system, various statistical quality control tools being used in industry
3. To expose students about the concept of work study,plant layout and supply chain management.

Unit 1. Production, Planning and Control:

Definition and importance, types of production -job, batch and mass forecasting, routing, scheduling, dispatching and follow up. Break even analysis and Gantt chart Project scheduling, application of CPM and PERT techniques Analysis and control of project cost in CPM and PERT, simple numerical problems.

Unit 2. Inventory Control and Job Evaluation:

Definition, types of inventory - Codification and standardization ABC analysis. Economic ordering quantity Procurement cost, carrying charges, lead-time, re-order point, simple problems. Definitions, types of inspection and procedure Statistical quality control - Basic theory of quality control, Process capability Control charts for variables - and R, relationship between control limits and specification limits. Control chart for fraction defective (p), control chart for number of defect .

Job Evaluation; Objective, Methods of job evaluation, job evaluation procedure, merit rating (Performance appraisal), method of merit rating,

Unit 3. Work Study :

Definition, advantages and procedure of work-study. Difference between production and productivity, Factors to improve productivity Method Study :- Definition, objectives and procedure of method study. Symbols, flow process chart (man-machine-material), flow diagram, machine chart, two hand chart Critical examination. Developing a new method Principles of motion economy. Therblig symbols, SIMO chart, simple problems. Work Measurement -time study, definition, principle and method of time study Stop watch study - number of reading,

calculation of basic time, rating techniques, normal time, allowances, standard time Simple numerical problems

Unit 4. Plant Location and Layout :

Definition, factors affecting the site selection of plant Factor affecting plant layout Types of layout - process, product, combination and fixed position layout Techniques in making layout- Flow diagram, templates, distance volume matrix, travel chart Line balancing, workstation Material Handling : Principles of economic material handling Hoisting equipment - forklift truck, Cranes- mobile motor cranes, overhead cranes, travelling bridges crane. Derrick crane. Whiler crane Conveying equipment - Package conveyors, gravity roller conveyors, screw conveyors, flight or scraper conveyors, bucket conveyors, bucket elevators, belt conveyors, pneumatic conveyors.

Unit 5 Supply Chain:

Supply Chain: Definition, Importance, expenditure and opportunities, Supply Chain Management (SCM), integration of inbound,outbound logistics and manufacturing to SCM, Flow of material, money and information, difficulties in SCM due to local v/s global, optimization and uncertainties in demand and transportation ,Bull-whip effect.

EVALUATION

Evaluation will be continuous an integral part of the class as well through external assessment.

REFERENCES:

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2. Muther Richard -Practical Plant Layout, Mc Graw Hill-1955.
3. Groover,M.P.,“Automation, Production Systems and Computer Integrated Manufacturing”,2nd 2001 Ed., Pearson Education Inc. Delhi
4. Khanna O.P. Industrial Engineering, Dhanpat rai
5. Mahajan M. Statistical Quality Control, Dhanpat Rai
6. Hira D.S and Gupta P.K.,Operation Research, S Chand & Sons
7. Kantiswarup,Operation Research,S Chand & Sons
8. Chopra and Kalra,Supply Chain Management,Pearson

RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL

New Scheme Based On AICTE Flexible Curricula

Robotics & Mechatronics, V-Semester

RM 503 (B)-Fundamentals of Systems Engineering

Course Objectives:

This course in systems engineering examines the principles and process of creating effective systems to meet application demands. The course is organized as a progression through the systems engineering processes of analysis, design, implementation, and deployment with consideration of verification and validation throughout.

Objectives of the course are: Students should be able to,

1. Plan and manage the systems engineering process
2. Examine systems from many perspectives (such as software, hardware, product, etc.)
3. Distinguish critical functions, diagnose problems, and apply descoping strategies and judge the complexity of production and deployment issues.
4. Know about the complexity in modern systems such as in missiles, rocket engines, modern automobiles etc. * Solve real complex problems

Unit 1: Overview of Systems Engineering: Introduction, Origin, Examples of Systems requiring systems engineering, Systems Engineer Career Development Model, Perspectives of Systems Engineering, Systems Domains, Systems Engineering Fields, System Engineering Approaches.

Unit 2: Structure of Complex Systems: System Building Blocks and Interfaces, Hierarchy of Complex Systems, System Building Blocks, The System Environment, Interfaces and Interactions, Complexity in Modern Systems.

Unit 3 Concept Development and Exploration: Originating a New System, Operational Analysis, Functional Analysis, Feasibility, System Operational Requirements, Implementation of Concept Exploration.Exploration in system life cycle, Concept definition phase, Activities involved in concept definition phase

Unit 4: Engineering Development: Reducing Program Risks, Requirements Analysis, Functional Analysis and Design, Prototype Development as a Risk Mitigation Technique, Development Testing, Risk Reduction. Place of engineering design phase in system life cycle, Various activities involved in engineering design phase.

Unit 5: Integration and Evaluation: Integrating, Testing, And Evaluating The Total System, Test Planning And Preparation, System Integration, Developmental System Testing, Operational Test And Evaluation, Engineering For Production, Transition From Development To Production, Production Operations.operation and support phase.

Evaluation: Evaluation will be continuous and integral part of the class as well as through external assessment

REFERENCES

1.Alexander Kossiakoff, William N Sweet, "System Engineering Principles and Practice, Wiley India 2.Blanchard Fabrycky, Systems engineering and analysis, Pearson

2. Dwivedi Krishna K, Pandey M., Fundamentals of Systems Engineering , Wiley Precise Text book Series, Wiley India.

3. Dennis M. Buede, William D.Miller, "The Engineering Design of Systems: Models & Methods" Wiley India

4.JeffreyL Whitten, Lonnie D Bentley, "System Analysis and Design Methods"

5.Richard Stevens, Peter Brook," System Engineering – Coping with complexity, Prentice Hall of India.

6.Eisner, H. Essentials of Projects and Systems Engineering Management, 2nd edition. John Wiley & Sons, New Jersey, USA.

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RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL

New Scheme Based On AICTE Flexible Curricula

Robotics & Mechatronics, V-Semester

RM 503 (C)- Intelligent Control Systems for Robots

Course Objectives:

1. To provide in-depth knowledge of the principal areas, problems, and concepts of Intelligent Systems Control

2. To familiarize students about the fundamentals concepts of Linear Neural networks, Neural Model of Robot manipulators, the Indirect Adaptive Control of a Robot manipulator, Controller Designs and the Fuzzy Control .

Unit 1: Introduction of Intelligent Systems and Control:

Overview of Intelligent systems ; structure, characteristics, chaining inferences, conflict resolution, control systems, dynamic effects of control systems.

Unit 2 Fuzzy Expert Systems

Fuzzy sets and their operations, linguistic variable, fuzzy rules, fuzzy inference, defuzzification, applications, Introduction of Fuzzy logic control

Unit 3 Genetic algorithms:

Introduction, Simulation of natural evolution, genetic algorithms, genetic operators, fitness function, applications,

Unit 4 Simulation and control of dynamics systems

Modeling using Simulink, PID controllers, implementation, fuzzy control, stability and performance evaluations

Unit 5. Artificial Neural Networks:

Introduction to Artificial neural networks, Types, Layers, Learning Processes, Semantic Net, Network inversion and Control, Neural model of a Robot Manipulator, adaptive Neural control.

Evaluation: Evaluation will be continuous and integral part of the class as well as through external assessment

REFERENCES:

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2. Craig J.J , Introduction to Robotics, Addison Wesley Publishers, 2005,

3. Hayking, S Neural Networks, Prentice Hall, 2nd edition

4.. Artificial Intelligence: Structures and Strategies for Complex Problem-Solving, 5th edition, Addison-Wesley, 2005.

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RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL

New Scheme Based On AICTE Flexible Curricula

Robotics & Mechatronics, V-Semester

RM 504 (A) Optimization Techniques

Course Objectives:

The student will be made .

1. To be familiar with all the OR Techniques and optimization methods.

2. To understand the role of transportation and assignment methods in reducing transportation costs of raw material and finished products.

3. To know about queuing theory.

3. To be familiar with various competitive strategies.

4. To able to solve network problems using network analysis techniques.

Unit 1 Linear system and distribution models:

Mathematical formulation of linear systems by LP, solution of LP for two variables,Graphical method, Simplex method,

Unit 2 Special cases of LP

Transportation and assignment model and their graphical solution, Vogels Approximation Method (VAM) or penalty method, Cell evaluation, Degeneracy.

Unit III Waiting Line Models:

Introduction, Input process, service mechanism, Queue discipline, single server (M/M/1), average length and average time calculations, optimum service rate; basic multiple server models (M/M/s)

Unit 4 Competitive strategy:

Concept and terminology, assumptions, pure and mixed strategies, two person zero sum games, saddle point, dominance, graphical, algebraic and LP methods for solving game theory problems.

Unit 5 Network Analysis:

Project Planning, Scheduling and Controlling; Project management; Network Techniques and its role in project management, Network logics, Fulkerson's Law, Merits and Demerits of AON Diagrams; Programme Evaluation and Review Technique (PERT), Critical Path Method (CPM), Determination of critical path, Float/Slack

Evaluation: Evaluation will be continuous and integral part of the class as well as through external assessment

References:

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7. Srinivasan G; Quantitative Models In Operations and SCM; PHI Learning
8. Mohanty RP and deshmukh SG; Supply Chain Management; Wiley India
9. Sen RP; Operations Research-Algorithms and Applications; PHI Learning
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11. Bronson R ;Theory and problems of OR; Schaum Series; TMH
12. Kantiswaroop Operation Research, Sultan Chand

RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL

New Scheme Based On AICTE Flexible Curricula

Robotics & Mechatronics, V-Semester

RM 504 (B) Finite Element Method

Course Outcomes:

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

1: Identify the application and characteristics of FEA elements such as bars, beams, plane and iso- parametric elements.

2: Develop element characteristic equation and generation of global equation.

3: Formulate and solve Axi-symmetric and heat transfer problems.

4: Apply suitable boundary conditions to a global equation for bars, trusses, beams, circular shafts, heat transfer, fluid flow, axi-symmetric and dynamic problems

Unit 1 Introduction to Finite Element Method

General steps of the finite element method. Engineering applications of finite element method. Advantages of the Finite Element Method. Boundary conditions: Homogeneous and non-homogeneous for structural, heat transfer and fluid flow problems. Potential energy method, Rayleigh Ritz method, Galerkin's method, Displacement method of finite element formulation. Convergence criteria, Discretisation process

Types of elements:1D, 2D and 3D, Node numbering, Location of nodes. Strain-displacement relations, Stress-strain relations, Plain stress and Plain strain conditions, temperature effects. Interpolation models: Simplex, complex and multiplex elements, linear interpolation polynomials in terms of global coordinates 1D, 2D, 3D Simplex Elements.

Unit 2 Introduction to Stiffness Method

Introduction, Derivation of stiffness matrix, Derivation of stiffness matrix for a spring element, Assembly the total stiffness matrix by superposition. One-Dimensional Elements-Analysis of Bars and Trusses, Linear interpolation polynomials in terms of local coordinate's for1D, 2Delements. Higher order interpolation functions for 1D quadratic and cubic elements in natural coordinates, Constant strain triangle, Four-Nodded Tetrahedral Element (TET 4), Eight-Nodded Hexahedral Element (HEXA 3 8), 2D iso-parametric element, Lagrange interpolation functions.

Numerical integration**:** Gaussian quadrature one point, two point formulae, 2D integrals. Force terms: Body force, traction force and point loads, Numerical Problems: Solution for displacement, stress and strain in 1D straight bars, stepped bars and tapered bars using elimination approach and penalty approach,

Unit 3 Beams and Shafts

Boundary conditions, Load vector, Hermite shape functions, Beam stiffness matrix based on Euler-Bernoulli beam theory, Examples on cantilever beams, propped cantilever beams, Numerical problems on simply supported, fixed straight and stepped beams using direct stiffness method with concentrated and uniformly distributed load. Torsion of Shafts: Finite element formulation of shafts, determination of stress and twists in circular shafts.

Unit 4 Heat Transfer

Basic equations of heat transfer: Energy balance equation, Rate equation: conduction, convection, radiation, 1D finite element formulation using vibration method, Problems with temperature gradient and heat fluxes, heat transfer in composite sections, straight fins.

Fluid Flow: Flow through a porous medium, Flow through pipes of uniform and stepped sections, Flow through hydraulic net works.

Unit 5 Axi-symmetric Solid Elements

Derivation of stiffness matrix of axisymmetric bodies with triangular elements, Numerical solution of axisymmetric triangular element(s) subjected to surface forces, point loads, angular velocity, pressure vessels. Dynamic Considerations:

Formulation for point mass and distributed masses, Consistent element mass matrix of one dimensional bar element, truss element, axisymmetric triangular element, quadrilateral element, beam element. Lumped mass matrix of bar element, truss element, Evaluation of eigen values and eigen vectors, Applications to bars, stepped bars, and beams.

Evaluation: Evaluation will be continuous and integral part of the class as well as through external assessment.

REFERENCES:

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6 Concepts and Application of Finite Elements Analysis Cook R. D., et al. Wiley & Sons 4th Edition 2003

RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL

New Scheme Based On AICTE Flexible Curricula

Robotics & Mechatronics, V-Semester

RM 504 (C) Flexible Manufacturing System

Course outcomes:

The students will be able to

1. Understand the manufacturing systems, flexibility, components of FMS
2. Understand production, planning, scheduling and simulation of FMS
3. Understand concepts of group technology and economics issues in the application of FMS
4. Understand the application of FMS in various operations & involvement of AI in flexible manufacturing system.
5. Understand the concepts of scheduling and simulation in FMS
6. Apply the concepts of scheduling in FMS

UNIT-I: Understanding of FMS

Introduction To FMS, Evolution of Manufacturing Systems, objective and Need, Benefits, Components, Types of Flexibility, Merits, Demerits and Applications of Flexibility. Composition of FMS, CNC machines, robots, automatic storage and retrieval, automatic material handling, computerized control, Hierarchy of Computer Control ,Computer Control of Work Centre and Assembly Lines, FMS Supervisory Computer Control.

UNIT-II: Planning, scheduling and control of flexible manufacturing systems:

Process planning, machine loading, cycle time, machine output vs cycle time, methods to reduce cycle time, machine balancing. Scheduling, data requirement for scheduling, mater production scheduling, Gantt charts, scheduling rules, scheduling in FMS, Single Product, Single Batch, N–Batch Scheduling Problem, Knowledge Based Scheduling System. Dispatching, Dispatch activities.

UNIT-III: FMS simulation and data base

Application of Simulation, Model of FMS, Simulation Software, Limitation, Manufacturing Data Systems, Data Flow, FMS Database Systems, Planning For FMS Database. Introduction to factors affecting the Performance of FMS, Introduction to Analytical model and Simulation model of FMS.

UNIT-IV: Group technology and justification of FMS

Introduction, Matrix Formulation, Mathematical Programming Formulation, Graph Formulation, Knowledge Based System for Group Technology, Economic Justification Of FMS, Implementation issues and maintenance of FMS, Application of Possibility Distributions in FMS Systems Justification.

UNIT-V: Applications of FMS and factory of the future

FMS Application in Machining, Sheet Metal Fabrication, Prismatic Component Production, Aerospace Application, FMS Development Towards Factories of The Future, Artificial Intelligence and Expert Systems in FMS, Design Philosophy and Characteristics for Future, case studies.

Evaluation: Evaluation will be continuous and integral part of the class as well as through external assessment

REFERENCES

1. Jha, N.K. “Handbook of Flexible Manufacturing Systems”, Academic Press Inc., 1991.

2. Radhakrishnan P. And Subramanyan S., “CAD/CAM/CIM”, Wiley Eastern Ltd., New Age International Ltd., 1994.

3. Raouf, A. And Ben-Daya, M., Editors, “Flexible Manufacturing Systems: Recent Development”, Elsevier Science, 1995.

4. GrooverM.P., “Automation, Production Systems And Computer Integrated Manufacturing”, Prentice Hall Of India Pvt., New Delhi, 1996.

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RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL

New Scheme Based On AICTE Flexible Curricula

Robotics & Mechatronics, V-Semester

RM 505: FEM/ CFD Lab

Suggested List of Experiments:

1. To study fundamentals of computational fluid dynamics (CFD)
2. To perform CFD analysis of lid driven cavity in open foam
3. To perform CFD analysis of square tube in in open foam
4. To perform CFD analysis of bifurcated blood vessel
5. To study fundamentals of FEM and FEA
6. To perform FEM analysis of deep drawing process
7. To study fundamentals of Sci-lab.

References:

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New Scheme Based On AICTE Flexible Curricula

Robotics & Mechatronics, V-Semester

RM 506: Python Programming Lab

Suggested List of Experiments:

(Please Expand it):

1. To write a Python program to find GCD of two numbers.
2. To write a Python Program to find the square root of a number by Newton's Method.
3. To write a Python program to find the exponentiation of a number.
4. To write a Python Program to find the maximum from a list of numbers.
5. To write a Python Program to perform Linear Search
6. To write a Python Program to perform binary search.
7. To write a Python Program to perform selection sort.
8. To write a Python Program to perform insertion sort.
9. To write a Python Program to perform Merge sort.
10. To write a Python program to find first n prime numbers.
11. To write a Python program to multiply matrices.
12. To write a Python program for command line arguments.
13. To write a Python program to find the most frequent words in a text read from a file.
14. To write a Python program to simulate elliptical orbits in Pygame.
15. To write a Python program to bouncing ball in Pygame.

References:

1. Timothy A. Budd: Exploring python, McGraw-Hill Education.
2. R.Nageshwar Rao ,"Python Programming" ,Wiley India
3. Allen B. Downey; Think Python, O'Reilly Media, Inc.