MCC1101: Computer Aided Design
Credits: 3
LTP 300

Course Description: The course aims to equip the students with knowledge of basic theory behind various CAD packages.

The course includes geometric modeling techniques viz. wireframe, solid, surface, 2D and 3D transformations,

Course Outcomes (CO):

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

CO1: Fit the curve and surface through a given set of data points.

CO2: Understand and differentiate the different solid modeling techniques and their representations.

CO3: Apply geometric transformations (2D or 3D) on any geometric model in theory and correlate it with the different tools of any CAD application.

Course Content

Unit I

Introduction: Historical Development, Geometric Modeling, Explicit and Implicit Equations, Intrinsic Equations, Parametric Equations, Coordinate Systems.
Curve Design: Fundamental of Curve Design, Parametric Space of a Curve, Blending Functions, Reparametrization, Space Curves, Straight lines, Spline Curves, Bezier Curves, B-Spline Curve, Rational Polynomials, NURBS.

Unit II

Surface Design: Fundamental of Surface Design, Parametric Space of a Surface, Reparametrization of a Surface patch, Sixteen Point form, Plane surface, Cylindrical and Ruled Surfaces, Surface of Revolution, Bezier Surface, B-Spline Surface.

Unit III

Solid Design: Fundamental of Solid Design, Parametric Space of a Solids, Continuity and Composite Solids, Surfaces and Curves in a Solid.
Solid Modeling: Topology and Geometry, Set Theory, Boolean Operators, Set-membership Classification, Euler operators, Graph Based Models, Boolean Models, Instances and Parameterized Shapes, Cell Decomposition and Spatial Occupancy Enumeration, Sweep Representation, Constructive Solid Geometry, Boundary Representation.

Unit IV

Transformations: Translation, Rotation, Scaling, Symmetry and Reflection, Homogeneous Transformations, Orthographic Projections, Axonometric Projections, Oblique Projections, Perspective Transformation.

Assembly Design: Assembly-Modeling, Analytical Properties, Relational Properties and Intersections, Data Transfer Formats.

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Recommended Books / Suggested Readings:

1. Zeid, I., CAD/CAM, McGraw Hill
2. Rogers, D. F. and Adams, J. A., Mathematical Elements for Computer Graphics, McGraw Hill
3. Rooney, J. and Steadman, P., Principles of Computer Aided Design, prentice Hall
4. Mallineuse, G., Computational Concepts and Methods, Kogan Page Ltd.
5. Radhakrishnan, P. and Kothandaraman, C. P., Computer Graphics & Design, Dhanpat Rai Publication
6. Krishnamoorathy, C. S. and Rajeev, J. S., Computer Aided Design (Software and Analysis Tools), Narosa

MCC1121: Computer Aided Design Lab
Credits: 2
LTP 004

CAD Lab: CAD Introduction. Sketcher, Solid modeling –Extrude, Revolve, Sweep, etc and Variational sweep, Loft ,etc, Surface modeling –Extrude, Sweep, Trim etc. and Mesh of curves, Free form etc, Feature manipulation – Copy, Edit, Pattern, Suppress, History operations etc, Assembly-Constraints, Exploded Views, Interference check, Drafting-Layouts, Standard & Sectional Views, Detailing & Plotting. Exercises in Modeling and drafting of Mechanical Components - Assembly using Parametric and feature based Packages like **CREO / SOLIDWORKS /CATIA / NX/ SOLIDEDGE etc.**

List of Experiments:

1. Practical demonstration of 2D sketch tools and constraints. Create all wireframes as depicted in Project file.
2. To make simple 3D solid structures by using Sketch based tools to improve their imagination power for developing virtual 3D components.(2D drawing file will provide)
3. Practical Application of modification tools for efficient product development.
4. Practical Demonstration of advance solid modeling tools to create products (Plastic, Casting) with variable cross section.
5. Practical Application of use of Boolean operations and new body concept for faster product development. Live project will be given for developing virtual model and its process planning.
6. To make a virtual assembly of single Piston Engine and Rotary Engine using Top-Down Assembly.
7. Practical Demonstration of Bottom-Up Assembly of Plastic mold tool design.
8. To create a new home use product by using Generative Shape design(Surface and integrated surface and solid modeling tools)
9. Practical Demonstration of Mold Die Layout and its various parts.
10. To create core and cavity design for real life industrial product. Practical Application of the use of sliders and inserts for the Mold design
11. To create drafting of products created in 3D Modeling for production processes.
12. Graphics programming in C++/MATLAB for geometric modeling of different Curves, Surfaces and Solid primitives. The generated geometric models will have the capability to be modified as per the user's requirements.

Recommended Books:

1. 3DS online Documentation
2. CATIA V5 R21 by Shyaam Tickoo, Tata McHill Publications

MCC1102: Computer Programming
Credits: 3
LTP 300

Course Description: The course aims to make student understand the basic programming constructs of computer.

The course includes knowledge about fundamental principles of scripting language for automated softwares.

Course Outcomes (CO):

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

CO1: Understand the basic-to-advanced functionality of VBScript.

CO2: Use VBScript in day-to-day life of any Web-based or automation project development.

CO3: Develop practical applications using VBScript.

Course Content

Unit I

Introduction & Building blocks of VBScript: Introduction, Features of VBScript, Basic of VB Scripting Concepts: Data types, Variables, Scope Of The Variables, Constants, Operators, The operator precedence rules, Environments Supporting VBScript, data types, Create A Simple VBScript, Insert Scripts In An HTML Page, VBScript in External File, Comments, Reserved Keywords.

Unit II

VBScript Conditional Statements, loops and functions: VBScript If, ElseIf, Select Case, VBScript Loops: For Loop, Do Loop, And While Loop, VBScript Functions And Procedures: Types Of Procedures In The VBScript, Ways To Pass A Value In The Function, Inbuilt Functions In The VBScript, Math and Conversion Functions.

Unit III

VBScript Arrays and strings: Declaration Of Arrays, assigning values to array,types of array, Using DIM, REDIM,in-built Array Functions, VBScript String Functions: VBScript InStr, Replace, Mid, And Trim Functions, cookies.

Unit IV

VBScript Error handling and dialogue Boxes: VBScript Error Handling: Purpose Of Error Handling, VBScript On Error, Dialouge Box in VBScript, regular expressions.

Recommended Books / Suggested Readings:

1. Sam Key , ”VBScript Programming Success in a Day: Beginner's Guide to Fast, Easy and Efficient Learning of VBScript Programming”.
2. Paul Lomax, “Learning VBScript” , 1997.
3. Matt Childs, “VBScript in a Nutshell”, 2003

MCC1122: Computer Programming Lab
Credits:1
LTP 002

List of Experiments:

1. Introduction to VBScript
2. Declaring and Using Variables in VBScript
3. Operators, Operator Precedence and Constants in VBScript
4. Using Conditional Statements in VBScript
5. Loops in VBScript
6. Using Procedures and Functions in VBScript
7. Arrays in VBScript
8. Date Functions in VBScript
9. Working with Strings and Cookies in VBScript
10. Error Handling in VBScript
11. Dialogue Boxes in VBScript.

MCC1103: Robotics and Control
Credits: 3
LTP 300

Course Description: The course aims to equip the students with knowledge of sensors and actuators for end effector of Robot Arm along with Robot Kinematics, trajectory planning, forward and inverse kinematics.

The course includes various Robot end effectors, Actuators and Sensors for Robot and Robot Kinematics.

Course Outcomes (CO):

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

CO1: Identify and consider the use of robotic manipulators for different tasks in industry.

CO2: Understand the function of different actuators and sensors to be employed in different robotic manipulators.

CO3: Plan the path and motion of robots for a specific tasks using forward and inverse kinematics.

Course Content

Unit I

Fundamentals of Robots: Introduction to Robotics, major component so a robot, robotic like devices, classification of robots – Classification by coordinate system and by control method, Basic components of robot system, functions and specifications of robot, fixed versus flexible automation, overview of robot application.
Robot end Effectors: Introduction, end effectors, interfacing, types of end effectors, grippers and tools, considerations in the selection and design of remote centered devices.

Unit II

Actuators: Types, Characteristics of actuating system: weight, Power-to-weight ratio, Operating pressure, Stiffness vs. compliance, Use of reduction gears, Comparison of hydraulic, Electric, pneumatic, actuators, Hydraulic actuators, Proportional feedback control, Electric Motors: DC motors, Reversible AC motors, Brushless DC motors, Stepper motors- structure and principle of operation, Stepper motor speed-torque characteristics.
Sensors: Sensor characteristics, Position sensors- potentiometers, Encoders, LVDT, Resolvers, Velocity sensor- encoders, tachometers, Force and Pressure sensors - piezoelectric, force sensing resistor, Torque sensors, Touch and tactile sensor, Proximity sensors-magnetic, Optical, Ultrasonic, Inductive, Capacitive, Eddy-current proximity sensors.

Unit III

Robot Kinematics: Robots as mechanism, Matrix representation representation of point, vector in space, representation of frame at origin and in reference frame. Homogeneous transformation Matrices, Representation of transformations – pure translation, pure rotation, combined transformations. Forward solution – Denavit Hartenberg procedure. Problems on simple 2R and 3R manipulator, Puma manipulator, SCARA manipulator, Inverse or backward solution – techniques, problems involved of 2R, 3R manipulator.

Unit IV

Velocity and Statics of Manipulators: Differential relationships, Jacobian, Differential motions of a frame (translation and rotation), Linear and angular velocities of links in serial 2R manipulators Jacobian of serial manipulator, Singularities. Dynamics of Manipulators: Equation of motion of 2R manipulators using Lagrangian, Newton-Euler formulation. Introduction to trajectory planning, basics of trajectory planning.

Recommended Books / Suggested Readings:

1. Robotics Technology and Flexible Automation 2nd Edition by S. R. Deb, McGraw Higher Ed.
2. Probabilistic Robotics: Sebastian Thrun, Wolfram Burgard, Dieter Fox
3. Springer Handbook of Robotics: Bruno Siciliano, Oussama Khatib

MCC1123: Robotics and Control Lab
Credits: 1
LTP 002

Basic Level

1. To demonstrate **Dobot Magician Robot Arm** and discuss its configuration, specifications, various end effectors, applications, features.
2. To connect Dobot Magician Robotic Arm using **Dobot Studio** using USB and perform following operations:
   I) **Jog** Mode
   II) **Mouse Control** Mode
   III) **Teach & Playback** Mode by installing vacuum suction/pneumatic gripper kit
   IV) **Write & Draw** Mode by installing writing & drawing kit
   V) **Engraving** Mode by installing engraving kit
   VI) **Hand Gesture** Mode by installing Leap Motion Controller Kit
   VII) **3D Printing** by installing 3D Printing Kit
3. To connect Dobot Magician Robot Arm using
   I) Bluetooth,
   II) Wi-Fi
   with PC/Android/iOS Devices.

Advanced Level

1. To demonstrate **Dobot M1 SCARA Robot Arm** and discuss its configuration, specifications, various end effectors, applications, features.
2. To demonstrate following Accessories for Dobot Family
   I) **Conveyor Belt** (Photo-electric Switch, Color Sensor)
   II) **Sliding Rail**
   Also discuss how these devices enhance the capabilities of Robotic Arm to help in Automation.
3. Design and Assemble an **automation system** using **Dobot Family** fulfilling the requirement of
   I) Pick and Place Operation over extended Workspace
   II) Sorting the different color material exiting from a particular workstation
   III) 3D printing over Extended Length (more than 1m) of Chart.
   IV) Engraving over Extended Length (more than 1m) of Object.

RES1101

RES1101: RESEARCH METHODOLOGY
Credits: 4
LTP 310

Course Description: The course aims to equip the students with the knowledge to understand the role of research development, research aptitude and comprehend pre-requisites of research. It also aim to formulate experimentation for productive research using appropriate methodology, techniques including Taguchi methods

The course includes the detail description of basic description of research methodology.

Course Outcomes (CO):

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

CO1:analyse research methodologies identified in existing literature.

CO2: propose and distinguish appropriate research designs and methodologies to apply to a specific research project.

CO3: develop a comprehensive research methodology for a research problem.

CO4: apply and evaluate research analytics in the core disciplines of interest.

Course Content

Unit I

Basic Principles: Nature and objective of research, Research Methods, Research topic, Literature review, Formulation of problem, Research design, Sampling techniques, Data collection, Sources of Error in Measurement.

Unit II

Introduction to Statistical Analysis: Measures of central tendency and dispersion: mean, median, mode, range, mean deviation and standard deviation. Regression and correlation analysis. Basic ideas of testing of hypotheses; Tests of significance based on normal, t and Chi-square distributions. Analysis of variance technique. Computer assisted statistical analysis.

Unit III

Design of Experiments: Error analysis in experiments. Classification of experimental designs, Design and analysis of one factor experiments -Completely randomized and randomized complete block designs,

Analysis of variance. Estimation of parameters, Residual analysis and model checking, Sample size problem. Design with two blocking variables, Latin squares, Analysis of data from a Latin square.

Unit IV

Experiment with two factors: Introduction, Main effects and interactions, Two-factor analysis of variance, Graphic analysis, Choice of sample size. Design of Experiments with the help of orthogonal arrays, Taguchi's Robust parameter design, Analysis, Noise factors, Tolerance on control factors.

Recommended Books / Suggested Readings:

1. Probability and Statistics for Engineers and scientists, Walpole, Myers, Myers and Ye, 7th ed, 2002, Pearson Education.
2. Statistics in Research, BernandOstle and Richard N.Mensing 3rd ed, 1975, Oxford & IBH Pub Co.
3. Probability and Statistics in Engineering, Hines, Montgomery, Goldsman and Borror, 4th ed, 2003, John Wiley & Sons.
4. Experimental design, Theory & application, Federer, 1955, Oxford & IBH pub Co.

MCC1201: Computer Aided Manufacturing
Credits: 3
LTP 300

Course Description: The course aims to equip the students with understanding of NC, CNC, DNC systems along with their programming.

The course includes part programming, Comparison of Conventional, NC, DNC and CNC machines.

Course Outcomes (CO):

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

CO1: Apply the concepts of machining for the purpose of selection of appropriate machining centers, machining parameters, select appropriate cutting tools for CNC milling and turning equipment, set-up, program, and operate CNC milling and turning equipment.

CO2: Create and validate NC part program data using manual data input (MDI) and automatically using standard commercial CAM package for manufacturing of required component using CNC milling or turning applications.

CO3: Produce an industrial component by interpreting 3D part model/ part drawings using Computer Aided Manufacturing technology through programming, setup, and ensuring safe operation of Computer Numerical Control (CNC) machine tools.

Course Content

Unit I

Introduction: Need of NC Technology, Fundamental Concepts in Numeric Control: structure and functions of NC System, advantages of NC technology over conventional manufacturing.

NC Machine Tools: Types, Definition and designation of control axes, Special constructional and design characteristics of NC machine tools, Standard tooling used for NC turning and milling centers.

Unit II

NC Part Programming: Work holding and tool setting procedure for NC turning and milling centers, Tool zero presetting, Block formats and introduction to ISO based G & M codes for NC part programming, Concepts of tool length and radius compensation, Standard canned cycles used in CNC turning and milling centers, Introduction to automatic NC part program generation from CAD models using standard CAD/CAM software for machining of surfaces, moulds and dies etc

Unit III

Computer Numerical Control of Machine Tools: Types and functions of computer numeric control (CNC), Types and functions of direct numeric control (DNC), Need of adaptive control types, functions and types of adaptive control, its uses & benefits, Advantages of combined CNC/DNC systems.

Unit IV

System Devices: Drives, Feedback devices, Interpolator systems, Control loop circuit elements in point to point (PTP) and contouring system, Interpolation schemes for linear and circular interpolations.

Recommended Books / Suggested Readings:

1. Ibrahim Zeid and R. Sivasubramaniam, 2nd Edition, CAD/CAM – Theory and Practice, Tata McGraw Hill, India, 2009
2. M. Groover and E. Zimmers, CAD/CAM: Computer Aided Design and Manufacturing, Pearson Education, 2007
3. James A. Rehg, Henry W. Kraebber, "Computer Integrated Manufacturing", Pearson Education. 2007
4. Chennakesava R. Alavala, "CAD/CAM: Concepts and Applications", PHI Learning Pvt. Ltd.

MCC1221: Computer Aided Manufacturing Lab
Credits: 2
LTP 004

List of Experiments:

1. To practically demonstrate the use of various Geometry (G) and Machine (M) codes.
2. To recognize origin point for 2D profiles and calculate absolute coordinate point calculation for cutter locations to generate an ISO Manual Part Program for 2D Profile.
3. Practical Demonstration of Data Migration to a CAM workstation.
4. Practical Demonstration of Part Specification and Raw Material Setting and set the Work Coordinate System and Machine Coordinate System for the Die to be manufactured.
5. Practical Demonstration of Roughing Operation, tool parameters, cutting parameters, feed and speed setting and tool path generation. (Casting, forging and sheetmetal dies)
6. Practical Demonstration of Rest Roughing Operation to maintain specific stock upon Die. (Casting, forging and sheetmetal dies)
7. Practical Demonstration of Finishing Operations for Die Finishing.
8. Practical Demonstration of Super Finishing Operations to achieve super smooth Die surface.
9. To perform Tool Path Dynamic Verification and validate the result and calculate total cutting time using simulate tool.
10. Live demonstration of cutting operation of CNC Program in VMC through DNC System.

MCC1202: Finite Element Analysis
Credits: 3
LTP 310

Course Description: The course aims to equip the students with knowledge of various approaches for analysis of a component under various conditions.

The course includes 1D and 2D problems for FEA, Analysis of Beams and Frames.

Course Outcomes (CO):

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

CO1: Apply the procedure involved to solve a structural problem using Finite Element Methods.

CO2: Develop the element stiffness matrices using different approach.

CO3: Analyze a 2D problem using line, triangular, axi-symmetric and quadrilateral element.

CO4: Analyze a 3D problem using tetrahedral and hexahedral elements.

Course Content

Unit I

Fundamental Concepts: Introduction, Historical background, stresses and. equilibrium, boundary conditions, strain-displacement relations, stress-strain relations, temperature effects, Rayleigh-Ritz Method, Galerkin's Method, Saint Venant's Principle, Matrix algebra, Gaussian Elimination.

Unit II

Finite Element Meshes: Choice of mesh, mesh data in numerical form, generation of mesh data, mesh modification.

One Dimensional Problems: Introduction, Finite element Modelling, Co-ordinates end Shape Functions. Potential energy approach, The Galerkin Approach, Assembly of Global stiffness matrix and load vector, properties of global stiffness, Finite element equations; 'Treatment of boundary conditions, quadratic shape functions, Temperature effects.

Unit III

Trusses: Introduction, plane trusses, three dimensional trusses, assembly of global stiffness matrix for the banded and skyline solution.
Two Dimensional Problems using Constant Strain Train: Introduction, finite element modelling, constant strain triangle (CST), Problem modelling and boundary conditions.

Unit IV

Two Dimensional Isoparametric Elements and Numerical Integration: Introduction, The four-node quadrilateral, Numerical Integration, Higher-order element, Problem related to beams.

Beams and Frames: Introduction, finite· element formulation, load vector, boundary considerations, shear force and bending moment beams on elastic supports, plane frames, three dimensional frames.

Recommended Books / Suggested Readings:

1. An Introduction to Finite Element Method by J.N. Reddy, McGraw-Hill, New York.
2. Introduction to FEM in Engineering by Tirupathi, R. .Chandrupatle and Ashoka D.Belegundu
3. The Finite Element Method in Engineering by S.S. Rao, Pergamon, New York.

MCC1222: Computer Aided Engineering Lab
Credits: 2
LTP 004

Course Content

Analysis of Mechanical Components – Use of FEA Packages like ANSYS/ NASTRAN etc., Exercises shall include:

1. FEA introduction
2. CAD Import
3. Types of elements 1D-2D-3D-Rigid Beam Elements
4. Meshing – 2D, 3D Meshing
5. Convergence of mesh size
6. Defining mesh Joints
8. Solver – Types of analysis a. Machine elements under Static loads b. Thermal Analysis of mechanical systems c. Modal Analysis d. Machine elements under Dynamic loads e. Non-linear systems
9. Post processing – a. Viewing FEA results – Stress, deflection; Mode shapes etc. b. Interpretation of FEA Results for design validation.
10. Machine elements under Static and dynamics loads
12. Modal Analysis

MCC1203: Rapid Prototyping
Credits: 3
LTP 300

Course Description: The course aims to equip the students with techniques of reverse engineering which can be used for rapid prototyping in various industries

The course includes tools for additive manufacturing like SLA, SGC, FDM etc.

Course Outcomes (CO):

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

CO1: Apply the reverse engineering concepts for design development.

CO2: Understand the variety of additive manufacturing techniques.

CO3: Design and develop newer tooling models.

CO4: Analyze the cases relevant to mass customization and some of the important research challenges associated with AM and its data processing tools

Course Content

Unit I

Introduction: Need - Classification of manufacturing processes, Different manufacturing systems, Development of AM systems – AM process chain - Impact of AM on Product Development - Virtual Prototyping- Rapid Tooling – RP to AM -Classification of AM processes-Benefits Applications.

Unit II

Reverse engineering and CAD modeling: Basic concept- Digitization techniques – Model reconstruction – Data Processing for Rapid Prototyping: CAD model preparation, Data requirements – Geometric modeling techniques: Wire frame, surface and solid modeling – data formats - Data interfacing, Part orientation and support generation, Support structure design, Model Slicing, Tool path generation-Software for AM- Case studies. Presentation and public defence, Engineer's verify the accuracy and validity of their designs by testing the system, creating prototyping and experimenting with the results.

Unit III

Liquid based and solid based additive manufacturing systems: Stereolithography Apparatus (SLA): Principle, pre-build process, part-building and post-build processes, photo polymerization of SL resins, part quality and process planning, recoating issues, materials, advantages, limitations and applications. Solid Ground Curing (SGC): working principle, process, strengths, weaknesses and applications. Fused deposition Modeling (FDM): Principle, details of processes, process variables, products, materials and

applications. Laminated Object Manufacturing (LOM): Working Principles, details of processes, products, materials, advantages, limitations and applications - Case studies.

Unit IV

Powder based additive manufacturing systems: Selective Laser Sintering (SLS): Principle, process, Indirect and direct SLS- powder structures, materials, post processing, surface deviation and accuracy, Applications. Laser Engineered Net Shaping (LENS): Processes, materials, products, advantages, limitations and applications– Case Studies.

Tooling: Classification, Soft tooling, Production tooling, Bridge tooling, direct and indirect tooling, Fabrication processes, Applications Case studies automotive, aerospace and electronics industries

Recommended Books / Suggested Readings:

1. Chua, C.K., Leong K.F. and Lim C.S., "Rapid prototyping: Principles and applications", second edition, World Scientific Publishers, 2010.
2. Gebhardt, A., "Rapid prototyping", Hanser Gardener Publications, 2003.
3. Gibson, I., Rosen, D.W. and Stucker, B., "Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010.
4. Hilton, P.D. and Jacobs, P.F., Rapid Tooling: Technologies and Industrial Applications, CRC press, 2005.

MCC1223: Rapid Prototyping Lab
Credits: 1
LTP 002

List of Practicals

1. Practical implementation and comparison of various rapid prototype technologies.
2. To import CAD STL file of the part to be printed in CATALYST EX Software and set part orientation units and scale.
3. To add the print model to pack and analysis model and support material requirement and time consumption for printer.
4. To prepare work table and set up the material cartridge in dimension SST 1200es for proper loading and unloading.
5. Practical demonstration of SLA.
6. To perform machine maintenance and verify stable condition of machine nozzle.

MCC1204: Computer Integrated Manufacturing Systems
Credits: 3
LTP 300

Course Description: The course aims to equip the students with understanding of description of Flexible Manufacturing Systems and its components. The students will also learn about the other advanced techniques like AI and expert systems in CIMS.

The course includes various advance technologies, Automated Material Handling Systems, different functions of CIMS.

Course Outcomes (CO):

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

CO1: Design the production systems for different types of industrial processes.

CO2: Perform design and analysis of different material handling systems for any type of industrial requirement.

CO3: Evaluate the space requirements of different storage system.

CO4: Design the workstation requirement for unattended operations and automated production system.

Course Content

Unit I

Flexible Manufacturing Systems-Concept and Classification, Types of Flexibility, pallets, fixtures, work handling systems, simulation and analysis in the design of FMS

Functions and Components of CIM System: Concept of CIMS, Group Technology and Cellular Manufacturing.

Unit II

Planning and Scheduling Functions in CIM System, Computer-Aided Process Planning: Approaches – Variant and Generative, Feature Classification and Recognition, Process Classifications and Selections, Machines and Tool Selection, Setting Process Parameters, Process Sheet Documentation.

Unit III

Automated Material Handling Systems: Industrial Robots, Conveyors, AGVs, Automatic Storage and Retrieval Systems

Computer Aided Quality Control: Co-ordinate Measuring Machine (CMM), Machine Vision and Image Processing

Unit IV

Advance Technologies in CAD/CAM: Introduction to Rapid prototyping, Knowledge Based Engineering, Virtual Reality, Augmented Reality, Artificial Intelligence and Expert system in CIM.

Recommended Books / Suggested Readings:

1. Ibrahim Zeid and R. Sivasubramaniam, 2nd Edition, CAD/CAM – Theory and Practice, Tata McGraw Hill, India, 2009
2. M. Groover and E. Zimmers, CAD/CAM: Computer Aided Design and Manufacturing, Pearson Education, 2007
3. P. N. Rao, CAD/CAM – Principles and Applications, Tata McGraw Hill, India.
4. Dr. Miltiadis A. Boboulos CAD-CAM & Rapid prototyping Application Evaluation,

MCC1141: Industrial Automation
Credits: 3
LTP 202

Course Description: The course aims to equip the students with detailed overview of basics of industrial Automation System and its components. The students will also learn about of Electro-hydraulics, Electro Pneumatics etc.

The course includes Material Handling Technologies equipped with Identification Methods, Flexible and Cellular Manufacturing Systems along with various control Systems.

Course Outcomes (CO):

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

CO1: To identify potential areas for automation and justify need for automation

CO2: To select suitable major control components required to automate a process or an activity

CO3: To translate and simulate a real time activity using modern tools and discuss the benefits of automation.

CO4: To identify suitable automation hardware for the given application.

Course Content

Unit I

Introduction: Automation in Production System, Principles and Strategies of Automation, Basic Elements of an Automated System, Advanced Automation Functions, Levels of Automations. Flow lines & Transfer Mechanisms, Fundamentals of Transfer Lines.

Unit II

Introduction to Hydraulics/Pneumatics/ Electro-pneumatic controls and devices: Basic elements hydraulics/pneumatics, Electro-pneumatic systems, Fluid power control elements and standard graphical symbols for them, Hydraulic & pneumatic cylinders - construction, design and mounting, Hydraulic & pneumatic valves for pressure, Flow & direction control, Solenoid valves, Different sensors and actuators interfaces in automation with their application criteria for electro-pneumatic system, hydraulic, pneumatic & electro-pneumatic circuits.

Unit II

Design of Circuits: Design of Pneumatic, Electro-Pneumatic and PLC Circuits for different applications.

Unit IV

Industrial control systems: Industrial control systems with PLC programming using ladder logic, Human-Machine-Interface design, SCADA & RTU, Motion controller, Servo and stepper motors, RFID Technologies & Integration and Machine Vision.

Recommended Books / Suggested Readings:

1. Automation, Production Systems and Computer Integrated Manufacturing M.P.Groover, Pearson Education.5th edition, 2009.
2. Computer Based Industrial Control- Krishna Kant, EEE-PHI,2nd edition,2010
3. An Introduction to Automated Process Planning Systems- Tiess Chiu Chang & Richard A. Wysk

GNA UNIVERSITY

MCC1142: Artificial Intelligence

Credits 3

LTP 202

Course Description: This course aims to impart knowledge to the students for building an expert systems and also building of intelligent machines which can work as the human minds do.

This course includes Expert Systems, Artificial Neural Networks, Fuzzy Logics etc.

Course Outcomes:

Student will be able to:

- **CO 1:** Apply the Artificial Intelligence technique to solve the problems.
- **CO II:** Apply the knowledge of neural network theory for developing an expert system.
- **CO III:** Apply the knowledge of Fuzzy logic for knowledge acquisition and inference.
- **CO IV:** Develop a robust expert system using hybrid Neuro-fuzzy Technique.

Introduction to Artificial intelligence: AI Problems, AI Techniques, Defining the Problem as a State Space Search, Problem Characteristics, Production Systems, Search: Issues in The Design of Search Programs.

Unit II

Expert system: Structure of an Expert Systems, Different Types of Expert Systems, Knowledge Acquisition and Validation Techniques, Black Board Architecture, Knowledge Building System Tools, Expert System Shells.

Unit III

Artificial Neural Network: Physiology of Human Brain, Machine learning, Models of Neuron, Learning Processes, Single Layer Perceptrons, Multi-Layer Feed Forward Neural Networks, Back Propagation Algorithm

Unit IV

Fuzzy Logic: An introduction to fuzzy logic, Operations on fuzzy sets, Fuzzy relations , Fuzzy implications , Linguistic variables; An introduction to fuzzy logic controllers , Construction of data base and rule base of FLC; Defuzzification methods Inference mechanisms; A robustness study of fuzzy logic controller, Applications of fuzzy systems; Neuro-Fuzzy systems.

List of Experiments:

Minor Project(Individual)**:**

Development of an expert system using the concept of ANN and Fuzzy logic.

Recommended Books:

1. Rich, E., Knight, K., and Nair, S.B., Artificial Intelligence, TMH (2019).
2. Timothy J Ross , Fuzzy Logic with Engineering Applications, Wiley publication.
3. David Kriesel, A Brief Introduction to Neural Networks.

MCC1143: Management Information System

Credits 3

LTP 300

Course Description: This course provides the students with techniques and skills which help in proper flow of information to the management at various levels of it. The student will also learn about the ERP software.

This course includes organizational management, application of MIS, development of a MIS system, database management system.

Course Outcomes:
After learning the course the students should be able to:
CO1: Apply MIS to any organization.
CO2: Develop an effective management information system.
CO3: Properly manage the database and retrieve it when required.
CO4: Understand and apply the ERP system in the organization.

Course Contents:

Unit I

Management within organizations: Management activities, roles and levels, Management Planning and Control, Strategic Planning within an organization: activities, techniques and results. The nature of decision-making: decision making models and classification of decision-making situations, the nature of information: classifications and characteristics. MIS sub types, Measurement of MIS performance and capabilities.

Unit II

MIS applications and relationships: Kinds of Information Systems: Transaction Processing System(TPS) – Office Automation System (OAS) – Management Information System (MIS) – Decision Support System (DSS) and Expert System (ES) – Executive Support System (ESS) Data warehouses and data mining facilities: the relationship between data warehousing and other MIS facilities

Unit III

Development of MIS: Development of Long range plans, Determining information requirement, Organization for Development of MIS, Choice of Information Technology, Strategic decision, IT implementation plan, Phases of MISD implementation Assessing information needs, Identification and development of information sources, design and development of information flow network and cost

considerations, need and design of an integrated information system for MIS, role of computers in MIS: Processing information flow, Maintaining records and generating outputs for decision making. Implementation and evaluation of MIS

Unit IV

Information System Application: Transaction Processing Applications, Applications for Budgeting and Planning, Automation, Manufacturing Management System, Database management system, relational database management system.

Enterprise System: Enterprise Resources Planning (ERP)-Features, selection criteria, merits, issues and challenges in Implementation.

Recommended Books

1. Kenneth C. L. and Jane P. L., Management Information Systems – Managing the Digital Firm – Tenth Edition.
2. Jame O Brien, Management Information System, TMH.
3. Alexis Leon and Mathews Leon, Fundamentals of Information Technology.
4. Jaiswal and Mittal, Management Information Systems, Oxford Printing Press.

MCC1241: Mechatronics
Credits: 3
LTP 300

Course Description: The course aims to equip the students with the knowledge of modern electro-mechanical devices. The student is also imparted with the knowledge to control, measure and interpret various process with the help of mechatronics.

The course includes introduction to mechatronics, various sensors, transducers and actuators used for the control of various processes using mechatronics, mathematical modeling of physical process.

Course Outcomes (CO):

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

CO1: Integrate mechanical, electronics, computer science to develop a mechatronic system to control any physical process.

CO2: Convert any physical model to the mathematical model and write equation of motion for mechanical, electrical, pneumatic and hydraulic systems.

CO3: Interface the sensors and actuators of a mechatronic device to the computer/laptop.

CO4: Develop a suitable controller to obtain the desired performance from the system by recognizing the key features of different type of controllers.

Course Contents:

UNIT I

Introduction Introduction to Mechatronics Systems - Integration of mechanical, electronics, control and computer science engineering, Elements of mechatronics system, Mechatronics in products - Measurement systems - control systems - traditional design and Mechatronics Design**.**

UNIT II

Sensors, Transducers, Actuators Introduction - performance terminology - displacement position and proximity - velocity and motion - fluid pressure - temperature sensors - light sensors - selection of sensors - signal processing - servo systems. Actuators in Mechatronics System: Electric actuators, Stepper motors, DC motors, and AC motors.

UNIT III

Mathematical Modeling of Dynamic Systems: Equations of motion of mechanical, electrical, pneumatic and hydraulic systems, Transforming physical model to mathematical model, Linearization, Frequency response, Modeling of different motors and generators, Laplace transformations, Sensitivity of the open-loop and closed-loop systems, Types of controller, Controller design using frequency domain and Laplace domain methods.

UNIT IV

Microprocessors and Programmable Logic Controllers Introduction - Architecture - pin configuration - instruction set - programming of microprocessor using 8085 instructions - interfacing input and output devices - interfacing D/A converters and A/D converters - applications - temperature control - stepper motor control - traffic light controller. PLC- Mnemonics timers, internal relays and counters - data handling - analog input and output - selection of PLC

Recommended Books / Suggested Readings:

1. *Bolton, W., Mechatronics, Pearson Education Asia (2004).*
2. Lawrence J.Kamm, "Understanding Electro-Mechanical Engineering, An Introduction to Mechatronics" , Prentice-Hall, 2000.
3. *Nagrath, I. J. and Gopal, M., Control System Engineering, New Age International (2008).*

MCC1242: Advanced Robotics
Credits: 3
LTP 300

Course Description: The course aims to equip the students with understanding of different control systems for manipulators.

The course includes Linear and Non Linear Control of Manipulator along with path and trajectory planning.

Course Outcomes (CO):

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

CO1: Develop and apply the mathematical model for path as well as trajectory planning of robots in joint space and Cartesian space.

CO2: Formulate and apply the control problem of robotic manipulators using linear control schemes

CO3: Formulate and apply the control problem of robotic manipulators using non-linear control schemes

CO4: Apply the concepts of multi-tasking of redundant manipulators like redundancy resolution, obstacle avoidance and singularity avoidance.

Course Content

Unit I

Review of Robot Manipulators: Review of forward kinematics, inverse kinematics and manipulator dynamics.

Path and Trajectory Planning: Joint-space schemes, Cartesian-space schemes, configuration space, path planning using potential fields, avoiding local minima, probabilistic roadmap methods; Trajectory planning: PTP method using via points.

Unit II

Linear Control of Manipulators: Feedback Control schemes for robotics: Proportional, Derivative and Integral Control, regulation problem, tracking problem, model based control and trajectory-following control.

Unit III

Nonlinear Control of Manipulators: Feed forward control, Feedback Linearization, PD control with gravity compensation, computed toque control, sliding mode Control, Lyapunov stability analysis, Introduction to Cartesian based control schemes.

Unit IV

Introduction to Redundant Manipulators: Singularity and Workspace analysis, redundancy resolution, obstacle avoidance and singularity avoidance.

Recommended Books / Suggested Readings:

1. Fu, K. S., Gonzalez, R. C. and Lee, C. S., Robotics: Control, Sensing, Vision, and Intelligence, McGraw Hill (1987).
2. Schilling, R. J., Fundamentals of Robotics Analysis & Control, Prentice Hall of India (2003).
3. Craig, J. J., Introduction to Robotics: Mechanics and Control, Pearson Education (2004).

MCC1243: Machine Tool Design

Credits 3

LTP 300

Course Description: This program is designed to equip the students with the knowledge of various machine tools and their designs from all aspects i.e. mechanical, electrical etc.

This course includes design principles to be followed during machine tool design, types of drives, design of slideways etc.

Course Outcomes: Upon successful completion of the course, the students should be able to:

CO1: Develop the conceptual design, manufacturing framework and systematic analysis of design problems on the machine tools.
CO2: apply the design procedures for different types of design problems such as gear box design, guide way design, shaft loading and its associated parts, rolling bearings, die design and jigs and fixtures and so on.
CO3: Design, develop and evaluate cutting tools and work holders for a manufactured product.

UNIT I

General Requirements of the Machine Tool: Accuracy of Shape, Dimensional accuracy and surface finish of the components produced, High Productivity, High Technical and Economic Efficiency.
Design Principles: Stiffness and Rigidity of the Separate Constructional Elements and their combined behavior under Load, Static Rigidity, Dynamic Rigidity, Natural frequencies, Damping, Mode of Vibration.

UNIT II

Electrical, Mechanical and Hydraulic Drives for the Operational Movements: Electric Drive and Control Equipment, Mechanical and Hydraulic Drives, Drives for Producing Rotational Movements, Stepped Drives, Step less Drives, Drives for Producing Rectilinear Movements, Backlash Eliminator in the Feed Drive Nut.

UNIT III

Design of Constructional Elements: Machine Tool Structures, Structural Elements Design for Centre Lathe, Drilling Machine, Knee Type Milling Machine, Planning Machine, Boring Machine and Grinding Machines.
Design of Slide Ways: Design of Slide ways for Tables, Saddles and Cross-slides, Anti-friction Bearings for slide ways, hydrostatically lubricated slide ways.

UNIT IV

Design of Spindles and Spindle Bearings: Design of Spindles for Strength and Stiffness, Design of Spindles for Balancing, General Layout and Design of the Driving Elements and the Spindle Bearings, Selection and General Layout of Ball and Roller Bearings for Supporting Spindles.

Design of Secondary Drives for Machine Tools: Design of Cutting Drives, Feed Drives and Setting Drives.

Recommended Books

1. Design Principles of Metal-Cutting Machine Tools by F. Koenigsberger
2. Machine Tool Design by N. K. Mehta. McGraw Hill Publishing
3. Machine Tool Design by Acherkan, Mir publishing
4. Machine Tool Design by S.K, Basu, Oxford and IBH Publishing
5. Machine tool design by Sen and Bhattacharya, CBS Publication.

MCC1341: Mechanics of Composite Materials
Credits: 3
LTP 300

Course Description: The course aims to equip the students with detailed knowledge of properties of composites and their advantages over the conventional materials.

The course includes behavior of Composites, their Micromechanical properties and analysis of different laminates.

Course Outcomes (CO):

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

CO1: Understand the significance of replacing existing metal structures with composite materials wherever beneficial

CO2: Highlight the appropriate use of composite structures in the industry

CO3: Comprehend the complexity of design of composite materials and structures

CO4: Mainly understand the mechanics of composite materials

Course Content

Unit I

Introduction to Composite material: Definitions: Composite material, Fiber, Matrix. Types of fibers and Raw Fiber Properties, Types of Matrix, Prepegs, Fillers and other Additives
Basics of composites: Mechanical Behavior of Composite Materials. Lamina, Laminate: The basic building block of a composite material, Introduction, Evaluation of the four elastic moduli – Rule of mixture, ultimate strengths of unidirectional lamina.

Unit II

Macro Mechanics of a Lamina: Hooke's law for different types of materials, number of elastic constants, Two – dimensional relationship of compliance & stiffness matrix. Hooke's law for two dimensional angle lamina, engineering constants – angle lamina, Invariants, Theories of failure.

Unit III

Micromechanical Analysis of Composite Strength and Stiffness: Properties of typical composite materials, Volume and Weight Fractions, Longitudinal Strength and Stiffness. Transverse Modulus. In-plane shear Modulus. Poisson's ratio

Unit IV

Analysis of Laminated Composites: Laminates, Basic Assumptions, Strain-Displacement Relationship, Stress-Strain Relationships, Equilibrium Equations, Laminate Stiffness, Determination of Lamina Stresses and Strains, Types of Laminate Configuration, Balanced Laminate, Anti-symmetric Laminate, Examples

Advantages and applications: Advantages of Composite Materials and Structures. Applications and Use of Composite materials in present world

Recommended Books / Suggested Readings:

1. Mukhopadhyay, M., Mechanics of Composite Materials and Structures, University Press.
2. Jones, R. M., Mechanics of Composite Materials, CRC Press.
3. Autar K. Kaw, Mechanics of Composite Materials, CRC Press.

MCC1342: Manufacturing of Plastic Products
Credits: 3
LTP 300

Course Description: The course aims to equip the students with basics of plastic processing techniques and their testing.

The course includes Plastic identification codes, various manufacturing techniques.

Course Outcomes (CO):

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

CO1: To understand various identification codes for plastic

CO2: To apply various processing techniques of plastics

CO3: To conduct various tests on polymers for design of component

CO4: To understand basic terminology of Fiber reinforced Polymeric composites.

Course Content

Unit I

Introduction to Polymers & Plastics –Types of polymers, Commodity plastics and special purpose plastics, Environment friendly plastics, Plastic recycling & plastic identification codes**,** Additives and fillers

Unit II

Polymer processing technologies - Melt flow, Extrusion, Injection molding, Rotational molding, Compression molding, Polymer foaming, Vacuum forming, Filament winding, Thermoforming, Calendaring, Resin transfer molding, foaming of polymers and its application in industries.

Unit III

Fiber Reinforced Polymeric Composites - Introduction, Types of fibers, Manufacturing techniques, Micro & Macro mechanical analysis of Lamina**,** Testing of composites, fiber volume fraction, tensile, shear, compressive, flexural and thermo-elastic responses of lamina and laminates, shear test, notched strength, essential work of fracture, fracture toughness, non destructive testing.

Unit IV

Testing of polymer products - Testing of plastics and dry rubber products– mechanical properties – tensile, Flexural, compressive, impact, hardness, abrasion and fatigue resistance tests, Thermal properties – thermal conductivity, thermal expansion and brittleness temperature, heat deflection temperature

Recommended Books / Suggested Readings:

1. Polymer Processing: Principles and Design by Donald G. Baird and Dimitris I. Collias, Elsevier
2. Polymer Processing by D. H. Morton-Jones, Elsevier

MCC1343: Non Destructive Testing

Credits 3

LTP 300

Course Description: This course will equip the students with the techniqus of Non-Destructive Testing (NDT), its types and applications in engineering and research fields.

This course includes overview of Non-Destructive Testing, types of NDT, Contact and non-contact inspection methods. Eddy current testing.

Course Outcomes (CO): Upon completion of this course, the students can able to:

CO1: Understand the fact where to apply NDT.

CO2: Use the various Non-Destructive Testing and testing methods understand for defects and characterization of industrial components.

UNIT I

OVERVIEW OF NDT : NDT Versus Mechanical testing, Overview of the Non Destructive Testing Methods for the detection of manufacturing defects as well as material characterization. Relative merits and limitations, Various physical characteristics of materials and their applications in NDT, Visual inspection – Unaided and aided.

UNIT II

SURFACE NDT METHODS: Liquid Penetrant Testing – Principles, types and properties of liquid penetrants, developers, advantages and limitations of various methods, Testing Procedure, Interpretation of results. Magnetic Particle Testing- Theory of magnetism, inspection materials Magnetisation methods, Interpretation and evaluation of test indications, Principles and methods of demagnetization, Residual magnetism.

UNIT III

THERMOGRAPHY : Principles, Contact and non-contact inspection methods, Techniques for applying liquid crystals, Advantages and limitation – infrared radiation and infrared detectors, Instrumentations and methods, applications.

UNIT IV

EDDY CURRENT TESTING (ET): Generation of eddy currents, Properties of eddy currents, Eddy current sensing elements, Probes, Instrumentation, Types of arrangement, Applications, advantages, Limitations, Interpretation/Evaluation.

Recommended Books

1. Baldev Raj, T.Jayakumar, M.Thavasimuthu "Practical Non-Destructive Testing", Narosa Publishing House, 2009.
2. Ravi Prakash, "Non-Destructive Testing Techniques", 1st revised edition, New Age International Publishers, 2010.
3. ASM Metals Handbook,"Non-Destructive Evaluation and Quality Control", American Society of Metals, Metals Park, Ohio, USA, 200, Volume-17.
4. Paul E Mix, "Introduction to Non-destructive testing: a training guide", Wiley, 2nd Edition New Jersey, 2005
5. Charles, J. Hellier," Handbook of Nondestructive evaluation", McGraw Hill, New York 2001.
6. ASNT, American Society for Non Destructive Testing, Columbus, Ohio, NDT Handbook,Vol. 1, Leak Testing, Vol. 2, Liquid Penetrant Testing, Vol. 3, Infrared and Thermal Testing Vol. 4, Radiographic Testing, Vol. 5, Electromagnetic Testing, Vol. 6, Acoustic Emission Testing, Vol. 7, Ultrasonic Testing.

MCC1441: Computational Fluid Dynamics
Credits: 3
LTP 202

Course Description: The course aims to equip the students with understanding of various algorithms behind any CFD packages.

The course includes FDM, FVM, Mesh Generation, Various Algorithms and Solution Procedure for CFD

Course Outcomes (CO):

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

CO1: Acquire the knowledge of various types of fluid flow governing equations.

CO2: Analyze the internal fluid flow phenomena of thermal and fluid system.

CO3: Acquire enough knowledge to design of the engineering systems using commercial computational code.

CO4: Design the thermal system using CFD

Course Content

Unit I

Introduction: Motivation and role of computational fluid dynamics, Concept of modelling and simulation.
Governing Equations: Continuity equation, Momentum equation, Energy equation, various simplifications, Dimensionless equations and parameters, Convective and conservation forms, Incompressible invisid flows Basic flows, Source panel method, and Vortex panel method.

Unit II

Finite Difference Method: Discretization, Various methods of finite differencing.
Hyperbolic equations: Explicit Schemes and Von Neumann Stability Analysis, Implicit Schemes, Multi Step Methods, Runge-Kutta Method.
Formulations of Incompressible Viscous Flows: Formulations of Incompressible Viscous Flows by Finite Difference Methods, Pressure Correction Methods, Vortex Methods.

Unit III

Treatment of Compressible Flows: Potential Equation, Euler Equations, Navier-Stokes System of Equations, Flow Field-Dependent Variation Methods, Boundary Conditions, Example Problems.
Finite Volume Method: Steady one-dimension convection and diffusion, Properties of discretization schemes, Various methods of finite volume scheme. Turbulence Modelling: Turbulence, effect of turbulence on N-S equations, different turbulent modelling scheme.

Unit IV

Mesh generation: Overview of mesh generation, Structured and Unstructured mesh, Guideline on mesh quality and design, Mesh refinement and adaptation.

Solution Algorithms: Discretization schemes for pressure, momentum and energy equations

List of Experiments:

CFD Solution Procedure: Problem setup – creation of geometry, mesh generation, selection of physics and fluid properties, initialization, solution control and convergence monitoring, results reports and visualization.

Minor Project(Individual)**:**

Design of Energy conversion system using commercial software like ANSYS FLUENT/CFX.

Recommended Books / Suggested Readings:

1. Ghosdastidar, P. S., Computer Simulation of Flow and Heat Transfer, McGraw Hill (1998) 87th Senate approved Courses Scheme & Syllabus for M.E. CAD/CAM Engg. (2015)
2. Roache, P. J., Computational Fluid Dynamics, Hermosa (1998).
3. Wendt, J. F., Computational Fluid Dynamics An Introduction, Springer-Verlag (2008).
4. Muralidhar, K. and Sundararajan, T., Computational Fluid Flow and Heat Transfer, Narosa (2008).
5. Jaluria, Y. and Torrance, K. E., Computational Heat Transfer, Taylor & Francis (2003)

MCC1442: Vehicle Dynamics
Credits: 3
LTP 300

Course Description: The course aims to equip the students with understanding of various different aspects of dynamics of vehicle

The course includes Longitudinal, lateral and Vertical dynamics.

Course Outcomes (CO):

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

CO1: The students will be able to possess the knowledge to understand the aerodynamics of vehicles

CO2: The student will be able to apply principles of dynamics in real time vehicles

CO3: The student will be able to apply different techniques to measure and test vehicles on-road and in test labs.

CO4: The student will be able to employ CFD to understand the flow behavior over the road vehicle model

Course Content

Unit I

Introduction to vehicle dynamics: evolution of road vehicles; commercial vehicles; motorcycles; shape and detail optimization; futuristic trends; performance analysis of cars and light Trucks.
Tyre Mechanics: Tyre types and construction, Tyre forces and moments, Tyre slip-grip and rolling resistance Cornering properties of tyres, Tyre models, Tyre performance on wet surfaces, Ride properties of tyres.

Unit II

Longitudinal Dynamics: Performance characteristics; Maximum tractive effort; Power plant and Transmission characteristics; Braking performance; Study of tractor; semitrailer; Anti-lock braking system; Traction control system;
Lateral Dynamics- Bicycle Model; Low speed turning; High speed cornering; and State space approach, Steady state handling characteristics of two axle vehicle, neutral steer, under-steer, and over-steer.
Vertical Dynamics- Vehicle ride characteristics, Human response to vibration, Vehicle ride models, Quarter car model, pitch and bounce model, Suspension performance for ride, vibration isolation, suspension travel, Road holding, active and Semi-active suspensions.

Unit III

Vehicle Aerodynamics: vehicle equation of motion, aerodynamic drag, tire rolling resistance, climbing resistance, effective mass, traction diagram, acceleration capability and vehicle elasticity, fuel consumption and economy.
Race cars: Front wings, Rear wings, Weight distribution, over steer and under steer, Center of gravity effects, Split streaming.
Commercial vehicle aerodynamics: Truck Aerodynamics, Improvements in design, Different styles of trailers, Effect of gap between truck and trailer, fairings.

Unit IV

Fundamentals of Acoustics: Noise and Vibrations, Frequency response functions, Modal analysis, Transfer path analysis, Single reference, Multi reference analysis.
Stability, comfort and safety: Flow field around a vehicle; interior and exterior flows; attached, separated and oscillating flows; aerodynamic forces and moments; cornering and side wind behaviors; stability index; passing maneuvers; spoiler design; safety and aesthetics; water and dirt accumulation; visibility impairment; ventilation, air flow and odor removal; Engine and interior cooling; radiators; HVAC systems.

Recommended Books / Suggested Readings:

1. Reza N Jazar "Vehicle Dynamics: Theory and Application", 3rd Edition, Springer International Publishing AG, Switzerland, 2017.
2. Theory and Applications of Aerodynamics for Ground Vehicles- T. Yomi Obidi. Published by SAE, 2014, ISBN 978-0-7680-2111-0.
3. Thomas D. Gillespie,(1992), "Fundamentals of Vehicle Dynamics (R114) Publisher: Society of Automotive Engineers Inc.,1992 .
4. C. Sujatha, "Vibration and Acoustics: Measurements and Signal Analysis", McGraw Hill Education (India) Private limited, 2010.
5. Aerodynamics of Road Vehicles, W.H.Hucho, Published by SAE International, 2015. Low Speed Wind Tunnel Testing, 3rd Edition, Jewel B. Barlow, William H. Rae Jr., Alan Pope, Wiley India Pvt Ltd, 2010.

MCC1443: Advanced Strength of Material

Credits 3

LTP 300

Course Description: This course is aimed to equip the students with the advanced knowledge of strength of material concepts like theories of failure, stresses in springs, thick vessels, discs etc.

This course includes theories of failure, springs, thick vessels, discs and shafts etc.

Course Outcomes: Upon successful completion of the course, the students should be able to:

CO1: Apply the concepts of solid mechanics in the problems related to analysis like finite element analysis.

CO2: Apply the concepts of material strength on various mechanical components like springs, thick cylindrical vessels, shafts etc.

CO3: Will be able to figure out the reasons of failure of various mechanical components and various theories behind it.

Course Content

UNIT I

Strain energy, energy of dilation and distortion, resilience stress due to suddenly applied loads, Castigliano's theorem, Maxwell's theorem of reciprocal deflection, Theories of Failure : Maximum principal stress theory, maximum shear stress theory, Total strain energy theory, shear strain energy theory, graphical representation and derivation of equation for each and their application to problems relating to two dimensional stress systems only.

UNIT II

Leaf spring, deflection and bending stresses; open coiled helical springs; derivation of formula and application for deflection and rotation of free end under the action of axial load and/or axial couple; flat spiral springs – derivation of formula for strain energy, maximum stress and rotation.

UNIT III

Thick Cylinders: Derivation of Lame's equations, calculation of radial longitudinal and hoop stresses and strains due to internal pressure in thick cylinders, compound cylinders, hub shrunk on solid shafts.

Bending of curved beams: Calculation of stresses in crane or chain hooks, rings of circular section and trapezoidal section and chain links with straight sided.

UNIT IV

Shear stress distribution in rectangular, circular, I, T and channel section and the compression with bending stresses, Importance of shear centre, Rotational stresses in discs and rims of uniform thickness; discs of uniform Strength

Recommended Books

1. Elements of Strength of Materials by Timoshenko and Gere
2. Advanced Solid Mechanics by LS Srinath
3. Advanced Mechanics of Materials by Seely and Smith
4. Strength of Materials by GH Ryder
5. Mechanics of Materials-I by EJ Hern; Paragaman, New York
6. Introduction to Mechanics of Solids by Crandell, Dahl and Lardner, McGraw Hill

MCC1444: Product Design and Development
Credits: 3
LTP 104

Course Description: The course aims to equip the students with knowledge from conceptual design to design for manufacturing.

The course includes design for manufacturing, assembly, various creativity techniques and asthetics.

Course Outcomes (CO):

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

CO1: Select an appropriate product design and development process for a given application

CO2: Choose an appropriate ergonomics for the product.

CO3: Select an appropriate standardization method.

CO4: Develop the methods to minimize the cost

Course Content

Unit I

Introduction: Classification/ Specifications of Products. Product life cycle, Product mix, Introduction to product design, Modern product development process, Innovative thinking, Morphology of design.

Unit II

Conceptual Design: Generation, selection & embodiment of concept, Product architecture. Industrial design: process, need. Robust Design: Taguchi Designs & DOE.

Unit III

Design for Manufacturing and Assembly: Methods of designing for Mfg& Assy. Designs for Maintainability. Designs for Environment, Product costing. Legal factors and social issues. Engineering ethics and issues of society related to design of products.

Unit IV

Ergonomics / Aesthetics: Gross human autonomy. Anthropometry, Man-Machine interaction, Concepts of size and texture, color .Comfort criteria, Psychological & Physiological considerations. Creativity Techniques: Creative thinking, conceptualization, brain storming, primary design, drawing, simulation, detail design.

Recommended Books / Suggested Readings:

1. Karl T Ulrich, Steven D Eppinger , " Product Design & Development." Tata McGraw Hill New Delhi 2003
2. David G Ullman, "The Mechanical Design Process." McGraw Hill Inc Singapore 1992 N J M Roozenberg , J Ekels ,

3. N F M Roozenberg“ Product Design Fundamentals and Methods .” John Willey & Sons 1995

MCC 1124: Industrial Automation Laboratory

Credits: 1
LTP 002

List of Experiments

1. Operation of a single acting cylinder
2. Operation of double acting cylinder.
3. Impulse pilot operation of single acting cylinder
4. Operation of single acting cylinder using dual pressure (AND) valve.
5. Operation of double acting cylinder using quick exhaust valve.
6. Operation of single acting cylinder using single solenoid valve(direct actuation of solenoid)
7. Operation of double acting cylinder using single solenoid valve(direct actuation of solenoid)
8. Operation of single acting cylinder using single solenoid valve(use relay for actuation of solenoid)
9. Operation of double acting cylinder using single solenoid valve(use relay for actuation of solenoid)
10. Multicycle operation of single acting cylinder using single solenoid valve with PLC.
11. Multicycle double acting cylinder using single solenoid valve with PLC.

MCC1141: Industrial Automation
Credits: 3
LTP 202

Course Description: The course aims to equip the students with detailed overview of basics of industrial Automation System and its components. The students will also learn about of Electro-hydraulics, Electro Pneumatics etc.

The course includes Material Handling Technologies equipped with Identification Methods, Flexible and Cellular Manufacturing Systems along with various control Systems.

Course Outcomes (CO):

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

CO1: To identify potential areas for automation and justify need for automation

CO2: To select suitable major control components required to automate a process or an activity

CO3: To translate and simulate a real time activity using modern tools and discuss the benefits of automation.

CO4: To identify suitable automation hardware for the given application.

Course Content

Unit I

Introduction: Automation in Production System, Principles and Strategies of Automation, Basic Elements of an Automated System, Advanced Automation Functions, Levels of Automations. Flow lines & Transfer Mechanisms, Fundamentals of Transfer Lines.

Unit II

Introduction to Hydraulics/Pneumatics/ Electro-pneumatic controls and devices: Basic elements hydraulics/pneumatics, Electro-pneumatic systems, Fluid power control elements and standard graphical symbols for them, Hydraulic & pneumatic cylinders - construction, design and mounting, Hydraulic & pneumatic valves for pressure, Flow & direction control, Solenoid valves, Different sensors and actuators interfaces in automation with their application criteria for electro-pneumatic system, hydraulic, pneumatic & electro-pneumatic circuits.

Unit II

Design of Circuits: Design of Pneumatic, Electro-Pneumatic and PLC Circuits for different applications.

Unit IV

Industrial control systems: Industrial control systems with PLC programming using ladder logic, Human-Machine-Interface design, SCADA & RTU, Motion controller, Servo and stepper motors, RFID Technologies & Integration and Machine Vision.

Recommended Books / Suggested Readings:

1. Automation, Production Systems and Computer Integrated Manufacturing M.P.Groover, Pearson Education.5th edition, 2009.
2. Computer Based Industrial Control- Krishna Kant, EEE-PHI,2nd edition,2010
3. An Introduction to Automated Process Planning Systems- Tiess Chiu Chang & Richard A. Wysk

MCC1142: Artificial Intelligence

Credits 3

LTP 202

Course Description: This course aims to impart knowledge to the students for building an expert systems and also building of intelligent machines which can work as the human minds do.

This course includes Expert Systems, Artificial Neural Networks, Fuzzy Logics etc.

Course Outcomes:

Student will be able to:

- **CO 1:** Apply the Artificial Intelligence technique to solve the problems.
- **CO II:** Apply the knowledge of neural network theory for developing an expert system.
- **CO III:** Apply the knowledge of Fuzzy logic for knowledge acquisition and inference.
- **CO IV:** Develop a robust expert system using hybrid Neuro-fuzzy Technique.

Introduction to Artificial intelligence: AI Problems, AI Techniques, Defining the Problem as a State Space Search, Problem Characteristics, Production Systems, Search: Issues in The Design of Search Programs.

Unit II

Expert system: Structure of an Expert Systems, Different Types of Expert Systems, Knowledge Acquisition and Validation Techniques, Black Board Architecture, Knowledge Building System Tools, Expert System Shells.

Unit III

Artificial Neural Network: Physiology of Human Brain, Machine learning, Models of Neuron, Learning Processes, Single Layer Perceptrons, Multi-Layer Feed Forward Neural Networks, Back Propagation Algorithm

Unit IV

Fuzzy Logic: An introduction to fuzzy logic, Operations on fuzzy sets, Fuzzy relations , Fuzzy implications , Linguistic variables; An introduction to fuzzy logic controllers , Construction of data base and rule base of FLC; Defuzzification methods Inference mechanisms; A robustness study of fuzzy logic controller, Applications of fuzzy systems; Neuro-Fuzzy systems.

List of Experiments:

Minor Project(Individual)**:**

Development of an expert system using the concept of ANN and Fuzzy logic.

Recommended Books:

1. Rich, E., Knight, K., and Nair, S.B., Artificial Intelligence, TMH (2019).
2. Timothy J Ross , Fuzzy Logic with Engineering Applications, Wiley publication.
3. David Kriesel, A Brief Introduction to Neural Networks.

MCC1143: Management Information System

Credits 3

LTP 300

Course Description: This course provides the students with techniques and skills which help in proper flow of information to the management at various levels of it. The student will also learn about the ERP software.

This course includes organizational management, application of MIS, development of a MIS system, database management system.

Course Outcomes:
After learning the course the students should be able to:
CO1: Apply MIS to any organization.
CO2: Develop an effective management information system.
CO3: Properly manage the database and retrieve it when required.
CO4: Understand and apply the ERP system in the organization.

Course Contents:

Unit I

Management within organizations: Management activities, roles and levels, Management Planning and Control, Strategic Planning within an organization: activities, techniques and results. The nature of decision-making: decision making models and classification of decision-making situations, the nature of information: classifications and characteristics. MIS sub types, Measurement of MIS performance and capabilities.

Unit II

MIS applications and relationships: Kinds of Information Systems: Transaction Processing System(TPS) – Office Automation System (OAS) – Management Information System (MIS) – Decision Support System (DSS) and Expert System (ES) – Executive Support System (ESS) Data warehouses and data mining facilities: the relationship between data warehousing and other MIS facilities

Unit III

Development of MIS: Development of Long range plans, Determining information requirement, Organization for Development of MIS, Choice of Information Technology, Strategic decision, IT implementation plan, Phases of MISD implementation Assessing information needs, Identification and development of information sources, design and development of information flow network and cost considerations, need and design of an integrated information system for MIS, role of computers in MIS: Processing information flow, Maintaining records and generating outputs for decision making. Implementation and evaluation of MIS

Unit IV

Information System Application: Transaction Processing Applications, Applications for Budgeting and Planning, Automation, Manufacturing Management System, Database management system, relational database management system.

Enterprise System: Enterprise Resources Planning (ERP)-Features, selection criteria, merits, issues and challenges in Implementation.

Recommended Books

1. Kenneth C. L. and Jane P. L., Management Information Systems – Managing the Digital Firm – Tenth Edition.
2. Jame O Brien, Management Information System, TMH.
3. Alexis Leon and Mathews Leon, Fundamentals of Information Technology.
4. Jaiswal and Mittal, Management Information Systems, Oxford Printing Press.

MCC1241: Mechatronics
Credits: 3
LTP 300

Course Description: The course aims to equip the students with the knowledge of modern electro-mechanical devices. The student is also imparted with the knowledge to control, measure and interpret various process with the help of mechatronics.

The course includes introduction to mechatronics, various sensors, transducers and actuators used for the control of various processes using mechatronics, mathematical modeling of physical process.

Course Outcomes (CO):

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

CO1: Integrate mechanical, electronics, computer science to develop a mechatronic system to control any physical process.

CO2: Convert any physical model to the mathematical model and write equation of motion for mechanical, electrical, pneumatic and hydraulic systems.

CO3: Interface the sensors and actuators of a mechatronic device to the computer/laptop.

CO4: Develop a suitable controller to obtain the desired performance from the system by recognizing the key features of different type of controllers.

Course Contents:

UNIT I

Introduction Introduction to Mechatronics Systems - Integration of mechanical, electronics, control and computer science engineering, Elements of mechatronics system, Mechatronics in products - Measurement systems - control systems - traditional design and Mechatronics Design**.**

UNIT II

Sensors, Transducers, Actuators Introduction - performance terminology - displacement position and proximity - velocity and motion - fluid pressure - temperature sensors - light sensors - selection of sensors - signal processing - servo systems. Actuators in Mechatronics System: Electric actuators, Stepper motors, DC motors, and AC motors.

UNIT III

Mathematical Modeling of Dynamic Systems: Equations of motion of mechanical, electrical, pneumatic and hydraulic systems, Transforming physical model to mathematical model, Linearization, Frequency response, Modeling of different motors and generators, Laplace transformations, Sensitivity of the open-loop and closed-loop systems, Types of controller, Controller design using frequency domain and Laplace domain methods.

UNIT IV

Microprocessors and Programmable Logic Controllers Introduction - Architecture - pin configuration - instruction set - programming of microprocessor using 8085 instructions - interfacing input and output devices - interfacing D/A converters and A/D converters - applications - temperature control - stepper motor control - traffic light controller. PLC- Mnemonics timers, internal relays and counters - data handling - analog input and output - selection of PLC

Recommended Books / Suggested Readings:

1. *Bolton, W., Mechatronics, Pearson Education Asia (2004).*
2. Lawrence J.Kamm, "Understanding Electro-Mechanical Engineering, An Introduction to Mechatronics" , Prentice-Hall, 2000.
3. *Nagrath, I. J. and Gopal, M., Control System Engineering, New Age International (2008).*

MCC1242: Advanced Robotics
Credits: 3
LTP 300

Course Description: The course aims to equip the students with understanding of different control systems for manipulators.

The course includes Linear and Non Linear Control of Manipulator along with path and trajectory planning.

Course Outcomes (CO):

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

CO1: Develop and apply the mathematical model for path as well as trajectory planning of robots in joint space and Cartesian space.

CO2: Formulate and apply the control problem of robotic manipulators using linear control schemes

CO3: Formulate and apply the control problem of robotic manipulators using non-linear control schemes

CO4: Apply the concepts of multi-tasking of redundant manipulators like redundancy resolution, obstacle avoidance and singularity avoidance.

Course Content

Unit I

Review of Robot Manipulators: Review of forward kinematics, inverse kinematics and manipulator dynamics.

Path and Trajectory Planning: Joint-space schemes, Cartesian-space schemes, configuration space, path planning using potential fields, avoiding local minima, probabilistic roadmap methods; Trajectory planning: PTP method using via points.

Unit II

Linear Control of Manipulators: Feedback Control schemes for robotics: Proportional, Derivative and Integral Control, regulation problem, tracking problem, model based control and trajectory-following control.

Unit III

Nonlinear Control of Manipulators: Feed forward control, Feedback Linearization, PD control with gravity compensation, computed toque control, sliding mode Control, Lyapunov stability analysis, Introduction to Cartesian based control schemes.

Unit IV

Introduction to Redundant Manipulators: Singularity and Workspace analysis, redundancy resolution, obstacle avoidance and singularity avoidance.

Recommended Books / Suggested Readings:

1. Fu, K. S., Gonzalez, R. C. and Lee, C. S., Robotics: Control, Sensing, Vision, and Intelligence, McGraw Hill (1987).
2. Schilling, R. J., Fundamentals of Robotics Analysis & Control, Prentice Hall of India (2003).
3. Craig, J. J., Introduction to Robotics: Mechanics and Control, Pearson Education (2004).

MCC1243: Machine Tool Design

Credits 3

LTP 300

Course Description: This program is designed to equip the students with the knowledge of various machine tools and their designs from all aspects i.e. mechanical, electrical etc.

This course includes design principles to be followed during machine tool design, types of drives, design of slideways etc.

Course Outcomes: Upon successful completion of the course, the students should be able to:

CO1: Develop the conceptual design, manufacturing framework and systematic analysis of design problems on the machine tools.
CO2: apply the design procedures for different types of design problems such as gear box design, guide way design, shaft loading and its associated parts, rolling bearings, die design and jigs and fixtures and so on.
CO3: Design, develop and evaluate cutting tools and work holders for a manufactured product.

UNIT I

General Requirements of the Machine Tool: Accuracy of Shape, Dimensional accuracy and surface finish of the components produced, High Productivity, High Technical and Economic Efficiency.
Design Principles: Stiffness and Rigidity of the Separate Constructional Elements and their combined behavior under Load, Static Rigidity, Dynamic Rigidity, Natural frequencies, Damping, Mode of Vibration.

UNIT II

Electrical, Mechanical and Hydraulic Drives for the Operational Movements: Electric Drive and Control Equipment, Mechanical and Hydraulic Drives, Drives for Producing Rotational Movements, Stepped Drives, Step less Drives, Drives for Producing Rectilinear Movements, Backlash Eliminator in the Feed Drive Nut.

UNIT III

Design of Constructional Elements: Machine Tool Structures, Structural Elements Design for Centre Lathe, Drilling Machine, Knee Type Milling Machine, Planning Machine, Boring Machine and Grinding Machines.
Design of Slide Ways: Design of Slide ways for Tables, Saddles and Cross-slides, Anti-friction Bearings for slide ways, hydrostatically lubricated slide ways.

UNIT IV

Design of Spindles and Spindle Bearings: Design of Spindles for Strength and Stiffness, Design of Spindles for Balancing, General Layout and Design of the Driving Elements and the Spindle Bearings, Selection and General Layout of Ball and Roller Bearings for Supporting Spindles.

Design of Secondary Drives for Machine Tools: Design of Cutting Drives, Feed Drives and Setting Drives.

Recommended Books

1. Design Principles of Metal-Cutting Machine Tools by F. Koenigsberger
2. Machine Tool Design by N. K. Mehta. McGraw Hill Publishing
3. Machine Tool Design by Acherkan, Mir publishing
4. Machine Tool Design by S.K, Basu, Oxford and IBH Publishing
5. Machine tool design by Sen and Bhattacharya, CBS Publication.

MCC1341: Mechanics of Composite Materials
Credits: 3
LTP 300

Course Description: The course aims to equip the students with detailed knowledge of properties of composites and their advantages over the conventional materials.

The course includes behavior of Composites, their Micromechanical properties and analysis of different laminates.

Course Outcomes (CO):

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

CO1: Understand the significance of replacing existing metal structures with composite materials wherever beneficial

CO2: Highlight the appropriate use of composite structures in the industry

CO3: Comprehend the complexity of design of composite materials and structures

CO4: Mainly understand the mechanics of composite materials

Course Content

Unit I

Introduction to Composite material: Definitions: Composite material, Fiber, Matrix. Types of fibers and Raw Fiber Properties, Types of Matrix, Prepegs, Fillers and other Additives

Basics of composites: Mechanical Behavior of Composite Materials. Lamina, Laminate: The basic building block of a composite material, Introduction, Evaluation of the four elastic moduli – Rule of mixture, ultimate strengths of unidirectional lamina.

Unit II

Macro Mechanics of a Lamina: Hooke's law for different types of materials, number of elastic constants, Two – dimensional relationship of compliance & stiffness matrix. Hooke's law for two dimensional angle lamina, engineering constants – angle lamina, Invariants, Theories of failure.

Unit III

Micromechanical Analysis of Composite Strength and Stiffness: Properties of typical composite materials, Volume and Weight Fractions, Longitudinal Strength and Stiffness. Transverse Modulus. In-plane shear Modulus. Poisson's ratio

Unit IV

Analysis of Laminated Composites: Laminates, Basic Assumptions, Strain-Displacement Relationship, Stress-Strain Relationships, Equilibrium Equations, Laminate Stiffness, Determination of Lamina Stresses and Strains, Types of Laminate Configuration, Balanced Laminate, Anti-symmetric Laminate, Examples

Advantages and applications: Advantages of Composite Materials and Structures. Applications and Use of Composite materials in present world

Recommended Books / Suggested Readings:

1. Mukhopadhyay, M., Mechanics of Composite Materials and Structures, University Press.
2. Jones, R. M., Mechanics of Composite Materials, CRC Press.
3. Autar K. Kaw, Mechanics of Composite Materials, CRC Press.

MCC1342: Manufacturing of Plastic Products
Credits: 3
LTP 300

Course Description: The course aims to equip the students with basics of plastic processing techniques and their testing.

The course includes Plastic identification codes, various manufacturing techniques.

Course Outcomes (CO):

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

CO1: To understand various identification codes for plastic

CO2: To apply various processing techniques of plastics

CO3: To conduct various tests on polymers for design of component

CO4: To understand basic terminology of Fiber reinforced Polymeric composites.

Course Content

Unit I

Introduction to Polymers & Plastics –Types of polymers, Commodity plastics and special purpose plastics, Environment friendly plastics, Plastic recycling & plastic identification codes**,** Additives and fillers

Unit II

Polymer processing technologies - Melt flow, Extrusion, Injection molding, Rotational molding, Compression molding, Polymer foaming, Vacuum forming, Filament winding, Thermoforming, Calendaring, Resin transfer molding, foaming of polymers and its application in industries.

Unit III

Fiber Reinforced Polymeric Composites - Introduction, Types of fibers, Manufacturing techniques, Micro & Macro mechanical analysis of Lamina**,** Testing of composites, fiber volume fraction, tensile, shear, compressive, flexural and thermo-elastic responses of lamina and laminates, shear test, notched strength, essential work of fracture, fracture toughness, non destructive testing.

Unit IV

Testing of polymer products - Testing of plastics and dry rubber products– mechanical properties – tensile, Flexural, compressive, impact, hardness, abrasion and fatigue resistance tests, Thermal properties – thermal conductivity, thermal expansion and brittleness temperature, heat deflection temperature

Recommended Books / Suggested Readings:

1. Polymer Processing: Principles and Design by Donald G. Baird and Dimitris I. Collias, Elsevier
2. Polymer Processing by D. H. Morton-Jones, Elsevier

MCC1343: Non Destructive Testing

Credits 3

LTP 300

Course Description: This course will equip the students with the techniqus of Non-Destructive Testing (NDT), its types and applications in engineering and research fields.

This course includes overview of Non-Destructive Testing, types of NDT, Contact and non-contact inspection methods. Eddy current testing.

Course Outcomes (CO): Upon completion of this course, the students can able to:

CO1: Understand the fact where to apply NDT.

CO2: Use the various Non-Destructive Testing and testing methods understand for defects and characterization of industrial components.

UNIT I

OVERVIEW OF NDT : NDT Versus Mechanical testing, Overview of the Non Destructive Testing Methods for the detection of manufacturing defects as well as material characterization. Relative merits and limitations, Various physical characteristics of materials and their applications in NDT, Visual inspection – Unaided and aided.

UNIT II

SURFACE NDT METHODS: Liquid Penetrant Testing – Principles, types and properties of liquid penetrants, developers, advantages and limitations of various methods, Testing Procedure, Interpretation of results. Magnetic Particle Testing- Theory of magnetism, inspection materials Magnetisation methods, Interpretation and evaluation of test indications, Principles and methods of demagnetization, Residual magnetism.

UNIT III

THERMOGRAPHY : Principles, Contact and non-contact inspection methods, Techniques for applying liquid crystals, Advantages and limitation – infrared radiation and infrared detectors, Instrumentations and methods, applications.

UNIT IV

EDDY CURRENT TESTING (ET): Generation of eddy currents, Properties of eddy currents, Eddy current sensing elements, Probes, Instrumentation, Types of arrangement, Applications, advantages, Limitations, Interpretation/Evaluation.

Recommended Books

1. Baldev Raj, T.Jayakumar, M.Thavasimuthu “Practical Non-Destructive Testing”, Narosa Publishing House, 2009.
2. Ravi Prakash, “Non-Destructive Testing Techniques”, 1st revised edition, New Age International Publishers, 2010.
3. ASM Metals Handbook,”Non-Destructive Evaluation and Quality Control”, American Society of Metals, Metals Park, Ohio, USA, 200, Volume-17.
4. Paul E Mix, “Introduction to Non-destructive testing: a training guide”, Wiley, 2nd Edition New Jersey, 2005
5. Charles, J. Hellier,“ Handbook of Nondestructive evaluation”, McGraw Hill, New York 2001.
6. ASNT, American Society for Non Destructive Testing, Columbus, Ohio, NDT Handbook,Vol. 1, Leak Testing, Vol. 2, Liquid Penetrant Testing, Vol. 3, Infrared and Thermal Testing Vol. 4, Radiographic Testing, Vol. 5, Electromagnetic Testing, Vol. 6, Acoustic Emission Testing, Vol. 7, Ultrasonic Testing.

MCC1441: Computational Fluid Dynamics
Credits: 3
LTP 202

Course Description: The course aims to equip the students with understanding of various algorithms behind any CFD packages.

The course includes FDM, FVM, Mesh Generation, Various Algorithms and Solution Procedure for CFD

Course Outcomes (CO):

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

CO1: Acquire the knowledge of various types of fluid flow governing equations.

CO2: Analyze the internal fluid flow phenomena of thermal and fluid system.

CO3: Acquire enough knowledge to design of the engineering systems using commercial computational code.

CO4: Design the thermal system using CFD

Course Content

Unit I

Introduction: Motivation and role of computational fluid dynamics, Concept of modelling and simulation.
Governing Equations: Continuity equation, Momentum equation, Energy equation, various simplifications, Dimensionless equations and parameters, Convective and conservation forms, Incompressible invisid flows Basic flows, Source panel method, and Vortex panel method.

Unit II

Finite Difference Method: Discretization, Various methods of finite differencing.
Hyperbolic equations: Explicit Schemes and Von Neumann Stability Analysis, Implicit Schemes, Multi Step Methods, Runge-Kutta Method.
Formulations of Incompressible Viscous Flows: Formulations of Incompressible Viscous Flows by Finite Difference Methods, Pressure Correction Methods, Vortex Methods.

Unit III

Treatment of Compressible Flows: Potential Equation, Euler Equations, Navier-Stokes System of Equations, Flow Field-Dependent Variation Methods, Boundary Conditions, Example Problems.
Finite Volume Method: Steady one-dimension convection and diffusion, Properties of discretization schemes, Various methods of finite volume scheme. Turbulence Modelling: Turbulence, effect of turbulence on N-S equations, different turbulent modelling scheme.

Unit IV

Mesh generation: Overview of mesh generation, Structured and Unstructured mesh, Guideline on mesh quality and design, Mesh refinement and adaptation.

Solution Algorithms: Discretization schemes for pressure, momentum and energy equations

List of Experiments:

CFD Solution Procedure: Problem setup – creation of geometry, mesh generation, selection of physics and fluid properties, initialization, solution control and convergence monitoring, results reports and visualization.

Minor Project(Individual)**:**

Design of Energy conversion system using commercial software like ANSYS FLUENT/CFX.

Recommended Books / Suggested Readings:

1. Ghosdastidar, P. S., Computer Simulation of Flow and Heat Transfer, McGraw Hill (1998) 87th Senate approved Courses Scheme & Syllabus for M.E. CAD/CAM Engg. (2015)
2. Roache, P. J., Computational Fluid Dynamics, Hermosa (1998).
3. Wendt, J. F., Computational Fluid Dynamics An Introduction, Springer-Verlag (2008).
4. Muralidhar, K. and Sundararajan, T., Computational Fluid Flow and Heat Transfer, Narosa (2008).
5. Jaluria, Y. and Torrance, K. E., Computational Heat Transfer, Taylor & Francis (2003)

MCC1442: Vehicle Dynamics
Credits: 3
LTP 300

Course Description: The course aims to equip the students with understanding of various different aspects of dynamics of vehicle

The course includes Longitudinal, lateral and Vertical dynamics.

Course Outcomes (CO):

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

CO1: The students will be able to possess the knowledge to understand the aerodynamics of vehicles

CO2: The student will be able to apply principles of dynamics in real time vehicles

CO3: The student will be able to apply different techniques to measure and test vehicles on-road and in test labs.

CO4: The student will be able to employ CFD to understand the flow behavior over the road vehicle model

Course Content

Unit I

Introduction to vehicle dynamics: evolution of road vehicles; commercial vehicles; motorcycles; shape and detail optimization; futuristic trends; performance analysis of cars and light Trucks.
Tyre Mechanics: Tyre types and construction, Tyre forces and moments, Tyre slip-grip and rolling resistance Cornering properties of tyres, Tyre models, Tyre performance on wet surfaces, Ride properties of tyres.

Unit II

Longitudinal Dynamics: Performance characteristics; Maximum tractive effort; Power plant and Transmission characteristics; Braking performance; Study of tractor; semitrailer; Anti-lock braking system; Traction control system;
Lateral Dynamics- Bicycle Model; Low speed turning; High speed cornering; and State space approach, Steady state handling characteristics of two axle vehicle, neutral steer, under-steer, and over-steer.
Vertical Dynamics- Vehicle ride characteristics, Human response to vibration, Vehicle ride models, Quarter car model, pitch and bounce model, Suspension performance for ride, vibration isolation, suspension travel, Road holding, active and Semi-active suspensions.

Unit III

Vehicle Aerodynamics: vehicle equation of motion, aerodynamic drag, tire rolling resistance, climbing resistance, effective mass, traction diagram, acceleration capability and vehicle elasticity, fuel consumption and economy.

Race cars: Front wings, Rear wings, Weight distribution, over steer and under steer, Center of gravity effects, Split streaming.

Commercial vehicle aerodynamics: Truck Aerodynamics, Improvements in design, Different styles of trailers, Effect of gap between truck and trailer, fairings.

Unit IV

Fundamentals of Acoustics: Noise and Vibrations, Frequency response functions, Modal analysis, Transfer path analysis, Single reference, Multi reference analysis.

Stability, comfort and safety: Flow field around a vehicle; interior and exterior flows; attached, separated and oscillating flows; aerodynamic forces and moments; cornering and side wind behaviors; stability index; passing maneuvers; spoiler design; safety and aesthetics; water and dirt accumulation; visibility impairment; ventilation, air flow and odor removal; Engine and interior cooling; radiators; HVAC systems.

Recommended Books / Suggested Readings:

1. Reza N Jazar "Vehicle Dynamics: Theory and Application", 3rd Edition, Springer International Publishing AG, Switzerland, 2017.
2. Theory and Applications of Aerodynamics for Ground Vehicles- T. Yomi Obidi. Published by SAE, 2014, ISBN 978-0-7680-2111-0.
3. Thomas D. Gillespie,(1992), "Fundamentals of Vehicle Dynamics (R114) Publisher: Society of Automotive Engineers Inc.,1992 .
4. C. Sujatha, "Vibration and Acoustics: Measurements and Signal Analysis", McGraw Hill Education (India) Private limited, 2010.
5. Aerodynamics of Road Vehicles, W.H.Hucho, Published by SAE International, 2015. Low Speed Wind Tunnel Testing, 3rd Edition, Jewel B. Barlow, William H. Rae Jr., Alan Pope, Wiley India Pvt Ltd, 2010.

MCC1443: Advanced Strength of Material

Credits 3

LTP 300

Course Description: This course is aimed to equip the students with the advanced knowledge of strength of material concepts like theories of failure, stresses in springs, thick vessels, discs etc.

This course includes theories of failure, springs, thick vessels, discs and shafts etc.

Course Outcomes: Upon successful completion of the course, the students should be able to:

CO1: Apply the concepts of solid mechanics in the problems related to analysis like finite element analysis.

CO2: Apply the concepts of material strength on various mechanical components like springs, thick cylindrical vessels, shafts etc.

CO3: Will be able to figure out the reasons of failure of various mechanical components and various theories behind it.

Course Content

UNIT I

Strain energy, energy of dilation and distortion, resilience stress due to suddenly applied loads, Castigliano's theorem, Maxwell's theorem of reciprocal deflection, Theories of Failure : Maximum principal stress theory, maximum shear stress theory, Total strain energy theory, shear strain energy theory, graphical representation and derivation of equation for each and their application to problems relating to two dimensional stress systems only.

UNIT II

Leaf spring, deflection and bending stresses; open coiled helical springs; derivation of formula and application for deflection and rotation of free end under the action of axial load and/or axial couple; flat spiral springs – derivation of formula for strain energy, maximum stress and rotation.

UNIT III

Thick Cylinders: Derivation of Lame's equations, calculation of radial longitudinal and hoop stresses and strains due to internal pressure in thick cylinders, compound cylinders, hub shrunk on solid shafts.

Bending of curved beams: Calculation of stresses in crane or chain hooks, rings of circular section and trapezoidal section and chain links with straight sided.

UNIT IV

Shear stress distribution in rectangular, circular, I, T and channel section and the compression with bending stresses, Importance of shear centre, Rotational stresses in discs and rims of uniform thickness; discs of uniform Strength

Recommended Books

1. Elements of Strength of Materials by Timoshenko and Gere
2. Advanced Solid Mechanics by LS Srinath
3. Advanced Mechanics of Materials by Seely and Smith
4. Strength of Materials by GH Ryder
5. Mechanics of Materials-I by EJ Hern; Paragaman, New York
6. Introduction to Mechanics of Solids by Crandell, Dahl and Lardner, McGraw Hill

MCC1444: Product Design and Development
Credits: 3
LTP 104

Course Description: The course aims to equip the students with knowledge from conceptual design to design for manufacturing.

The course includes design for manufacturing, assembly, various creativity techniques and asthetics.

Course Outcomes (CO):

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

CO1: Select an appropriate product design and development process for a given application

CO2: Choose an appropriate ergonomics for the product.

CO3: Select an appropriate standardization method.

CO4: Develop the methods to minimize the cost

Course Content

Unit I

Introduction: Classification/ Specifications of Products. Product life cycle, Product mix, Introduction to product design, Modern product development process, Innovative thinking, Morphology of design.

Unit II

Conceptual Design: Generation, selection & embodiment of concept, Product architecture. Industrial design: process, need. Robust Design: Taguchi Designs & DOE.

Unit III

Design for Manufacturing and Assembly: Methods of designing for Mfg& Assy. Designs for Maintainability. Designs for Environment, Product costing. Legal factors and social issues. Engineering ethics and issues of society related to design of products.

Unit IV

Ergonomics / Aesthetics: Gross human autonomy. Anthropometry, Man-Machine interaction, Concepts of size and texture, color .Comfort criteria, Psychological & Physiological considerations. Creativity Techniques: Creative thinking, conceptualization, brain storming, primary design, drawing, simulation, detail design.

Recommended Books / Suggested Readings:

1. Karl T Ulrich, Steven D Eppinger , " Product Design & Development." Tata McGraw Hill New Delhi 2003
2. David G Ullman, "The Mechanical Design Process." McGraw Hill Inc Singapore 1992 N J M Roozenberg , J Ekels ,
3. N F M Roozenberg" Product Design Fundamentals and Methods ." John Willey & Sons 1995