

Estd. 1989

# SIR C R REDDY COLLEGE OF ENGINEERING

## (AUTONOMOUS)

(SPONSORED BY SIR C R R EDUCATIONAL INSTITUTIONS, SOCIETY REGD. NO.: 10/1950)

VATLURU, ELURU-534007, ELURU DISTRICT, ANDHRA PRADESH, INDIA

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Website: [www.sircrrengg.ac.in](http://www.sircrrengg.ac.in)

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M.Tech - I Sem		L	T	P	C
		3	0	0	3
MD 101	ADVANCED MECHANICS OF SOLIDS				

### UNIT I

Theories of stress and strain, Definition of stress at a point, stress notation, principal stresses, other properties, differential equations of motion of a deformable body, deformation of a deformable body, strain theory, principal strains, strain of a volume element, small displacement theory.

Stress –strain temperature relations: Elastic and non elastic response of a solid, first law of thermodynamics, Hooke's Law, Anisotropic elasticity, Hooke's Law, Isotropic elasticity, initiation of Yield, Yield criteria.

### UNIT II

**Failure criteria:** Modes of failure, Failure criteria, Excessive deflections, Yield initiation, fracture, Progressive fracture, (High Cycle fatigue for number of cycles  $N > 10^6$ , buckling.

Application of energy methods: Elastic deflections and statically indeterminate members and structures: Principle of stationary potential energy, Castiglione's theorem on deflections, Castiglione's theorem on deflections for linear load deflection relations, deflections of statically determinate structures.

### UNIT III

**Unsymmetrical bending:** Bending stresses in Beams subjected to Nonsymmetrical bending; Deflection of straight beams due to nonsymmetrical bending.

**Curved beam theory:** Winkler Bach formula for circumferential stress – Limitations – Correction factors – Radial stress in curved beams – closed ring subjected to concentrated and uniform loads- stresses in chain links.

### UNIT IV

**Torsion:** Linear elastic solution; Prandtl elastic membrane (Soap-Film) Analogy; Narrow rectangular cross Section; Hollow thin wall torsion members, Multiply connected Cross Section.

### UNIT V

**Contact stresses:** Introduction; problem of determining contact stresses; Assumptions on which a solution for contact stresses is based; Expressions for principal stresses; Method of computing contact stresses; Deflection of bodies in point contact; Stresses for two bodies in contact over narrow rectangular area (Line contact), Loads normal to area; Stresses for two bodies in line contact, Normal and Tangent to contact area.

**TEXTBOOKS:**

1. Advanced Mechanics of materials by Boresi & Sidebottom-Wiley International.
2. Theory of elasticity by Timoshenko S.P. and Goodier J.N. McGraw-Hill Publishers 3<sup>rd</sup> Edition.
3. Advanced Mechanics of Solids, L.S Srinath.

**REFERENCES:**

1. Advanced strength of materials by Den Hartog J.P.
2. Theory of plates – Timoshenko.
3. Strength of materials & Theory of structures (Vol I & II) by B.C Punmia.
4. Strength of materials by Sadhu singh.

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M.Tech - I Sem		L	T	P	C
		3	0	0	3
MD 102	MECHANICAL VIBRATIONS AND ACOUSTICS				

## UNIT-I: INTRODUCTION

Relevance of and need for vibrational analysis – Basics of SHM - Mathematical modelling of vibrating systems - Discrete and continuous systems - single-degree freedom systems - free and forced vibrations, damped and undamped systems.

## UNIT-II: MULTI DEGREE FREEDOM SYSTEMS

Free and forced vibrations of multi-degree freedom systems in longitudinal, torsional and lateral modes - Matrix methods of solution- normal modes - Orthogonality principle-Energy methods, Eigen values and Eigen vectors

## UNIT-III: CONTINUOUS SYSTEMS

Torsional vibrations - Longitudinal vibration of rods - transverse vibrations of beams - Governing equations of motion - Natural frequencies and normal modes - Energy methods, Introduction to non linear and random vibrations.

## UNIT-IV: BASICS OF ACOUSTICS

Speed of Sound, Wavelength, Frequency, and Wave Number, Acoustic Pressure and Particle Velocity, Acoustic Intensity and Acoustic Energy Density, Spherical Wave propagation, Directivity Factor and Directivity Index, Levels and the Decibel, Addition and subtraction of Sound levels, Octave Bands, Weighted Sound Levels.

## UNIT-V: NOISE MEASUREMENT AND CONTROL

Sound Level Meters, Intensity Level Meters, Octave Band Filters Acoustic Analyzers, Dosimeter, Measurement of Sound Power, Impact of noise on humans, A-Weighting, Noise control strategy, sound absorption and insulation.

**TEXT BOOKS:**

1. S.S.Rao, "Mechanical Vibrations ", 5th Edition, Prentice Hall, 2011.
2. L.Meirovitch, "Elements of vibration Analysis", 2nd Edition, McGraw-Hill, New York, 1985.

**REFERENCES:**

1. W.T. Thomson, M.D. Dahleh and C Padmanabhan, "Theory of Vibration with Applications", 5th Edition, Pearson Education, 2008.
2. M.L.Munjal, "Noise and Vibration Control", World Scientific, 2013.
3. Beranek and Ver, "Noise and Vibration Control Engineering: Principles and Applications", John Wiley and Sons, 2006.
4. Randall F. Barron, "Industrial Noise Control and Acoustics", Marcel Dekker, Inc., 2003.

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M.Tech - I Sem		L	T	P	C
		3	0	0	3
MD 1031	DESIGN OF MODERN VEHICLE SYSTEMS (Programme Elective – I)				

## UNIT I

Conceptual design of automobiles: body shape definition based on aerodynamic structure safety, sub - systems integration considerations, road load analysis, transmission of road loadsto structure. Detail design of structural elements, load analysis for different vehicles, safety consideration, design for bending, torsion conditions, criteria for toppling, based on cornering loads.

## UNIT II

Basics of Electric vehicles (EV), Review of existing design of EV, EV design, Performance, Operation and charging.

Hybrid Vehicles Principles-serial, parallel, electrical, hydraulic

## UNIT III

Definition of hybridness, Hybrid design philosophy, Hybridness: parallel hybrid, series, mixed and range extender (plug-in) hybrids, Range extender, Optimization and hybridness, Battery power and electric motor power

## UNIT IV

Introduction to UAVs/Drones, Drone Applications, Working Principle and Design, Inertial Measurement Unit, Sensors and Calibration, PID - Implementation and Tuning, Flight controller, Remote Controller, Quadcopter dynamics

## UNIT V

Safety aspects of automobiles, devices, energy absorbing systems, crash worthiness, legislation relating to safety, vehicle performance requirements, sub systems packaging and verification of vehicle performance through testing (lab, field testing).

## TEXT BOOKS:

- 1 Donald E.Males, Fundamentals of automobile body structure design(R-394), SAE2011
- 2 W.F.Milliker,D.L.Milliker,Maurice Olly, Chassis design: principles an analysis (R-206)SAE2002
- 3 J.H Smith, Introduction to Modern Vehicle Design, Butterworth-Heinemann

## REFERENCES:

<https://nptel.ac.in/downloads/108103009/>

<https://www.iith.ac.in/~raji/courses.html>



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M.Tech - I Sem		L	T	P	C
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MD 1032	<b>PRODUCT DESIGN</b> <b>(Programme Elective - I)</b>				

## UNIT I

Product Design Process: Design Process Steps, Morphology of Design. Problem Solving and Decision Making: Problem-Solving Process, Creative Problem Solving, Invention, Brainstorming, Morphological Analysis, Behavioral Aspects of Decision Making, Decision Theory, Decision Matrix, Decision Trees.

Modeling and Simulation: Triz, Role of Models in Engineering Design, Mathematical Modeling, Similitude and Scale Models, Computer Simulation, Geometric Modeling on Computer, Finite- Element Analysis.

## UNIT II

Product management:

The operation of product management: Customer focus of product management , product planning process, Levels of strategic planning, Wedge analysis, Opportunity search, Product life cycle Life cycle theory and practice.

Product development: Managing new products, Generating ideas, Sources of product innovation, Selecting the best ideas, The political dimension of product design, Managing the product launch and customer feedback.

Product managers and manufacturing: The need for effective relationships, The impact of manufacturing processes on product decisions, Prototype planning, Productivity potentials, Management of product quality, Customer service levels.

## UNIT III

Risk and Reliability: Risk and Society, Hazard Analysis, Fault Tree Analysis. Failure Analysis and Quality: Causes of Failures, Failure Modes, Failure Mode and Effect Analysis, FMEA Procedure, Classification of Severity, Computation of Criticality Index, Determination of Corrective Action, Sources of Information, Copyright and Copying. Patent Literature.

## UNIT IV

Product Testing; thermal, vibration, electrical, and combined environments, temperature testing, vibration testing, test effectiveness. Accelerated testing and data analysis, accelerated factors. Weibull probability plotting, testing with censored data.

## UNIT V

Design For Maintainability: Maintenance Concepts and Procedures, Component Reliability, Maintainability and Availability, Fault Isolation in design and Self-Diagnostics.

Product Design for Safety, Product Safety and User Safety Concepts, Examples of Safe Designs. Design Standardization and Cost Reduction: Standardization Methodology, Benefits of Product Standardization; International, National, Association and Company Level Standards; Parts Modularization.

**TEXT BOOKS:**

1. Engineering Design, George E. Dieter, McGRAW-HILL
2. Product Integrity and Reliability in Design, John W. Evans and Jillian Y. Evans, Springer Verlag

**REFERENCES:**

1. The Product Management Handbook, Richard S. Handscombe, McGRAW-HILL
2. New Product Design, Ulrich Eppinger, 3. Product Design, Kevin Otto.



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M.Tech - I Sem		L	T	P	C
		3	0	0	3
MD 1033	GEOMETRIC MODELING (Programme Elective - I)				

### UNIT - I

**Introduction:** Definition, Explicit and implicit equations, parametric equations.

### UNIT - II

**Cubic Splines-1:** Algebraic and geometric form of cubic spline, tangent vectors, parametric space of a curve, blending functions, four point form, reparametrization, truncating and subdividing of curves. Graphic construction and interpretation, composite pc curves.

### UNIT - III

**Bezier Curves:** Bernstein basis, equations of Bezier curves, properties, derivatives.

**B-Spline Curves:** B-Spline basis, equations, knot vectors, properties, and derivatives.

### UNIT - IV

**Surfaces:** Bicubic surfaces, Coon's surfaces, Bezier surfaces, B-Spline surfaces, surfaces of revolutions, Sweep surfaces, ruled surfaces, tabulated cylinder, bilinear surfaces, Gaussian curvature.

### UNIT - V

**Solids:** Tricubic solid, Algebraic and geometric form.

**Solid modeling concepts:** Wire frames, Boundary representation, Half space modeling, spatial cell, cell decomposition, classification problem.

### TEXT BOOKS:

1. CAD/CAM by Ibrahim Zeid, Tata McGraw Hill.
2. Elements of Computer Graphics by Roger & Adams Tata McGraw Hill.

### REFERENCES:

1. Geometric Modeling by Micheal E. Mortenson, McGraw Hill Publishers
2. Computer Aided Design and Manufacturing, K.Lalit Narayan, K.MallikarjunaRao, MMM Sarcar, PHI Publishers

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M.Tech - I Sem		L	T	P	C
		3	0	0	3
MD 1034	FRACTURE MECHANICS (Programme Elective - I)				

### UNIT-I

**Introduction:** Prediction of mechanical failure. Macroscopic failure modes; brittle and ductile behaviour. Fracture in brittle and ductile materials – characteristics of fracture surfaces; inter-granular and intra-granular failure, cleavage and micro-ductility, growth of fatigue cracks, the ductile/brittle fracture transition temperature for notched and unnotched components. Fracture at elevated temperature.

### UNIT-II

**Griffiths analysis:** Concept of energy release rate,  $G$ , and fracture energy,  $R$ . Modification for ductile materials, loading conditions. Concept of  $R$  curves.

**Linear Elastic Fracture Mechanics, (LEFM).** Three loading modes and the state of stress ahead of the crack tip, stress concentration factor, stress intensity factor and the material parameter the critical stress intensity factor, crack tip plasticity, effect of thickness on fracture toughness.

### UNIT-III

**Elastic-Plastic Fracture Mechanics; (EPFM).** The definition of alternative failure prediction parameters, Crack Tip Opening Displacement, and the  $J$  integral. Measurement of parameters and examples of use.

### UNIT-IV

**Fatigue:** definition of terms used to describe fatigue cycles, High Cycle Fatigue, Low Cycle Fatigue, mean stress  $R$  ratio, strain and load control.  $S-N$  curves. Goodmans rule and Miners rule. Micromechanisms of fatigue damage, fatigue limits and initiation and propagation control, leading to a consideration of factors enhancing fatigue resistance. Total life and damage tolerant approaches to life prediction.

### UNIT-V

**Creep deformation:** the evolution of creep damage, primary, secondary and tertiary creep. Micro- mechanisms of creep in materials and the role of diffusion. Ashby creep deformation maps. Stress dependence of creep – power law dependence. Comparison of creep performance under different conditions – extrapolation and the use of Larson-Miller parameters. Creep-fatigue interactions. Examples.

**TEXT BOOKS:**

1. T.L. Anderson, Fracture Mechanics Fundamentals and Applications, 2nd Ed. CRC press, (1995)
2. B. Lawn, Fracture of Brittle Solids, Cambridge Solid State Science Series 2nd ed1993.

**REFERENCES:**

1. J.F. Knott, Fundamentals of Fracture Mechanics, Butterworths (1973)
2. J.F. Knott, P Withey, Worked examples in Fracture Mechanics, Institute of Materials.
3. H.L.Ewald and R.J.H. Wanhill Fracture Mechanics, Edward Arnold, (1984).
4. S. Suresh, Fatigue of Materials, Cambridge University Press, (1998)
5. L.B. Freund and S. Suresh, Thin Film Materials Cambridge University Press, (2003).



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M.Tech - I Sem		L	T	P	C
		3	0	0	3
MD 1035	ADVANCED MECHANISMS (Programme Elective - I)				

### UNIT - I

**Introduction:** Elements of Mechanisms; Mobility Criterion for Planar mechanisms and manipulators; Mobility Criterion for spatial mechanisms and manipulators. Spherical mechanisms- spherical trigonometry.

### UNIT – II

**Advanced Kinematics of plane motion- I:** The Inflection circle ; Euler – Savary Equation; Analytical and graphical determination of  $d_i$ ; Bobillier's Construction ;Collineation axis ; Hartmann's Construction ;Inflection circle for the relative motion of two moving planes; Application of the Inflection circle to kinematic analysis.

**Advanced Kinematics of plane motion - II:** Polode curvature; Hall's Equation; Polode curvature in the four bar mechanism; coupler motion; relative motion of the output and input links; Determination of the output angular acceleration and its Rate of change; Freudenstein's collineation –axis theorem; Carter –Hall circle; The circling – point curve for the Coupler of of a four bar mechanism.

### UNIT – III

**Introduction to Synthesis-Graphical Methods - I:** The Four bar linkage ;Guiding a body through Two distinct positions; Guiding a body through Three distinct positions; The Rotocenter triangle ; Guiding a body through Four distinct positions; Burmester's curve.

**Introduction to Synthesis-Graphical Methods - II:** Function generation- General discussion; Function generation: Relative –rotocenter method, Overlay's method, Function generation- Velocity – pole method; Path generation: Hrones's and Nelson's motion Atlas, Roberts's theorem.

### UNIT – IV

**Introduction to Synthesis - Analytical Methods:** Function Generation: Freudenstien's equation, Precision point approximation, Precision – derivative approximation; Path Generation: Synthesis of Four-bar Mechanisms for specified instantaneous condition; Method of components; Synthesis of Four-bar Mechanisms for prescribed extreme values of the angular velocity of driven link; Method of components.

### UNIT – V

**Manipulator Kinematics:** D-H transformation matrix ; Direct and Inverse kinematic analysis of Serial manipulators: Articulated, spherical & industrial robot manipulators- PUMA, SCARA,STANFORD ARM, MICROBOT.

**TEXT BOOKS:**

1. Jeremy Hirschhorn, Kinematics and Dynamics of plane mechanisms, McGraw-Hill, 1962.
2. L.Sciavicco and B.Siciliano, Modelling and control of Robot manipulators, Second edition , Springer - Verlag, London, 2000.
3. Amitabh Ghosh and Ashok Kumar Mallik, Theory of Mechanisms and Machines.  
E.W.P.Publishers.

**REFERENCES:**

1. Allen S.Hall Jr., Kinematics and Linkage Design, PHI, 1964.
2. J.E Shigley and J.J. Uicker Jr., Theory of Machines and Mechanisms, McGraw-Hill, 1995.
3. Joseph Duffy, Analysis of mechanisms and Robot manipulators, Edward Arnold, 1980.

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M.Tech - I Sem		L	T	P	C
		3	0	0	3
MD 1041	NON - DESTRUCTIVE EVALUATION (Programme Elective - II)				

## UNIT – I

**General Methods:** Flaw Detection Using Dye Penetrants. Magnetic Particle Inspection introduction to electrical impedance, Principles of Eddy Current testing, Flaw detection using eddy currents.

## UNIT – II

**X- Ray Radiography:** The Radiographic process, X-Ray and Gamma-ray sources, Geometric Principles, Factors Governing Exposure, Radio graphic screens, Scattered radiation, Arithmetic of exposure, Radiographic image quality and detail visibility, Industrial X-Ray films, Film review.

Fundamentals of processing techniques, Process control, The processing Room, Special Processing techniques, Paper Radiography, Sensitometric characteristics of x-ray films, Film graininess signal to noise ratio in radiographs, The photographic latent image, Radiation Protection.

## UNIT – III

Generation of ultrasonic waves, Horizontal and shear waves, Near field and far field acoustic wave description, Ultrasonic probes- straight beam, direct contact type, Angle beam, Transmission/reflection type, and delay line transducers, acoustic coupling and media, Transmission and pulse echo methods, A-scan, B-scan, C-scan, F-scan and P-scan modes, Flaw sizing in ultrasonic inspection: AVG, Amplitude, Transmission, TOFD, Satellite pulse, Multi-modal transducer, Zonal method using focused beam. Flow location methods, Signal processing in Ultrasonic NDT; Mimics, spurious echos and noise. Ultrasonic flaw evaluation.

## UNIT – IV

**Holography:** Principles and practices of Optical holography, acoustical, microwave, x-ray and electron beam holography techniques.

## UNIT – V

**Applications:** NDT in flaw analysis of Pressure vessels, piping, NDT in Castings, Welded constructions, etc., Case studies.

## TEXT BOOKS:

1. Ultrasonic testing by Krautkramer and Krautkramer
2. Ultrasonic inspection 2 Training for NDT : E. A. Gingel, Prometheus Press,
3. ASTM Standards, Vol 3.01, Metals and alloys.
4. Non-Destructive Test and Evaluation of Materials/ J Prasad GCK Nair/TMH Publishers.

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M.Tech - I Sem		L	T	P	C
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MD 1042	ROBOTICS (Programme Elective - II)				

## UNIT – I

**Fundamentals of Robots:** Introduction, definition of robot, classification of robots, History of robotics, robot components, degree of freedom, robot joints, robot coordinates, reference frames, programming modes, robot characteristics, robot work space, robot languages, advantages, disadvantages and applications of robots.

## UNIT – II

**Matrix transformations:** Introduction, robots as a mechanisms, matrix representation-representation of a point in a space, representation of a vector in space, representation of a frame at the origin of a reference frame, representation of a frame in a reference frame, representation of a rigid body.

Homogeneous transformation matrices, representation of a pure translation, pure rotation about an axis, representation of combined transformations, transformations relative to the rotating, inverse of transformation matrices.

**Robot kinematics:** Forward and inverse kinematics of robots-forward and inverse kinematic equations for position, forward and inverse kinematic equations for orientation, forward and inverse kinematic equations for position and orientation, Denavit-Hartenberg (D-H) representation of forward kinematic equations of robots, The inverse kinematic solution and programming of robots, Degeneracy and Dexterity, simple problems with D-H representation.

## UNIT – III

### Differential motions and Velocities:

Introduction, differential relationship, Jacobian, differential motions of a frame-translations, rotation, rotating about a general axis, differential transformations of a frame. Differential changes between frames, differential motions of a robot and its hand frame, calculation of Jacobian, relation between Jacobian and the differential operator, Inverse Jacobian.

## UNIT – IV

**Dynamic analysis and forces:** Introduction, Lagrangian mechanics, Effective moments of inertia, dynamic equations for multi-degree of freedom robots-kinetic energy, potential energy, the Lagrangian, robot's equations of motion, static force analysis of robots.

**Trajectory planning:** Introduction, path Vs trajectory, basics of trajectory planning, joint space trajectory planning-third order polynomial trajectory planning, fifth order polynomial trajectory planning, Cartesian-space trajectories.



## **UNIT – V**

**Robot Actuators:** Introduction, characteristics of Actuating systems-weight, power to weight ratio, operating pressure, stiffness Vs compliance, comparison of actuating systems, hydraulic devices, pneumatic devices, Electric motors-DC motorcar motors, Brushless DC motors, direct Drive electric motors, servomotors, stepped motors.

**Robot sensors:** Introduction, sensor characteristics, Position sensors-potentiometers, encoders, LVDT, Resolvers, time of travel displacement sensor, Velocity sensors-Encoders, Tachometers, differentiation of position signal, Accelerating sensors, force and pressure sensors-piezoelectric, force sensing resistor, strain gauges, Torque sensors, light and infrared sensors, touch and tactile sensors, proximity sensors-magnetic proximity sensors, optical proximity sensors, Ultrasonic proximity sensors, inductive proximity sensors, capacitive proximity sensors, eddy current proximity sensors, sniff sensors.

### **TEXT BOOKS:**

- 1.Introduction to Robotics – Analysis, System, Applications by Saeed B. Niku, PHI Publications
2. Industrial Robotics – Mikell P. Groover & Mitchell Weiss, Roger N. Nagel, Nicholas G.Odrey – Mc Graw Hill, 1986

### **REFERENCES:**

1. Robot Modeling and Kinematics – Rachid Manseur, Firewall Media Publishers (An imprint of Laxmi Publications Pvt. Ltd., New Delhi)
- 2 Robot Analysis and Control - H. Asada and J.J.E. Slotine John Willey & Sons.
- 3.Fundamentals of Robotics: Analysis and control, Robert J. Schilling, Prentice Hall, 1990.
- 4.A robot Engineering text book – Mohsen shahinpoor, Harper & Row Publishers,1987
- 5.Introduction to Robotics: Mechanics and Control, John.J.Craig, Addison- Wesley, 1999
- 6.Robotics: Control, sensing, vision, and intelligence – K.S. FU, R.C. Gonzalez and C.S.G Lee. Mc Graw Hill, 1987.
- 7.Modeling and control of Robot manipulators, L. sciavicco and b. Siciliano, Springer.
8. ROBOTICS (Fundamental concepts and analysis) ASHITAVA GHOSAL. Oxford university press

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M.Tech - I Sem		L	T	P	C
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MD 1043	<b>DESIGN FOR MANUFACTURING &amp; ASSEMBLY</b> (Programme Elective - II)				

### UNIT - I

Introduction to DFM, DFMA: How Does DFMA Work? Reasons for Not Implementing DFMA, What Are the Advantages of Applying DFMA During Product Design?, Typical DFMA Case Studies, Overall Impact of DFMA on Industry.

Design for Manual Assembly: General Design Guidelines for Manual Assembly, Development of the Systematic DFA Methodology, Assembly Efficiency, Effect of Part Symmetry, Thickness, Weight on Handling Time, Effects of Combinations of Factors, Application of the DFA Methodology.

### UNIT - II

Machining processes: Overview of various machining processes-general design rules for machining-dimensional tolerance and surface roughness-Design for machining – ease –redesigning of components for machining ease with suitable examples. General design recommendations for machined parts.

### UNIT - III

Metal casting: Appraisal of various casting processes, selection of casting process,-general design considerations for casting-casting tolerance-use of solidification, simulation in casting design-product design rules for sand casting.

**Extrusion & Sheet metal work:** Design guide lines extruded sections-design principles for punching, blanking, bending, deep drawing-Keeler Goodman forging line diagram – component design for blanking.

### UNIT - IV

Metal joining: Appraisal of various welding processes, factors in design of weldments – general design guidelines-pre and post treatment of welds-effects of thermal stresses in weld joints-design of brazed joints. Forging: Design factors for forging – closed die forging design – parting lines of dies – drop forging die design – general design recommendations.

### UNIT – V

Design for Assembly Automation: Fundamentals of automated assembly systems, System configurations, parts delivery system at workstations, various escapement and placement devices used in automated assembly systems, Quantitative analysis of Assembly systems, Multi station assembly systems, single station assembly lines.

**TEXT BOOKS:**

1. Design for manufacture, John cobert, Adisson Wesley. 1995.
2. Design for Manufacture by Boothroyd.
3. Design for manufacture, James Bralla.

**REFERENCE:**

ASM Hand book Vol.20

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M.Tech - I Sem		L	T	P	C
		3	0	0	3
MD 1044	MULTI BODY DYNAMICS (Programme Elective - II)				

### UNIT-I

Review of kinematics and dynamics of point mass and rigid body - types of constraints - constraints for revolute joints, translational joints, composite joints.

### UNIT-II

Formulation of planar multi-body systems, kinematics and dynamics in point coordinates, body coordinates, and joint coordinates.

### UNIT-III

Numerical methods for solution - analysis of planar multi-body systems, kinematic analysis in various formulations.

### UNIT-IV

Inverse dynamic analysis, forward dynamic analysis, constraint stabilization - case studies, McPherson strut suspension, Double A-arm suspension, planar robot manipulator.

### UNIT-V

Spatial multi-body systems-formulation- joints: - revolute, prismatic, cylindrical, spherical, universal- case studies.

### TEXT BOOKS:

1. Planar Multibody Dynamics Formulation, Programming and Applications by Parviz E.Nikravesh, CRC Press
2. Dynamics of Multibody Systems by Ahmed A. Shabana, Cambridge University Press.

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M.Tech - I Sem		L	T	P	C
		3	0	0	3
MD 1045	VISION SYSTEMS AND IMAGE PROCESSING (Programme Elective - II)				

## UNIT – I

**Machine vision:** Vision sensors - Comparison with other types of sensors - Image acquisition and recognition - Recognition of 3D objects - Lighting techniques - Machine vision applications.

## UNIT – II

**Image representation:** Application of image processing - Image sampling, Digitization and quantization - Image transforms.

## UNIT – III

**Spatial domain techniques:** Convolution, Correlation. Frequency domain operations - Fast Fourier transforms, FFT, DFT, Investigation of spectra. Hough transform.

## UNIT – IV

**Image enhancement:** Filtering, Restoration, Histogram equalisation, Segmentation, Region growing.

## UNIT – V

**Image compression:** Edge detection - Thresholding - Spatial smoothing - Boundary and Region representation - Shape features - Scene matching and detection - Image classification.

## TEXT BOOKS:

1. Digital Image Processing by Gonzalez, R.C. and Woods, R.E., Addison Wesley Publications.
2. Robot Vision by Prof. Alan Pugh (Editor), IFS Ltd., U.K.
3. Digital Image Processing by A. Rosenfeld and A. Kak, Academic Press.

## REFERENCES:

1. The Psychology of Computer Vision by P. Winston, McGraw-Hill.
2. Algorithms for Graphics and Image Processing by T. Pavidis, Springer Verlag.



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M.Tech - I Sem		L	T	P	C
		0	0	4	2
MD 105	MACHINE DYNAMICS LAB				

1. Determination of damped natural frequency of the vibrating system with different viscous oils.
2. Determination of steady state amplitude of a forced vibratory system.
3. Determination of natural frequency and mode shape of multi degree freedom system
4. Static balancing of disc
5. Determination of the magnitude and orientation of the balancing mass in dynamic balancing.
6. Field balancing of the thin rotors using vibration pickups.
7. Determination of the magnitude of gyroscopic couple, angular velocity of precession, and representation of vectors.
8. Diagnosis of a machine using FFT analyzer. (FFT)
9. Direct kinematic analysis of a robot.
10. Inverse kinematic analysis of a robot.
11. Determination of friction, wear using pin-on-disc.
12. Experimental modal analysis of Beams
  - Estimation of Natural frequency
  - Extraction of mode shape
  - Estimation of Damping
  - Modal Assurance Criteria (MAC) analysis between experimental data and numerical method
13. An experiment on evaluation of stress intensity factor
  - Computation of stresses by mounting 3 axis strain gauges (Rosettes)

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M.Tech - I Sem		L	T	P	C
		0	0	4	2
MD 106	DESIGN PRACTICE LAB-I				

## I. Modeling

1. Surface modeling
2. Solid modeling
3. Drafting
4. Assembling

**II. Structural Analysis using any FEA Package** for different structures that can be discretised with 1-D, 2-D & 3-D elements

1. Static Analysis
2. Modal Analysis
3. Harmonic Analysis
4. Spectrum Analysis
5. Buckling Analysis
6. Analysis of Composites
7. Fracture mechanics

**III. Thermal Analysis using any FEA Package** for different structures that can be discretised with 1-D, 2-D & 3-D elements

1. Steady state thermal analysis
2. Transient thermal analysis

**IV. Transient analysis using any FEA Package** for different structures that can be discretised with 1-D, 2-D & 3-D elements

## REFERENCE:

User manuals of ANSYS package Version 9.0



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M.Tech - I Sem		L	T	P	C
		2	0	0	2
MD 107	RESEARCH METHODOLOGY AND IPR				

### UNIT-I

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

### UNIT-II

Effective literature studies approaches, analysis Plagiarism, Research ethics, Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.

### UNIT-III

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

### UNIT-IV

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

### UNIT-V

New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

### REFERENCES:

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students"
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
3. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"
4. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd, 2007.
5. Mayall, "Industrial Design", McGraw Hill, 1992.

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M.Tech - I Sem		L	T	P	C
		2	0	0	0
MD 108	SOFT SKILLS				

### UNIT-I

Planning and Preparation, Word Order, Breaking up long sentences. Structuring Paragraphs and Sentences, Being concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

### UNIT-II

Clarifying Who Did What, Highlighting your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction

### UNIT-III

Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

### UNIT-IV

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, useful phrases, how to ensure paper is as good as it could possibly be the first-time submission.

### UNIT-V

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions.

### REFERENCES:

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM Highman's book.
4. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

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M.Tech - II Sem		L	T	P	C
		3	0	0	3
MD 201	ADVANCED FINITE ELEMENT METHODS				

## UNIT - I

**Formulation Techniques:** Methodology, Engineering problems and governing differential equations, finite elements. Variational methods-potential energy method, Raleigh Ritz method, strong and weak forms, Galerkin and weighted residual methods, calculus of variations, Essential and natural boundary conditions.

## UNIT – II

**One-dimensional elements:** Bar, trusses, beams and frames, displacements, stresses and temperature effects.

## UNIT – III

**Two dimensional problems:** CST, LST, four noded and eight noded rectangular elements, Lagrange basis for triangles and rectangles, serendipity interpolation functions. Axisymmetric Problems: Axisymmetric formulations, Element matrices, boundary conditions. Heat Transfer problems: Conduction and convection, examples: - two-dimensional fin.

## UNIT – IV

**Isoparametric formulation:** Concepts, sub parametric, super parametric elements, numerical integration, Requirements for convergence, h-refinement and p-refinement, complete and incomplete interpolation functions, Pascal's triangle, Patch test.

## UNIT – V

Finite elements in Structural Analysis: Static and dynamic analysis, eigen value problems, and their solution methods, case studies using commercial finite element packages.

## TEXT BOOK:

1. Finite element methods by Chandrubatla & Belagondur.

## REFERENCES:

1. J.N. Reddy, Finite element method in Heat transfer and fluid dynamics, CRC press, 1994
2. Zienkiwicz O.C. & R. L. Taylor, Finite Element Method, McGraw-Hill, 1983.
3. K. J. Bathe, Finite element procedures, Prentice-Hall, 1996.

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M.Tech - II Sem		L	T	P	C
		3	0	0	3
MD 202	ADVANCED MACHINE DESIGN				

### UNIT-I

**Design philosophy:** Design process, Problem formation, Introduction to product design, Various design models- Shigley model, Asimov model and Norton model, Need analysis, Strength considerations -standardization. Creativity and Creative techniques, Material selection in machine design, design for safety and Reliability, concept of product design.

### UNIT-II

**Failure theories:** Static failure theories, Distortion energy theory, Maximum shear stress theory, Coulomb-Mohr's theory, Modified Mohr's theory, Fracture mechanics theory., Fatigue mechanisms, Fatigue failure models, Design for fatigue strength and life, creep: Types of stress variation, design for fluctuating stresses, design for limited cycles, multiple stress cycles.

### UNIT-III

**Fatigue failure theories:** Cumulative fatigue damage, thermal fatigue and shock, harmful and beneficial residual stresses, Yielding and transformation.

### UNIT-IV

**Surface failures:** Surface geometry, mating surfaces, oil film and their effects, design values and procedures, adhesive wear, abrasive wear, corrosion wear, surface fatigue, different contacts, dynamic contact stresses, surface fatigue failures, surface fatigue strength.

### UNIT-V

**Economic factors influencing design:** Economic analysis, Break-even analysis, Human engineering considerations, Ergonomics, Design of controls, Design of displays. Value engineering, Material and process selection in value engineering, Modern approaches in design. Team work and Ethics in engineering design: Team formation, functioning, discharge, team dynamics, Ethical issues considered during engineering design process

**TEXT BOOKS:**

1. Machine Design An Integrated Approach by Robert L. Norton, Prentice-Hall New Jersey, USA.
2. Mechanical Engineering Design by J.E. Shigley and L.D. Mitchell published by McGrawHill International Book Company, New Delhi.

**REFERENCES:**

1. Fundamentals of machine elements by Hamrock, Schmid and Jacobian, 2nd edition, McGraw- Hill International edition.
2. Product design and development by Karl T. Ulrich and Steven D. Eppinger. 3rd edition, Tata McGraw Hill.
3. Product Design and Manufacturing by A.K. Chitale and R.C. Gupta, Prentice Hall
4. Engineering Design / George E Dieter / McGraw Hill /2008
5. Fundamentals of machine elements/ Hamrock, Schmid and Jacobian/ 2nd edition /McGrawHill International edition

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M.Tech - II Sem		L	T	P	C
		3	0	0	3
MD 2031	THEORY OF PLASTICITY (Programme Elective - III)				

### UNIT – I

**Introduction:** Modeling Uniaxial behavior in plasticity. Index notation, Cartesian tensors. Yield and failure criteria Stress, stress deviator tensors. Invariants, principal, mean stresses. Elastic strain energy. Mohr's representation of stress in 2 & 3 dimensions. Haigh-Westergaard stress space. Equilibrium equations of a body. Yield criteria: Tresca's, von Mises rules, Drucker-Prager criterion, anisotropic yield criteria.

**Strain at point:** Cauchy's formulae for strains, principal strains, principal shear strains, derivative strain tensor. Strain-displacement relationships. Linear elastic stress strain relations, Generalized Hooke's law, nonlinear elastic stress strain relations.

### UNIT – II

**Principle of virtual work and its rate forms:** Drucker's stability postulate, normality, convexity and uniqueness for an elastic solid. Incremental stress strain relations.

**Criteria for loading and unloading:** Elastic and plastic strain increment tensors, Plastic potential and flow rule associated with different Yield criteria, Convexity, normality and uniqueness considerations for elastic-plastic materials. Expansion of a thick walled cylinder.

### UNIT – III

**Incremental stress strain relationships:** Prandtl-Reuss material model.  $J_2$  deformation theory, Drucker-Prager material, General Isotropic materials.

**Deformation theory of plasticity:** Loading surface, Hardening rules. Flow rule and Druckers stability postulate. Concept of effective stress and effective strain, mixed hardening material. Problems.

### UNIT – IV

**Finite element formulation for an elastic plastic matrix:** Numerical algorithms for solving non linear equations, Convergence criteria, Numerical implementations of the elastic plastic incremental constitutive relations.

### UNIT – V

**Bounding surface theory:** Uniaxial and multiaxial loading anisotropic material behaviour.

Theroms of limit analysis: Statically admissible stress field and kinematically admissible velocity field. Upper and lower bound theorms, examples and problems.

**TEXT BOOK:**

1. Theory of Elasticity by S.P. Timoshenko & J.K Goodier, MGH

**REFERENCES:**

1. Plasticity for structural engineering W.F.Chen s and D.J.Han, Springer verlag-1987.
2. Mechanics of Materials –II, Victor E. Saouma.
3. Theory of plasticity, Sadhu Singh.

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M.Tech - II Sem		L	T	P	C
		3	0	0	3
MD 2032	SIGNAL ANALYSIS AND CONDITION MONITORING (Programme Elective - III)				

## UNIT-I

Introduction, Basic concepts. Fourier analysis. Bandwidth. Signal types. Convolution.

**Signal analysis:** Filter response time. Detectors. Recorders. Analog analyzer types.

## UNIT-II

**ANALYSIS OF STATIONARY SIGNALS:** Stepped filter analysis. Swept filter analysis. High speed analysis. Real-time analysis.

## UNIT-III

**ANALYSIS OF CONTINUOUS NON-STATIONARY SIGNALS:** Choice of window type. Choice of window length. Choice of incremental step. Practical details. Scaling of the results.

## UNIT-IV

**ANALYSIS OF TRANSIENTS:** Analysis as a periodic signal. Analysis by repeated playback (constant bandwidth). Analysis by repeated playback (variable bandwidth).

## UNIT-V

**CONDITION MONITORING IN REAL SYSTEMS:** Diagnostic tools. Condition monitoring of two stage compressor. Cement mill foundation. I.D. fan. Sugar centrifugal. Cooling tower fan. Air separator. Preheater fan. Field balancing of rotors. ISO standards on vibrations, active, passive hybrid methods of condition monitoring

## TEST BOOK:

1. Condition Monitoring of Mechanical Systems / Colcote.

## REFERENCES:

1. Frequency Analysis /R.B.Randall.
2. Mechanical Vibrations Practice with Basic Theory / V. Ramamurti/ Narosa Publishing House.
3. Theory of Machines and Mechanisms/ Amitabh Ghosh& AK Malik/ EWP



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		<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>M.Tech - II Sem</b>		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>MD 2033</b>	<b>COMPUTATIONAL FLUID DYNAMICS (Programme Elective - III)</b>				

## UNIT – I

**Introduction:** Finite difference method, finite volume method, finite element method, governing equations and boundary conditions. Derivation of finite difference equations.

**Solution methods:** Solution methods of elliptical equations – finite difference formulations, interactive solution methods, direct method with Gaussian elimination.

Parabolic equations-explicit schemes and Von Neumann stability analysis, implicit schemes, alternating direction implicit schemes, approximate factorization, fractional step methods, direct method with tridiagonal matrix algorithm.

## UNIT – II

**Hyperbolic equations:** explicit schemes and Von Neumann stability analysis, implicit schemes, multi step methods, nonlinear problems, second order one-dimensional wave equations.

Burgers equations: Explicit and implicit schemes, Runge-Kutta method.

## UNIT – III

**Formulations of incompressible viscous flows:** Formulations of incompressible viscous flows by finite difference methods, pressure correction methods, vortex methods.

**Formulations of compressible flows:** potential equation, Euler equations, Navier-stokes system of equations, flow field-dependent variation methods, boundary conditions, example problems.

## UNIT – IV

**Finite volume method:** Finite volume method via finite difference method, formulations for two and three-dimensional problems.

## UNIT – V

**Standard variational methods:** Linear fluid flow problems, steady state problems, Transient problems.

## TEXT BOOK:

1. Computational fluid dynamics, T. J.Chung, Cambridge University press, 2002.

## REFERENCE:

1. Text book of fluid dynamics, Frank Chorlton, CBS Publishers & distributors, 1985.

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M.Tech - II Sem		L	T	P	C
		3	0	0	3
MD 2034	COMPOSITE MATERIALS (Programme Elective - III)				

## UNIT I

**Introduction:** History and basic concept of composites. Definition and Classification of Composites, MMC, PMC, CMC. Reinforcing fibres- Natural fibres (cellulose, jute, coir etc), boron, carbon, ceramic glass, aramids, polyethylene (UHMWPE), polybenzthiazoles etc.

## UNIT II

### Fundamental concepts:

Particulate fillers-importance of particle shape and size. Matrix resins-thermoplastics and thermosetting matrix resins. Coupling agents-surface treatment of fillers and fibres, significance of interface in composites. Nanocomposites, short and continuous fibre reinforced composites, critical fibre length, and anisotropic behaviour.

## UNIT III

Fabrication techniques: pultrusion, filament winding, prepreg technology, injection and compression moulding, bag moulding, resin transfer moulding, reaction injection moulding.

## UNIT IV

**Properties and performance of composites:** Properties and microstructure of high-strength fiber materials (glass, carbon, polymer, ceramic fibers) and matrix materials (polymer, metal, ceramic, and carbon matrices). Specific strength and stiffness of high-performance composites. Rule of mixtures. Stress, strain transformations.

## UNIT V

**Failure criteria:** Hygrothermal stresses, bending of composite plates, analysis of sandwich plates, buckling analysis of laminated composite plates, inter-laminar stresses, First Order Shear Deformation Theory (FSDT). Applications: Industrial, aerospace, automobile, house hold etc.

## TEXT BOOKS:

1. Steven L. Donaldson, ASM Handbook Composites Volume 21, 2001.
2. Krishan K. Chawla, Composite Materials, Science and Engineering, Springer, 2001.
3. Suresh G. Advani, E. Murat Sozer, Process Modelling in Composites Manufacturing, 2nd Ed. CRC Press, 2009

Estd. 1989

# SIR C R REDDY COLLEGE OF ENGINEERING

## (AUTONOMOUS)

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VATLURU, ELURU-534007, ELURU DISTRICT, ANDHRA PRADESH, INDIA

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Phone (Off) : (08812) 230840,230565

Fax : (08812) 224193

M.Tech - II Sem		L	T	P	C
		3	0	0	3
MD 2035	SOFT COMPUTING (Programme Elective - III)				

### UNIT I

**Introduction to Soft Computing:** Concept of computing systems, "Soft" computing versus "Hard" computing, Characteristics of Soft computing Some applications of Soft computing techniques.

### UNIT II

**Fuzzy logic:** Introduction to Fuzzy logic, Fuzzy sets and membership functions, Operations on Fuzzy sets, Fuzzy relations, rules, propositions, implications and inferences, Defuzzification techniques, Fuzzy logic controller design, Some applications of Fuzzy logic.

### UNIT III

**Genetic Algorithms:** Concept of "Genetics" and "Evolution" and its application to probabilistic search techniques Basic GA framework and different GA architectures, GA operators: Encoding,

### UNIT IV

**Multi-objective Optimization Problem Solving:** Concept of multi-objective optimization problems (MOOPs) and issues of solving them, Multi-Objective Evolutionary Algorithm (MOEA), Non-Pareto approaches to solve MOOPs, Pareto-based approaches to solve MOOPs. Some applications with MOEAs.

### UNIT V

**Artificial Neural Networks:** Biological neurons and its working, Simulation of biological neurons to problem solving, Different ANNs architectures, Training techniques for ANNs, Applications of ANNs to solve some real life problems.

## **TEXT BOOKS:**

1. Fuzzy Logic: A Practical approach, F. Martin, , McNeill, and Ellen Thro, AP Professional, 2000.
2. Fuzzy Logic with Engineering Applications (3rd Edn.), Timothy J. Ross, Wiley, 2010.

## **REFERENCES:**

1. Foundations of Neural Networks, Fuzzy Systems, and Knowledge Engineering, Nikola K. Kasabov, MIT Press, 1998.
2. Fuzzy Logic for Embedded Systems Applications, Ahmed M. Ibrahim, Elsevier Press, 2004.
3. An Introduction to Genetic Algorithms, Melanie Mitchell, MIT Press, 2000.
4. Genetic Algorithms in Search, Optimization And Machine Learning, David E. Goldberg, Pearson Education, 2002.
5. Practical Genetic Algorithms, Randy L. Haupt and sue Ellen Haupt, John Wiley & Sons, 2002.
6. Neural Networks, Fuzzy Logis and Genetic Algorithms: Synthesis, and Applications, S. Rajasekaran, and G. A. Vijayalakshmi Pai, Prentice Hall of India, 2007.
7. Soft Computing, D. K. Pratihari, Narosa, 2008.

**Course Outcomes:**

**On Completion of the course, the student should be able to**

<b>CO</b>	<b>CO Description</b>
<b>CO1</b>	Understand the fundamental concepts of soft computing and its applications in engineering problem-solving.
<b>CO2</b>	Apply fuzzy logic techniques to model and control complex systems with uncertainty.
<b>CO3</b>	Utilize genetic algorithms for optimization and search problems.
<b>CO4</b>	Solve multi-objective optimization problems using evolutionary algorithms.
<b>CO5</b>	Design and implement artificial neural networks for pattern recognition and prediction tasks.

Estd. 1989

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M.Tech - II Sem		L	T	P	C
		3	0	0	3
MD 2041	EXPERIMENTAL TECHNIQUES AND DATA ANALYSIS (Programme Elective - IV)				

### UNIT-I

Measurement of cutting forces: Strain gauge and piezoelectric transducers and their characteristics. Dynamometer construction, Bridge circuits. Instrumentation and calibration. Displacement and Strain measurements by photoelasticity, Holography, interferometer, Moir techniques, strain gauge rosettes. **UNIT-II** Temperature Measurement: Circuits and instrumentation for different transducers viz., bimetallic, expanding fluid, electrical resistance, thermister, thermocouples, pyrometers.

Flow Measurement: Transducers for flow measurements of Non-compressible fluids, Obstruction and drag methods. Vortex shredding flow meters. Ultrasonic, Laser Doppler and Hotwire anemometer. Flow visualization techniques, Shadow graphs, Schlieren photography. Interferometer.

### UNIT-III

Metallurgical Studies: Optical and electron microscopy, X-ray diffraction, Bragg's Law and its application for studying crystal structure and residual stresses. Electron spectroscopy, electron microprobe.

Surface Measurement: Micro hardness, roughness, accuracy of dimensions and forms. 3-D Co- ordinate measuring machines.

### UNIT-IV

Experiment design & data analysis: Statistical methods, Randomised block design, Latin and orthogonal squares, factorial design. Replication and randomization.

Data Analysis: Deterministic and random data, uncertainty analysis, test of significance: Chi-square, student's 't' test. Regression modeling, direct and interaction effects. ANOVA, F-test. Time Series analysis, Autocorrelation and autoregressive modeling.

### UNIT-V

Taguchi Methods: Experimental design and planning with Orthogonal arrays and linear graphs. Additive cause-effect model, Optimization of response level. Identification of Design and noise factors. Performance evaluation and Optimization by signal to noise ratios. Concepts of loss function and its application.

### TEXT BOOKS:

1. Jack Philip Holman, Experimental Methods for Engineers, 7th edition, McGraw-Hill, 2001
2. V. C. Venkatesh, H. Chandrasekaran, Experimental Techniques in Metal Cutting, Eastern economy edition, Prentice-Hall of India, 1987

**REFERENCES:**

1. George E. P. Box, Gwilym M. Jenkins, Gregory C. Reinsel, Greta M. Ljung, Time Series Analysis: Forecasting and Control, 5th Edition, John Wiley & Sons, 2015
2. Richard C. Dove, Paul H. Adams, Experimental stress analysis and motion measurement: theory, instruments and circuits, techniques, C. E. Merrill Books, 1964
3. Bagchi Tapan P, Taguchi Methods Explained: Practical Steps to Robust Design, Prentice-Hall (India), 1993.

**Course Outcomes:**

**On Completion of the course, the student should be able to**

<b>CO</b>	<b>CO Description</b>
<b>CO1</b>	Select appropriate experimental techniques and instrumentation for measuring physical quantities in engineering systems.
<b>CO2</b>	Conduct experiments to investigate material properties, fluid flow characteristics, and mechanical system behavior.
<b>CO3</b>	Analyze experimental data using statistical methods and draw meaningful conclusions.
<b>CO4</b>	Apply advanced measurement techniques, such as optical and spectroscopic methods, for material characterization.
<b>CO5</b>	Design and conduct experiments to optimize processes and improve product performance.



Estd. 1989

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M.Tech - II Sem		L	T	P	C
		3	0	0	3
MD 2042	DESIGN WITH ADVANCED MATERIALS (Programme Elective - IV)				

### UNIT – I

Fundamentals of material science: Elasticity in metals and polymers, mechanism of plastic deformation, role of dislocations, yield stress, shear strength of perfect and real crystals, strengthening mechanism, work hardening, solid solution, grain boundary strengthening.

Poly phase mixture, precipitation, particle, fiber and dispersion strengthening, effect of temperature, strain and strain rate on plastic behavior, super plasticity, deformation of non crystalline material.

### UNIT – II

Motivation of selection, cost basis and service requirements, selection for mechanical properties, strength, toughness, fatigue and creep, use of material property charts for material selection.

### UNIT – III

Modern metallic Materials: Dual phase steels, micro alloyed, high strength low alloy (HSLA) Steel, maraging steel, intermetallics, Ni and Ti aluminides, super alloys.

### UNIT – IV

Non metallic materials: Polymeric materials and their molecular structures, production techniques for fibers, foams, adhesives and coatings, structure, properties and applications of engineering polymers. composites; Introduction, reinforcement, types of composite materials, - properties, processing and application of composite materials.

### UNIT – V

Smart materials, shape memory alloys, metallic glass, quasi crystal and nano crystalline materials.

### TEXT BOOKS:

1. Mechanical behavior of materials/Thomas H.Courtney/2<sup>nd</sup> Edition, McGraw-Hill, 2000
2. Mechanical Metallurgy/George E.Dieter/McGraw Hill, 1998
3. Material selection in mechanical design by M.F Ashby. Bott

### REFERENCES:

1. Selection and use of Engineering Materials 3e/Charles J.A/Butterworth Heiremann.

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M.Tech - II Sem		L	T	P	C
		3	0	0	3
MD 2043	MECHATRONICS (Programme Elective - IV)				

## UNIT – I

**Introduction:** Definition of Mechatronics products, design considerations and trade offs. Overview of Mechatronic products. Intelligent machine Vs Automatic machine economic and social justification. **Actuators and drive systems:** Mechanical, Electrical, hydraulic drive systems, Characteristics of mechanical, Electrical, Hydraulic and pneumatic actuators and their limitations.

## UNIT – II

**Motion Control:** Control parameters and system objectives, Mechanical Configurations, Popular control system configurations. S-curve, motor/load inertia matching, design with linear slides.

**Motion Control algorithms:** Significance of feed forward control loops, shortfalls, fundamentals concepts of adaptive and fuzzy – control. Fuzzy logic compensatory control of transformation and deformation non-linearity's.

## UNIT – III

**Sensor interfacing:** Analog and digital sensors for motion measurement, digital transducers, human- Machine and machine- Machine inter facing devices and strategy.

**Architecture of intelligent machines:** Introduction to Microprocessor and programmable logic controls and identification of systems. System design classification, motion control aspects in design.

## UNIT – IV

**Machine vision:** Feature and pattern recognition methods, concepts of perception and cognition in decision-making, basics of image processing, binary and grey scale images, sharpening and smoothening of images.

## UNIT – V

**Micromechatronic Sytems:** Micro sensors, micro actuators, smart instrumentation, micro- fabrication methods – lithography, etching, micro-joining.

## TEXT BOOKS:

1. “Designing intelligent machines”, open university, London. Michel B.Histand and David G. Alciatore.
2. Introduction to Mechatronics and Measurement systems, Tata McGraw Hill.
3. .C.W.desilva, “ Control sensors and actuators, Prentice Hall.

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M.Tech - II Sem		L	T	P	C
		3	0	0	3
MD 2044	TRIBOLOGY (Programme Elective - IV)				

## UNIT – I

**Introduction:** Nature of surfaces and contact-Surface topography-friction and wear mechanisms, wear maps, effect of lubricants- methods of fluid film formation.

**Lubrication:** Choice of lubricants, types of oil, Grease and solid lubricants- additives- lubrication systems and their selection.

## UNIT – II

**Selection of rolling element bearings:** Nominal life, static and dynamic capacity-Equivalent load, probabilities of survival- cubic mean load- bearing mounting details, pre loading of bearings, conditioning monitoring using shock pulse method.

## UNIT – III

**Hydrostatic Bearings:** Thrust bearings – pad coefficients- restriction- optimum film thickness- journal bearings – design procedure –Aerostatic bearings; Thrust bearings and Journal bearings – design procedure.

## UNIT – IV

**Hydrodynamic bearings:** Fundamentals of fluid formation – Reynold's equation; Hydrodynamic journal bearings – Sommerfield number- performance parameters – optimum bearing with maximum load capacity – Friction – Heat generated and Heat dissipated. Hydrodynamic thrust bearings; Raimondi and Boyd solution for hydrodynamic thrust bearings- fixed tilting pads, single and multiple pad bearings-optimum condition with largest minimum film thickness.

## UNIT – V

**Seals:** different type-mechanical seals, lip seals, packed glands, soft piston seals, Mechanical piston rod packing, labyrinth seals and throttling bushes, oil flinger rings and drain grooves – selection of mechanical seals.

**Failure of Tribological components:** Failure analysis of plain bearings, rolling bearings, gears and seals, wear analysis using soap and Ferrography.

**Dry rubbing Bearings:** porous metal bearings and oscillatory journal bearings – qualitative approach only.

**TEXT BOOKS:**

1. Rowe WW& O' Dionoghue, "Hydrostatic and Hybrid bearing design" Butterworths & Co. Publishers Ltd, 1983.
2. Collacott R.A," Mechanical Fault diagnosis and condition monitoring", Chapman and Hall, London 1977.
3. Bernard J.Hamrock, "Fundamentals of fluid film lubricant", McGraw-Hill Co.,1994.

**REFERENCES:**

1. Neale MJ, (Editor) "Tribology hand Book" Neumann Butterworths, 1975.
2. Connor and Boyd JJO (Editors) "Standard hand book of lubrication engineers " ASLE,Mc Graw Hill Book & Co.,1968
- 3.Shigley J, E Charles," Mechanical Engineering Design ", McGraw Hill Co., 1989.

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M.Tech - II Sem		L	T	P	C
		3	0	0	3
MD 2045	<b>EXPERIEMNTAL MODAL ANALYSIS</b> (Programme Elective - IV)				

## UNIT I

**Theoretical basis for modal analysis:** Overview of modal analysis, Vibrations of single and multiple degree of freedom (SDOF, MDOF) systems, Frequency response functions (FRFs) for SDOF/MDOF systems. Types of FRFs. Orthogonality of modes and their application in modal analysis, Theory of undamped, proportionally damped, and non-proportionally damped SDOF/MDOF systems, Analyses for complex modes and sensitivity analysis of modal models.

## UNIT II

**FRF measurement considerations:** Introduction to test planning, Excitation of structures (electromagnetic and electrohydraulic shakers, hammers, etc.), Transducers and amplifiers for measurements (force transducer, accelerometers, laser vibrometers, signal conditioners, amplifiers etc.), Actuator/sensor placement considerations, Revision of Fourier analysis and Fourier transforms, Discussions on aliasing, leakage, windowing, filtering and averaging, Role of excitations signals in structural testing.

## UNIT III

Modal Parameter Extraction Methods: Introduction – Preliminary checks of FRF Data – SDOF Modal Analysis-I – Peak-amplitude – SDOF Modal Analysis-II – Circle Fit Method – SDOF Modal Analysis III.

## UNIT IV

Inverse Method – Residuals – MDOF curve-fitting procedures – MDOF curve fitting in the Time Domain – Global or Multi-Curve fitting – Non linear systems.

## UNIT V

Applications and advanced topics: Model correlation. Concepts of modal assurance criterion and some of its variants, Dynamic substructuring, Modal reduction and expansion, Model updating, Advanced curve fitting for modal parameter extractions, Testing of weakly nonlinear structures.

**TEXT BOOKS**

1. W T Thomson., “Theory of Vibrations with Applications”, CBS Publishers
2. S S Rao, “Mechanical Vibrations”, Addison-Wesley Publishing Co.

**REFERENCES**

1. Leonard Meirovitch, “Fundamentals of Vibration”, McGraw Hill International Edison.
2. J P Den Hartog, “Mechanical Vibrations”, Mc Graw Hill.
3. Srinivasan, “Mechanical Vibration Analysis”, Mc Graw Hill.
4. Nuno Manuel Mendes Maia et al,” Theoretical and Experimental Modal Analysis”, Wiley John & sons, 1999.
5. Modal Analysis, by Jimin He and Zhi-Fang Fu, Butterworth-Heinemann.

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M.Tech - II Sem		L	T	P	C
		0	0	4	2
MD 205	COMPUTATIONAL MATHEMATICS LAB				

1. Generate a MATLAB and Python code for solving a system of linear equation using Gauss Elimination Method.
2. Generate a MATLAB and Python code for LU Decomposition (Factorization)
3. Generate a MATLAB and Python code for Iterative methods to solve equations using Jacobi Iteration.
4. Generate a MATLAB and Python code for Curve fitting
  - i. Straight line fit
  - ii. Polynomial Curve fit
5. Generate a MATLAB and Python code for Fourier transformation
  - i. FFT Vs DFT
  - ii. Interpolation by DFS
6. Generate a MATLAB and Python code for Euler's method differential equations
7. Generate a MATLAB and Python code for Runge – Kutta method differential equations
8. Generate a MATLAB and Python code for Matrices and Eigen values
  - i. Eigen values and Eigen vectors
  - ii. Jacobi method
9. Generate a MATLAB and Python code for Partial Differential equations
  - i. Elliptical PDE
  - ii. Parabolic PDE
  - iii. The Crank – Nicholson method
  - iv. Two dimensional parabolic PDE

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M.Tech - II Sem		L	T	P	C
		0	0	4	2
MD 206	DESIGN PRACTICE LAB – II				

## OBJECTIVES:

To know the method of programming the microprocessor and pneumatic experiments in basic electrical, hydraulic & pneumatic Systems which enable the students to understand the concept.

## LIST OF EXPERIMENTS:

### Part: A- MECHATRONICS

- 1) Simulation of basic Hydraulic, Pneumatic and Electric circuits using software.
- 2) Testing of circuits using basic pneumatic trainer kits.
- 3) Tircuits with logic sequence using Electro pneumatic trainer kit.
- 4) Tequential circuits in Electro pneumatic kit using PLC.
- 5) Testing of fluid power circuits to control (i) Velocity (ii) direction and (iii) force of single and double acting actuators.
- 6) Study of sequential and hydraulic motor circuit using hydraulic systems.
- 7) Servo controller interfacing for open loop.
- 8) Servo controller interfacing for closed loop.
- 9) PID controller interfacing.
- 10) Stepper motor interfacing with 8051 Micro controller.  
(i) Full step resolution (ii) half step resolution

### Part: B – Material Characterization

- 1) Microscopy: Different microscopy techniques, Resolution, Magnification, Depth of field Imaging – theory and concepts.
- 2) Optical Microscopy: Grain size estimation, Phase Percentage Estimation
- 3) XRD- Estimation of Crystal planes, Crystal size, phase analysis etc.
- 4) X-ray microanalysis: EDS, EPMA (Surface analysis)
- 5) XRD, EBSD, SEM (Applications to crystallography)
- 6) X-ray methods (EDS, XRF)
- 7) Spectroscopy (IR, Raman)
- 8) FTIR, UV Visible Spectrophotometer
- 9) Sputtering, PVD/CVD Coatings
- 10) Testing of Materials- Micro hardness, Tensile strength, Flexural strength, Wear, Abrasion



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M.Tech - II Sem		L	T	P	C
		2	0	0	0
MD 107	VALUE EDUCATION				

## UNIT I

Values and self-development –Social values and individual attitudes, Work ethics, Indian vision of humanism, Moral and non- moral valuation. Standards and principles, Value judgements.

## UNIT II

Importance of cultivation of values, Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness, Honesty, Humanity. Power of faith, National Unity, Patriotism. Love for nature, Discipline.

## UNIT III

Personality and Behavior Development - Soul and Scientific attitude, Positive Thinking. Integrity and discipline, Punctuality, Love and Kindness, Avoid fault Thinking, Free from anger, Dignity of labour, Universal brotherhood and religious tolerance, True friendship.

## UNIT IV

Happiness Vs suffering, love for truth, Aware of self-destructive habits, Association and Cooperation. Doing best for saving nature.

## UNIT V

Character and Competence –Holy books vs Blind faith, Self-management and Good health, Science of reincarnation, Equality, Nonviolence, Humility, Role of Women, All religions and same message, Mind your Mind, Self-control, Honesty, Studying effectively.

## TEXT BOOK:

1. Chakroborty, S.K. “Values and Ethics for organizations Theory and practice”, Oxford University, Press, New Delhi.

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<b>M.Tech - II Sem</b>		<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>0</b>	<b>0</b>	<b>4</b>	<b>2</b>
<b>MD 208</b>	<b>MINI PROJECT</b>				