Department of Mechanical Engineering

Birla Institute of Technology, Mesra, Ranchi - 835215 (India)

Institute Vision

To become a Globally Recognized Academic Institution in consonance with the social, economic and ecological environment, striving continuously for excellence in education, research and technological service to the National needs.

Institute Mission

To educate students at Undergraduate, Post Graduate, Doctoral, and Post Doctoral levels to perform challenging engineering and managerial jobs in industry.

- To provide excellent research and development facilities to take up Ph.D. programmes and research projects.
- To develop effective teaching and learning skills and state of art research potential of the faculty.
- To build national capabilities in technology, education and research in emerging areas.
- To provide excellent technological services to satisfy the requirements of the industry and overall academic needs of society.

Department Vision

To become an internationally recognized Centre of excellence in academics, research and technological services in the area of Mechanical Engineering and related inter-disciplinary fields.

Department Mission

- Imparting strong fundamental concepts to students and motivate them to find innovative solutions to engineering problems independently
- Developing engineers with managerial attributes capable of applying latest technology with responsibility
- Creation of congenial atmosphere and excellent research facilities for undertaking quality research by faculty and students
- To strive for more internationally recognized publication of research papers, books and to obtain patent and copyrights
- To provide excellent technological services to industry.

Programme Educational Objectives (PEOs) – Computer Aided Analysis and Design

PEO 1: To prepare post graduates who will have strong fundamentals of commuter aided design and modern computational techniques for analysing and improving mechanical equipment.

PEO 2: To prepare post graduates who will be competent enough to work successfully in challenging industrial environment.

PEO 3: To posses wisdom regarding group dynamics to efficaciously utilize opportunities for positive contribution to collaborative multidisciplinary engineering research and rational analysis to manage projects economically.

PEO 4: To communicate with engineering community and society at large adhering to relevant safety regulations as well as quality standards.

PEO 5: To inculcate the ability for life-long learning to acquire professional and intellectual integrity, ethics of scholarship and to reflect on individual action for corrective measures to prepare for leading edge position in industry, academia and research institutes.

PROGRAM OUTCOMES (POs)
M. Tech. in Mechanical Engineering (Computer Aided Analysis and Design)

PO1: An ability to independently carry out research/investigation and development work to solve practical problems.

PO2: An ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.

PO4: Recognize the need for continuous learning and will prepare one to create, select and apply appropriate techniques and modern engineering and IT tools to solve complex control system problems.

PO5: Demonstrate knowledge of engineering and management principles and apply to manage projects efficiently and economically with intellectual integrity and ethics for sustainable development of society.

COURSE INFORMATION SHEET

Course code: ME521
Course title: Computational Methods in Engineering
Pre-requisite(s): Mathematics course of UG level
Co- requisite(s): Nil
Credits: 3 L: 3 T: 0 P: 0
Class schedule per week: 03
Class: M. Tech.
Semester / Level: I/05
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students to:

1.	Learn different numerical techniques for solving problems in linear algebra, differential and integral calculus.
2.	Apply numerical methods for solving engineering problems.

Course Outcomes

After the end of the course, a student should be able to:

CO1.	Understand several numerical techniques used in linear algebra.
CO2.	Solve systems of linear and nonlinear algebraic equations encountered in engineering problems.
CO3.	Evaluate differentiation and integration using different numerical techniques.
CO4.	Solve ordinary and partial differential equations using numerical methods
CO5.	Create new ideas in engineering computations.

SYLLABUS

Module 1:

Numerical Methods in Linear Algebra: Direct and iterative solution techniques for simultaneous linear algebraic equations – Gauss elimination, Gauss – Jordan, LU and QR decomposition, Jacobi and Gauss-Seidel methods, Eigenvalues and Eigenvectors – Power and inverse power method, physical interpretation of eigen values and eigenvectors, householder transformation. (8L)

Module 2:

Solution of nonlinear algebraic equations: Bisection method, fixed-point iteration method, Newton – Raphson, Secant method. Interpolation: Polynomial interpolation, Lagrange interpolating polynomial, Hermite interpolation, interpolation in two and three dimensions. (7L)

Module 3:

Numerical differentiation and Integration: Finite difference formula using Taylor series, Differentiation of Lagrange polynomials, Simpson's rule, Gauss – quadrature rule, Romberg method, multiple integral. (9L)

Module 4:

Numerical solutions of ordinary differential equations: Euler's method, Heun's method and stability criterion, second and fourth order Runge-Kutta methods, Adams – Bashforth – Moulton method, system of ODEs and nonlinear ODEs. (10L)

Module 5:

Partial Differential Equations: Classifications of PDEs, Elliptic equations, Parabolic equations, Hyperbolic equations (wave equation). (6L)

Text Books

1. Joe D Hoffman, Numerical Methods for Engineer and Scientists, Marcel Dekker.
2. S. P. Venkateshan and P. Swaminathan, Computational Methods in Engineering, Ane books.

Reference Books

1. Gilbert Strang, Computational Science and Engineering, Wessley – Cambridge press.
2. Steven C. Chapra, Applied Numerical Methods with MATLAB for Engineers and Scientists, Tata Mc Graw Hill.

Course Evaluation:
Individual assignment, Seminar, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements) :
Approximate methods
POs met through Gaps in the Syllabus: **PO1**

Topics beyond syllabus/Advanced topics/Design:
Asymptotic and perturbation methods
POs met through Topics beyond syllabus/Advanced topics/Design: **PO1**

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	3	-	2	1	1
CO2	3	-	2	1	1
CO3	3	-	2	1	1
CO4	3	-	2	1	1
CO5	2	1	3	3	1

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1,CD2,CD6
CO2	CD1,CD2, CD6
CO3	CD1, CD2,CD6
CO4	CD1,CD2,CD6
CO5	CD1,CD2,CD6

COURSE INFORMATION SHEET

Course code: ME502
Course title: Advanced Computer Aided Design
Pre-requisite(s): Computer aided Design, Machine Design
Co- requisite(s): Nil
Credits: 3 L: 3 T: 0 P: 0
Class schedule per week: 03
Class: M. Tech
Semester / Level: I/05
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students to:

1.	Understand the transformation techniques and solid modelling.
2.	Generate the Synthetic Curves.
3.	Develop programs for design and drawing of Machine Elements.

Course Outcomes

At the end of the course, a student should be able to:

CO1.	Understand the concept of solid modeling and transformation techniques.
CO2.	Understand how to transfer data in CAD system.
CO3.	Apply the knowledge to generate surface patches, synthetic surfaces.
CO4.	Understand how to generate different curves.
CO5.	Apply the knowledge to develop programs for design and drawing of Machine Elements.

SYLLABUS

Module 1:

Review of 2D representation in CAD Homogeneous representation; Translation, Scaling, Reflection, Rotation, Shearing in 3D; Projections; Introduction to assembly modelling, IGES, STEP & DXF data exchange format. (8L)

Module 2:

Representation of surface patches; Analytic surfaces; Synthetic surfaces; Surface modelling; Solid entities; CSG approach of solid modelling; Boolean operations; B-rep approach of Solid Modelling; Boundary evaluation technique. (8L)

Module 3:

Synthetic Curves: Concept of continuity, cubic spline curve, Bezier curve, B-Spline curve and NURBS. (8L)

Module 4:

Animation and Collaborative Design: Mechanism and Animation, Collaborative Design Principles, Approaches, Tools, Design Systems. (8L)

Module 5:

Development of programs for design and drawing of Machine Elements: Shafts, Gears, Pulleys, Flywheel, Connecting rods. (8L)

Text Books

1. Mastering CAD/CAM by Ibrahim Zeid, Tata McGraw-Hill
2. Computer Graphics by Donald Hearn and M. Pauline Baker, Prentice Hall of India Pvt. Ltd. Delhi

Reference Books

1. CAD/CAM Principles and Applications by P.N. Rao, Tata McGraw-Hill
2. CAD/CAM: Computer Aided design and Manufacturing by Mikell Groover and Zimmer, Pearson Education

Course Evaluation:
Individual assignment, Seminar, Theory (Quiz and End semester) examinations

<u>Gaps in the syllabus (to meet Industry/Profession requirements)</u> :
Computer graphics.
POs met through Gaps in the Syllabus: **PO1 to PO5**

Topics beyond syllabus/Advanced topics/Design:
Viewing, Clipping
POs met through Topics beyond syllabus/Advanced topics/Design: **PO1 to PO5**

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	3	-	3	3	1
CO2	3	-	3	1	1
CO3	3	2	2	1	2
CO4	3	1	3	1	1
CO5	2	2	3	3	3

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1,CD2,CD6
CO2	CD1,CD2, CD6
CO3	CD1, CD2,CD6
CO4	CD1,CD2,CD6
CO5	CD1,CD2,CD6

COURSE INFORMATION SHEET

Course code: ME503
Course title: Advanced Stress Analysis
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 3 L: 3 T: 0 P:0
Class schedule per week: 03
Class: M.Tech.
Semester / Level: I/05
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students to:

1.	Get familiar with the fundamentals of solid mechanics.
2.	Understand mathematical formulations of solid mechanics problems.
3.	Explain the theories of failure and basic of plasticity.
4.	Solve the advanced problems in torsion, plates and shells.

Course Outcomes

At the end of the course, a student should be able to:

CO1.	Understand the fundamentals of 2D and 3D stresses.
CO2.	Analyse 2D and 3D advanced solid mechanics problems of strains.
CO3.	Understand the fundamentals of theories of failure and basic equations of plasticity.
CO4.	Evaluate stress functions in Cartesian and polar coordinate systems to solve stresses in advanced solid mechanics.
CO5.	Apply the concepts of solid mechanics to solve torsion, plate and shell problems.

SYLLABUS

Module 1:

Components of stress at a point; Tensorial character; Cauchy's stress relations; Principal stresses and stress invariants; Octahedral stress components; Homogeneous and deviatoric stress components; Equilibrium equations; Boundary conditions. (7L)

Module 2:

Components of strain at a point; Tensorial character; Principal strains and strain invariants; Strain-displacement relations; Compatibility conditions; Generalized Hooke's law; Engineering and Lemi's elastic constants; Plane stress and plane strain problems; Biharmonic equation. (7L)

Module 3:

Yield criteria; Stress space; Tresca's and Von-Mises' theories of failure; Yield curves on π-plane; Analysis of fundamental equation of plasticity; The equation of plasticity for a plain strain; The influence of the mean stress on the shear strength; Characteristics and slip lines as a method of determining stresses; Properties of slip lines. (6L)

Module 4:

Principle of superposition; Uniqueness theorem; St. Venant's principle; Stress function; Plane problems in Cartesian coordinates; Solutions by polynomials; Plane problems in polar coordinates; Complex stress functions. (10L)

Module 5:

Applications – Torsion of bars: Saint-Venant's free torsion; Torsion of circular, elliptical and rectangular sections; Membrane analogy. Bending of plates: Variation of stress within a plate; The governing equation for plate deflection; Strain energy of plates. Shells: Symmetrically loaded shells of revolution; Strain energy in bending and stretching of shells; Axi-symmetrically loaded circular cylindrical shells. (8L)

Text Books

1. L.S. Srinath, Advanced Mechanics of Solids, 3rd Ed. Tata McGraw-Hills Publishing Company Ltd., 2008.
2. S.P. Timoshenko, J.N. Goodier, Theory of Elasticity, 3rd Ed., McGraw-Hill Book Company, 1970.
3. A.C. Ugural, Stresses in Beams, Plates, and Shells, 3rd Ed., CRC Press, 2009.

Reference Books

1. A.P. Boresi, R.J. Schmidt, Advanced Mechanics of Materials, 6th Ed., John Wiley & Sons Inc., 2002.
2. Tselikov, Stress and Strain in Metal Forming, MIR Publishers, 1967.

Course Evaluation:
Individual assignment, Seminar, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements) :
Solution to more complex problems like propagation of waves in a continuous media, and anisotropic elasticity.
POs met through Gaps in the Syllabus: **PO1 to PO5**

Topics beyond syllabus/Advanced topics/Design:
An improved boundary-integral equation method for three dimensional elastic stress analysis
POs met through Topics beyond syllabus/Advanced topics/Design: **PO1 to PO5**

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	3	-	2	3	1
CO2	3	-	3	1	1
CO3	3	2	2	2	2
CO4	3	1	3	2	2
CO5	2	2	3	3	3

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1,CD2,CD6
CO2	CD1,CD2, CD6
CO3	CD1, CD2,CD6
CO4	CD1,CD2,CD6
CO5	CD1,CD2,CD6

COURSE INFORMATION SHEET

Course code: ME504
Course title: Computational Fluid Dynamics
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 3 L: 3 T: 0 P: 0
Class schedule per week: 03
Class: M.Tech.
Semester / Level: I/05
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students to:

1.	Get familiar with the fundamentals of CFD.
2.	Understand various mathematical techniques used in CFD.
3.	Develop the ability to formulate the problems and apply appropriate numerical schemes.
4.	Understand the difference as well as suitability to apply the RANS and scale resolving approach.
5.	Implement the concepts using simple CFD codes.

Course Outcomes

At the end of the course, a student should be able to:

CO1.	Understand the fundamentals of CFD.
CO2.	Develop an intuitive understanding of the CFD techniques.
CO3.	Understand the fundamentals of turbulence modelling.
CO4.	Learn fundamentals on the near-wall modelling approach.
CO5.	Apply the CFD concepts on real-world problems.

SYLLABUS

Module 1:

Introduction to CFD; Conservative and non-conservative forms of the continuity equation, momentum equation and energy equation; Types of boundary conditions and description about standard test cases; Burger's equations. (7L)

Module 2:

Mathematical behaviour of PDE: Nature of coordinates, Classification of quasi-linear PDE – hyperbolic, parabolic, elliptical equations. CFD techniques: Discretization of governing equations – finite difference method, finite volume method, finite element method, spectral method; temporal discretization. (8L)

Module 3:

CFD techniques: Converting governing equations to algebraic equation system; Steady one-dimensional convection and diffusion; Direct methods to solve algebraic equations: Gaussian elimination, forward elimination process, Thomas algorithm; Iterative methods to solve algebraic equations: Jacobi and Gauss-Seidel methods; Pressure-velocity coupling – SIMPLE and SIMPLEC scheme. (10L)

Module 4:

Turbulent-flow modelling: The physics of fluid turbulence – the Kolmogorov hypothesis, energy cascade, turbulent energy spectrum; Turbulence modelling: Direct numerical simulation, Large-eddy simulations, Reynolds decomposition, models based on the turbulent viscosity hypothesis; Near-wall modelling; Inlet and outlet boundary conditions. (8L)

Module 5:

Best practice guidelines: Application uncertainty; Numerical uncertainty – convergence, enhancing convergence, numerical errors; Numerical stability. (7L)

Text Books

1. J.D. Anderson, Jr., Computational Fluid Dynamics: The Basics with Applications, McGraw Hill, Inc., 1995.
2. B. Andersson, R. Andersson, L. Kansson, M. Mortensen, R. Sudiyo, B.V. Wachem, Computational Fluid Dynamics for Engineers, Cambridge University Press, 2012.
3. J. Tu, G.H. Yeoh, C. Liu, Computational Fluid Dynamics: A Practical Approach, 2nd Ed., Elsevier, 2015.

Reference books

1. S.V. Patankar, Numerical heat transfer and fluid flow, Taylor & Francis, 2004.
2. J.H. Ferziger, M. Perić, Computational methods for fluid dynamics, 3rd Ed., Springer Berlin-Heidelberg, 2003.

Course Evaluation:
Individual assignment, Seminar, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements) :
Implementing DNS on flow problems
POs met through Gaps in the Syllabus: **PO1 to PO5**

Topics beyond syllabus/Advanced topics/Design:
Application of Computational Fluid Dynamics in complicated problems
POs met through Topics beyond syllabus/Advanced topics/Design: **PO1 to PO5**

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	3	-	3	3	1
CO2	3	-	3	1	1
CO3	3	2	2	1	2
CO4	3	1	3	1	1
CO5	2	2	3	3	3

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1,CD2,CD6
CO2	CD1,CD2, CD6
CO3	CD1, CD2,CD6
CO4	CD1,CD2,CD6
CO5	CD1,CD2,CD6

COURSE INFORMATION SHEET

Course code: ME505
Course title: Mechatronics
Pre-requisite(s): Basic Electronics
Co- requisite(s): Nil
Credits: 3 L: 3 T: 0 P: 0
Class schedule per week: 03
Class: M. Tech
Semester / Level: I/05
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students to:

1.	Understand the basics of Mechatronics, sensors and actuators
2.	Analyse various actuation systems, and enable to understand the basic concept of motors
3.	Develop system models and control systems for new developed equipments and applications
4.	Analyse and deal with the programmable logic controllers and circuits
5.	Develop new models and concepts, understand the new technology and usage.

Course Outcomes

At the end of the course, a student should be able to:

CO1.	Analyse mechatronic systems and automated systems
CO2.	Apply sensors and controllers in the circuit
CO3.	Apply actuation system and drives to the new developed mechatronic system
CO4.	Analyse various programmable logic controllers and microcontrollers
CO5.	Develop and predict for the performance for various new systems, robotic systems and possible design solutions

SYLLABUS

Module 1:

Introduction and Overview: Introduction to Mechatronics, Mechatronics in product design and system control, Sensors and Transducers, displacement, pressure, temperature, optical, piezoelectric, strain gauge, Review of fundamentals of electronics. Data conversion devices, micro-sensors, signal processing devices, Relay. (9L)

Module 2:

Actuation systems Drives: stepper motors, servo drives. Ball screws, linear motion bearings, cams, systems controlled by camshafts, electronic cams, indexing mechanisms, tool magazines, transfer systems, hydraulic, pneumatic drives. (9L)

Module 3:

System models and controllers Microprocessors, Description of PID controllers. CNC machines and part programming, adaptive control, Flexible manufacturing systems. (8L)

Module 4:

Programmable Logic Controllers (PLC)- input and output processing and programming, timers, internal relays and controllers, shift resistor, Ladder programming, converters. (8L)

Module 5:

Stages in designing, Mechatronic Systems, Traditional and Mechatronics design, Case studies of Mechatronics systems, Pick and place robot, Autonomous mobile robot, wireless surveillance, balloon engine management, car parking barrier systems, Design for manufacture and assembly. (6L)

Text Books

1. HMT ltd. Mechatronics, Tata Mcgraw-Hill, New Delhi, 1988.
2. Introduction to Mechatronics and Measurement System by David G. Alciatore, Michael B. Histamd, Mc Graw Hill
3. Mechatronics by Bolton, Pearson Education

Reference Books

1. Mechatronics System Design by Devdas and Shetty, Pearson Education

Course Evaluation:

Individual assignment, Seminar, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements):
Microcontrollers
POs met through Gaps in the Syllabus: **PO1 to PO5**

Topics beyond syllabus/Advanced topics/Design:
Fuzzy Logic
POs met through Topics beyond syllabus/Advanced topics/Design: **PO1 to PO5**

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	3		3	3	1
CO2	3		3	1	1
CO3	3	2	2	1	2
CO4	3	1	3	1	1
CO5	2	2	3	3	3

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1,CD2,CD6
CO2	CD1,CD2, CD6
CO3	CD1, CD2,CD6
CO4	CD1,CD2,CD6
CO5	CD1,CD2,CD6

COURSE INFORMATION SHEET

Course code: ME506
Course title: Applied Tribology
Pre-requisite(s): Industrial Tribology
Co- requisite(s): Nil
Credits: 3 L: 3 T:0 P: 0
Class schedule per week: 03
Class: M. Tech
Semester / Level: I/05
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students to:

1.	Comprehend the concept of tribology for applying lubrication in bearings and other machine elements
2.	Design the tribological systems consisting bearings

Course Outcomes

At the end of the course, a student should be able to:

CO1.	Understand the basic concepts of friction, wear, and lubrication
CO2.	Apply the knowledge of surface texture parameters for selection of bearing materials
CO3.	Write Reynold’s equation for various bearing problems and design thrust bearings
CO4.	Design journal bearings and squeeze-film bearings
CO5.	Design hydrostatic and rolling element bearings

SYLLABUS

Module 1:

Friction, Wear, and Lubrication, Tribology principles, Principles for selection of bearing types, Lubricants and Lubrication, Mineral oils, Synthetic oils, Viscosity, Density and compressibility, Thermal Properties, Oil life, Greases, Solid lubricants, Lubricant supply methods. (6L)

Module 2:

Surface Texture and Interactions, Geometric characterization of surfaces, Surface parameters, Measurement of surface texture, Measurement of surface flatness, Statistical descriptions, Contact between surfaces, Lubrication regime relation to surface roughness, Bearing Materials, Distinctive selection factors, Oil-film bearing materials, Dry and semi-lubricated bearing materials, Air bearing materials, High-temperature materials, Rolling bearing materials. (8L)

Module 3:

Fundamentals of Viscous Flow, Conservation of mass, momentum, and energy, non-dimensionalisation, Reynolds Equation and Applications, Performance parameters, Thrust Bearings, Thrust bearing types, Design factors, Performance analysis, Design procedure. (7L)

Module 4:

Journal Bearings, Full-arc plain journal bearing with infinitely long approximation, Boundary conditions, Definition of the Sommerfeld number, Cavitation phenomena, Bearing performance parameters, Finite journal bearing design and analysis, Bearing Stiffness, Rotor Vibration, and Oil-Whirl Instability, General design guides, Squeeze-Film Bearings, Governing equations, Planar squeeze film, Non-planar squeeze film, Squeeze film of finite surfaces, Piston rings. (10L)

Module 5:

Hydrostatic Bearings, Types and configurations, Circular step thrust bearings, Capillary-compensated hydrostatic bearings, Orifice-compensated bearings, Design procedure for compensated bearings, Hydraulic lift, Rolling Element Bearings, Ball bearing types, Roller bearing types, Thrust bearing types, Load–life relations, Adjusted rating life, Static load capacity. (9L)

Text Books

1. M. M. Khonsari and E. R. Booser. Applied Tribology: Bearing Design and Lubrication, Second Edition. John Wiley & Sons, Ltd, 2008.

Reference Books

1. B. J. Hamrock, S. R. Schmid, B. O. Jacobson. Fundamental of Fluid Film Lubrication. Second Edition. Marcel Dekker, Inc., 2004.
2. G. W. Stachowiak, A. W. Batchelor. Engineering tribology. Butterworth-Heinemann, 2001.

Course Evaluation:
Individual assignment, Seminar, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements) :
Gas bearings, dry and starved bearings.
POs met through Gaps in the Syllabus: **PO1 to PO5**

Topics beyond syllabus/Advanced topics/Design:
Seals and condition monitoring.
POs met through Topics beyond syllabus/Advanced topics/Design: **PO1 to PO5**

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	1	2	2	2	2
CO2	1	3	3	2	2
CO3	2	3	3	3	3
CO4	2	3	3	3	3
CO5	3	3	3	3	3

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1,CD2,CD6
CO2	CD1,CD2, CD6
CO3	CD1, CD2,CD6
CO4	CD1,CD2,CD6
CO5	CD1,CD2,CD6

COURSE INFORMATION SHEET

Course code: ME508
Course title: Computer Programming & Simulation Lab
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 2 L: 0 T: 0 P: 4
Class schedule per week: 04
Class: M.Tech.
Semester / Level: I/05
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students to:

1.	Understand the concept of programming and simulation in MATLAB.
2.	Enhance their analysing and problem solving skills using computational simulation techniques.

Course Outcomes

At the end of this course, a student should be able to:

CO1.	Understand the concept of programming using computer language.
CO2.	Understand the concept of computer simulation.
CO3.	Analyse design problems using programming.
CO4.	Apply the computer programming and simulation in control systems.
CO5.	Apply the knowledge of MATLAB programming and simulation in soft computational techniques.

List of Experiments

Experiment 1: Introduction to MATLAB.
Experiment 2: Matrix operations and polynomials.
Experiment 3: MATLAB graphics.
Experiment 4: Programming with loops and functions in M file.
Experiment 5: Solution of differential equations and symbolic mathematics
Experiment 6: Applications of MATLAB commands to vibration engineering problems.
Experiment 7: Applications of MATLAB commands and graphics to solve computer aided design problems
Experiment 8: Introduction to Simulink.
Experiment 9: State space modelling of engineering systems and solution in Simulink.
Experiment 10: Simulation of non-linear systems.

Experiment 11: MATLAB applications in control systems
Experiment 12: MATLAB applications soft computational techniques..

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	60
Semester End Examination	40

Continuous Internal Assessment	% Distribution
Day to day performance & Lab files	30
Quiz (es)	10
Viva	20

Semester End Examination	% Distribution
Examination Experiment Performance	30
Quiz	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	2	1
CO2	3	2	2	2	1
CO3	3	1	3	1	1
CO4	3	2	3	1	2
CO5	2	3	3	2	1

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1,CD2,CD3 CD6,CD7
CO2	CD1,CD2,CD3 CD6,CD7
CO3	CD1,CD2,CD3 CD6,CD7
CO4	CD1,CD2,CD3 CD6,CD7
CO5	CD1,CD2,CD3 CD6,CD7

COURSE INFORMATION SHEET

Course code: ME509
Course title: Computer Aided Analysis Lab.
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 2 L: 0 T: 0 P: 4
Class schedule per week: 04
Class: M.Tech.
Semester / Level: I/05
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students to:

1.	Understand the concepts of simulation using ANSYS Mechanical and Fluent
2.	Enhance their analysing and problem-solving skills using computational techniques.

Course Outcomes

At the end of the course, a student should be able to:

CO1.	Understand and apply the numerical techniques via computer simulations.
CO2.	Identify the problem and generate suitable mesh.
CO3.	Import mesh file into the solver and apply appropriate boundary conditions.
CO4.	Run the solver with pre-defined user settings.
CO5.	Extract the results in the form of graphs and plots from the solver or by making use of the post-processing tools and analysing them.

List of Experiments

Experiment 1: Application of 1D element to analyse beam and truss structures under point and distributed static loadings.
Experiment 2: Application of 2D element to analyse plate structure.
Experiment 3: Application of 3D element to analyse 3D objects.
Experiment 4: Modal Analysis of structures to detect natural frequencies and mode shapes.
Experiment 5: Harmonic Analysis of structures.
Experiment 6: Transient analysis of structures.
Experiment 7: Fluid flow and heat transfer in a mixing elbow/heat exchanger.
Experiment 8: Modelling external compressible flow.
Experiment 9: Modelling flow through porous media.
Experiment 10: Using the VOF model.
Experiment 11: Modelling flow inside Cyclone separators.
Experiment 12: Multiphase flow problem.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	60
Semester End Examination	40

Continuous Internal Assessment	% Distribution
Day to day performance & Lab files	30
Quiz (es)	10
Viva	20

Semester End Examination	% Distribution
Examination Experiment Performance	30
Quiz	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	2	1
CO2	3	2	2	2	1
CO3	3	1	3	1	1
CO4	3	2	3	1	2
CO5	2	3	3	2	1

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1,CD2,CD3 CD6,CD7
CO2	CD1,CD2,CD3 CD6,CD7
CO3	CD1,CD2,CD3 CD6,CD7
CO4	CD1,CD2,CD3 CD6,CD7
CO5	CD1,CD2,CD3 CD6,CD7

COURSE INFORMATION SHEET

Course code: ME510
Course title: Advanced Vibration & Simulation
Pre-requisite(s): Engineering mechanics, Strength of Material
Co- requisite(s): Nil
Credits: 3 L: 3 T: 0 P: 0
Class schedule per week: 03
Class: M. Tech.
Semester / Level: II/05
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students to:

1.	Understand the advanced multi degrees of freedom system analysis techniques.
2.	Analyse non-linear vibration systems.
3.	Analyse the signatures of vibrating systems and detect the faults.

Course Outcomes

After the end of the course, a student should be able to:

CO1.	Understand the concept of modeling and simulation of vibrating systems.
CO2.	Analyse multi degrees of freedom and continuous systems.
CO3.	Evaluate the natural frequencies and mode shapes of vibrating systems.
CO4.	Analyse nonlinear vibrating systems.
CO5.	Apply the knowledge of vibration to detects the faults of machineries and take preventive maintenance.

SYLLABUS

Module 1:

Review of free and forced vibration analysis of single degree of freedom system with and without damping; Transient vibration; rotor unbalance; whirling of rotating shaft; Torsional vibration; state-space modelling of single degree of freedom system; Introduction to vibration simulation software. (8L)

Module 2:

Vibration analysis of two and multi degrees of freedom system; matrix formulation; influence coefficient; flexibility matrix; stiffness matrix; coordinate coupling; Vibration analysis of continuous systems: Lateral vibration of string, Longitudinal vibration of bar, Torsional vibration of uniform shaft, Transverse vibration of beams; state space modelling of multi degrees of freedom system; Utilization of finite element method in simulation of continuous systems (8L)

Module 3:

Determination of natural frequencies and mode shapes of multi degrees of freedom system; Eigen values and Eigenvectors; Approximate methods: Dunkerley's method, Holzer's method, Stodola's method, Rayleigh-Ritz method, Method of matrix iteration; Modal analysis using simulation tools (8L)

Module 4:

Introduction to Nonlinear Vibration: Commonly observed nonlinear phenomena; Development of nonlinear governing equation of motion of Mechanical systems; linearization techniques; commonly used nonlinear equations: Duffing equation, Van der Pol's equation, Mathieu's and Hill's equations; Different Approximate solution methods; Simulation of non-linear systems. (8L)

Module 5:

Application of vibration: Vibration measuring Instruments; Vibration exciters; Vibration analysers; time domain and frequency domain vibration analysis; Signature analysis of vibrating systems; Machinery faults detections using vibration analysis (crack detection, bearing faults detections) (8L)

Text Books

1. Advanced Theory of Vibration by J.S.Rao, New Age International Publishers.
2. Nonlinear Oscillations by A.H.Nayfeh and D.T. Mook, Wiley-Interscience

Reference Books

1. Introductory Course on Theory and Practice Mechanical Vibration, J.S. Rao & K.Gupta, New Age International (P) Ltd.

Course Evaluation:
Individual assignment, Seminar, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements) :
Vibration of plates.
POs met through Gaps in the Syllabus: **PO1 to PO5**

Topics beyond syllabus/Advanced topics/Design:
Random vibration
POs met through Topics beyond syllabus/Advanced topics/Design: **PO1 to PO5**

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	3	-	3	3	1
CO2	3	-	3	1	1
CO3	3	2	2	1	2
CO4	3	1	3	1	1
CO5	2	2	3	3	3

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1,CD2,CD6
CO2	CD1,CD2, CD6
CO3	CD1, CD2,CD6
CO4	CD1,CD2,CD6
CO5	CD1,CD2,CD6

COURSE INFORMATION SHEET

Course code: ME511
Course title: Finite Element Analysis
Pre-requisite(s): Engineering Mathematics, Fundamentals of Programming Language, Mechanics of materials, Thermodynamics
Co- requisite(s): Nil
Credits: 3 L: 3 T: 0 P: 0
Class schedule per week: 03
Class: M. Tech.
Semester / Level: II /05
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students to:

1.	Understand the basic concepts and procedures in finite element analysis.
2.	Analyze different types of mechanics problems in engineering using the finite element method.
3.	Have proficiency in the application of the finite element method.

Course Outcomes

After the end of the course, a student should be able to:

CO1.	Obtain an understanding of the fundamental theory of the FEA method.
CO2.	Develop the ability to generate the governing FE equations for systems governed by partial differential equations.
CO3.	Understand the use of the basic finite elements for structural applications using truss, beam,frame, and plane elements.
CO4.	Ability to evaluate and interpret FEA analysis results for design and evaluation Purposes.
CO5.	Apply and use of the FE method for heat transfer problems.

SYLLABUS

Module 1: Overview of Engineering systems

Continuous and discrete systems (discussion on differential equations, matrix algebra), steady state, propagation and eigen value problems. (8L)

Module 2: Energy methods

Variational principles and weighted residual techniques (least square method, collocation, sub-domain collocation, Galerkin method) for one-dimensional equation, Rayleigh-Ritz Formulation, development of bar and beam element, application to truss and frames. (8L)

Module 3: Finite elements for two-dimensions

Equivalence between energy formulation and Galerkin approach, discretization concepts, choice of elements, derivation of element shape functions (Lagrangian and Hermite) in physical coordinates. (8L)

Module 4: Iso-parameteric mapping

Iso-parameteric mapping, numerical integration, Assembly procedure, solution techniques, Jacobian matrix. Numerical integration – 2 and 3 point Gauss Quadrature, full and reduced integration. Sub-modeling, sub-structuring, introduction to finite element programming. (8L)

Module 5: Case study

Torsion of prismatic bars, modal analysis; direct integration methods for dynamic analysis; contact analysis, applications to problems in engineering: plane elasticity, heat conduction, potential flow and Transient problems. Computer implementation. (8L)

Text Books

1. Chandrupatla T . R., and Belegundu, A. D., Introduction to Finite Elements in Engineering, Prentice Hall, 2003.
2. Reddy, J. N., An Introduction to the Finite Element Method, 3rd Edition, McGraw-Hill Science/Engineering/Math, 2005.
3. Bhatti, M.A., Fundamental Finite Element Analysis and Applications: with Mathematica and Matlab Computations, Wiley, 2005.

Reference Books

1. Bathe, K-J., Finite Element Procedures, Prentice Hall, 1996.
2. Logan D. L., A First Course in the Finite Element Method, Thomson- Engineering, 3rd edition, 2001.
3. Zienkiewicz, O.C. and Taylor, R.L., The Finite Element Method, 6th Ed., Vol. 1, Elsevier, 2005.

Course Evaluation:
Individual assignment, Seminar, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements) :
Finite Element Analysis in three dimensional problem.
POs met through Gaps in the Syllabus: **PO1 & PO3**

Topics beyond syllabus/Advanced topics/Design:
Numerical methods in finite element analysis
POs met through Topics beyond syllabus/Advanced topics/Design: **PO1 to PO5**

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	3	1	3	1	-
CO2	3	1	3	-	-
CO3	3	1	3	-	-
CO4	3	1	3	-	-
CO5	3	1	3	3	1

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1,CD2,CD6
CO2	CD1,CD2, CD6
CO3	CD1, CD2,CD6
CO4	CD1,CD2,CD6
CO5	CD1,CD2,CD6

COURSE INFORMATION SHEET

Course code: ME512
Course title: Reverse Engineering and Rapid prototyping
Pre-requisite(s): CAD
Co- requisite(s): Nil
Credits: 3 L: 3 T: 0 P: 0
Class schedule per week: 03
Class: M. Tech.
Semester / Level: II /05
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students to:

1.	Develop a comprehensive and better designing for an engineering perspective and change from an older design to newer.
2.	Lay the foundation for subsequent studies in conventional and nonconventional product development phases and to prepare the students to effectively use it in the practice of engineering.
3.	Develop an intuitive understanding of why and how to reverse engineer an older product to new concept and design its improvements.
4.	Understand CAD CAE and RP tools and to redraw a circuit with new amendments

Course Outcomes

After the end of the course, a student should be able to:

CO1.	Explain the Reverse engineering methodology.
CO2.	Examine the disassembled parts with concern to its functionality
CO3.	Choose the different types of RE systems
CO4.	Analyze the basics of RP processes and their advantages.
CO5.	Adapt RE and RP processes in basic design

SYLLABUS

Module 1: Basic concepts in reverse engineering

Introduction to RE forward engineering, reverse engineering, value engineering, design thought and process, design step, mechatronics system design The problem what is Reverse Engineering The RE process, Technical Data Development, Benefits of RE, RE as a Quality function, Uses of RE, Value Engineering and RE, Origin of RE, legal issues, Patent Infringement and Theft. (8L)

Module 2: Reverse engineering methodology

RE steps, system level design and examples, product development, product function, product teardown, engineering specification, product architecture visual and Dimensional inspection, comparison to technical data, Disassembly and assembly procedures, material analysis, Technical data generation, Developing engineering drawings, Dimensional accuracy ,technical data package completed, Design verification prototype determination prototype failure and retesting, Inspection criteria, Project Implementation. (8L)

Module 3: Scanning devices

Reverse Engineering and CAD interface, Scanners , Contact type, Non-contact type, Coordinate measuring Devices, 3D scanning white light scanners, Cloud data scanning, Processing, Surface recreation, 3D modeling, Final model development, Digital representation for communication of Product development. (8L)

Module 4: Introduction to Rapid prototyping

Prototyping fundamentals, Historic development, advantages and disadvantages, Limitations of RP, Classification of RP Liquid Based Prototyping, Stereo lithography (SLA), methods, principle, specifications and areas of application, Solid Based RP systems, (SGC), FDM Fused Deposition Modeling, SLS Selective Laser Sintering, 3D Printing. (8L)

Module 5: RE in design

Design of new products, R.E. in computer application, Reverse engineering of PLC programmes. Rapid Tooling, aerospace, automotive, Basic design procedures for implementing RE medical and bioengineering, customized implants and prosthetics, forensic science and anthropology. RE and RP interrelation, Case studies. (8L)

Text Books

1. Reverse Engineering by Kathryn A. Ingle , McGraw Hill 1994.
2. Rapid prototyping Principles and Application by Rafiq, Nooraani , Wiley and Sons

Reference Books

1. Rapid Prototyping Principles and Applications, Chua C K Leong K F LMCS World Science Publication.
2. Rapid Manufacturing , D.T. Pham and S.S Dhmav, Springer, 1997.

Course Evaluation:
Individual assignment, Seminar, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements) :
Model development
POs met through Gaps in the Syllabus: **PO1 to PO5**

Topics beyond syllabus/Advanced topics/Design:
Advance Rapid prototyping
POs met through Topics beyond syllabus/Advanced topics/Design: **PO1 to PO5**

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	3	3
CO2	3	3	3	3	3
CO3	3	-	2	3	-
CO4	3	-	3	3	-
CO5	2	2	3	3	2

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1,CD2,CD6
CO2	CD1,CD2, CD6
CO3	CD1, CD2,CD6
CO4	CD1,CD2,CD6
CO5	CD1,CD2,CD6

COURSE INFORMATION SHEET

Course code: ME513
Course title: Continuum Mechanics
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 3 L: 3 T: 0 P: 0
Class schedule per week: 03
Class: M. Tech.
Semester / Level: II /05
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students to:

1.	Get familiar with the fundamentals of continua.
2.	Work on using the lower and higher rank tensors.
3.	Understand various mathematical techniques used in continuum mechanics.
4.	Develop the ability to formulate the problems based on continuum approach.
5.	Implement the concepts in wide variety of practical problems.

Course Outcomes

After the end of the course, a student should be able to:

CO1.	Understand the fundamentals of continuum mechanics.
CO2.	Understand the fundamentals of vectors and tensors.
CO3.	Develop an intuitive understanding of the advanced mathematical techniques.
CO4.	Be familiar with the situations to treat the medium as continuous and its advantages.
CO5.	Apply the concepts of continuum mechanics on real-world problems both in solid and fluid mediums.

SYLLABUS

Module 1: Fundamentals of Continuum Mechanics

Continuum Hypothesis; Tensors – Index notation and summation convention; Quotient rule; Inner products; Transformation law for Cartesian components of a tensor; Symmetric and Anti-symmetric tensors; Principal values and Principal directions of a tensor. Tensor Calculus – The del operator; Gradient, divergence, curl and Laplacian. Curvilinear coordinates – Polar, Cylindrical and Spherical coordinates. (7L)

Module 2: Kinematics of a Continuum

Bodies and their configurations; Deformation and configuration; Engineering strains; General kinematics of a solid continuum; Deformation – Pure dilatation, simple extension, simple shear, nonhomogeneous deformation; Green strain tensor; Infinitesimal strain tensor; Principal values and principal planes of strains. (7L)

Module 3: Conservation of Mass, Momentum and Energy

Conservation of mass – conservation of mass in spatial, and material description, Reynolds transport theorem; Conservation of momenta – principle of conservation of linear, and angular momentum; Thermodynamic principles – energy equations for 1-D flows, and a 3-D continuum. (9L)

Module 4: Linear constitutive equations

Constitutive equations and ideal materials; Material symmetry; Linear elasticity; Newtonian viscous fluids; Linear viscoelasticity; Heat transfer. (7L)

Module 5: Applications

Heat transfer – analytical solutions of 1-D and 2-D heat transfer, axisymmetric heat conduction in a circular cylinder; Fluid mechanics – inviscid fluid statics, parallel flow, diffusion process; Solid mechanics – analysis of bars and beams, analysis of plane elasticity problems. (10L)

Text Books

1. J.N. Reddy, An Introduction to Continuum Mechanics, 2nd Ed., Cambridge University Press, 2013.
2. A.J.M. Spencer, Continuum Mechanics, Dover Publications Inc., 1980.

Reference Books

1. S. Nair, Introduction to Continuum Mechanics, Cambridge University Press, 2009.Fracture Mechanics - Fundamentals and Applications by T. L. Anderson, Taylor and Francis

Course Evaluation:
Individual assignment, Seminar, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements) :
Practical Industry Problems
POs met through Gaps in the Syllabus: **PO1 to PO5**

Topics beyond syllabus/Advanced topics/Design:
Advanced applications.
POs met through Topics beyond syllabus/Advanced topics/Design: **PO1 to PO5**

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	3	-	3	3	1
CO2	3	-	3	1	1
CO3	3	2	2	1	2
CO4	3	1	3	1	1
CO5	2	2	3	3	3

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1,CD2,CD6
CO2	CD1,CD2, CD6
CO3	CD1, CD2,CD6
CO4	CD1,CD2,CD6
CO5	CD1,CD2,CD6

COURSE INFORMATION SHEET

Course code: ME514
Course title: Design Against Fatigue and Failure
Pre-requisite(s): Machine Design, Materials Technology
Co- requisite(s): Nil
Credits: 3 L: 3 T: 0 P: 0
Class schedule per week: 03
Class: M. Tech.
Semester / Level: II /05
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students to:

1.	Develop a knowledge of the effect of variable loading on the materials response and the origin of fatigue failure.
2.	Design approach to fatigue - design for infinite life and finite life and to prepare the students to effectively use it in the practice of engineering.
3.	Develop an intuitive understanding of why and how to incorporate Fracture mechanics and its importance in the real world
4.	Get aware of Design of components against fatigue.
5.	Know about the Testing of the component designed against fatigue and failure.

Course Outcomes

After the end of the course, a student should be able to:

CO1.	Understand the fatigue failure and its application in real world.
CO2.	Know for the Design for fatigue and failure.
CO3.	Analyse different systems for Statistical and physical aspect of Fatigue behaviour.
CO4.	Emphasize on the phases in fatigue life and dislocation.
CO5.	Outline the Testing of the components designed against fatigue and failure.

SYLLABUS

Module 1: Fatigue consideration in Design

Variable load - basic concept; load or stress variations- Cyclic stressing/straining - materials response and the origin of fatigue failure. Stress life relations; S-N curve-fatigue strength and endurance limit Factors influencing fatigue and endurance strength modification factors, Effect of stress concentration and fatigue stress concentration, Effect of mean stress - Goodman and Soderberg's relations Design approach to fatigue - design for infinite life and finite life. (8L)

Module 2: Statistical aspect of Fatigue Behaviour

Low cycle and high cycle fatigue – Coffin – Manson’s relation – Transition life – cyclic strain hardening and softening – Analysis of load histories Cycle counting techniques - Cumulative damage Miner’s theory Other theories. (8L)

Module 3: Physical aspects of Fatigue

Phase in fatigue life – Crack initiation – Crack growth – Final Fracture – Dislocations – fatigue fracture surfaces. (8L)

Module 4: Fracture Mechanics

Strength of cracked bodies – Potential energy and surface energy – Griffith’s theory – Irwin – Orwin extension of Griffith’s theory to ductile materials – stress analysis of “cracked bodies – Effect of thickness on fracture toughness – stress intensity factors for typical geometries. (8L)

Module 5: Fatigue Design and Testing

Types of fatigue tests-load controlled high cycle and strain controlled low cycle fatigue, Design problems based on fatigue and failure. (8L)

Text Books

1. Elements of fracture mechanics by Prasanth Kumar, Tata McGraw Hill, New Delhi
2. Fracture Mechanics for Modern Engineering Design by K. R.Y. Simha, Universities Press (India) Limited

Reference Books

1. Elementary Engineering Fracture Mechanics, D. Broek, Kluwer Academic Publishers, Dordrecht
2. Fundamentals of Fracture Mechanics by J. F. Knott, Buterworth& Co., Ltd., London
3. Fracture Mechanics - Fundamentals and Applications by T. L. Anderson, Taylor and Francis

Course Evaluation:
Individual assignment, Seminar, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements) :
Dynamic loading
POs met through Gaps in the Syllabus: **PO1 to PO5**

Topics beyond syllabus/Advanced topics/Design:
Complicated Dynamic loading
POs met through Topics beyond syllabus/Advanced topics/Design: **PO1 to PO5**

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	3	-	3	3	1
CO2	3	-	3	1	1
CO3	3	2	2	1	2
CO4	3	1	3	1	1
CO5	2	2	3	3	3

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1,CD2,CD6
CO2	CD1,CD2, CD6
CO3	CD1, CD2,CD6
CO4	CD1,CD2,CD6
CO5	CD1,CD2,CD6

COURSE INFORMATION SHEET

Course code: ME515
Course title: Computer Integrated Manufacturing
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 3 L: 3 T: 0 P: 0
Class schedule per week: 03
Class: M. Tech.
Semester / Level: II /05
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students to:

1.	Understand the basic knowledge and skills in the field of computer integrated manufacturing.
2.	Apply the knowledge of design, production and manufacturing systems
3.	Iintegrate manufacturing systems with computer .

Course Outcomes

After the end of the course, a student should be able to:

CO1.	Develop an understanding of classical and state-of-the-art production systems, control systems, management technology, cost systems, and evaluation techniques
CO2.	Develop an understanding of computer-integrated manufacturing (CIM) and its impact on productivity, product cost, and quality..
CO3.	Obtain an overview of computer technologies including computers, database and data collection, networks, machine control, etc, as they apply to factory management and factory floor operations.
CO4.	Describe the integration of manufacturing activities into a complete system
CO5.	Develop an FMS layout for given simple part family, using group technology concepts and familiarize with computer aided process planning

SYLLABUS

Module 1:

Brief introduction to CAD and CAM, Manufacturing Planning and control, Introduction to CIM Concepts & scope of CIM, Nature & type of manufacturing system, Evolution, Benefits of CIM, Mathematical models of Production Performance, Basic Elements of an Automated system, Lean Production and Just-In Time Production (8L)

Module 2:

Numerical Controls, types, evolution of controllers, components of NC/CNC system, specification of CNC system, NC part programming, Programming for drilling, lathe and milling machine operations, Programmable Logic Controllers. (8L)

Module 3:

Group Technology, Part Families – Parts Classification and coding, benefits of group technology, Production flow analysis, Cellular Manufacturing, Quantitative analysis in Cellular Manufacturing. (8L)

Module 4:

Introduction & Component of FMS, Needs of FMS, general FMS consideration, Objectives, Types of FMS, advantages of FMS, Automated material movement & AS/RS AGVS , RGV Manufacturing Cells, Cellular & Flexible manufacturing, Tool Management, Tool supply system, Tool Monitoring System, Work piece Handling, FMS scheduling, sequencing. (8L)

Module 5:

Introduction, Industrial Robots, Robot physical Configuration, Basic Robot motions, Robotic Power sources, Sensors, Actuators, Transducer and Grippers, Technical features such as work volume, precision of movement, speed of movement, weight carrying capacity, Robot Accuracy and Repeatability, Robot applications & economics. (8L)

Text Books

1. Groover, M. P., Automation production systems, and computer integrated manufacturing, second edition, Prentice Hall of India, New Delhi, 2001.

Reference Books

1. Vajpayee, S. K., Principles of computer integrated manufacturing, Prentice Hall of India, New Delhi, 2005.

Course Evaluation:
Individual assignment, Seminar, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements):
Automated inspection
POs met through Gaps in the Syllabus: **PO1 to PO5**

Topics beyond syllabus/Advanced topics/Design:
Design for Assembly.
POs met through Topics beyond syllabus/Advanced topics/Design: **PO3**

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	2	2	1	3	-
CO2	2	2	1	3	-
CO3	2	2	1	3	-
CO4	3	2	2	3	-
CO5	3	2	3	3	2

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1,CD2,CD6
CO2	CD1,CD2, CD6
CO3	CD1, CD2,CD6
CO4	CD1,CD2,CD6
CO5	CD1,CD2,CD6

COURSE INFORMATION SHEET

Course code: ME516
Course title: Advanced CAD and Reverse Engineering Lab
Pre-requisite(s): CAD
Co- requisite(s): Nil
Credits: 2 L: 0 T: 0 P: 4
Class schedule per week: 04
Class: M.Tech.
Semester / Level: II/05
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students to:

1.	Understand various 2D and 3D Modeling techniques
2.	Analyse reverse engineering technique and design attributes
3.	Understand various software for curve fitting
4.	Generate prototypes with various RP techniques

Course Outcomes

At the end of the course, a student should be able to:

CO1.	Create 3D models and prepare a new design
CO2.	Analyse the cloud data points and to further process it
CO3.	Generate usable data after curve fitting and segmentation
CO4.	Produce rapid prototyped parts out of scanned data
CO5.	Generate new ideas and products for varied uses

List of Experiments

Experiment 1: Review of 2-Dimensional drawing.
Experiment 2: Introduction to 3-Dimensional modelling (Part modelling)
Experiment 3: Introduction to assembly modelling and assembly of mechanical engineering components.
Experiment 4: Writing program for 2-D and 3-D transformation for Translation, Scaling, Rotation, Shearing and Reflection.
Experiment 5: To scan and gather the cloud data from the digitizer/ scanner.
Experiment 6: To convert the point cloud to a polygonal mode (Clean, smoothen and sculpt the required shape and memory).
Experiment 7: To draw or create curves on the mesh using automated tools such as feature detection.
Experiment 8: Fit the B Spline surfaces using surface fitting and editing tools.

Experiment 9: Export the final fitted curves to a CAD package and generate tool paths for machining.
Experiment 10: Analysis and measurement of the dimensions of each component for a new design.
Experiment 11: Convert finally to .stl and pass the drawing to the Rapid Prototyping Machine.
Experiment 12: Analyse the final prototype with the initial prototype.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	60
Semester End Examination	40

Continuous Internal Assessment	% Distribution
Day to day performance & Lab files	30
Quiz (es)	10
Viva	20

Semester End Examination	% Distribution
Examination Experiment Performance	30
Quiz	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	3	2
CO2	3	3	3	1	1
CO3	3	2	2	1	2
CO4	3	-	3	1	1
CO5	2	2	3	3	3

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1,CD2,CD3 CD6,CD7
CO2	CD1,CD2,CD3 CD6,CD7
CO3	CD1,CD2,CD3 CD6,CD7
CO4	CD1,CD2,CD3 CD6,CD7
CO5	CD1,CD2,CD3 CD6,CD7

COURSE INFORMATION SHEET

Course code: ME517
Course title: Finite Element Analysis Lab
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 2 L: 0 T: 0 P: 4
Class schedule per week: 04
Class: M.Tech.
Semester / Level: II / 05
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students to:

1.	Understand and apply finite element technique to solve different problems.
2.	Analyse stresses and deformations under various loading conditions.
3.	Determine natural frequencies of structures.
4.	Develop computer codes to solve problems using FEM technique.

Course Outcomes

At the end of the course, a student should be able to:

CO1.	Analyse finite element models of structures under different types of loads.
CO2.	Analyse the structures due to thermal loading.
CO3.	Evaluate the natural frequencies of structures.
CO4.	Analyse non-linear behavior of structures.
CO5.	Create finite element program for analysis of different structures.

List of Experiments

Experiment 1: Stress and deflection analysis of beam due to self-weight.
Experiment 2: Stress and deflection analysis of fixed and overhanging beams.
Experiment 3: Stress and deflection analysis of simply supported beam with distributed loads.
Experiment 4: Stress analysis of rectangular plate with circular hole and determine the stress concentration factor.
Experiment 5: Thermal stress analysis in rectangular plate.
Experiment 6: Geometric Non-linear (*change in response due to large deformation*) analysis of beam.
Experiment 7: Program to solve force and stresses using link element in trusses.
Experiment 8: Program to solve deflection and stresses using beam element in cantilever beam using point load.

Experiment 9: Program to solve deflection and stresses using beam element in simply supported beam using point load.
Experiment 10: Program to solve modal analysis of beam to find natural frequencies using beam element.
Experiment 11: Program to solve plate problems using 2D element.
Experiment 12: Program to solve shell problems using 2D element.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	60
Semester End Examination	40

Continuous Internal Assessment	% Distribution
Day to day performance & Lab files	30
Quiz (es)	10
Viva	20

Semester End Examination	% Distribution
Examination Experiment Performance	30
Quiz	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	2	1
CO2	3	3	3	2	1
CO3	3	3	3	2	1
CO4	3	3	3	2	1
CO5	3	3	3	2	1

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1,CD2,CD3 CD6,CD7
CO2	CD1,CD2,CD3 CD6,CD7
CO3	CD1,CD2,CD3 CD6,CD7
CO4	CD1,CD2,CD3 CD6,CD7
CO5	CD1,CD2,CD3 CD6,CD7

COURSE INFORMATION SHEET

Course code: ME600
Course title: Thesis Part I
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 8 L: T: P:
Class schedule per week:
Class: M.Tech.
Semester / Level: III/06
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students to:

1.	Solve real world problems and challenges.
2.	Solve the various research challenges in the field of Energy Technology.
3.	Create awareness among the students of the characteristics of several domain areas where their project ideas could help humanity.
4.	Improve the team building, communication and management skills of the students

Course Outcomes

At the end of the course, a student should be able to:

CO1.	Demonstrate a sound technical knowledge of their selected project topic.
CO2.	Undertake problem identification, formulation and solution.
CO3.	Design engineering solutions to complex problems utilizing a systems approach.
CO4.	Communicate with engineers and the community at large in written and oral forms.
CO5.	Demonstrate the knowledge, skills and attitudes of a professional engineer.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	60
Semester End Examination	40

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	3	2
CO2	3	-	3	3	2
CO3	3	-	3	3	2
CO4	1	3	3	3	2
CO5	3	3	3	3	2

< 34% = 1, 34-66% = 2, > 66% = 3

COURSE INFORMATION SHEET

Course code: ME612
Course title: Optimization Techniques
Pre-requisite(s): Mathematics, Basics of operation research
Co- requisite(s): Nil
Credits: 3 L: 3 T: 0 P: 0
Class schedule per week: 03
Class: M. Tech.
Semester / Level: III /06
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students to:

1.	Formulate the different engineering optimization problems using the concept of optimization technique.
2.	Develop basic concept of algorithm to solve the different engineering optimization problems.
3.	Analyse and appreciate different algorithm methods in the field of optimization technique.

Course Outcomes

After the end of the course, a student should be able to:

CO1.	Understand and formulation of various engineering optimization problem.
CO2.	Analyze the single variable optimization algorithm.
CO3.	Analyze the multi variable optimization algorithm.
CO4.	Analyze the constrained optimization algorithm.
CO5.	Design and modelling of specialized algorithm.

SYLLABUS

Module 1: Introduction

Introduction to optimization, optimal problem formulation: design variables, constraints, objective function, variable bounds, engineering optimization problems, optimization algorithms. (8L)

Module 2: Single variable optimization algorithms

Optimality criteria, bracketing methods, regional –elimination method, point estimation method, gradient based method, root finding using optimization techniques. (8L)

Module 3: Multi variable optimization algorithms

Optimality criteria, Unidirectional search, direct search method: evolutionary optimization method, Simplex search method (8L)

Module 4: Constrained Optimization algorithms

Transformation methods, sensitivity analysis, direct search for constrained minimization, linearized search technique. (8L)

Module 5: Specialized algorithms

Integer Programming: penalty function, branch and bound method, geometric programming, Bathtub curve, Genetic algorithm (GA): working principle, Differences and similarity between GAs and traditional methods, GAs for constrained optimization, real coded GAs, Advanced GAs. (8L)

Text Books

1. Kalyanmoy Deb, "Optimization for Engineering Design", First Edition, Prentice-Hall India Publishers, 2009.
2. Singiresu S. Rao, "Engineering Optimization theory and practice", Third Edition, New Age Publishers, 2018.

Reference Books

1. Jasbir Arora, "Optimal Design", Mc Graw Hill (International) Publishers.
2. D. E. Goldberg, "Genetic Algorithms in Search, Optimization and Machine Learning", First Edition, John Wiley Publishers, 2009.
3. Kalyanmoy Deb, "Multi Objective Optimization using Evolutionary Algorithms", Wiley Student Edition.

Course Evaluation:
Individual assignment, Seminar, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements) :
Various optimization techniques
POs met through Gaps in the Syllabus: **PO3**

Topics beyond syllabus/Advanced topics/Design:
Practical aspect of optimization
POs met through Topics beyond syllabus/Advanced topics/Design: **PO3**

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	3	1
CO2	3	2	3	2	1
CO3	2	2	3	3	1
CO4	3	3	3	2	1
CO5	3	3	3	3	1

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1,CD2,CD6
CO2	CD1,CD2, CD6
CO3	CD1, CD2,CD6
CO4	CD1,CD2,CD6
CO5	CD1,CD2,CD6

COURSE INFORMATION SHEET

Course code: ME603
Course title: Soft Computational Techniques in Design
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 3 L: 3 T: 0 P: 0
Class schedule per week: 03
Class: M. Tech.
Semester / Level: III /06
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students to:

1.	Conceptualize neural networks and its learning methods.
2.	Infer the basics of genetic algorithms and their applications in optimization and planning.
3.	Interpret the ideas of fuzzy sets, fuzzy logic and fuzzy inference system.
4.	Categorize the tools and techniques available for soft computing, while

Course Outcomes

After the end of the course, a student should be able to:

CO1.	Identify the soft computing techniques and their roles in building intelligent machines.
CO2.	Recognize an appropriate soft computing methodology for an engineering problem.
CO3.	Apply fuzzy logic and reasoning to handle uncertainty while solving engineering problems.
CO4.	Apply neural network to solve engineering problems.
CO5.	Apply genetic algorithms to analyze optimization problems.

SYLLABUS

Module 1:

Introduction: Background, uncertainty and imprecision, statistics and random processes, uncertainty in Information. Fuzzy sets and membership, chance versus ambiguity, fuzzy control from an industrial perspective, Knowledge based systems for process control, knowledge-based controllers, knowledge representation in knowledge-based controllers. (8L)

Module 2:

Mathematics of Fuzzy Control: Classical sets, Fuzzy sets, Properties of fuzzy sets, operations on fuzzy sets. Classical relations and fuzzy relations - Cartesian product, crisp relation, Fuzzy relations, Tolerance and Equivalence Relations, Fuzzy tolerance and equivalence relations, operation on fuzzy relations, The extension principle. (9L)

Module 3:

Membership Function: Features of membership functions, standard forms and boundaries, Fuzzification, Membership value assignment. Fuzzy-to-Crisp conversions: Lambda-cuts for fuzzy sets, Lambda-cuts for fuzzy relations. De-fuzzification Methods. (8L)

Module 4:

Introduction: Structure and foundation of Single Neuron, Neural Net Architectures, Neural Learning Application, Evaluation of Networks, Implementation. Supervised Learning - Single Layer Networks, Perceptions, Linear separability, Training algorithms, Guarantee of success, Modifications. (9L)

Module 5:

Genetic Algorithms: Terminology in GA – strings, structure, parameter string, data structures, operators, coding fitness function, algorithm, applications. (6L)

Text Books

1. Fuzzy logic with Engineering Applications - Timothy J. Ross, McGraw-Hill International Editions.
2. Fuzzy Sets and Fuzzy logic: Theory and Applications - George J. Klir and Bo. Yuan, Prentice- Hall of India Private Limited.
3. Neural Networks: A Comprehensive Foundation – SimanHaykin, IEEE, Press, MacMillan, N.Y. 1994.

Reference Books

1. Elements of Artificial Neural Networks – Kishan Mehrotra, Chilakuri K. Mohan, Sanjay Ranka (Penram International Publishing (India)

Course Evaluation:
Individual assignment, Seminar, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements) :
Cost effective Soft Computational Techniques in Design
POs met through Gaps in the Syllabus: **PO3**

Topics beyond syllabus/Advanced topics/Design:
Advanced Soft Computational Techniques in Design
POs met through Topics beyond syllabus/Advanced topics/Design: **PO3**

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	3	-	3	3	1
CO2	3	-	3	2	1
CO3	3	2	3	2	1
CO4	3	1	3	2	1
CO5	3	2	3	2	1

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1,CD2,CD6
CO2	CD1,CD2, CD6
CO3	CD1, CD2,CD6
CO4	CD1,CD2,CD6
CO5	CD1,CD2,CD6

COURSE INFORMATION SHEET

Course code: ME604
Course title: Computer Graphics
Pre-requisite(s): Computer Aided Design
Co- requisite(s): Nil
Credits: 3 L: 3 T: 0 P: 0
Class schedule per week: 03
Class: M. Tech.
Semester / Level: III /06
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students to:

1.	Develop a knowledge of what is computer graphics.
2.	Do future studies in Graphic primitives and attributes of primitives and to prepare the students to effectively use it in the practice of engineering.
3.	Develop an intuitive understanding of why and how to incorporate computer graphics and its importance in the real world
4.	Get aware of transformations and analytical & synthetic curve generation.
5.	Know about viewing and clipping systems and the various applications of it in computer graphics system.

Course Outcomes

After the end of the course, a student should be able to:

CO1.	Understand the Computer Graphics and its application in real world.
CO2.	To know about the Graphic primitives.
CO3.	Able to understand the Attributes of primitives and Antialiasing.
CO4.	Able to understand the Transformations in computer graphics.
CO5.	Outline the concepts of Viewing and Clipping.

SYLLABUS

Module 1:

Display device: Refresh Cathode ray Tubes, Random Scan and Raster Scan monitors, Colour CRT Monitors, Direct view Storage Tubes, Continuous Refresh and Storage display, LED and LCD Monitors.

Graphic primitives: Points & Lines, Line drawing Algorithm, DDA and Bresenham's Algorithm. (8L)

Module 2:

Attributes of primitives: Line style, Type, Width, Colour, Character Attributes, Area Filling, Antialiasing. Fill Algorithm: Scan-Line Polygon Fill algorithm, Boundary Fill Algorithm, Flood Fill Algorithm, Seed fill algorithm. (8L)

Module 3:

Analytical & Synthetic curve: C0, C1 & C2 Continuity, Convex hull, Parametric & non-parametric representation of curves.

Analytic curves: Circle, Ellipse, Parabola, Hyperbola, Splines: linear, quadratic, cubic, hermite, Bezier curves, Synthetic Curves: Circle and ellipse drawing, Parametric and Breshenham's algorithm. (8L)

Module 4:

2D Transformation: Basic transformation- Translation, Scaling, Rotation, Reflection, Twist, Matrix Representation, Composite Transformations.

3D Transformation: Basic Transformations, 3D Display parallel & perspective projection. (8L)

Module 5:

Viewing: Viewing world co-ordination system, Normalized co-ordinate system, Device/Image co-ordination system, Window definitions, View port definitions, Viewing transformation.

Clipping: Point clipping, Line clipping, Cohen- Sutherland clipping, Midpoint clipping method, Sutherland and Hodgman Clipping. (8L)

Text Books

1. Computer Graphics-Donald Hearn and M. Pauline Baker - Prentice Hall of India Pvt Ltd.
2. Introduction to Computer Graphics - N. Krishnamurhy - TMH Publication

Reference Books

1. Computer Graphics - Harrington S. - TMH Publication
2. CAD-CAM Theory and Practice - Ibrahim Zeid - TMH Publication
3. Computer Graphics - Schaum's Outline - TMH Publication

Course Evaluation:
Individual assignment, Seminar, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements) :
Computer Aided Design
POs met through Gaps in the Syllabus: **PO1 to PO5**

Topics beyond syllabus/Advanced topics/Design:
Advance Computer Aided Design
POs met through Topics beyond syllabus/Advanced topics/Design: **PO1 to PO5**

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	3	-	3	3	1
CO2	3	-	3	1	1
CO3	3	2	2	1	2
CO4	3	1	3	1	1
CO5	2	2	3	3	3

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1,CD2,CD6
CO2	CD1,CD2, CD6
CO3	CD1, CD2,CD6
CO4	CD1,CD2,CD6
CO5	CD1,CD2,CD6

COURSE INFORMATION SHEET

Course code: ME605
Course title: Additive Manufacturing
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 3 L: 3 T: 0 P: 0
Class schedule per week: 03
Class: M. Tech.
Semester / Level: III /06
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students to:

1.	Exploit technology used in additive manufacturing.
2.	Understand importance of additive manufacturing in advance manufacturing process.
3.	Acquire knowledge, techniques and skills to select relevant additive manufacturing process.
4.	Explore the potential of additive manufacturing in different industrial sectors.
5.	Apply 3D printing technology for additive manufacturing.

Course Outcomes

After the end of the course, a student should be able to:

CO1.	Define the various process used in Additive Manufacturing.
CO2.	Analyse and select suitable process and materials used in Additive Manufacturing.
CO3.	Identify, analyse and solve problems related to Additive Manufacturing.
CO4.	Apply knowledge of additive manufacturing for various real-life applications
CO5.	Apply technique of CAD and reverse engineering for geometry transformation in Additive Manufacturing.

SYLLABUS

Module 1: Introduction

Overview, Basic principle need and advantages of additive manufacturing, Procedure of product development in additive manufacturing, Classification of additive manufacturing processes, Materials used in additive manufacturing, Challenges in Additive Manufacturing. (8L)

Module 2: Additive Manufacturing Processes

Z-Corporation 3D-printing, Stereolithography apparatus (SLA), Fused deposition modeling (FDM), Laminated Object Manufacturing (LOM), Selective deposition lamination (SDL), Ultrasonic consolidation, Selective laser sintering (SLS), Laser engineered net shaping (LENS), Electron beam free form fabrication (EBFFF), Electron beam melting (EBM), Plasma transferred arc additive manufacturing (PTAAM), Tungsten inert gas additive manufacturing (TIGAM), Metal inert gas additive manufacturing (MIGAM). (8L)

Module 3: Additive Manufacturing Machines and Systems

Axes, Linear motion guide ways, Ball screws, Motors, Bearings, Encoders/ Glass scales, Process Chamber, Safety interlocks, Sensors. Introduction to NC/CNC/DNC machine tools, CNC programming and introduction, Hardware Interpolators, Software Interpolators, Recent developments of CNC systems for additive manufacturing. (8L)

Module 4: Pre-Processing in Additive Manufacturing

Preparation of 3D-CAD model, Reverse engineering, Reconstruction of 3D-CAD model using reverse engineering, Part orientation and support generation, STL Conversion, STL error diagnostics, Slicing and Generation of codes for tool path, Surface preparation of materials. (8L)

Module 5: Post-Processing in Additive Manufacturing

Support material removal, surface texture improvement, accuracy improvement, aesthetic improvement, preparation for use as a pattern, property enhancements using non-thermal and thermal techniques, Brief information on characterization techniques used in additive manufacturing, Applications of additive manufacturing in rapid prototyping, rapid manufacturing, rapid tooling, repairing and coating. (8L)

Text Books

1. Gibson, I, Rosen, D W., and Stucker,B., Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing,Springer, 2010
2. Chua C.K., Leong K.F., and Lim C.S., "Rapid prototyping: Principles and applications", Third Edition, World Scientific Publishers, 2010
3. Chee Kai Chua, Kah Fai Leong, 3D Printing and Additive Manufacturing: Principles and Applications: Fourth Edition of Rapid Prototyping, World Scientific Publishers, 2014
4. Gebhardt A., "Rapid prototyping", Hanser Gardener Publications, 2003

Reference Books

1. Liou L.W. and Liou F.W., "Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press, 2007
2. Kamrani A.K. and Nasr E.A., "Rapid Prototyping: Theory and practice", Springer, 2006
3. Mahamood R.M., Laser Metal Deposition Process of Metals, Alloys, and Composite Materials, Engineering Materials and Processes, Springer International Publishing AG 2018
4. Ehsan Toyserkani, Amir Khajepour, Stephen F. Corbin, "Laser Cladding", CRC Press, 2004

Course Evaluation:
Individual assignment, Seminar, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements):
Finite element simulation of additive process
POs met through Gaps in the Syllabus: **PO1 to PO5**

Topics beyond syllabus/Advanced topics/Design:
Thermal model to predict size of deposition such as width and height of deposition.
POs met through Topics beyond syllabus/Advanced topics/Design: **PO3**

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	-	2	-	3	1
CO2	2	1	1	-	3
CO3	1	3	2	3	-
CO4	-	-	1	3	1
CO5	-	-	3	2	3

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1,CD2,CD6
CO2	CD1,CD2, CD6
CO3	CD1, CD2,CD6
CO4	CD1,CD2,CD6
CO5	CD1,CD2,CD6

COURSE INFORMATION SHEET

Course code: ME606
Course title: Optimization Techniques Lab
Pre-requisite(s): Basic programming knowledge
Co- requisite(s): Nil
Credits: 2 L: 0 T: 0 P: 4
Class schedule per week: 04
Class: M. Tech.
Semester / Level: III/06
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students to:

1.	Learn various optimization technique methods.
2.	Understand the use of matlab in optimization problems.
3.	Generate different programming in matlab for different cases.
4.	Use of genetic algorithm in different optimization problems.

Course Outcomes

At the end of the course, a student should be able to:

CO1.	Learn efficient computational procedures to solve optimization problems.
CO2.	Implementation of matlab in important optimization methods.
CO3.	Generate usable data after matlab programming for optimization problems.
CO4.	Produce solution for different engineering maxima/minima problems.
CO5.	Formulation of genetic algorithm in optimization problems.

List of Experiments

Experiment 1: Introduction to optimization techniques using MATLAB
Experiment 2: Study of introduction of MATLAB
Experiment 3: Study of basic matrix operation using MATLAB
Experiment 4: Differentiation of a vector and matrix in Matlab
Experiment 5: Integration of a vector and matrix in Matlab
Experiment 6: Introduction to linear programming.
Experiment 7: Formulation of simplex algorithm in Matlab.
Experiment 8: Introduction to quadratic programming.
Experiment 9: Implementation of Newton's method in MATLAB
Experiment 10: Implementation of Secant method in MATLAB
Experiment 11: Introduction of Genetic Algorithm in optimization
Experiment 12: Formulation of genetic algorithm in MATLAB

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	60
Semester End Examination	40

Continuous Internal Assessment	% Distribution
Day to day performance & Lab files	30
Quiz (es)	10
Viva	20

Semester End Examination	% Distribution
Examination Experiment Performance	30
Quiz	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	3	2
CO2	3	3	3	2	2
CO3	3	2	2	1	1
CO4	3	1	2	3	3
CO5	2	1	2	2	3

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1,CD2,CD3 CD6,CD7
CO2	CD1,CD2,CD3 CD6,CD7
CO3	CD1,CD2,CD3 CD6,CD7
CO4	CD1,CD2,CD3 CD6,CD7
CO5	CD1,CD2,CD3 CD6,CD7

COURSE INFORMATION SHEET

Course code: ME650
Course title: Thesis Part II
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 16 L: T: P:
Class schedule per week:
Class: M.Tech.
Semester / Level: IV/06
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students to:

1.	Solve real world problems and challenges.
2.	Solve the various research challenges in the field of Energy Technology.
3.	Create awareness among the students of the characteristics of several domain areas where their project ideas could help humanity.
4.	Improve the team building, communication and management skills of the students

Course Outcomes

At the end of the course, a student should be able to:

CO1.	Demonstrate a sound technical knowledge of their selected project topic.
CO2.	Undertake problem identification, formulation and solution.
CO3.	Design engineering solutions to complex problems utilizing a systems approach.
CO4.	Communicate with engineers and the community at large in written and oral forms.
CO5.	Demonstrate the knowledge, skills and attitudes of a professional engineer.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	60
Semester End Examination	40

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	3	2
CO2	3		3	3	2
CO3	3		3	3	2
CO4	1	3	3	3	2
CO5	3	3	3	3	2

< 34% = 1, 34-66% = 2, > 66% = 3

OPEN ELECTIVES

COURSE INFORMATION SHEET

Course code: ME582
Course title: Design Methodology
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 3 L: 3 T: 0 P: 0
Class schedule per week: 03
Class: M. Tech
Semester / Level: I/II /05
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students to:

1.	Gain concepts of design research and methodology
2.	Carry out research into design.
3.	Understand design as a phenomenon.
4.	Identify research topics.
5.	Understand structures of research documentation.

Course Outcomes

At the end of the course, a student should be able to:

CO1.	Determine type of research to be persuaded.
CO2.	Improve design aspects in a systematic way.
CO3.	Develop a research plan.
CO4.	Validate the improvements in a methodical manner.
CO5.	Document and report research process and outcomes.

SYLLABUS

Module 1:

Introduction to design research: What and Why; Current issues with design research and the need for a design research methodology; Major facets of design and design research. Introduction to design research methodology - its main components, and examples to explain the components. (8L)

Module 2:

Starting design research: Clarification of requirements: Identifying research topics, carrying out literature search, consolidating the topic into research questions and hypotheses, and developing a research plan. (8L)

Module 3:

Descriptive study: Type, Processes for carrying out descriptive studies for developing an understanding a facet of design and its influences; Introduction to associated descriptive study real-time and retrospective research methods for data collection such as protocol analysis, questionnaire surveys, interviews etc; Introduction to quantitative and qualitative data analysis methods. (8L)

Module 4:

Prescriptive study: Types, Processes for developing design support and associated prescriptive study research methods. Types of support evaluation; Processes for evaluating a design support, and associated Evaluation study research methods. (8L)

Module 5:

Documentation: Types and structures of research documentation, Approaches and guidelines for documenting and reporting research process and outcomes. (8L)

Text Books

1. The Future of Design Methodology, Editors: Birkhofer, Herbert (Ed.) Springer-Verlag, 2011.
2. Design Thinking Methodology, Emrah Yayici.
3. Universal Methods of Design: 100 Ways to Research Complex Problems, Develop Innovative Ideas, and Design Effective Solutions, Bruce Hanington and Bella Martin 2012

Reference Books

1. Blessing, L.T.M., Chakrabarti A. and Wallace, K.M. An Overview of Design Studies in Relation to a Design Research Methodology, Designers: the Key to Successful Product Development, Frankenberger & Badke-Schaub (Eds.), Springer-Verlag, 1998.

Course Evaluation:
Individual assignment, Seminar, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements) :
Cost effective design methods.
POs met through Gaps in the Syllabus: **PO3**

Topics beyond syllabus/Advanced topics/Design:
Advanced design methods.
POs met through Topics beyond syllabus/Advanced topics/Design: **PO3**

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	2		2
CO2	1	3	2		2
CO3	1	3	2		1
CO4	2	3	2		1
CO5	2	3	2		3

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1,CD2,CD6
CO2	CD1,CD2,CD6
CO3	CD1,CD2,CD6
CO4	CD1,CD2,CD6
CO5	CD1,CD2,CD6

COURSE INFORMATION SHEET

Course code: ME583
Course title: Renewable Energy
Pre-requisite(s): Basic of Physics, Chemistry and Mathematics
Co- requisite(s): Nil
Co- requisite(s): Nil
Credits: 3 L: 3 T: 0 P: 0
Class schedule per week: 03
Class: M. Tech
Semester / Level: I/II /05
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students to:

1.	Create awareness about sources of energy and able to estimate how long the available conventional fuel reserves will last.
2.	Learn the fundamental concepts about solar energy systems and devices.
3.	Design wind turbine blades and know about applications of wind energy for water pumping and electricity generation.
4.	Understand the working of advanced renewable energy sources.

Course Outcomes

At the end of the course, a student should be able to:

CO1.	Understand of renewable and non-renewable sources of energy.
CO2.	Gain knowledge about working principle of various solar energy systems
CO3.	Understand the application of wind energy and wind energy conversion system.
CO4.	Develop capability to do basic design of bio gas plant.
CO5.	Understand the applications of different advanced renewable energy sources.

SYLLABUS

Module 1: INTRODUCTION TO ENERGY STUDIES

Introduction, Energy science and Technology, Forms of Energy, Importance of Energy Consumption as Measure of Prosperity, Per Capita Energy Consumption, Roles and responsibility of Ministry of New and Renewable Energy Sources, Needs of renewable energy, Classification of Energy Resources, Conventional Energy Resources , Non-Conventional Energy Resources, World Energy Scenario, Indian Energy Scenario. (8L)

Module 2: SOLAR ENERGY

Introduction, Solar Radiation, Sun path diagram, Basic Sun-Earth Angles, Solar Radiation Geometry and its relation, Measurement of Solar Radiation on horizontal and tilted surfaces, Principle of Conversion of Solar Radiation into Heat, Collectors, Collector efficiency, Selective surfaces, Solar Water Heating system , Solar Cookers , Solar driers, Solar Still, Solar Furnaces, Solar Greenhouse. Solar Photovoltaic, Solar Cell fundamentals, Characteristics, Classification, Construction of module, panel and array. Solar PV Systems (stand-alone and grid connected), Solar PV Applications. Government schemes and policies.

(8L)

Module 3: WIND ENERGY

Introduction, History of Wind Energy, Wind Energy Scenario of World and India. Basic principles of Wind Energy Conversion Systems (WECS), Types and Classification of WECS, Parts of WECS, Power, torque and speed characteristics, Electrical Power Output and Capacity Factor of WECS, Stand alone, grid connected and hybrid applications of WECS, Economics of wind energy utilization, Site selection criteria, Wind farm, Wind rose diagram.

(8L)

Module 4: BIOMASS ENERGY

Introduction, Biomass energy, Photosynthesis process, Biomass fuels, Biomass energy conversion technologies and applications, Urban waste to Energy Conversion, Biomass Gasification, Types and application of gasifier, Biomass to Ethanol Production, Biogas production from waste biomass, Types of biogas plants, Factors affecting biogas generation, Energy plantation, Environmental impacts and benefits, Future role of biomass , Biomass programs in India. (8L)

Module 5: ADVANCED RENEWABLE ENERGY SOURCES

Introduction to advanced renewable energy, Hydropower, Wave Energy, Tidal Energy, Ocean Thermal Energy, Geothermal Energy, Bio-fuels, Animal Energy. (8L)

Text Books

1. Sukhatme. S.P., Solar Energy, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1997.
2. B. H. Khan, Non-Conventional Energy Resources, , The McGraw Hill
3. G N Tiwari, R K Mishra, Advanced renewable energy sources, RSC Publishing, 2012
4. Twidell, J.W. & Weir, A. Renewable Energy Sources, EFN Spon Ltd., UK, 2006.
5. S. P. Sukhatme and J.K. Nayak, Solar Energy – Principles of Thermal Collection and Storage, Tata McGraw-Hill, New Delhi.
6. Garg, Prakash, Solar Energy, Fundamentals and Applications, Tata McGraw Hill.

Reference Books

1. G.D. Rai, Non-Conventional Energy Sources, Khanna Publications, New Delhi, 2011.
2. Godfrey Boyle, "Renewable Energy, Power for a Sustainable Future", Oxford University Press, U.K., 1996.
3. Khandelwal, K.C., Mahdi, S.S., Biogas Technology – A Practical Handbook, Tata McGraw-Hill, 1986.
4. Tiwari. G.N., Solar Energy – "Fundamentals Design, Modeling & Applications", Narosa Publishing House, New Delhi, 2002.
5. Freris. L.L., "Wind Energy Conversion Systems", Prentice Hall, UK, 1990.
6. Frank Krieth& John F Kreider ,Principles of Solar Energy, John Wiley, New York

Course Evaluation:

Individual assignment, Seminar, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements) :

High temperature solar thermal application

POs met through Gaps in the Syllabus: **PO3**

Topics beyond syllabus/Advanced topics/Design:

Advance bio fuels

POs met through Topics beyond syllabus/Advanced topics/Design: **PO3**

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	1	2	3	-	2
CO2	1	2	3	-	2
CO3	1	2	3	-	2
CO4	2	2	3	-	2
CO5	1	2	3	-	2

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1,CD2,CD6
CO2	CD1,CD2, CD6
CO3	CD1, CD2,CD6
CO4	CD1,CD2,CD6
CO5	CD1,CD2,CD6

COURSE INFORMATION SHEET

Course code: ME584
Course title: Energy Management Principles and Auditing
Pre-requisite(s): Basic of Physics, Chemistry and Mathematics
Co- requisite(s): Nil
Co- requisite(s): Nil
Credits: 3 L: 3 T: 0 P: 0
Class schedule per week: 03
Class: M. Tech
Semester / Level: I/II /05
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students to:

1.	Gain introductory knowledge of Energy management and energy audit.
2.	Understand basic concepts of Energy conservation.
3.	Understand Energy efficiency and cost benefit.

Course Outcomes

At the end of the course, a student should be able to:

CO1.	Outline energy management system and related policies and Acts.
CO2.	Apply the concept of Energy Management in energy related issues.
CO3.	Work with energy management system and energy audit of whole system.
CO4.	Analyze energy conservation related to environmental issues.
CO5.	Carry out Auditing of relevant interdisciplinary systems.

SYLLABUS

Module 1: INTRODUCTION

Energy and Sources of energy, Energy consumption and GDP, Costs of exploration and utilization of resources, Energy pricing, Energy demand and supply, National energy plan, Need for Energy Policy, National and State level Energy Policies. Basic concepts of Energy Conservation and its importance, Energy Strategy for the Future, The Energy Conservation Act and its Features, Energy conservation in household, Transportation, Agricultural, Service and Industrial sectors, Lighting, HVAC Systems. (8L)

Module 2: ENERGY MANAGEMENT

History of Energy Management, Definition and Objective of Energy Management and its importance. Need of energy management, General Principles of Energy Management, Energy Management Skills, and Energy Management Strategy. Energy Management Approach. Understanding Energy Costs, Benchmarking, Energy performance, Matching energy usage to requirements, Maximizing system efficiency, Optimizing the input energy requirements, Fuel and Energy substitution. Organizing, Initiating and Managing an energy management program. Roles, responsibilities and accountability of Energy Managers. (8L)

Module 3: ENERGY AUDIT

Energy audit concepts, Definition, Need and Types of energy audit. Energy Audit Approach and Methodology. Systematic procedure for technical audit. Understanding energy audit costs, Benchmarking and Energy Performance. Energy audit based on First law and Second law of thermodynamics, Mass and Energy balances, Availability analysis, Evaluation of energy conserving opportunities, Economic analysis and life cycle costing. Duties and responsibilities of energy auditors. Energy audit instruments and their usage for auditing**.** Report-writing, preparations and presentations of energy audit reports. (8L)

Module 4: ENERGY CONSERVATION AND ENVIRONMENT

Energy conservation areas**,** Energy transmission and storage, Plant Lecture wise energy optimization Models, Data base for energy management, Energy conservation through controls, Computer aided energy management, Program organization and methodology. Energy environment interaction, Environmental issues, Global Warming, Climate Change Problem and Response, Carbon dioxide emissions, Depletion of ozone layer, Governments Regulations, Energy Economy interaction. Energy Conservation in Buildings, Energy Efficiency Ratings & ECBC (Energy Conservation Building Code). (8L)

Module 5: INTERDISCIPLINARY CASE STUDIES

Study of 4 to 6 cases of Energy Audit & Management in Industries (Mechanical, Chemical and other systems). (8L)

Text Books

1. Amlan Chakrabarti, Energy Engineering and Management, PHI, Eastern Economy Edition.
2. Smith CB, Energy Management Principles, Pergamon Press, New York.
3. Hamies, Energy Auditing and Conservation; Methods, Measurements, Management & Case study, Hemisphere, Washington
4. L. C. Witte, P. S. Schmidt and D. R. Brown, Industrial Energy Management and Utilization, Hemisphere Publications, Washington.

Reference Books

1. W.R.Murphy, G.Mckay, Energy Management, Butterworths.
2. C.B.Smith Energy Management Principles, Pergamon Press.
3. L.C. Witte, P.S. Schmidt, D.R. Brown , Industrial Energy Management and Utilization, Hemisphere Publication, Washington
4. Archie, W Culp , Principles of Energy Conservation, McGraw Hill
5. Munasinghe, Mohan Desai, Ashok V, Energy Demand: Analysis, Management and Conservation, Wiley Eastern Ltd., New Delhi.

Course Evaluation:

Individual assignment, Seminar, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements) :

Cost effective energy management

POs met through Gaps in the Syllabus: **PO3**

Topics beyond syllabus/Advanced topics/Design:

Advance energy auditing system

POs met through Topics beyond syllabus/Advanced topics/Design: **PO3**

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	1	2	3	-	2
CO2	1	2	3	-	2
CO3	1	2	3	-	2
CO4	1	2	3	-	2
CO5	1	2	3	-	2

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1,CD2,CD6
CO2	CD1,CD2, CD6
CO3	CD1, CD2,CD6
CO4	CD1,CD2,CD6
CO5	CD1,CD2,CD6

COURSE INFORMATION SHEET

Course code: ME585
Course title: Industrial Robotics
Pre-requisite(s): Engineering Mathematics, Engineering Mechanics.
Co- requisite(s): Nil
Credits: 3 L: 3 T: 0 P: 0
Class schedule per week: 03
Class: M. Tech
Semester / Level: I/II /05
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students to:

1.	Understand the kinematic design and dynamic formulation of a typical industrial robot.
2.	Foresee the possibilities in design uncertainties in kinematic model of a robot and make necessary changes in the modelling to make the controller perform precisely.
3.	Estimate the possible errors in dynamic forces/torques that may come on the actuators due to un-modelled parameters.
4.	Understand the parallel robot kinematic design and solve its inverse and forward kinematics.
5.	Evaluate a robot performance based on standard parameters.

Course Outcomes

At the end of the course, a student should be able to:

CO1.	Outline the structure of a typical robotic system, understand its link and joint parameters, and perform robot kinematics.
CO2.	Identify the geometric parameters of a serial robot by applying the knowledge of serial robot kinematics and generalized differential model of the robot.
CO3.	Identify the dynamic parameters of a serial robot by applying the knowledge of general form of dynamic equation of motion.
CO4.	Analyse planar and spatial parallel robots in context to its forward and inverse kinematics, and evaluate its singularity, condition number and manoeuvrability.
CO5.	Design a robotic manipulator and evaluate its primary and secondary workspace. Evaluate the performance of an industrial robot based on ISO standards.

SYLLABUS

Module 1:

Robotic systems - Its role in automated manufacturing; robot anatomy; classifications and specifications, Serial robot kinematics: forward and inverse, homogeneous transformations. (8L)

Module 2:

Robot sensors, different types of contact and non-contact sensors; Robot vision and their interfaces. (8L)

Module 3:

Robot actuators and control; Pneumatic, hydraulic and electrical drives, controls used in robots. Robot end-effectors: mechanical, magnetic and vacuum grippers, gripping forces RCC and design features of grippers. (8L)

Module 4:

Robot languages and programming techniques. Performance analysis of Robots: Accessibility, Workspace of a robot manipulator: primary and secondary spaces, Orientation workspace, Local performances: Manipulability, Repeatability, Isotropy and Dexterity. (8L)

Module 5:

Applications of robots in materials handling, machine loading/unloading, inspection, welding, spray painting and finish coating, and assembly, etc. Robot installation and planning. (8L)

Text Books

1. Industrial Robotic Technology - Programming and Application by M. P. Groover et. al., McGraw Hill
2. KS Fu, C. S. G Lee, R. Gonzalez, Robotics: Control, Sensing, Vision and Intelligence, McGraw-Hill Education, 1987.
3. S. K. Saha, Introduction to Robotics, McGraw Hill Education, 2008.

Reference Books

1. Bruno Siciliano and Oussama Khatib, Handbook of Robotics, Springer, 2016.
2. ISO 9283:1998 Manipulating industrial robots -- Performance criteria and related test methods, ISO, 1998.

Course Evaluation:

Individual assignment, Seminar, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements):
Cost effective performance analysis of robots.
POs met through Gaps in the Syllabus: **PO3**

Topics beyond syllabus/Advanced topics/Design:
Performance analysis of robots.
POs met through Topics beyond syllabus/Advanced topics/Design: **PO3**

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	2	2	2	3	2
CO2	3	3	3	3	2
CO3	3	3	3	3	2
CO4	3	3	3	3	2
CO5	3	3	3	3	3

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1,CD2,CD6
CO2	CD1,CD2,CD6
CO3	CD1,CD2,CD6
CO4	CD1,CD2,CD6
CO5	CD1,CD2,CD6

COURSE INFORMATION SHEET

Course code: ME586
Course title: Reliability in Design
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 3 L: 3 T: 0 P: 0
Class schedule per week: 03
Class: M. Tech
Semester / Level: I/II /05
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students to:

1.	Understand role of reliability evaluation.
2.	Identify reliability assessment techniques that may provide guidance for robust designs.
3.	Apply common concepts from statistics in design.
4.	Explore types of maintenance.
5.	Assess reliability of components and systems.

Course Outcomes

At the end of the course, a student should be able to:

CO1.	Perform reliability improvement and life tests.
CO2.	Recommend how further analysis, testing, or quality control may increase safety and efficiency of a structural design.
CO3.	Evaluate and apply statistical methods to structural design.
CO4.	Design for maintainability and its considerations.
CO5.	Formulate and solve reliability-based structural optimization problems.

SYLLABUS

Module 1: RELIABILITY BASICS

Basic Concepts of Reliability, Definition of Reliability, Role of Reliability evaluation, Design for reliability, Design under uncertainty, Why use probabilistic methods, Success stories, bath-tub-curve, system reliability, reliability improvement, maintainability and availability, Life tests, Acceptance sampling based on life tests. (8L)

Module 2: RELIABILITY IN DESIGN AND DEVELOPMENT

Introduction to Design of Experiments (DOE) and Taguchi Method, Failure mode and effects analysis, Basic symbols, Fault Tree construction and analysis, Monte Carlo Simulation, Human factors in design and design principles. (8L)

Module 3: RELIABILITY MANAGEMENT

Objectives of maintenance, types of maintenance, Maintainability, factors affecting maintainability, system down time, availability - inherent, achieved and operational availability (Numerical treatment). Introduction to Reliability Centered Maintenance. Design for maintainability and its considerations, Reliability and costs, Costs of Unreliability. (8L)

Module 4: SYSTEM RELIABILITY ANALYSIS

Reliability Improvement, Redundancy, element redundancy, unit redundancy, standby redundancy types of stand by redundancy, parallel components single redundancy, multiple redundancies (problems). (8L)

Module 5: LIFE TESTING & RELIABILITY ASSESSMENT

Censored and uncensored field data, burn-in testing, acceptance testing, accelerated testing, identifying failure distributions & estimation of parameters, reliability assessment of components and systems. (8L)

Text Books

1. Nikolaidis E., Ghiocel D. M., Singhal S., Engineering Design Reliability Handbook, CRC Press, Boca Raton, FL, 2004.
2. McPherson J.W., Reliability Physics and Engineering: Time to Failure Modeling, 2nd Edition, Springer, 2013.
3. Ebeling, C. E., An Introduction to Reliability and Maintainability Engineering, Waveland Press, Inc., 2009 (ISBN 1-57766-625-9).
4. Bryan Dodson, Dennis Nolan, Reliability Engineering Handbook, Marcel Dekker Inc, 2002.
5. Kapur, K. C., and Lamberson, L. R., Reliability in Engineering Design, John Wiley and Sons, 1977.

Reference Books

1. Reliability toolkit: Commercial practices edition. Reliability Analysis Center, 1995.
2. Blischke, Wallace R., and DN Prabhakar Murthy. Reliability: modeling, prediction, and optimization. Vol. 767. John Wiley & Sons, 2011.
3. Leemis, Lawrence M. Reliability: probabilistic models and statistical methods. Prentice-Hall, Inc., 1995.
4. Modarres, Mohammad, Mark P. Kaminskiy, and Vasiliy Krivtsov. Reliability engineering and risk analysis: a practical guide. CRC press, 2009.
5. O'Connor, Patrick, and Andre Kleyner. Practical reliability engineering. John Wiley & Sons, 2011.
6. Singiresu S Rao, Reliability Engineering, Pearson Education, 2014, ISBN: 978-0136015727.
7. Webpage : https://goremote.itap.purdue.edu/Citrix/XenApp/auth/login.aspx

Course Evaluation:

Individual assignment, Seminar, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements) :

Cost effective reliable design methods.

POs met through Gaps in the Syllabus: **PO3**

Topics beyond syllabus/Advanced topics/Design:

Advanced methods for reliable design.

POs met through Topics beyond syllabus/Advanced topics/Design: **PO3**

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

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Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

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MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	2	2	2	-	1
CO2	2	2	3	-	1
CO3	2	2	2	3	1
CO4	2	2	2	-	1
CO5	2	3	3	3	1

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1,CD2,CD6
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CO4	CD1,CD2,CD6
CO5	CD1,CD2,CD6