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 appropriate technology with responsibility.
- Creation of congenial atmosphere and ample research facilities for undertaking quality research to achieve national and international recognition by faculty and students.
- To strive for 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 acquire in depth knowledge of computer aided design and modern computational techniques for modeling, analyzing and optimizing mechanical components.

PEO 2: To foster a confident and competent post graduate who will be able to solve real life problems successfully in challenging industrial environment.

PEO 3: To develop the capacity of students in up-coming areas of research in computer aided design of mechanical systems..

PEO 4: To prepare post graduates who will work in a team to carry out multidisciplinary research and will be able to present a substantial technical report

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

PO1: Analyze and conduct independent research on complex design-based problems.

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

PO3: 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: Function effectively with others as part of collaborative and multidisciplinary team.

PO5: Understand professional and ethical responsibility while carrying out research and design activities.

COURSE INFORMATION SHEET

Course code: ME501
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.
2.	Learn linear algebra for solving problems.
3.	Learn differential calculus to solve numerical problems
4.	Learn integral calculus to solve numerical problems.
5.	Apply numerical methods for solving engineering problems.

Course Outcomes

At 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 eigenvalues and eigenvectors, householder transformation.

(8 L)

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.

(8 L)

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 integrals. (8 L)

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.

(8 L)

Module 5:

Partial Differential Equations: Classifications of PDEs, Elliptic equations, parabolic equations, Hyperbolic equations (wave equation). (8 L)

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 McGrawhill.

Course Evaluation:
Individual assignment, 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 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,CD6
CO2	CD1, CD6,CD7
CO3	CD1, CD2, CD3,CD6,CD7
CO4	CD1, CD3,CD6,CD7
CO5	CD1,CD2,CD3,CD4,CD5,CD7

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:

1.	To understand the transformation techniques and solid modelling.
2.	To generate the Synthetic Curves.
3.	To develop programs for design and drawing of Machine Elements.
4.	To develop 3D drawings and analyse.
5.	To develop machine elements and design on CAD software

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 I:

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. (8 L)

Module II:

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. (8 L)

Module III:

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

Module IV:

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

Module V:

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

Text Book

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 Book

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

Course Evaluation:

Individual assignment, 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 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

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MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1,CD6
CO2	CD1, CD6,CD7
CO3	CD1, CD2, CD3,CD6,CD7
CO4	CD1, CD3,CD6,CD7
CO5	CD1,CD2,CD3,CD4,CD5,CD7

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:

1.	To get familiar with the fundamentals of solid mechanics.
2.	To understand mathematical formulations of several problems.
3.	To develop the ability to formulate the problems and apply appropriate numerical schemes.
4.	To clearly understand the difference as well as suitability to apply the RANS and scale resolving approach.
5.	To be able to 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 I:

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. (8 L)

Module II:

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. (8 L)

Module III:

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. (8 L)

Module IV:

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. (8 L)

Module V:

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. (8 L)

Text Book

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 Book

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

Course Evaluation:
Individual assignment, 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:
Fretting fatigue stress analysis in heterogeneous material
POs met through Topics beyond syllabus/Advanced topics/Design: PO3

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,CD6
CO2	CD1, CD6,CD7
CO3	CD1, CD2, CD3,CD6,CD7
CO4	CD1, CD3,CD6,CD7
CO5	CD1,CD2,CD3,CD4,CD5,CD7

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:

1.	To get familiar with the fundamentals of CFD.
2.	To understand various mathematical techniques used in CFD.
3.	To develop the ability to formulate the problems and apply appropriate numerical schemes.
4.	To clearly understand the difference as well as suitability to apply the RANS and scale resolving approach.
5.	To be able to implement the concepts using simple CFD codes.

Course Outcomes:

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

CO1	To understand the fundamentals of CFD.
CO2	To develop an intuitive understanding of the CFD techniques.
CO3	To understand the fundamentals of turbulence modelling.
CO4	To learn fundamentals on the near-wall modelling approach.
CO5	To apply the CFD concepts on real-world problems.

SYLLABUS

Module I:

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. (8 L)

Module II:

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. (8 L)

Module III:

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. (8 L)

Module IV:

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 condition. (8 L)

Module V:

Best practice guidelines: Application uncertainty; Numerical uncertainty – convergence, enhancing convergence, numerical errors; Numerical stability. (8 L)

Text Book

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 Book

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, 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:
Discontinuous Galerkin methods for computational fluid dynamics
POs met through Topics beyond syllabus/Advanced topics/Design: **PO3**

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,CD6
CO2	CD1, CD6,CD7
CO3	CD1, CD2, CD3,CD6,CD7
CO4	CD1, CD3,CD6,CD7
CO5	CD1,CD2,CD3,CD4,CD5,CD7

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.	To understand the basics of Mechatronics, sensors and actuators
2.	To analyse various actuation systems, and enable to understand the basic concept of motors
3.	To develop system models and control systems for new developed equipments and applications
4.	To analyse and deal with the programmable logic controllers and circuits
5.	To 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 I:

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. (8 L)

Module II:

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 (8 L)

Module III:

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

Module IV:

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

Module V:

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. (8 L)

Text Book

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 Book

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

Course Evaluation:
Individual assignment, 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 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	2	-	2	1	1
CO3	2	2	2	1	2
CO4	3	1	3	1	1
CO5	2	2	3	3	3

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MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1,CD6
CO2	CD1, CD6,CD7
CO3	CD1, CD2, CD3,CD6,CD7
CO4	CD1, CD3,CD6,CD7
CO5	CD1,CD2,CD3,CD4,CD5,CD7

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:

1.	To comprehend the concept of tribology for applying lubrication in bearings and other machine elements
2.	To design the tribological systems consisting bearings
3.	To understand the concept of journal bearing
4.	To design hydrostatic and rolling element bearings
5.	To acquire the knowledge of surface texture parameters for selection of bearing materials

Course Outcomes:

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

CO1	To understand the basic concepts of friction, wear, and lubrication
CO2	To apply the knowledge of surface texture parameters for selection of bearing materials
CO3	To write Reynold's equation for various bearing problems and design thrust bearings
CO4	To design journal bearings and squeeze-film bearings
CO5	To design hydrostatic and rolling element bearings

SYLLABUS

Module I:

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.

(8 L)

Module II:

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.

(8 L)

Module III:

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.

(8 L)

Module IV:

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, Nonplanar squeeze film, Squeeze film of finite surfaces, Piston rings.

(8 L)

Module V:

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. (8 L)

Books recommended:

Text Book

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

Reference Book

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, 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 Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
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CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	1	2	2	2	2
CO 2	1	3	3	2	2
CO 3	2	3	3	3	3
CO 4	2	3	3	3	3
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MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
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CO2	CD1, CD6,CD7
CO3	CD1, CD2, CD3,CD6,CD7
CO4	CD1, CD3,CD6,CD7
CO5	CD1,CD2,CD3,CD4,CD5,CD7

OPEN ELECTIVES

COURSE INFORMATION SHEET

Course code: ME582
Course title: DESIGN METHODOLOGY
Pre-requisite(s): NIL
Co- requisite(s):
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 advanced topics of rigid body kinematics and dynamics
2.	Analyse free and forced vibration of single and multi-degree of freedom system.
3.	Apply principles of classical mechanics to analyse dynamical systems.
4.	Design dynamical systems.
5.	Understand working principles of gyroscopic couple.

Course Outcomes

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

CO1.	Demonstrate various principles related to kinematics and dynamics of rigid bodies in space.
CO2.	Apply classical mechanical approach to construct equations of motion for dynamical systems
CO3.	Evaluate gyroscopic couple for systems with simultaneous spin and precession.
CO4.	Design and analyse simple dynamical systems.
CO5.	Evaluate natural frequencies and mode shapes of single and multi DOF vibrating systems.

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

(8 L)

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

(8 L)

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

(8 L)

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

(8 L)

Module 5

Documentation: Types and structures of research documentation, Approaches and guidelines for documenting and reporting research process and outcomes

(8 L)

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, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements) :
Various composite materials, their properties and applications.
POs met through Gaps in the Syllabus: PO1 TO PO5

Topics beyond syllabus/Advanced topics/Design:
Characterisation of the composite materials.
POs met through Topics beyond syllabus/Advanced topics/Design: PO1 TO PO5

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	1
CO2	3	2	3	3	1
CO3	3	2	3	1	1
CO4	3	1	3	3	1
CO5	3	1	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,CD6
CO2	CD1, CD6,CD7
CO3	CD1, CD2, CD3,CD6,CD7
CO4	CD1, CD3,CD6,CD7
CO5	CD1,CD2,CD3,CD4,CD5,CD7

COURSE INFORMATION SHEET

Course code: ME586
Course title: RELIABILITY IN DESIGN
Pre-requisite(s): NIL
Co- requisite(s):
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 advanced topics of rigid body kinematics and dynamics
2.	Analyse free and forced vibration of single and multi-degree of freedom system.
3.	Apply principles of classical mechanics to analyse dynamical systems.
4.	Design dynamical systems.
5.	Understand working principles of gyroscopic couple.

Course Outcomes

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

CO1.	Demonstrate various principles related to kinematics and dynamics of rigid bodies in space.
CO2.	Apply classical mechanical approach to construct equations of motion for dynamical systems
CO3.	Evaluate gyroscopic couple for systems with simultaneous spin and precession.
CO4.	Design and analyse simple dynamical systems.
CO5.	Evaluate natural frequencies and mode shapes of single and multi DOF vibrating systems.

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.

(8 L)

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.

(8 L)

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.

(8 L)

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).

(8 L)

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.

(8 L)

Text Book

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 Book

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, Theory (Quiz and End semester) examinations

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

Variational and Complex Variables Methods

POs met through Gaps in the Syllabus: PO1, PO3, PO4

Topics beyond syllabus/Advanced topics/Design:

Nonlinear deformations of materials

POs met through Topics beyond syllabus/Advanced topics/Design: PO1 TO PO4

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	1
CO2	3	2	3	3	1
CO3	3	2	3	1	1
CO4	3	1	3	3	1
CO5	3	1	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,CD6
CO2	CD1, CD6,CD7
CO3	CD1, CD2, CD3,CD6,CD7
CO4	CD1, CD3,CD6,CD7
CO5	CD1,CD2,CD3,CD4,CD5,CD7

COURSE INFORMATION SHEET

Course code: ME 583
Course title: Renewable Sources of Energy
Pre-requisite(s): Basic of Physics, Chemistry and Mathematics
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.	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 OTEC system and different possible ways of extracting energy from ocean; know about Biomass energy, mini-micro hydro systems and geothermal energy system.

Course Outcomes

After 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 renewable energy sources like ocean thermal, hydro, geothermal energy etc.

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: HYDRO POWER AND OTHER RENEWABLE ENERGY SOURCES

Hydropower: Introduction, Capacity and Potential, Small hydro, Environmental and social impacts. Tidal Energy: Introduction, Capacity and Potential, Principle of Tidal Power, Components of Tidal Power Plant, Classification of Tidal Power Plants. Ocean Thermal Energy: Introduction, Ocean Thermal Energy Conversion (OTEC), Principle of OTEC system, Methods of OTEC power generation. Geothermal Energy: Introduction, Capacity and Potential, Resources of geothermal 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. Twidell, J.W. & Weir, A. Renewable Energy Sources, EFN Spon Ltd., UK, 2006.
4. S. P. Sukhatme and J.K. Nayak, Solar Energy – Principles of Thermal Collection and Storage, Tata McGraw-Hill, New Delhi.
5. 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, 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 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: ME 584
Course title: Energy Management and Auditing
Pre-requisite(s): Basic of Physics, Chemistry and Mathematics
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.	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

After 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.	Analyse energy conservation related to environmental issues.
CO5.	Carry out Auditing of energy equipment and to prepare energy flow diagrams and energy audit report

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: CASE STUDIES

Study of 4 to 6 cases of Energy Audit & Management in Industries (Boilers, Steam System, Furnaces, Insulation and Refractories, Refrigeration and Air conditioning, Cogeneration, Waste Heat recovery etc.). (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, 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 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: 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.	To understand the concept of programming and simulation in MATLAB.
2.	To enhance their analysing and problem- solving skills using computational simulation techniques.
3	To understand the application of programming to solve optimization problems.
4	To enhance their knowledge in Fuzzy logic toolbox MATLAB.
5	To understand the computational methods to solve nonlinear problems.

Course Outcomes:

At the end of the 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:

1. Introduction to MATLAB
2. Matrix operations and polynomials.
3. MATLAB graphics.
4. Programming with loops and functions in M file..
5. Solution of differential equations and symbolic mathematics.
6. Applications of MATLAB commands to vibration engineering problems.
7. Applications of MATLAB commands and graphics to solve compute aided design problems.
8. Introduction to Simulink.
9. State space modeling of engineering systems and solution in Simulink.
10. Simulation of non-linear systems.
11. MATLAB applications in control systems.
12. MATLAB applications soft computational techniques.

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 OF COURSE OUTCOMES ONTO PROGRAM OUTCOMES

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	3	3	2	1
CO2	3	2	2	2	1
CO3	2	2	2	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,CD6,CD3
CO2	CD1, CD6,CD7,CD3
CO3	CD1, CD2, CD3,CD6,CD7
CO4	CD1, CD3,CD6,CD7
CO5	CD1,CD2,CD3,CD4,CD5,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.	To understand the concepts of simulation using ANSYS Mechanical
2.	To enhance their analysing and problem-solving skills using computational techniques.
3	To understand the concepts of simulation using Fluent
4	To Model external compressible flow. .
5	To Model flow through porous media

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:

ANSYS Mechanical

1. Application of 1D element to analyse beam and truss structures under point and distributed static loadings.
2. Application of 2D element to analyse plate structure.
3. Application of 3D element to analyse 3D objects.
4. Modal Analysis of structures to detect natural frequencies and mode shapes.
5. Harmonic Analysis of structures.
6. Transient analysis of structures.

ANSYS Fluent

7. Fluid flow and heat transfer in a mixing elbow/heat exchanger.
8. Modelling external compressible flow.
9. Modelling flow through porous media.
10. Using the VOF model.
11. Modelling flow inside Cyclone separators.
12. Multiphase flow problem.

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 OF COURSE OUTCOMES ONTO PROGRAM OUTCOMES

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	3	3	2	1
CO2	3	2	2	2	1
CO3	2	2	2	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,CD6,CD3
CO2	CD1, CD6,CD7,CD3
CO3	CD1, CD2, CD3,CD6,CD7
CO4	CD1, CD3,CD6,CD7
CO5	CD1,CD2,CD3,CD4,CD5,CD7