MECHANICS-II

Sub. Code: BMAT1-514 **L T P C** **Contact Hrs.: 75**
4 1 0 5

Course Objectives: The course will give introduction to Mechanics. This theory and its applications are an excellent example of how physics and mathematics work hand in hand to give a complete picture of the real problems.

Course Outcomes: The study of the laws of Mechanics started in Mechanics-II in Semester V will now be extended to the dynamical problems. Thorough understanding of dynamics is essential to understanding any modern development of Physical sciences.

UNIT-I (19 Hrs.)

Langrangian Dynamics: Basic concepts, Constraints, Generalized coordinates, Holonomic and non-holonomic dynamical systems, Principle of virtual work, D'Alembert's principle, Langrange's equations from D'Alembert's principle, Langrange's equations in presence of non-conservative forces, Generalized potential, Hamilton's principle and Derivation of Langrange's equations from it, Guage invariance of the Lagrangian.

UNIT-II (18 Hrs.)

Hamiltonian Dynamics: Generalized momentum and cyclic coordinates, Conservation theorems, Hamiltonian function H and Conservation of energy, Hamilton's equations, Hamilton's equations in different coordinate systems, Hamiltonian dynamics, Principle of least action, Routhain.

UNIT-III (20 Hrs.)

Two-Body Central Force Problem: Reduction of two-body central force problem to an equivalent one-body problem, Central force motion in a plane, Equations of motion under central force and First integrals, Differential equation of an orbit, Inverse square law of force, Kepler's laws of planetary motion and their deduction, Stability of orbit under central force, Virial theorem.

UNIT-IV (18 Hrs.)

Variational Principles: Motivating problems of calculus of variations, Functional and its properties, Variation of Functional, Eular-Langrange's equations, Modified Hamilton principle, Variational principle, Lagrange's method of undetermined multipliers, Physical significance of Lagrange's multipliers.

Recommended Textbooks/ Reference Books:

1. John L. Synge and Byron A. Griffith: Principles of Mechanics 3rd Edition McGraw-Hill international ,2000.
2. J C Upadhyay, 3rd Edition 'Classical-Mechanics' Himalaya Publication House 2014.
3. J. G. Chakraborty, and P R Ghosh, Advanced Analytical Dynamics, U.N. Dhur & Sons,1982.
4. F Chorltan, Textbook of Dynamics, Published by Van Nostrand NJ, 1967.
5. Lev. D. Elsgolc: Calculus of Variations, Dover Publication, 2007.

MATHEMATICAL METHODS

Sub. Code: BMAT1-515 **L T P C** **Contact Hrs.: 75**
4 1 0 5

Course Objectives: The course aims to provide students with adequate knowledge of methods to find exact or approximate solutions of their problems through various methods.

Course Outcomes: Having done this course the students will be at ease to find analytical/ semi analytical solution of their problems by suitable methods mentioned in this course.

Unit I(18 hrs.)

Fourier Series: Dirichlet's conditions, Expansion of functions in the form of Fourier Series, Even and Odd functions, half range series, Complex Fourier Series, practical harmonic analysis.

Unit II(19 hrs.)

Fourier transforms: Fourier integrals, Fourier transforms (finite and infinite), Inverse Fourier transforms, Parseval's identities, Convolution theorem.

Unit III(20 hrs.)

Laplace transforms: Definition, Laplace transform of standard functions, Laplace transform of derivatives and integrals, Inverse Laplace transform, Convolution theorem, Unit step function, Application of Laplace transforms to boundary value problems.

Unit IV(18 hrs.)

Z - transforms: Difference equations, Basic definition of Z transform, Z- transform of standard functions, Shifting rules, Initial and final value theorems, Inverse Z- transforms, Application of Z- transform to solve difference equations.

Recommended Textbooks/ Reference Books:

1. R. K. Jain & S.R.K. Iyengar: Advanced Engineering Mathematics (Narosa Publishing House), 2nd edition, 2003.

2. Sokolnikoff and Redheffer : Mathematics for Physics and Engineering, McGraw-Hill, 2nd Edition, 1966.

3. Erwin Kreyszig : Advanced Engineering Mathematics (Wiley Eastern Limited), 8th edition, 2006.

4. George B. Thomas, Jr, Ross L. Finney: Calculus &Analytic Geometry, Pearson Publication, 2016.

DIFFERENTIAL GEOMETRY

Sub. Code: BMAT1-516 **L T P C** **Contact Hrs.: 75**

4 1 0 5

Course Objectives: The course aims to introduce space curves and their intrinsic properties of a surface and geodesics. Further the non-intrinsic properties of surfaces are explored.

Course Outcomes: To explain the concepts of differential geometry and its role in modern Mathematics, Apply differential geometry techniques to specific research problems in Mathematics.

UNIT-I (19 Hrs.)

Curves in Space: Space curves, Path, Arc length, Tangent line, Contact of nth order of a curve and surface, Plane of curvature, Tangent plane at any point of the surface $f(x, y, z) = 0$, The Principal normal and bi-normal, Definitions of curvature, Torsion and screw- curvature, Serret-Frenet Formulae, To find curvature and torsion of curve, Helices.

UNIT-II (18 Hrs.)

Intrinsic equations, Fundamental theorems for space curves, the circle of curvature, Osculating sphere, Behavior of curve in the neighborhood of a point, Involute and Evolute.

UNIT-III (18 Hrs.)

Concept of a Surface and Fundamental Forms: Concept and Definition of a surface, Curvilinear equations of the curve on the surface, Parametric curves, Tangent plane and normal, First and Second Fundamental Form, Derivatives of N, Weingarton equations, Angle between parametric curves, Direction coefficients, Angle between any two intersecting curves on the surface.

UNIT-IV (20 Hrs.)

Geodesics: Geodesics, Differential equation of geodesics, Normal property of geodesics, Geodesics curvature, Gauss bonnet theorem, Torsion of geodesics, Geodesics on $F(x, y, z) = 0$, Geodesics parallel.

Recommended Textbooks/ Reference Books:

1. D. Somasundaram, 'Differential Geometry: A First Course', Alpha Science Publishers, **2008.**

2. S. Kobayashi and K. Nomizu, 'Foundations of Differential Geometry', Inter-science Publishers, **1963.**

3. D.T. Struik, 'Lectures on Classical Differential Geometry', Addison - Wesley, Mass, **1950.**

4.Martin M. Lipschutz, 'Differential Geometry' Schaum's Outlines, McGraw-Hill Education, **2012.**

5. Taha Sochi, 'Introduction of Differential Geometry of space Curves' Createspace Independent Pub, McGraw-Hill Education, **2017.**

6. C E Weatherburn, "Differential Geometry of Three Dimensions "Cambridge University Press, **2016.**

FINITE ELEMENT METHODS

Sub. Code: BMAT1-517 **L T P C** **Contact Hrs.: 75**

4 1 0 5

Course Objectives: To introduce the concept of finite element method for its applications in ODE, PDE and Time dependent problems.

Course Outcomes: 1) to obtain an understanding of the fundamental theory of the FEA method; 2) to develop the ability to generate the governing FE equations for systems governed by partial differential equations; 3) to understand the use of the basic finite elements for structural applications using truss, beam, frame.

UNIT-I (19 hrs.)

Introduction to finite element method: Variational methods: Rayleigh-Ritz's method, Galerkin's method, Least Square method and Collocation method, General description of the finite element method.

UNIT-II(18 hrs.)

Finite element method for ODE: Finite Element Formulations for the solutions of ordinary differential equations, Calculation of element matrices, Assembly and solution of linear equations.

UNIT-III(19 hrs.)

Finite element method for PDE: Finite Element formulations for the solutions of partial differential equations, Finite element method for Elliptic, Parabolic and Hyperbolic partial differential equations.

UNIT-IV(19 hrs.)

Application of finite element method: Finite element method in time dependent problem, Elasticity, Solid Mechanics and Stress strain behaviour of different structure.

Recommended Textbooks/ Reference Books:

1. Logan, D. L., A first course in the finite element method, 6th Edition, Cengage Learning, 2016.
2. J.N. Reddy, "Finite Element Method"- McGraw -Hill International Edition. Bathe K. J. Finite Elements Procedures, PHI.
3. Cook R. D., et al. "Concepts and Application of Finite Elements Analysis"- 4th Edition, Wiley & Sons, 2003.

MATLAB

Sub. Code: BCAP1-509 **L T P C** **Contact Hrs.: 45**
3 0 0 3

Course Objectives: Students will be able to integrates computation, visualization, and programming in an easy-to-use environment, being able to develop algorithms, Data analysis, exploration and visualization

Course Outcomes: Able to use MatLab for interactive computations, Able to generate plots and export this for use in reports and presentations, Able to program scripts and functions using the MatLab development environment, Able to use basic flow controls (if-else, for, while).

UNIT-I(12 hrs.)

Introduction to MatLab , MatLab software: Introduction, MatLab window, command window , workspace ,command history ,basic commands ,operation with variables . Data Files and data types, Basic Mathematics: BODMAS RULES, Arithmetic operations, Mathematical and logical operators, solving arithmetic equations. Basic matrix operations.

UNIT-II(11 hrs.)

Other Operations: trigonometric functions, complex numbers, fractions, real numbers Functions: Writing user defined functions, Built in Function, Function Calling, Return value, Types of functions, Global variables. M files: Working with script tools, Writing Script File, Executing script file, The MATLAB editor, Saving M file.

UNIT-III(12 hrs.)

MATLAB Programming: Automating commands with Scripts, Writing programmes with logic and flow control, Writing functions, Control and conditional Statement programming. Loops and Conditional Statement: Control flow Conditional control: if , else , switch; Loop control- for, while, continue , break , programming termination – return.

UNIT-IV(10 hrs.)

Symbolic Math in MatLab: calculus: numerical integration, linear algebra, roots of polynomials, algebraic equations, differential equations, transforms (laplace and fourier), ODE. 2D Plots

Recommended Text Books/ Reference Books:

1) Andrew knight, "Basics of Matlab and beyond", Chapman and Hall/Crc,1st edition ,1999.
2) Stephen .J. Chapman ,Matlab Programming for engineers`, 4th Edition, 2007
3) Brian.R.Hunt `A Guide To Matlab`, 3rd edition , 2014
4) Rudra Partap Singh, Getting Started with MatLab: A Quick Introduction for Scientists & Engineers, 2010.

MATLAB LAB.

Sub. Code: BCAP1-510 **L T P C** **Contact Hrs.: 15**
0 0 2 1

Course Objectives:

1) Understanding the MatLab environment.
2) Being able to do simple calculations using MatLab.
3) Being able to carry out simple numerical computations and analyses using MatLab.

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

1) Understand the main features of the MatLab development environment
2) Design simple algorithms to solve problems
3) Write simple programs in MatLab to solve scientific and mathematical problems

EXPERIMENTS

To develop algorithms/ programming in MATLAB language for following:

1) Study of basic matrix operations
2) Solve linear simultaneous equations
3) Determine eigen value and eigen vector of square matrix
4) Euler's method and Modified Euler's Method
5) Picard Method
6) 4^{th} order Runge – Kutta method
7) Determine roots of polynomial
8) Simpson's $1/3^{rd}$ and 3/8 rules for numerical integration
9) Trapezoidal Method

Note: At least eight must be performed from the list

Recommended Textbooks/ Reference Books:

(1) Andrew knight, "Basics of Matlab and beyond", Chapman and Hall/Crc,1^{st} edition ,1999.
(2) Stephen .J. Chapman ,`Matlab Programming for engineers`4^{th} edition 2007
(3) Brian.R.Hunt `A Guide To Matlab`3^{rd} edition ,2014
(4) Rudra Partap Singh ,Getting Started with MATLAB: A Quick Introduction for Scientists & Engineers, 2010.