MECHANICS-II

Sub. Code: BMATS1-501 **L T P C** **Contact Hrs.: 60**

3 1 0 4

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 (12 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 (16 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 (14 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: BMATS1-502 **L T P C** **Contact Hrs.: 60**

3 1 0 4

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 (14 hrs.)

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

Unit III (18 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 (10 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, McGrawHill, 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: BMATS1-503 **L T P C** **Contact Hrs.: 60**

3 1 0 4

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 (14 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-Fernet Formulae, To find curvature and torsion of curve, Helices.

UNIT-II (14 Hrs.)

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

UNIT-III (16 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 (16 Hrs.)

Geodesics: Geodesics, Differential equation of geodesics, Normal property of geodesics, Geodesics curvature, Gauss bonnet theorem, Torsion of geodesics, Geodesics on 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' Createsapce Independent Pub, McGraw-Hill Education, **2017.**

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

FINITE ELEMENT METHODS

Sub. Code: BMATS1-504 **L T P C** **Contact Hrs.: 60**

3 1 0 4

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 (16 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 (14 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 (17 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 (13 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: BMATS1-505 **L T P C** **Contact Hrs.: 60**

3 1 0 4

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 (18 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 (18 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,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) RudraPartap Singh, Getting Started with MATLAB: A Quick Introduction for Scientists & Engineers, **2010**.

MATLAB LAB.

Sub. Code: BMATS1-506	**L T P C** **0 0 2 1**	**Contact Hrs.: 15**

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) RudraPartapSingh ,Getting Started with MATLAB: A Quick Introduction for Scientists & Engineers, **2010**.

LINEAR PROGRAMMING PROBLEM

Sub. Code: BMATS1-601 **L T P C** **Contact Hrs.: 60**
3 1 0 4

Course Objectives: To introduce the basic concepts of linear programming among the students for its applications in solving optimization problems.

Course Outcomes: Formulate a linear programming problem from a real word problem and solve them graphically and using some computational procedure while employing some convex analysis. Introducing concept of duality in linear programming. Explain game theory concepts for scientific study of strategic decision making.

UNIT-I (14 hrs.)

System of Linear Equations, Linear independence and dependence of vectors, Concept of basis, Basic feasible solution, Convex sets. Extreme points, Hyperplanes, Introduction and formulation of linear programming problem (LPP), Solution of LPP using graphical method: Unbounded solution, infeasible solutions.

UNIT-II (15 hrs.)

Standard form of LPP, Slack, surplus and artificial variables, Optimal solution of LPP using Simplex, Big-M and two phase computational procedure, Exceptional cases in LPP i.e., Infeasible, unbounded, alternate and degenerate solutions.

UNIT-III (16 hrs.)

Duality in Linear Programming: General Primal- Dual pair, Formulating a dual problem from primal problem, Duality theorems, Complementary slackness theorem, Duality and simplex method, Dual simplex method.

UNIT-IV (15 hrs.)

Game Theory: Two person zero sum games, pure strategies (minimax and maximin principles), Game with saddle point, Mixed strategies: Game without saddle point, Rule of Dominance, Solution methods for games without saddle point: Graphical method, Linear programming method.

Recommended Text Books/ Reference Books:

1. G. Hadley: "Linear Programming", Narosa, Reprint, **2002**.
2. KantiSwarup, P.K. Gupta and Man Mohan, "Operations Research", 9th Edn., Sultan Chand & Sons, **2002.**
3. Hamdy A. Taha, "Operations Research-An Introduction", Prentice Hall, 9th Edition, **2010**.
4. Martin Osborne, "An Introduction to Game Theory", Oxford University Press, **2003**.
5. F.S. Hillier. G.J. Lieberman: "Introduction to Operations Research- Concepts and Cases", 9th Edition, Tata Mc-Graw Hill, **2010**.

6.S. D. Sharma,Himanshu Sharma, Operations Research: Theory, Methods and Applications KedarNathRamNath, **2010.**

COMPLEX ANALYSIS

Sub. Code: BMATS1-602 **L T P C** **Contact Hrs.: 60**
3 1 0 4

Course Objectives: The course aims to introduce the basic ideas of analysis for complex functions in complex variables which includes differentiability and geometrical representation of complex functions. The course also discuss the expansion of complex function in form of series.

Course Outcomes: The completion of the course will enable the students to understand the important concepts of analytic functions, their geometrical meaning and expansion in the form of series.

Unit-1(14 HOURS)

Limits, continuity and derivatives of the function of complex variable, Analytic function, Necessary and sufficient conditions for analytic functions, Cauchy-Riemannequations,C-R equations in polar form.

Unit-II(15 HOURS)

Harmonic functions, Conjugate functions, Applications of Milne Thomson Method, Application to flow problems, Stereographic projection

Unit-III (15 HOURS)

Geometrical representation of $w = f(z)$, Standard Transformations, Bilinear Transformatios, Conformal transformations.

Unit –IV (16 HOURS)

Expansion of f(z), Taylor's series, Laurent's Theorem, Zeros and singularities of analytic functions..

Reference:

1. Brown, James Ward, & Churchill, Ruel V. **(2014).**"*Complex Variables and Applications* (9th ed.)", McGraw-Hill Education, New York.
2. Bak, Joseph & Newman, Donald J. **(2010)**. "*Complex analysis* (3rd ed.)". Undergraduate Texts in Mathematics, Springer. New York.
3. Zills, Dennis G., & Shanahan, Patrick D. **(2003)**. "*A First Course in Complex Analysis with Applications"*. Jones & Bartlett Publishers, Inc.
4. "Higher Engineering Mathematics" B.S Grewal, KhannaPublishers,Edition 35th.

MATHEMATICAL MODELLING

Sub. Code: BMATS1-603 **L T P C** **Contact Hrs.: 60**
3 1 0 4

Course Objectives: To introduce the basic concepts of mathematical modelling and some basic models among the students for its applications in dealing with mathematical problems.

Course Outcomes: This course introduced mathematical modelling, that is, the construction and analysis of mathematical models inspired by real life problems. This will present several modelling techniques and means to analyse the resulting systems**.**

UNIT-I (15 hours)

Simple situations requiring Mathematical Modelling, The techniques of Mathematical modelling, Classifications and some characteristics of Mathematical Modelling, Limitations of Mathematical Modelling.Thomus Malthus Population Model, and Ecology models, Classical equations: Chebyshev Polynomials and their properties. Laplace, Heat, Wave equations, The Vibrating string.

UNIT-II (15 hours)

Bessel's and Legendre's equations, orthogonal properties & recurrences relation, Generating Function. Laplace transform and inverse transform application to initial value problem up to second order.

UNIT-III (16 hours)

Monte Carlo Simulation Modelling: simulating deterministic behaviour (area under a curve, volume under a surface), Generating Random Numbers: middle square method, linear congruence.

UNIT-IV (14 hours)

Queuing Models: harbour system, morning rush hour, Overview of optimization modelling, Linear Programming Model: geometric solution algebraic solution, simplex method.

Recommended Text Books/ Reference Books:

1. "Mathematical Modelling", J.N.Kapur, New Age International (P) Ltd., Publishers Reprint **2003.**
2. TynMyint-U and LokenathDebnath, "Linear Partial Differential Equation for Scientists and Engineers, Springer", Indian reprint, **2006**.
3. "Mathematical Modelling", J.G. Andrews and R. R. Mclone (**1976**). Butterwerths London.
4. Frank R. Giordano, Maurice D. Weir and William P. Fox, "A First Course in Mathematical Modelling", Thomson Learning, London and New York, **2003**.
5. "Partial Differential equations of Mathematical Physics"-TynMyint-U.
6. "Mathematical Modelling Techniques", R. Aris (1**978**), Pitman.

DISCRETE MATHEMATICS

Sub. Code: BMATS1-604 | **L T P C** **3 1 0 4** | **Contact Hrs.:60**

Course Objectives: The objective of this course is to make the students familiar with the basic concepts in Discrete Mathematics and Graph Theory.

Course Outcomes: Students will have knowledge of significant concepts of partial order relations, Recurrence relations, Boolean Algebra , Lattices and Graph Theory.

UNIT-I (14 Hrs.)

Partial order relations, Chains and anti-chains, Pigeon hole principle, Principle of inclusion and exclusion, Analysis of algorithms-Time complexity. Complexity of problems, Discrete numeric functions and Generating functions.

UNIT-II (16 Hrs.)

Recurrence relations and Recursive algorithms, Linear recurrence relations with constant coefficients. Homogeneous solutions. Particular solution.Total solution. Solution by the method of Generating functions.

UNIT-III (16 Hrs.)

Boolean Algebra-Lattices as ordered sets and as Algebraic structures. Duality. Distributive and Modular lattices. Boolean lattices and Boolean algebras. Boolean functions and expressions. Prepositional calculus. Design and implementation of digital networks. Switching circuits.

UNIT-IV (14 Hrs.)

Graph Theory: Graphs and Planar graphs-Basic concept. Biparitemultigraphs. Weighted graphs. Paths and circuits, Shortest paths. Eulerian and Hamiltonian trails and cycles. Travelling salesman problem. Planar graphs. Trees.

Recommended Text Books/ Reference Books:

1. C. L. Liu, “Elements of Discrete Mathematics”, 2nd Edition, McGraw Hill, International Edition, Computer Science Series, **1986**.
2. Dr.Babu Ram, “Discrete Mathematics”, Pearson Education India; First edition **2010.**
3. B A. Davey and H. A. Priestley, “Introduction to Lattices and Order”, Cambridge University Press, Cambridge, **1990**.
4. Edgar G. Goodaire and Michael M. Parmenter, “Discrete Mathematics with Graph Theory”, 2nd Edition , Pearson Education (Singapore) P.Ltd., Indian Reprint **2003**.

FINANCIAL MATHEMATICS

Sub. Code: BMATS1-605	**L T P C**	**Contact Hrs.: 60**
	3 1 0 4	

Course Objectives : The course explores fundamentals of mathematical finances through basic concepts and some important theories related to finance.

Course Outcomes: The financial mathematics course helps the students to learn the basic theories of economics and finance with their mathematical interpretation.

Unit I (13 hrs.)

Accumulation and discounting: Term factor in quantitative analysis of financial transactions, Interest and interest rates, Accumulation with simple interest, Compound interest, Nominal and effective interest rates, Determining the loan duration and interest rates, The notion of discounting.

Unit II (17 hrs.)

Payment annuity streams: Basic definitions, The accumulated sum of the annual annuity, Accumulated sum of annual annuity, Accumulated sum of annual annuity with interest calculation m times a year, Accumulated sum of p-due annuity, Accumulated sum of p-due annuity with p not equal to m and m not equal to 1, The present value of the ordinary annuity and also with interest calculation m times a year, Relation between accumulated and present value of annuity

Unit III(15 hrs.)

Financial transaction yield: Absolute and average annual transaction yield, Tax and inflation accounting, Payment stream and its yield, Instant profit, Basic credit calculations.

Unit IV(15 hrs.)

Analysis of real Investments: Introduction, Net present value, Internal rate of return, Payback period, profitability index, Model of human capital investment.

Recommended Text Books/ Reference Books:

1. A. A. Mitsel, "Basics of Financial Mathematics",Department of Higher Mathematics and Mathematical Physics,**2012**.
2. Mark S.Joshi, "The Concepts and practice of Mathematical finance", 2nd edition, **2014**.
3. A Fahim, "Introduction of Financial Mathematics",**2018.**
4. Giuseppe Campolieti and Roman N. Makarov "Financial Mathematics-A Comprehensive Treatment" ,CRC press,**2014.**