TEACHING PLAN for Academic Year 2020 – 2021

Course: B.Sc.(H) Mathematics

Paper: Multivariate Calculus

SEMESTER: III

SESSION: 2020– 2021 (Odd Semester)

TEACHER NAME: Meenakshi Gupta

- **SYLLABUS**

Unit 1: Calculus of Functions of Several Variables

Functions of several variables, Level curves and surfaces, Limits and continuity, Partial differentiation, Higher order partial derivative, Tangent planes, Total differential and differentiability, Chain rule, Directional derivatives, The gradient, Maximal and normal property of the gradient, Tangent planes and normal lines.

Unit 2: Extrema of Functions of Two Variables and Properties of Vector Field

Extrema of functions of two variables, Method of Lagrange multipliers, Constrained optimization problems; Definition of vector field, Divergence and curl.

Unit 3: Double and Triple Integrals

Double integration over rectangular and nonrectangular regions, Double integrals in polar co-ordinates, Triple integral over a parallelopiped and solid regions, Volume by triple integrals, Triple integration in cylindrical and spherical coordinates, Change of variables in double and triple integrals.

Unit 4: Green's, Stokes' and Gauss Divergence Theorem

Line integrals, Applications of line integrals**:** Mass and Work, Fundamental theorem for line integrals, Conservative vector fields, Green's theorem, Area as a line integral, Surface integrals, Stokes' theorem, Gauss divergence theorem.

LESSON PLAN 14 weeks (Approximately)

Week 1: Definition of functions of several variables, Graphs of functions of two variables – Level curves and surfaces, Limits and continuity of functions of two variables.
[1] Sections 11.1 and 11.2.

Week 2: Partial differentiation, and partial derivative as slope and rate, Higher order partial derivatives. Tangent planes, incremental approximation, Total differential.
[1] Chapter 11 (Sections 11.3 and 11.4).
Week 3: Differentiability, Chain rule for one parameter, Two and three independent parameters. [1] Chapter 11 (Sections 11.4 and 11.5).
Week 4: Directional derivatives, The gradient, Maximal and normal property of the gradient, Tangent and normal lines.
[1] Chapter 11 (Section 11.6).
Week 5: First and second partial derivative tests for relative extrema of functions of two variables, and absolute extrema of continuous functions.
[1] Chapter 11 [Section 11.7 (up to page 605)].
Week 6: Lagrange multipliers method for optimization problems with one constraint, Definition of vector field, Divergence and curl.
[1] Sections 11.8 (Pages 610-614)] and 13.1.
Week 7: Double integration over rectangular and nonrectangular regions. [1] Sections 12.1 and 12.2.
Week 8: Double integrals in polar co-ordinates, and triple integral over a parallelopiped. [1] Chapter 12 (Sections 12.3 and 12.4).
Week 9: Triple integral over solid regions, Volume by triple integrals, and triple integration in cylindrical coordinates.
[1] Chapter 12 (Sections 12.4 and 12.5).
Week 10: Triple integration in spherical coordinates, Change of variables in double and triple integrals.
[1] Chapter 12 (Sections 12.5 and 12.6).
Week 11: Line integrals and its properties, applications of line integrals: mass and work. [1] Chapter 13 (Section 13.2).
Week 12: Fundamental theorem for line integrals, Conservative vector fields and path independence. [1] Chapter 13 (Section 13.3).
Week 13: Green's theorem for simply connected region, Area as a line integral, Definition of surface integrals**.**
[1] Chapter 13 [Sections 13.4 (Pages 712 to 716), 13.5 (Pages 723 to 726)].
Week 14: Stokes' theorem and the divergence theorem.
[1] Chapter 13 [Sections 13.6 (Pages 733 to 737), 13.7 (Pages 742 to 745)].

ASSESSMENT

Internal Assessment: 25 Marks (Assignment and class test)

Reference:

1. Strauss, Monty J., Bradley, Gerald L., & Smith, Karl J. (2007). *Calculus* (3rd ed.). Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). Delhi. Indian Reprint 2011.

Additional Reading:

i. Marsden, J. E., Tromba, A., & Weinstein, A. (2004). *Basic Multivariable Calculus*. Springer (SIE). First Indian Reprint.

Course: B.Sc.(H) Mathematics

Paper: SEC-1: LaTeX and HTML

SEMESTER: III

SESSION: 2020– 2021 (Odd Semester)

TEACHER NAME: Meenakshi Gupta

- **SYLLABUS**

Unit 1: Getting Started with LaTeX

Introduction to TeX and LaTeX, Typesetting a simple document, Adding basic information to a document, Environments, Footnotes, Sectioning and displayed material.

Unit 2: Mathematical Typesetting with LaTeX

Accents and symbols, Mathematical typesetting (elementary and advanced)**:** Subscript/ Superscript, Fractions, Roots, Ellipsis, Mathematical Symbols, Arrays, Delimiters, Multiline formulas, Spacing and changing style in math mode.

Unit 3: Graphics and Beamer Presentation in LaTeX

Graphics in LaTeX, Simple pictures using PSTricks, Plotting of functions, Beamer presentation.

Unit 4: HTML

HTML basics, Creating simple web pages, Images and links, Design of web pages.

LESSON PLAN 14 weeks (Approximately)

Weeks 1 to 3: Introduction to TeX and LaTeX, Typesetting a simple document, Adding basic information to a document, Environments, Footnotes, Sectioning and displayed material.

[1] Chapter 9 (9.1 to 9.5).
[2] Chapter 2 (2.1 to 2.5).

Weeks 4 to 6: Accents of symbols, Mathematical typesetting (elementary and advanced): Subscript/Superscript, Fractions, Roots, Ellipsis, Mathematical symbols, Arrays, Delimiters, Multiline formulas, Spacing and changing style in math mode.

[1] Chapter 9 (9.6 and 9.7).
[2] Chapter 3 (3.1 to 3.3).

Weeks 7 and 8: Graphics in LaTeX, Simple pictures using PSTricks, Plotting of functions. [1] Chapter 9 (Section 9.8). Chapter 10 (10.1 to 10.3).

[2] Chapter 7 (7.1 and 7.2).

Weeks 9 and 10: Beamer presentation.

[1] Chapter 11 (Sections 11.1 to 11.4).

Weeks 11 and 12: HTML basics, Creating simple web pages. [1] Chapter 15 (Sections 15.1 and 15.2).

Weeks 13 and 14: Adding images and links, Design of web pages.

[1] Chapter 15 (Sections 15.3 to 15.5).

ASSESSMENT

Internal Assessment: 25 Marks (Assignment and Presentation)

References:

1. Bindner, Donald & Erickson, Martin. (2011). *A Student's Guide to the Study, Practice, and Tools of Modern Mathematics*. CRC Press, Taylor & Francis Group, LLC.
2. Lamport, Leslie (1994). *LaTeX*: *A Document Preparation System*, User's Guide and Reference Manual (2nd ed.). Pearson Education. Indian Reprint.

Additional Readings:

i. Dongen, M. R. C. van (2012). *LaTeX and Friends*. Springer-Verlag.

ii. Robbins, J. N. (2018). *Learning Web Design*: *A Beginner's Guide to HTML* (5th ed.). O'Reilly Media Inc.

Course: B.Sc.(H) Mathematics

Paper: SEC-1: Numerical Methods

SEMESTER: V

SESSION: 2020– 2021 (Odd Semester)

TEACHER NAME: Meenakshi Gupta/ Dr. Anuj Kumar

- **SYLLABUS**

Unit 1: Methods for Solving Algebraic and Transcendental Equations
Algorithms, Convergence, Bisection method, False position method, Fixed point iteration method, Newton's method and Secant method.
Unit 2: Techniques to Solve Linear Systems
LU decomposition and its applications, Iterative methods: Gauss−Jacobi, Gauss−Seidel and SOR methods.
Unit 3: Interpolation
Lagrange and Newton interpolation: Linear and higher order, finite difference operators.
Unit 4: Numerical Differentiation and Integration
Numerical differentiation: forward difference, backward difference and central difference. Integration: trapezoidal rule, Simpson's rule, Euler's method.

LESSON PLAN: 14 Weeks (Approximately)

Week 1: Algorithms, Convergence, Order of convergence and examples.
[1] Chapter 1 (Sections 1.1 and 1.2).
Week 2: Bisection method, False position method and their convergence analysis, Stopping condition and algorithms.
[1] Chapter 2 (Sections 2.1 and 2.2).
Week 3: Fixed point iteration method, its order of convergence and stopping condition.
[1] Chapter 2 (Section 2.3).
Week 4: Newton's method, Secant method, their order of convergence and convergence analysis.
[1] Chapter 2 (Sections 2.4 and 2.5).
Week 5: Examples to understand partial and scaled partial pivoting. LU decomposition.
[1] Chapter 3 (Sections 3.5 up to Example 3.15).
Weeks 6 and 7: Application of LU decomposition to solve system of linear equations. Gauss−Jacobi method, Gauss−Seidel and SOR iterative methods to solve system of linear equations.
[1] Chapter 3 (Sections 3.5 and 3.8).
Week 8: Lagrange interpolation**:** Linear and higher order interpolation, and error in it.
[1] Chapter 5 (Section 5.1).
Weeks 9 and 10: Divided difference and Newton interpolation, finite difference operators.

[1] Chapter 5 (Sections 5.3).
[2]: Chapter 4 (Section 4.3).
Weeks 11 and 12: First and higher order approximation for first derivative and error in the approximation. Second order forward, Backward and central difference approximations for second derivative.
[1] Chapter 6 (Sections 6.2).
Week 13: Numerical integration**:** Trapezoidal rule, Simpson's rule and its error analysis.
[1] Chapter 6 (Section 6.4).
Week 14: Euler’s method to solve ODEs.
[1] Chapter 7 (Section 7.2).

ASSESSMENT
Internal Assessment: 25 Marks (Assignment and class test)

REFERENCES
[1]. B. Bradie, *A Friendly Introduction to Numerical Analysis*, Pearson Education, India, 2007.
[2]. M. K. Jain, S. R. K. Iyengar and **R. K. Jain**, *Numerical Methods for Scientific and Engineering Computation*, New age International Publisher, India, 5th edition, 2007.

Course: B.Sc.(H) Mathematics

Paper: Partial Differential Equations (including practicals)

SEMESTER: IV

SESSION: 2020– 2021 (Even Semester)

TEACHER NAME: Meenakshi Gupta

- **SYLLABUS**

Unit 1: First Order PDE and Method of Characteristics

Introduction, Classification, Construction and geometrical interpretation of first order partial differential equations (PDE), Method of characteristic and general solution of first order PDE, Canonical form of first order PDE, Method of separation of variables for first order PDE.

Unit 2: Mathematical Models and Classification of Second Order Linear PDE
Gravitational potential, Conservation laws and Burger's equations, Classification of second order PDE, Reduction to canonical forms, Equations with constant coefficients, General solution.

Unit 3: The Cauchy Problem and Wave Equations

Mathematical modeling of vibrating string and vibrating membrane, Cauchy problem for second order PDE, Homogeneous wave equation, Initial boundary value problems, Non- homogeneous boundary conditions, Finite strings with fixed ends, Non-homogeneous wave equation, Goursat problem.

Unit 4: Method of Separation of Variables

Method of separation of variables for second order PDE, Vibrating string problem, Existence and uniqueness of solution of vibrating string problem, Heat conduction problem, Existence and uniqueness of solution of heat conduction problem, Non-homogeneous problem.

LESSON PLAN 14 weeks (Approximately)

Week 1: Introduction, Classification, Construction of first order partial differential equations (PDE). [1] Chapter 2 (Sections 2.1 to 2.3).
Week 2: Method of characteristics and general solution of first order PDE. [1] Chapter 2 (Sections 2.4 and 2.5).
Week 3: Canonical form of first order PDE, Method of separation of variables for first order PDE. [1] Chapter 2 (Sections 2.6 and 2.7).

Week 4: The vibrating string, Vibrating membrane, Gravitational potential, Conservation laws. [1] Chapter 3 (Sections 3.1 to 3.3, 3.5 and 3.6).

Weeks 5 and 6: Reduction to canonical forms, Equations with constant coefficients, General solution. [1] Chapter 4 (Sections 4.1 to 4.5).

Weeks 7 and 8: The Cauchy problem for second order PDE, Homogeneous wave equation. [1] Chapter 5 (Sections 5.1, 5.3 and 5.4).

Weeks 9 and 10: Initial boundary value problem, Non-homogeneous boundary conditions, Finite string with fixed ends, Non-homogeneous wave equation, Goursat problem.
[1] Chapter 5 (Sections 5.5 to 5. and 5.9).

Weeks 11 and 12: Method of separation of variables for second order PDE, Vibrating string problem. [1] Chapter 7 (Sections 7.1 to 7.3).

Weeks 13 and 14: Existence (omit proof) and uniqueness of vibrating string problem. Heat conduction problem. Existence (omit proof) and uniqueness of the solution of heat conduction problem. Non-homogeneous problem.
[1] Chapter 7 (Sections 7.4 to 7.6 and 7.8).

- **ASSESSMENT**

- **Internal Assessment: 25 Marks (Assignment and class test)**

Reference:

1. Myint-U, Tyn & Debnath, Lokenath. (2007). *Linear Partial Differential Equation for Scientists and Engineers* (4th ed.). Springer, Third Indian Reprint, 2013.

Additional Readings:

i. Sneddon, I. N. (2006). *Elements of Partial Differential Equations*, Dover Publications. Indian Reprint.
ii. Stavroulakis, Ioannis P & Tersian, Stepan A. (2004). *Partial Differential Equations*: *An Introduction with Mathematica and* MAPLE (2nd ed.). World Scientific.

Course: B.Sc.(H) Mathematics

Paper: Linear Programming and Theory of games

SEMESTER: VI

SESSION: 2020– 2021 (Even Semester)

TEACHER NAME: Meenakshi Gupta

- **SYLLABUS**

Unit 1: Introduction to Linear Programming and Methods of Solving Linear Programming Problem

Introduction to linear programming problem, Theory of simplex method, optimality and unboundedness, the simplex algorithm, simplex method in tableau format, introduction to artificial variables, two-phase method, Big-M method and their comparison.
[1]: Chapter 3 (Sections 3.2-3.3, 3.5-3.8), Chapter 4 (Sections 4.1-4.4).

Unit 2: Duality Theory of Linear Programming

Duality, formulation of the dual problem, primal-dual relationships, economic interpretation of the dual.
[1]: Chapter 6 (Sections 6.1-6.3).

Unit 3: Transportation Problem and Assignment Problem

Transportation problem and its mathematical formulation, northwest-corner method least cost method and Vogel approximation method for determination of starting basic solution, algorithm for solving transportation problem, assignment problem and its mathematical formulation, Hungarian method for solving assignment problem.
[3]: Chapter 5 (Sections 5.1, 5.3-5.4).

Unit 4: Game Theory

Game theory: formulation of two person zero sum games, solving two person zero sum games, games with mixed strategies, graphical solution procedure, linear programming solution of games.
[2]: Chapter 14.

LESSON PLAN 14 weeks (Approximately)

Week 1: Linear programming problem: Standard, Canonical and matrix forms, Graphical solution. [1] Chapter 1 (Section 1.1).

Weeks 2:, Basic feasible solutions; Reduction of any feasible solution to a basic feasible solution; Correspondence between basic feasible solutions and extreme points.

[1] Chapter 3 (Section 3.2).

Week 3 and 4: Simplex Method: Optimal solution, Termination criteria for optimal solution of the linear programming problem, Unique and alternate optimal solutions, Unboundedness.

[1] Chapter 3 (Sections 3.3 and 3.6).

Weeks 5 and 6: Simplex algorithm and its tableau format. [1] Chapter 3 (Sections 3.7 and 3.8).

Weeks 7 and 8: Artificial variables, Two-phase method, Big-M method. [1] Chapter 4 (Sections 4.1 to 4.3).

Weeks 9 and 10: Motivation and formulation of dual problem; Primal-dual relationships. [1] Chapter 6 (Section 6.1 and 6.2, up to Example 6.4).

Week 11: Statements of the fundamental theorem of duality and complimentary slackness theorem with examples.

[1] Chapter 6 (Section 6.2).

Weeks 12 and 13: Transportation problem, Assignment problem. [3] Chapter 5 (Sections 5.1, 5.3 and 5.4).

Week 14: Game Theory**:** Basic concept, Formulation and solution of two-person zero-sum games, Games with mixed strategies, Linear programming method of solving a game.

[2] Chapter 14

- **ASSESSMENT**

- **Internal Assessment: 25 Marks (Assignment and class test)**

REFERENCES:

1. **Mokhtar S. Bazaraa**, **John J. Jarvis** and **Hanif D. Sherali**, *Linear Programming and Network Flows* (2nd edition), John Wiley and Sons, India, 2004.
2. **F. S. Hillier** and **G. J. Lieberman**, *Introduction to Operations Research-Concepts and Cases* (9th Edition), Tata McGraw Hill, 2010.
3. **Hamdy A. Taha**, *Operations Research, An Introduction* (9th edition), Prentice-Hall, 2010.

SUGGESTED READING:

1. G. Hadley, *Linear Programming*, Narosa Publishing House, New Delhi, 2002.