# ARSD College, University of Delhi

## Lesson Plan

| Course Name : B.Sc. (Prog.) Physical Sciences-Mathematics | | | | | | |
|---|---|---|---|---|---|---|
| **Semester** | **Course Code** | **Course Title** | **Lecture (L)** | **Tutorial (T)** | **Practical (P)** | **Credit (C)** |
| VI | 42357618 | Numerical Methods | 4 | 0 | 2 | 6 |
| Teacher/Instructor(s) | | Vinit Chauhan | | | | |
| Session | | January- May (even Semester) 2022 | | | | |

**Course Objective:**

The goal of this paper is to acquaint students for the study of certain algorithms that uses numerical approximation for the problems of mathematical analysis. Also, the use of Computer Algebra Systems (CAS) by which the intractable problems can be solved both numerically and analytically

**Course Learning Outcomes:**

After completion of this course, students will be able to:
(i) Find the consequences of finite precision and the inherent limits of numerical methods.
(ii) Appropriate numerical methods to solve algebraic and transcendental equations.
(iii) Solve first order initial value problems of ODE's numerically using Euler methods.

**Lesson Plan:**

| Unit No. | Learning Objective | Lecture No. | Topics to be covered |
|---|---|---|---|
| 1. | Errors and Roots of Transcendental and Polynomial Equations | 1-2 | Floating point representation and computer arithmetic |
| | | 3-4 | Significant digits |
| | | 5-7 | Errors: Roundoff error, Local truncation error, Global truncation error |
| | | 8-10 | Order of a method, Convergence and terminal conditions |
| | | 11-12 | ; Bisection method, Secant method |
| | | 13-14 | Regula−Falsi method |
| | | 15-16 | Newton−Raphson method. |
| 2. | | 17-19 | Gaussian elimination method (with row pivoting) |
| | | 20-21 | Gauss−Jordan method |

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|---|---|---|---|
| | Algebraic Linear Systems and Interpolation | 22-25 | Iterative methods: Jacobi method, Gauss−Seidel method |
| | | 26-28 | Interpolation: Lagrange form, Newton form |
| | | 29-32 | Finite difference operators, Gregory-Newton forward and backward difference interpolations |
| | | 33-36 | Piecewise polynomial interpolation (Linear and quadratic). |
| 3. | Numerical Differentiation, Integration and ODE | 37-40 | Numerical differentiation: First and second order derivatives |
| | | 41-43 | Richardson extrapolation method |
| | | 44-47 | Numerical integration: Trapezoidal rule, Simpson's rule |
| | | 48-51 | Ordinary differential equation: Euler's method |
| | | 52-56 | Modified Euler's methods (Heun's and midpoint). |

**Evaluation Scheme:**

| No. | Component | Duration | Marks |
|---|---|---|---|
| 1. | Internal Assessment | | 25 |
| | • Quiz | | |
| | • Class Test | | |
| | • Attendance | | |
| | • Assignment | | |
| 2. | End Semester Examination | 3 hours | 75 |

| Details of the Course | | |
|---|---|---|
| **Unit** | **Contents** | **Contact Hours** |
| 1 | Floating point representation and computer arithmetic, Significant digits; Errors: Roundoff error, Local truncation error, Global truncation error; Order of a method, Convergence and terminal conditions; Bisection method, Secant method, Regula−Falsi method, Newton−Raphson method. | 16 |
| 2 | Linear homogenous equations with constant coefficients, Linear non-homogenous equations, The method of variation of parameters, The Cauchy-Euler equation; Simultaneous differential equations. | 20 |
| 3 | Partial differential equations: Basic concepts and definitions with mathematical problems; First order partial differential equations: Classification, Construction, Geometrical interpretation, Method of characteristics and general solutions, Canonical forms and method of separation of variables; Second order partial differential equations: Classification, Reduction to canonical forms; Linear second order partial differential equations with constant coefficients: Reduction to canonical forms with general solutions. | 20 |
| | **Total** | **56** |

| **Suggested Books:** | | |
|---|---|---|
| **Sl. No.** | **Name of Authors/Books/Publishers** | **Year of Publication/Reprint** |
| 1 | Chapra, Steven C. (2018). Applied Numerical Methods with MATLAB for Engineers and Scientists (4th ed.). McGraw-Hill Education. | 2018 |
| 2 | Fausett, Laurene V. (2009). Applied Numerical Analysis Using MATLAB. Pearson. India. | 2009 |
| 3 | Jain, M. K., Iyengar, S. R. K., & Jain R. K. (2012). Numerical Methods for Scientific and Engineering Computation (6th ed.). New Age International Publishers. Delhi. | 2006 |
| **Mode of Evaluation:** | Internal Assessment / End Semester Exam | |

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