**Shyama Prasad Mukherji College**

**Teaching Plan**

**Course and Year: BSc(Hons) Mathematics - III yr.(July to Nov – 2022)**

**Semester: V**

**Taught individually or shared: Shared**

**Paper: DSE-I: Numerical Methods with practicals**

**Faculty: Dr. Kanica Goel, Mr. Pardeep Kumar, Ms. Tripti Anand**

**No. of Classes** (per week)**: 4 Lectures and 4 Practical (For each group)**

**Total Marks:** 150 (Theory: 75 + Internal Assessment: 25 + Practical: 50)

**Duration:** 14 Weeks (56 Hrs. Theory + 56 Hrs. practical) **Examination:** 3 Hrs.

**Course Objectives:** To introduce various computational methods to find an approximate value for possible root(s) of transcendental equations, and to find the approximate solutions of a system of linear equations. Also, the use of the Computer Algebra System (CAS) by which the numerical problems can be solved both analytically and practically, and builds problem-solving skills in students.

**Course Learning Outcomes:** The course will enable the students to learn the following:

i) Some numerical methods to find the zeroes of nonlinear functions and solution of a system of linear equations, up to a certain given level of precision.

ii) Interpolation techniques to compute the corresponding continuous function on the given discrete data approximately.

iii) Applications of numerical differentiation and integration.

**Teaching Plan**

**Name of the Paper Units**

**Numerical Methods : Unit-I: (i) Methods for solving Transcendental equations**

**(With Practicals)** Bisection Method, Regula False Method, Secant Method, Newton Raphson Method and Fixed point method, Convergence analysis.

**(ii) Methods for solving Linear Algebraic System of Equations**

LU-Decomposition Method, Gauss Jacobi Method, Gauss-Siedel Method and SOR Method.

**Unit-II: Interpolations and Operators**

Linear and Lagrange’s Interpolation, Higher Order Interpolation and Finite Difference Operators.

**Unit-III: Numerical Differentiation and Integration**

Forward difference, Backward difference and Central difference methods. Trapezoidal rule, Simpson’s rule, Euler’s method..

**Readings : [1] Bradie B(2007), A Friendly Introduction to Numerical Analysis, Pearson Education, India**.

**[2] Jain M.K., Iyengar S.R.K. and Jain R.K.(2007), Numerical Methods for Scientific and Engineering Computation, New age International Publisher, India, 5th edition.**

**[3] Gerald C.F. and Wheatley P.O.(2008), App;ied Numerical Analysis, Pearson Education, India,7th edition.**

**Suggested Readings : [1] Frank R.G., William P.F. and Steven B.H. (2014), A first course in Mathematical Modelling, Cenage Learning, India.**

**[2] Richard L.B. and Faires J.D.(2005), Numerical Analysis, Thompson Book,USA.**

**[3] Grewal B.S. (2013), Numerical Methods in Engineering & Science, Khanna Publication, India.**

**[4] Epperson J.F., An Introduction to Numerical Methods and Analysis, Second edition, Wiley.**

**[5]Brin L.Q. , Tea Time Numerical Analysis, (The first in a series of Tea Time Textbooks), Southern Connecticut State University.**

**e-refrences [1] Mathematical Science - VLE , University of Delhi.**

**[2] Paul’s Online Maths Notes**

**[3] NPTEL Video Lectures**

**[4] web link :** mathfaculty.fullerton.edu/mathews/n2003/Web

**No of the classes required to complete the unit (approx.): Scheduled Time (app.)**

1. **Unit I: (i) 18-20 Classes 20 July to 19 Aug**

**(ii) 15-18 Classes 20 Aug to 20 Sept**

1. **Unit II: 10-12 Classes 21Sept 10 Oct**
2. **Unit III: 18-20 Classes 18 to 15 Nov**

**Sub-topics to be covered and their order along with the respective time frames (if any)**

**Homogenous and Non Homogenous system of Linear equations and Mean Values Theorems.**

**Concept of convergence of functions from Calculus.**

**Methodology of Teaching: [1] Using Different Software (Mathematica, Latex, R and MS- Office) and online available Resources.**

**[2] Visualize the Mathematical Concept by 2D -Imaging through some Software.**

**[3] Guide, how to read and write research articles and elaboration of the research papers.**

**[4] Mentor students to present research, paper and poster.**

**[5] Participating in academic activities with the students by visiting different colleges.**

**ASSESSMENT**

**Tentative date of assessments/ assignments (time frame): Test -1 in the mid of Sept.**

**Test-2 and Assignment-1 in mid of Oct.**

**Test -3 and Assignment-2 in first week of Nov.**

**Criteria of Assessment: Written Tests/Assignments/Presentations/Mock Tests/Viva Voice Examinations/Performance in Inter-College academic activities.**

**Teaching Plan (Weakly)**

**Week 1:** Algorithms, Convergence.

[1] Chapter 1 (Sections 1.1, and 1.2) (Ex.1.1 and 1.2)

**Practical 1: Basic Introduction of programming language in Mathematica.**

**Week 2:** Bisection method, False position method and their convergence analysis.

[1] Chapter 2 (Sections 2.1, and 2.2) (Ex.2.1 and 2.2)

**Practical 2: (i) Calculate the sum 1/1 + 1/2 + 1/3 + 1/4 + ----------+ 1/ N.**

**(ii) To find the absolute value of an integer**

**Week 3:** Fixed point iteration method and its related theorems.

[1] Chapter 2 (Section 2.3) (Ex. 2.3)

**Practical 3: Introduction of Programming using while and If commands**

**Week 4:** Newton's method, Secant method, their order of convergence..

[1] Chapter 2 (Sections 2.4, and 2.5) (Ex. 2.4 and 2.5)

**Practical 4. Bisection and Regula False Methods.**

**Week 5:** Gauss elimination methods and LU decomposition.

[1] Chapter 3 (Sections 3.2, and 3.5, up to Example 3.15) (Ex. 3.1 of [2])

**Practical 5: Secant and Newton Raphson Methods.**

**Weeks 6 and 7:**  Gauss-Jacobi method, Gauss-Seidel and SOR iterative methods to solve a system of linear equations.

[1] Chapter 3 (Sections 3.5, and 3.8)

[2] Chapter 3 (Section 3.2 with exercise)

**Practical 6. Preparation of Practicals: 1-5**

**Practical 7: Mock Test and viva – I**

**Week 8:** Lagrange interpolation**:** Linear and higher order interpolation, and error in it.

[1] Chapter 5 (Section 5.1)

[2] Chapter 4(Section 4.1 with Exercise)

**Practical 8: Lu Decomposition,Gauss Jacobi and Gauss-Seidel.**

**Weeks 9 and 10:** Divided difference and Newton interpolation.

[1] Chapter 5 (Sections 5.3, and 5.4)

[2] Chapter 4(Section 4.1 with Exercise)

**Prcatical 9 and 10 : Lagrange Interpolation and Newton Divided Difference**

**Weeks 11 and 12:** First order 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 (Section 6.2 with Exercise)

**Practical 11: Mock Test and Viva-II**

**Practical 12: Euler’s and Runge Kutta Method**

**Week 13:** Numerical integration**:** Trapezoidal rule, Simpson's rule and its error analysis.

[1] Chapter 6 (Section 6.4 with Exercise)

**Prcatical 13 : Trapezoidal rule and Simpson's rule**

**Week 14:** Euler’s method to solve first order ODE initial value problems.

[1] Chapter 7 (Section 7.2 up to page 562)

**Practical 14: Preparation of Final Exam and Mock test with Viva-III.**