Syllabus template

Semester: III	
Programme: Mathematics	
Course: Numerical Methods [Economics + Computer Science]	
Paper code: B2MT230321T	**Credits: 4**
Hours/week: 4	
Category: Core/MDC/SEC/VAC: Minor	
Theory / Practical / Composite: Theory	
No of Modules: NA	

Course Overview: This course provides a structured introduction to Numerical Methods, focusing on techniques for approximating solutions to mathematical problems where analytical methods are difficult or impossible. Students will learn about sources and control of computational errors, interpolation strategies for estimating unknown values, and numerical integration techniques. The course further explores iterative and direct methods for solving non-linear equations and systems of linear equations, developing both theoretical understanding and practical efficiency. Additionally, students are introduced to numerical approaches for solving ordinary differential equations using single-step and multi-step methods. The course equips learners with essential computational tools widely used in scientific computation, data analysis, and algorithmic problem solving.

Course Outcome: On successful completion of this course, the student will be able to:

1. **Identify and classify** different types of numerical errors (absolute, relative, truncation, round-off) and evaluate error propagation in computations.
2. Explain finite difference operators (Δ, ∇, μ, δ, E) and **apply** their algebraic relations in numerical formulations.
3. **Construct** interpolation polynomials using Newton's Forward, Backward, Lagrange and Divided Difference formulas to estimate unknown functional values.
4. **Apply** numerical integration rules such as the Trapezoidal rule and Simpson's $\frac{1}{3}$ rule to approximate definite integrals and **analyse** the degree of precision.
5. **Determine** roots of non-linear equations using iterative numerical methods (Bisection, Regula–Falsi, Newton–Raphson, Fixed-Point) and **interpret** convergence behaviour.
6. **Solve** systems of linear equations using direct methods (Gauss, Gauss–Jordan) and iterative methods (Jacobi, Gauss–Seidel).
7. **Solve** ordinary differential equations numerically using Euler's method, Picard's method, Runge–Kutta method, and Adams–Bashforth method.

Prerequisites: *Basic knowledge of Higher Secondary Mathematics, including algebra, elementary calculus, and solution of simple equations.*

SYLLABUS

UNIT/Module	CONTENT	HOURS or NUMBER OF CLASSES	CO Mapping	COGNITIVE LEVEL
I. Sources of Error in Numerical Methods	Accuracy and Precision, Absolute error, Relative Error, Sources of Error: Truncation error and Round-Off error [2]. Error of a sum, difference, product & quotient of two approximate numbers [2].	**4 hours**	**CO1**	**K3**

II.	**Operators in Finite Differences**	Δ , ∇, μ , δ , E (Definitions and simple relations among them) [4].	**4 hours**	**CO2**	**K2, K3**
III.	**Interpolation**	Polynomial Interpolation, Difference Tables, (Deduction) of Newton's Forward and Backward interpolation; Lagrange's interpolation formula; Newton's Divided Difference formula; properties and related problems. [12]	**12 hours**	**CO3**	**K3**
IV.	**Numerical Integration**	Integration of Newton's interpolation formula. Newton-Cotes' formula, Basic Trapezoidal, Simpson's $\frac{1}{3}$ rule and their composite forms. Degree of precision (definition only) and related problems. [6]	**6 hours**	**CO4**	**K3, K4**
V.	**Numerical solution to non-linear equations**	Location of a real root by the Tabular method. Bisection method. Regula-Falsi and Newton-Raphson methods, their geometrical significance. Fixed point iteration method.[10]	**10 hours**	**CO5**	**K3, K4**
VI.	**Numerical solution of a system of linear equations**	Direct methods— [Gauss elimination method, Operation count. Gauss-Jordan elimination method [4]. Iterative methods—[Jacobi iteration method, Gauss-Seidel method] [4]	**8 hours**	**CO6**	**K3**
VII.	**Solution of Ordinary Differential Equations**	Euler's method, Picard's method, Runge-Kutta method fourth order) [4]. (Single step methods) Multistep methods: Adam's Bashforth method. [4]	**8 hours**	**CO7**	**K3**
Text Books					
1. Elementary Numerical Analysis: Conte de Boor.					
2. Elementary Numerical Analysis: Atkinson.					
3. Numerical Analysis and Computational Procedures: S.A.Mollah.					
4. Numerical Analysis and Statistical Methods: Sinha and Pradhan.					
Suggested readings					
1.					
2.					
3.					
Web Resources					
1.					

2.
3.
4.
Evaluation: Theory CIA: 20+5+5=30; Semester Exam: 70.
Paper Structure for Theory Semester Exam Module: 7 questions each carrying 10 marks needs to be answered out of 12/13 questions.

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive levels
CO1	**Identify and classify** different types of numerical errors (absolute, relative, truncation, round-off) and evaluate error propagation in computations.	**K3**
CO2	Explain finite difference operators (Δ, ∇, μ, δ, E) and **apply** their algebraic relations in numerical formulations.	**K2, K3**
CO3	**Construct** interpolation polynomials using Newton's Forward, Backward, Lagrange, and Divided Difference formulas to estimate unknown functional values.	**K3**
CO4	**Apply** numerical integration rules such as the Trapezoidal rule and Simpson's $\frac{1}{3}$ rule to approximate definite integrals and **analyse** the degree of precision.	**K3, K4**
CO5	**Determine** roots of non-linear equations using iterative numerical methods (Bisection, Regula–Falsi, Newton–Raphson, Fixed-Point) and **interpret** convergence behaviour.	**K3, K4**
CO6	**Solve** systems of linear equations using direct methods (Gauss, Gauss–Jordan) and iterative methods (Jacobi, Gauss–Seidel).	**K3**
CO7	**Solve** ordinary differential equations numerically using Euler's method, Picard's method, Runge–Kutta method, and Adams–Bashforth method.	**K3**