AC/24.02.2024/RS1

SIES College of Arts, Science & Commerce

RISE WITH EDUCATION

NAAC REACCREDITED "A" GRADE, CGPA 3.51/4.00

(AUTONOMOUS)

# SIES College of Arts, Science and Commerce

## ( Autonomous)

**(Affiliated to University of Mumbai)**

**Programme: B.Sc.**

**Class: S.Y. B.Sc. Semester IV(CBCS)**

**Subject: Mathematics**

**Skill Enhancement Course (SEC)**

**Syllabus Revised in June 2024 under NEP**

**Choice Based Credit System (CBCS)**
**with effect from the academic year 2024-25**

**CONTENTS**



## 1. Preamble

Mathematics has been fundamental to the development of science and technology. In recent decades, the extent of application of Mathematics to real world problems has increased by leaps and bounds. It is imperative that the content of the undergraduate syllabi of Mathematics should support other branches of science such as Physics, Chemistry, Statistics, Computer Science, Data Science. This syllabus of S.Y.B.Sc. Mathematics has been designed to provide learners sufficient knowledge and skills enabling them to undertake further studies in mathematics and its allied areas.

## 2. Learning Objectives

- ➢ To develop critical thinking, reasoning and logical skills of the learners
- ➢ To improve learners' analytical and problem solving skills
- ➢ To take the learners from simple to difficult and from concrete to abstract
- ➢ To equip learners with a deeper understanding of abstract theory and concepts
- ➢ To improve learners' capacity to communicate mathematical/logical ideas in writing.

## 4. Course structure with minimum credits and Lectures/ Week

**Name of Program**: Bachelor of Science **Name of Department:** Mathematics
**Type of course:** Skill Enhancement Course – Practical Course
Evaluation Pattern: Continuous Internal Evaluation

| Option | Course Name | Course Code | Credits | L/P (per week) | Marks |
|---|---|---|---|---|---|
| **1** | Ordinary Differential Equations of order 2 | SIUMTSE221 | 2 | 2 P ( 4L) | 50 |
| **2** | Numerical Methods | SIUMTSE222 | 2 | 2 P (4L) | 50 |
| **1P (Practical) = 2 Hours per week** | | | | | |

**Option 1**

| Course Name: **ORDINARY DIFFERENTIAL EQUATIONS** | | | |
|---|---|---|---|
| Credits**: 2** | **Course Code:** SIUMTSE221 | **SEM-IV** | **Course** Type**: Practical** |
| **Skill Enhancement Course** | | | |

**Expected Course Outcomes**

On completion of this course, students will be able to

1. To apply various techniques for solving second order linear differential equations with constant coefficients.
2. To analyze the appropriate method to find the complete solution of a nonhomogeneous differential equation.
3. Create an equivalent system of first order differential equations from a higher order differential equation.

**The following contents will be covered in Practical sessions.**

**Duration: 30 Practical Sessions of 2 hours per batch, of not more than 30 students.**

## SIUMTSE221: ORDINARY DIFFERENTIAL EQUATIONS

### A) Higher order Linear Differential equations

1. The general nth order linear differential equations, Linear independence, Existence and uniqueness theorem[Statement only], Wronskian, General solution of homogeneous and non-homogeneous LDE.

2. Higher order homogeneous linear differential equations with constant coefficients, the auxiliary equations, Roots of the auxiliary equations: real and distinct, real, and repeated, complex, and complex repeated.

3. Higher order homogeneous linear differential equations with constant coefficients, the method of undetermined coefficients, method of variation of parameters.

4. The inverse differential operator and particular integral, Evaluation of $\frac{1}{f(D)}$ for the functions like $e^{ax}$ , $sin\, ax$ , $cos\, ax$ , $x^m$, $x^m sin\, ax$ , $x^m cos\, ax$ , $e^{ax}V$ and $xV$ where V is any function of x.

5. Higher order linear differential equations with variable coefficients: The Cauchy's equation:$a_0x^3\frac{d^3y}{dx^3} + a_1x^2\frac{d^2y}{dx^2} + a_2x\frac{dy}{dx} + a_3y = f(x)\ where\ a_0, a_1, a_2, a_3 \in R,$

Legendre's linear equation:

$a_0(ax+b)^3\frac{d^3y}{dx^3} + a_1(ax+b)^2\frac{d^2y}{dx^2} + a_2(ax+b)\frac{dy}{dx} + a_3y = f(x)\ where\ a_0, a_1, a_2, a_3 \in R,$

### B) Systems of First Order Linear Differential Equations

1. Existence and uniqueness theorem for the solutions of initial value problems for a system of two first order linear differential equations in two unknown functions x, y of a single independent variable t, of the form: $\frac{dx}{dt} = F(t,x,y)$, $\frac{dy}{dt} = G(t,x,y)$ (Statement only).

2. Homogeneous linear system of two first order differential equations in two unknown functions of a single independent variable t of the form $\{\frac{dx}{dt} = a_1(t)x + b_1(t)y\,,\ \frac{dy}{dt} = a_2(t)x + b_2(t)y\}$

3. Wronskian for a homogeneous linear system of first order linear differential equations in two functions x, y of a single independent variable t. Vanishing properties of the Wronskian. Relation with linear independence of solutions.

4. Homogeneous linear systems with constant coefficients in two unknown functions x, y of a single independent variable t. Auxiliary equation associated with a homogenous system of equations with constant coefficients. Description for the general solution depending on the roots and their multiplicities of the auxiliary equation, proof of independence of the solutions. Real form of solutions in case the auxiliary equation has complex roots.

5.Non-homogeneous linear system of two first order differential equations in two unknown functions of a single independent variable t of the form $\{\frac{dx}{dt} = a_1(t)x + b_1(t)y + f_1(t)\,,\ \frac{dy}{dt} = a_2(t)x + b_2(t)y + f_2(t)\}$. General Solution of non-homogeneous systems. Relation between the solutions of a system of non-homogeneous linear differential equations and the associated system of homogeneous linear differential equations.

**Practical sessions:**

| **Practical** | **Topic** |
|---|---|
| **01** | Finding the general solution of homogeneous and non-homogeneous higher order linear differential equations using the method of undetermined coefficients. |
| **02** | Finding the general solution of homogeneous and non-homogeneous higher order linear differential equations using the method of variation of parameters |
| **03** | Solving higher order linear differential equations with constant coefficients using inverse operators for $e^{ax}$ , $sin\,ax$ , $cos\,ax$ |
| **04** | Solving higher order linear differential equations with constant coefficients using inverse operators for $x^m$, $x^m sin\,ax$ , $x^m cos\,ax$ |
| **05** | Solving higher order linear differential equations with constant coefficients using inverse operators for $e^{ax}V$ and $xV$ where V is any function of x |
| **06** | Solving Cauchy's equation and Legendre's equation. |
| **07** | Solving a system of first order linear ODES having auxiliary equations with real roots. |
| **08** | Solving a system of first order linear ODES having auxiliary equations with complex roots. |

Reference Books


1. Units 5, 6, 7 and 8 of E.D. Rainville and P.E. Bedient; Elementary Differential Equations; Macmillan.
2. Units 5, 6 and 7 of M.D. Raisinghania; Ordinary and Partial Differential Equations; S. Chand.
3. G.F. Simmons; Differential Equations with Applications and Historical Notes; Taylor's and Francis.
4. Elementary Differential Equations and Boundary Value Problems; Boyce DiPrima; John Wiley & Sons (Asia) Pte Ltd
5. K. Atkinson, W.Han and D Stewart, Numerical Solution of Ordinary Differential Equations, Wiley.

**Option 2**

Course Name: **Numerical Methods**

Credits**: 2** **Course Code:** SIUMTSE222 **SEM-IV** **Course** Type**: Practical**

**Skill Enhancement Course**

**Expected Course Outcomes**

On completion of this course, students will be able to

1. Apply numerical techniques to find the roots of algebraic and transcendental equations, and solution of systems of linear equations,
2. Evaluate limitations,advantages,disadvantages and accuracy of different numerical methods
3. To carry out numerical integration, differentiation and comparison with analytical methods.

**The following contents will be covered in Practical sessions.**

**Duration: 2 Practical Session of 2 hours per batch per week, of not more than 30 students.**

**Unit I. Solution of Algebraic,Transcendental Equations and Linear Systems of Equations**

1. Measures of Errors: Relative, absolute and percentage errors, Accuracy, and precision: Accuracy to n decimal places, accuracy to n significant digits or significant figures, Rounding and Chopping of a number, Types of Errors: Inherent error, Round-off error, and Truncation error.
2. Iteration methods based on the first degree equation: Bisection method, General Iteration method: Fixed point iteration method, Newton-Raphson method. Secant method. Regula-Falsi method. Derivations and geometrical interpretation and rate of convergence of all above methods to be covered.
3. Linear Systems of Equations: LU Decomposition Method (Dolittle's Method and Crout's Method). Gauss-Seidel Iterative method, Gauss-Jacobi method.

**Unit II. Interpolation, Curve fitting, Numerical Integration and Differentiation**

1. Interpolation: Lagrange's Interpolation. Finite difference operators: Forward Difference operator, Backward Difference operator, Shift operator, Newton's forward difference interpolation formula, Newton's backward difference interpolation formula. Derivations of all above methods.
2. Curve fitting: linear curve fitting. Quadratic curve fitting.
3. Numerical Integration: Trapezoidal Rule. Simpson's $\frac{1}{3}$ rd Rule. Simpson's $\frac{3}{8}$th Rule.
4. Numerical Differentiation: Introduction,Derivatives using Newton's forward and backward interpolation formula,maxima and minima.

**Practical sessions:** Use of scientific calculators/free open source mathematical softwares is

encouraged.

| Practical | Topic |
|---|---|
| **01** | Problems on computing relative error,absolute,percentage error and rounding. |
| **02** | Problems on calculus of finite differences and operators-Shift,forward and backward difference |
| **03** | Roots of transcendental equations using Newton-Raphson method, Secant method. Regula-Falsi method, Iteration Method. |
| **04** | Interpolating polynomial for equal intervals Newton forward and backward difference methods. |
| **05** | Interpolating polynomial for unequal intervals by Lagrange's Interpolation, and Newton divided difference formula. |
| **06** | Curve fitting, Trapezoidal Rule, Simpson's $\frac{1}{3}$ rd Rule, Simpson's $\frac{3}{8}$th Rule.. |
| **07** | LU decomposition method, Gauss-Seidel and Gauss Jacobi Iterative method. |
| **08** | Finding first order,second order derivatives,maxima,minima using Newton's forward and backward difference formulae. |

**Reference Books:**

1. Kendall E. and Atkinson; An Introduction to Numerical Analysis; Wiley.
2. M. K. Jain, S. R. K. Iyengar and R. K. Jain; Numerical Methods for Scientific and Engineering Computation; New Age International Publications.
3. S. Sastry; Introductory methods of Numerical Analysis; PHI Learning.
4. An introduction to Scilab-Cse iitb

**Additional Reference Books:**

1. S.D. Comte and Carl de Boor; Elementary Numerical Analysis, An algorithmic approach; McGraw Hill International Book Company.
2. Hildebrand F.B.; Introduction to Numerical Analysis; Dover Publication, NY.
3. Scarborough James B.; Numerical Mathematical Analysis; Oxford University Press, New Delhi.

## 6. Teaching Pattern

This is a practical course of 2 credits- 4 hours per week. The Practicals shall be conducted in batches formed as per the University circular. The Practical session shall consist of discussion between the teacher and the students in which students should participate actively. The students should maintain a journal for practicals which should be submitted for checking regularly and at the end of the semester.

## 7. Scheme of Evaluation

There will be continuous internal assessment throughout the semester.
A practical examination will be conducted at the end of the semester.
Students will have to submit the certified journal at the time of practical examination.

| | |
|---|---|
| 1. Project and Viva/ Assignment | 10 |
| 2. Journal | 15 |
| 3. Attendance and participation | 05 |
| 4. Practical Examination | 20 |
| **Total Marks** | **50** |

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