AC/27.06.2023/RS1

College of Arts, Science & Commerce (Autonomous)

SIES

RISE WITH EDUCATION

NAAC REACCREDITED - 'A' GRADE

SIES College of Arts, Science and Commerce, (Autonomous)

Affiliated to University of Mumbai

Syllabus under NEP effective from June 2023

Department of Mathematics

Programme: B.Sc.

Sem: I and II

Class: FYBSc

Skill Enhancement Course

Course Name

1. **Techniques of solving differential equations and applications**
2. **Linear Algebra for Machine Learning (ML)**

Choice Based Credit System (CBCS)

with effect from the academic year 2023-24

Skill Enhancement Course

This course is offered to students of BSc in semester I or II, who have chosen Mathematics as a Major/ Minor subject. Any one of the two options may be offered.

Name of Programme: 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
SEC option1	Techniques of solving differential equations and applications	SIUMTSE111/ SIUMTSE121	2	2 P	50
SEC option2	Linear Algebra for Machine Learning (ML)	SIUMTSE111/ SIUMTSE121	2	2 P	50

1P (Practical) = 2 Hours per week

Skill Enhancement Course - option1

Course Name: Techniques of solving differential equations and applications

Credits**: 2** Type**: Practical Course**

Expected Course Outcomes

On completion of this course, students will be able to:

1) Solve first-order linear differential equations using various methods, finding integrating factors, for non-exact equations.
2) Apply differential equations to model and solve real-world problems, such as population growth, radioactive decay, orthogonal trajectories including identifying families of curves that are orthogonal to a given family.
3) Analyse and interpret solutions of first-order linear differential equations, including equilibrium solutions, growth and decay behaviour, and the effect of initial conditions.
4) Recognize the limitations and challenges in solving ODEs analytically and the need for numerical methods.
5) Demonstrate proficiency in using numerical methods, such as Euler's method, the improved Euler method, and the Runge-Kutta methods, to approximate solutions of first-order ODEs

The following contents will be covered in Practical sessions.

Duration: 30 Practical Sessions of 2 hours per batch, of not more than 30 students.		
Pre-requisites:	Fundamental concepts of first-order linear differential equations, including variables, functions, derivatives, order and degree of a differential equation. Formation of DE and solution by separation of variables.	
a)	**First Order Differential Equations**	
	• Solutions of Homogeneous and non-homogeneous differential equations of first order and first degree • Notion of partial derivative, exact equations and condition of exactness • Rules for finding integrating factors[without proof] for non-exact equations. • Solving linear and Bernoulli DE.	
b)	**Applications and Mathematical Modelling of DE**	
	• Formulation and solving DE related to Orthogonal trajectories • Solving differential equations related to population growth and decay and Half life period • Solving differential equations related to electrical circuits	
c)	**Numerical solutions of Ordinary differential equations**	
	• Euler's method • Euler's modified method • Picard's method • Runge-Kutta method	

Practical Sessions	
Practical	Topic
01	Solving homogeneous and non-homogeneous differential equations of first order and first degree,linear and Bernoulli
02	Solving problems on exact differential equations and finding integrating factors
03	Solving linear and Bernoulli differential equations
04	Solving differential equations related to Orthogonal trajectories

05	Formation and solving differential equations related to electric circuits-RL and RC
06	Formation and solution of differential equations related to exponential growth, decay and half life period.
07	Numerical solutions of ODE using Euler's method and Euler's modified methods.
08	Numerical solutions of ODE using Picard's method and Runge- Kutta methods.

References:

1) Ordinary and Partial Differential Equations; S. Chand.
2) G.F. Simmons; Differential Equations with Applications and Historical Notes; Taylor's and Francis
3) K. Atkinson, W.Han and D Stewart, Numerical Solution of Ordinary Differential Equations, Wiley.
4) Kendall E. and Atkinson; An Introduction to Numerical Analysis; Wiley.
5) M. K. Jain, S. R. K. Iyengar and R. K. Jain; Numerical Methods for Scientific and Engineering Computation; New Age International Publications.
6) S. Sastry; Introductory methods of Numerical Analysis; PHI Learning.

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

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Skill Enhancement Course option 2

Course Name: **Linear Algebra for Machine Learning(ML)** Credits**: 2 Type: Practical Course**	
Expected Course Outcomes On completion of this course, students will be able to: 1) Understand the fundamental concepts of matrices, including matrix notation, dimensions, and operations such as addition, subtraction, and scalar multiplication. 2) Apply matrix operations to solve basic problems, such as matrix multiplication and finding inverse, transpose. 3) Comprehend the properties of matrices, including commutativity, associativity, and distributivity, and their implications in matrix operations. 4) Gain proficiency in solving systems of linear equations using various methods, such as substitution, elimination, and matrix inversion.	
The following contents will be covered in Practical sessions. **Duration: 30 Practical Sessions of 2 hours per batch, of not more than 30 students.**	
Prerequisites:	Vectors in R^2, R^3, Dot product, norm.
a)	**Systems of Linear equations and matrices**
	• Introduction to Machine Learning • Parametric equation of lines and planes • System of homogeneous and non-homogeneous linear equations • The solution of homogeneous system of m linear equations in n unknowns by elimination and their geometrical interpretation for (n, m) = (1, 2), (1, 3), (2, 2), (2, 3), (3, 3) • Definition of n−tuples of real numbers, sum of two n−tuples and scalar multiple of an n−tuple.
b)	**Matrices with real entries**
	• Addition, scalar multiplication, multiplication of matrices and transpose

	• Types of matrices: zero matrix, identity matrix, scalar matrices, diagonal matrices, orthogonal matrices,upper triangular matrices, lower triangular matrices, symmetric matrices, skew-symmetric matrices, Invertible matrices. • Identities such as $(AB)^t = (B^t)(A^t)$, $(AB)^{-1} = (B^{-1})(A^{-1})$
c)	**System of linear equations in matrix form**
	• Elementary row operations, row echelon matrix, • Gaussian elimination method

Practical Sessions	
Practical	Topic
01	Finding equation of line and plane
02	Drawing appropriate figures for (n, m) = (1, 2), (1, 3), (2, 2), (2, 3), (3, 3) And possible interpretation of their solutions geometrically
03	Solving homogeneous systems by elimination and back substitution
04	Problems on handling different types of matrices
05	Finding inverse of a matrix using elementary row transformations.
06	Checking for consistency
07	Solving the system for unique / infinitely many solutions using Gaussian elimination.
08	Solving system to find value of unknown k

References:

1) Howard Anton, Chris Rorres, Elementary Linear Algebra, Wiley Student Edition.
2) S Kumaresan, Linear Algebra - A Geometric Approach, PHI Learning.
3) Serge Lang, Introduction to Linear Algebra, Springer.
4) K. Hoffman and R. Kunze : Linear Algebra, Tata McGraw-Hill, New Delhi.

Scheme of Evaluation:

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

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