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College of Arts, Science & Commerce

SIES

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.

Subject: Mathematics- Minor

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

Syllabus Revised in June 2024 under NEP

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

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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, Biotechnology. 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.

3. Programme Outcomes

SIES has integrated the Learning Outcome Based Curriculum Framework in the syllabi of all the programmes since the academic year 2021-22. Upon completing the B.Sc. Mathematics Programme, the students are expected to develop the following abilities and skills:

I. **Solving Complex Problems:**

Applying the knowledge of various courses learned under a program with an ability to break down complex problems into simple components, by designing processes required for problem solving.

II. **Critical Thinking and reasoning ability:**

Exhibits ability to understand abstract concepts,analyze, and apply them in problem solving. Ability to formulate and develop logical arguments. developing the ability to think with different perspectives and ideas. (Skills necessary for progression to higher education and research.)

III. **Research Aptitude:**

Acquiring the ability to explore and gain knowledge in independent ways through reading assignments, problem solving assignments, projects, seminars, presentations.

IV. **Information and Digital literacy**:

Equip to select, apply appropriate tools and techniques, resources through electronic media for the purpose of visualizing mathematical objects, geometrical interpretations, coding, and analyzing data.

V. **Sound Disciplinary knowledge:**

Demonstrate comprehensive knowledge and understanding of the fundamental concepts and theories of mathematics; apply them to interdisciplinary areas of study.

VI. **Communicating Mathematical Ideas:**

Organize and deliver mathematical ideas through effective written, verbal, graphical/virtual communications.

4. Course structure with minimum credits and Lectures/ Week

SYBSc student who has chosen Mathematics as a Minor subject will study the following courses in Semester III and Semester IV.

Name of Program: Bachelor of Science Name of Department: Mathematics Class: SYBSc								
Semester	**Course Code**	**Course Name**	Type of Course	**No. of lectures/ per week**	**Credits**	**Internal Marks**	**Sem End Marks**	**Total Marks**
III	SIUMTMN211	LINEAR ALGEBRA	Theory Course for Minor	3	3	25	50	75
III	SIUMTMNP211	Mathematics Practical 3	Practical Course for Minor	2 per batch	1	—-	25	25
IV	SIUMTMN221	INTEGRAL CALCULUS	Theory Course for Minor	3	3	25	50	75
IV	SIUMTMNP221	Mathematics Practical 4	Practical Course for Minor	2 per batch	1	—-	25	25

SEMESTER III				
LINEAR ALGEBRA				
Course Code	UNIT	TOPICS	Credits	L/Week
SIUMTMN211	I	Vector Spaces, Linear Transformations	3	3
	II	Systems of Linear Equations and Matrices		
	III	Eigenvalues, Eigenvectors & Diagonalisation		
PRACTICALS				
Course Code	Unit	TOPICS	Credits	L/Week
SIUMTMNP211	I	Practicals in Linear Algebra	1	2
SEMESTER IV				
INTEGRAL CALCULUS				
Course Code	UNIT	TOPICS	Credits	L/Week
SIUMTMN221	I	Sequences of real numbers	3	3
	II	Infinite Series		
	III	Riemann Integration and applications		
PRACTICALS				
Course Code	UNIT	TOPICS	Credits	L/Week
SIUMTMNP221	I	Practicals in integral Calculus	1	2

5. Consolidated Syllabus for semester III & IV with Course Outcomes

SEMESTER III

Course Code: SIUMTMN211 **3 credits**

Course Name: LINEAR ALGEBRA

Expected Course Outcomes:

On completion of this course, students are expected to

1. State the definitions and prove results based on Vector spaces, basis, linear transformation, Systems of homogeneous and non-homogeneous linear equations, row echelon form of matrices, .
2. Apply various definitions and results learnt to solve problems on checking Linear independence of subsets of a vector space, checking subspace of vector space, system of linear equations using Gaussian elimination, Eigenvalues, Eigenvectors and Diagonalization.

SIUMTMN211: LINEAR ALGEBRA

Unit 1: Vector Spaces, Linear Transformations

1. Definition of a vector space over R. Subspaces; criterion for a nonempty subset to be a subspace of a vector space. Examples of vector spaces, including the Euclidean space R^n, lines, planes in R^2, R^3 passing through the origin, space of real valued functions on a set. Intersections and sums of subspaces.
2. Linear combination of vectors. Linear span of a subset of a vector space. Definition of a finitely generated vector space. Linear dependence and independence of subsets of a vector space.
3. Basis of a vector space. Statements of Basic results that (i) any two bases of a finitely generated vector space have the same number of elements, (ii) bases of a vector space as a maximal linearly independent sets and as minimal generating sets.
4. Definition of a linear transformation of vector spaces; elementary properties. Examples. Sums and scalar multiples of linear transformations. Composites of linear transformations. Statement - A Linear transformation of $V \rightarrow W$, where V, W are vector spaces over R with V a finite-dimensional vector space, is completely determined by its action on an ordered basis of V.
5. Null-space (kernel) and the image (range) of a linear transformation. Rank -Nullity Theorem (Fundamental Theorem of Homomorphism Statement only). Isomorphism.

Unit 2: Systems of Linear Equations and Matrices

1. Systems of homogeneous and non-homogeneous linear equations, Simple examples of finding solutions of such systems. Geometric and algebraic understanding of the solutions. Matrices (with real entries), Matrix representation of systems of homogeneous and non-homogeneous linear equations. Algebra of solutions of systems of homogeneous linear equations. A system of homogeneous linear equations with a number of unknowns more than the number of equations has infinitely many solutions.
2. Elementary row and column operations. Row equivalent matrices. Row reduction (of a matrix to its row echelon form). Gaussian elimination. Applications to solving systems of linear equations. Examples. Rank of a matrix.
3. space of systems of homogeneous linear equations, space of various types of matrices, Matrix associated with linear transformation of $V \to W$ where V and W are finite dimensional vector spaces over R. Matrix of the composite of two linear transformations. Equivalence of the rank of a matrix and the rank of the associated linear transformation. Similar matrices.

Unit 3: Eigenvalues, Eigenvectors and Diagonalization

1. Eigenvalues and eigenvectors of a linear transformation of a vector space into itself and of square matrices. The eigenvectors corresponding to distinct eigenvalues of a linear transformation are linearly independent. Eigenspaces. Algebraic and geometric multiplicity of an eigenvalue.
2. Characteristic polynomial. Properties of characteristic polynomials (only statements). Examples. Cayley-Hamilton Theorem. Applications.
3. Invariance of the characteristic polynomial and eigenvalues of similar matrices.
4. Diagonalizable matrix. A real square matrix A is diagonalizable if and only if there is a basis of R^n consisting of eigenvectors of A. (Statement only - $A_{n\times n}$ is diagonalizable if and only if sum of algebraic multiplicities is equal to sum of geometric multiplicities of all the eigenvalues of $A = n$). Procedure for diagonalizing a matrix.

Reference books

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

Course Code: SIUMTMNP211 **1 credit**

Course Name: Practicals in LINEAR ALGEBRA

Upon completion of this course, students are expected to

1. Apply various definitions, results and methods learnt in theory courses to solve problems.
2. Test validity of mathematical statements using results and constructing appropriate examples

Practicals based on SIUMTMN211

1. Subspace of vector space, linearly independent sets, basis
2. Linear transformations, Kernel and image of linear transformation
3. Solving homogeneous and non- homogeneous system of linear equations
4. Rank of a matrix, matrix representation of linear transformation
5. Eigenvalues, Eigenvectors, Characteristic polynomial.
6. Diagonalisation of matrix

SEMESTER IV

Course Code: SIUMTMN221 **3 credits**

Course Name: INTEGRAL CALCULUS

Expected Course Outcomes:

On completion of this course, students are expected to

1. State the definitions and prove results based on sequences of real numbers, State the definitions and prove results based on concepts summation and convergence of a series, the lower and upper Riemann integrals.
2. Apply various definitions and results learnt to solve problems on convergence and divergence of a sequence, convergence of infinite series, upper and lower sums and checking integrability, problems in physics
3. Test the validity of mathematical statements and converses based upon the gained knowledge, choose appropriate methods to discuss integrability of a function, convergence of a sequence and series.

SIUMTMN221: INTEGRAL CALCULUS OF ONE VARIABLE

Unit I: Sequences of real numbers (15 Lectures)

1.1 Definition of a sequence and examples, Definition of convergent and divergent sequences. Limit of sequence, uniqueness of limit, if it exists. Simple examples such as seq(1/n) , where convergence is checked using definition.Sandwich theorem, Algebra of convergent sequences , Examples.
1.2 Monotonic and Bounded sequences: Definition of bounded sequence. Every convergent sequence is bounded .Monotone sequences and Monotone convergence theorem. Examples. Subsequences, results on subsequences. Definition of Cauchy sequence and examples on Cauchy criteria for convergence of sequences.
(Limits of some special sequences like $(1+\frac{1}{n})^n$,$\sqrt[n]{n}$ TO BE DISCUSSED ONLY IN PRACTICALS)

Unit II: Infinite Series (15 Lectures)

2.1 Definition of Series as a Sequence of partial sums, Summation of a series, simple examples like Geometric series. Convergent and divergent series, Necessary condition for convergence of series, Converse not true. Algebra of convergent series. Cauchy criterion for convergence of a series.
2.2Alternating series, Leibnitz Test, Examples. Absolutely convergent series. Absolute convergence implies convergence but not conversely. Conditional convergence. Convergence of a p- series- $\sum_{n=0}^{\infty}\frac{1}{n^p}$; divergence of the Harmonic series $\sum_{n=0}^{\infty}\frac{1}{n}$. Tests for convergence of an infinite series: Comparison test, limit form of comparison test, Ratio test, Limit form of ratio test, Root test, Limit form of root test.
Abel's Test and Dirichlet's test as assignments.

Unit III: Riemann Integration (15 Lectures)

3.1 Idea of approximating the area under a curve by inscribed and circumscribed rectangles. Partitions of an interval. Refinement of a partition. Upper and Lower sums for a bounded real valued function on a closed and bounded interval. Riemann integrability and the Riemann integral.
3.2 Criterion for Riemann integrability. Characterization of the Riemann integral as the limit of a sum. Examples.

3.3 Algebra of integrable functions: Sum, scalar multiplication, product of integrable functions are integrable. Properties of integrable functions: Integral of a non negative function is nonnegative, $\left|\int_a^b f\right| \leq \int_a^b |f|$; domain additivity, Examples and counterexamples.

3.4 Riemann integrability of a continuous function, and more generally of a bounded function whose set of discontinuities has only finitely many points. Riemann integrability of monotone functions.

3.5 Applications of integration

Topics for assignment and self-study:

i) Applications of definite Integrals: Area between curves, finding volumes of solids of revolution Lengths of plane curves, Areas of surfaces of revolution, finding average value of a function, finding mass and center of mass, any other application.

ii) Abel's and Dirichlet's Test of convergence of an infinite series, Applications of Infinite series.

Course Code: SIUMTMNP221 **1 credits**

Course Name: Practicals in INTEGRAL CALCULUS

Expected Course Outcomes

Upon completion of this course, students are expected to

1. Apply various definitions, results and methods learnt in theory courses to solve problems.
2. Explore mathematical softwares/mobile apps like Matlab/ Scilab/ Geogebra/ SAGE/ Desmos to solve problems and visualize graphs. (free and open versions)
3. Test validity of mathematical statements using results and constructing appropriate examples

Practicals based on SIUMTMN221

1. Testing if a sequence is convergent / divergent using definition.
2. Convergence of a sequence using tests of convergence. Application of necessary condition, results of definition.
3. Finding sum of a series, convergence of series.
4. Problems based on Tests for convergence of series.
5. Calculation of upper sum, lower sum and Riemann integral, properties of Riemann integral.
6. Applications of integration to find average value, area, volume, surface area, length of a curve, applications in physics. (two applications to be given as assignment topic)

Reference Books:

1) Howard Anton, Calculus-A new Horizon, Sixth Edition, John Wiley and Sons Inc.
2) K. Stewart, Calculus, Booke /Cole Publishing Co.
3) Bartle and Sherbet, Introduction to real analysis, fourth edition or earlier, John Wiley and Sons Inc.
4) Ajit Kumar, Kumaresan S., A Basic Course in Real Analysis, first edition, CRC Press.
5) Apostol T. , Calculus Vol.2, any edition, John Wiley and Sons Inc.
6) J .E. Marsden, A. J. Tromba and A. Weinstein, Basic multivariable calculus, 3rd edition, W.H. Freeman and Co Ltd.

6. Teaching Pattern for semester III & IV

A) Theory Course:

Three lectures of one hour each, per week in each semester.

B) Practical Course based on Theory course

One practical per week per batch based on Theory course. (1 credit - 2 hours)
Minimum 6 practicals to be conducted in each semester.

Conduct of Practicals:

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 for Semesters III & IV

A) Theory Course

The performance of the learners shall be evaluated in two ways:

(1) Continuous Internal Assessment of 25 marks in the Theory course in each semester.

Sr No	Evaluation type	Marks
1	One class test	10
2	Teachers may use various methods to encourage experiential learning and problem-solving skills of the student. Written assignment/ project assignment/ oral or ppt or poster presentation/ reading assignment with viva voce, seminar etc.	15
Total		25

(2) Semester End Examinations of 50 marks at the end of each semester.

Marks: 50 Duration – 2 hours.

Question Paper Pattern:

One question on each unit (Questions 1, 2, 3), Question 4 will be based on the entire syllabus.

B) Practical Course based on Theory Course

A Practical exam of 25 marks, 1 hour 30 minutes, based on practicals on the Theory course will be conducted at the end of each semester. Students will be required to submit certified journal at the time of examination.

Evaluation Head	Marks
Semester End Practical Examination	20 Marks
Journal and Viva	5 marks
Total	**25 marks**

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