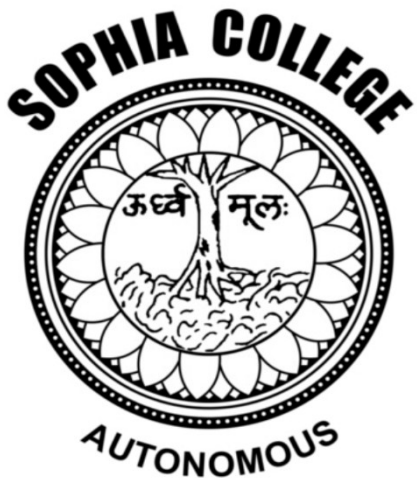

SOPHIA COLLEGE FOR WOMEN(EMPOWERED AUTONOMOUS)
Affiliated to the University of Mumbai

Programme: Science

Syllabus for the Academic Year 2024-2025
based on the National Education Policy 2020

DEPARTMENT OF MATHEMATICS & STATISTICS

COURSE DETAILS FOR MINOR:

	SEMESTER 3		SEMESTER 4
TITLE	**Algebra**		**Discrete Mathematics**
TYPE OF COURSE-DSC	**Minor**		**Minor**
CREDITS	**4**		**4**

Preamble:

Many people believe that mathematics is one of the most challenging subjects to learn in school. However, it is still very important in today's world. Mathematics is crucial to comprehending and resolving issues that arise in our daily lives, from the sophisticated systems that run our society to the everyday devices we utilise.

An essential component in the continual development of science and technology has been mathematics. The number of applications of mathematics used in practical problems has grown significantly in recent decades. The S.Y.B.Sc. Mathematics syllabus for Semesters III and IV have been designed to demonstrate to students the fundamental concepts of mathematics while exposing them to rigorous techniques systematically. Discrete Mathematics and Algebra encourage logical and mathematical reasoning.

Today, mathematics is an important instrument in many areas, including natural science, engineering, medicine, and the social sciences, used extensively throughout the world. New mathematical discoveries are inspired by and implemented by applied mathematics, the area of mathematics that deals with transferring mathematical knowledge to other domains. Applied mathematics additionally encourage the development of completely new sciences.

PROGRAMME OBJECTIVES

PO 1	To develop in the learner a scientific temperament.
PO 2	Along with developing domain knowledge of several disciplines in the scientific stream, to develop among the learners, the fundamental practical skills towards technical proficiency.
PO 3	To enable the students to gain employability in various professional courses, meet the requirements for industrial professions, and have an opportunity of pursuing entrepreneurship.
PO 4	To enable the learners to comprehend a wide range of social and environmental challenges and develop solutions-oriented strategies to issues

PROGRAMME SPECIFIC OUTCOMES

PSO 1	The learner will be able to use logical and critical thinking abilities in problem solving and develop the habit of self-learning by the end of the course.
PSO 2	The learner will be able to create and apply quantitative models that emerge in business, social science, and other areas.
PSO 3	The learner will be able to analyse the mathematical outcomes and use them to solve numerous issues that arise in various areas of mathematics and associated disciplines
PSO 4	The learner will be able to identify trends and make a distinction between the problems' core components and non-essential ones.
PSO 5	The learner will be able to utilise technological expertise to address certain theoretical and applied issues in mathematics and other fields.

PSO 6	The learner will be able to convert verbally supplied information into a mathematical form, choose and use the proper mathematical formulas or techniques to process the information, and then make the necessary conclusion.
PSO 7	The learner will be able to recognise the relationships between different areas of mathematics and the connections between mathematics and other disciplines.

Programme: Science **Mathematics Minor**		**Semester – 1**	
Course Title: Calculus-1		**Course Code: SMAT111MN**	
COURSE OBJECTIVES: To enable the learner 1. To provide the learner the necessary skills to work on the numerical applications of the concepts while understanding the structure of the natural number and integer systems 2. To enable the learner become competent in numerical computations using division, GCD, prime number concepts, and congruence relations. 3. To develop in the learner, the ability to use equivalence relations and associated features to differentiate between sets of numbers. 4. To enable the learner to develop the capacity to comprehend, apply, and solve numerical problems involving the principles of functions and binary operations.			
COURSE OUTCOMES: At the end of the course the learner will be able to 1. The learner will be able to comprehend and apply the concepts of binary operators, relations, functions, prime number congruence's, division of integers, and GCD. 2. Through logical inductions, the learner will be able to prove mathematical propositions and develop mathematical ideas from the foundational axioms. 3. In order to fulfill the requirements of the numerical assignments, the learner will be able to identify and construct bijective and invertible functions. 4. The learner will be able identify and compute factors of a polynomial with multiplicity over the set of real and complex numbers, and also identify irreducible polynomials.			
Lectures per week (1 Lecture is 60 minutes)		**3**	
Total number of Hours in a Semester		**45**	
Credits		**3**	
Evaluation System	**Semester End Examination**	**2 Hours**	**50 marks**
	Internal Assessment	**--**	**50 marks**

UNIT 1	Integers and divisibility (15 Hours)
1.1	Statements of well-ordering property of non-negative integers, Principle of finite induction (first and second) as a consequence of well-ordering property, Binomial theorem for non-negative exponents, Pascal's Triangle.
1.2	Divisibility in integers, division algorithm, greatest common divisor (g.c.d.) and least common multiple (l.c.m) of two integers, basic properties of gcd such as existence and uniqueness of g.c.d. of integers a and b, g.c.d can be expressed as $ma+nb$, m,n are integers. Euclid's lemma, Euclidean algorithm.
1.3	Results on prime numbers and fundamental theorem of arithmetic.
UNIT 2	Equivalence Relations and Congruences (15 Hours)
2.1	Equivalence relations, Equivalence classes, properties such as two equivalence classes are either identical or disjoint, definition of partition, every partition gives rise of an equivalence relation and vice versa
2.2	Congruence - definition, elementary properties and applications. Euler's φ function, Statements of Euler's theorem, Fermat's theorem and Wilson theorem and their applications.

2.3.	Congruence as an equivalence relation on Z (set of integers), Residue classes and its properties.
2.4	Binary operations, properties and examples.
UNIT 3	Polynomials (15 Hours)
3.1	Definition of polynomial, Polynomials over F where F = Q or R, Algebra of polynomials, basic properties, division algorithm in F[X] (without proof) and g.c.d of two polynomials and its basic properties (without proof), Euclidean algorithm (without proof), applications,
3.2	Roots of a polynomial, relation between roots and coefficients, multiplicity of a root, remainder theorem, Factor theorem, applications, Necessary conditions for a rational number p/q to be a root of a polynomial with integer coefficients, simple consequences such as $\sqrt{p}$ is an irrational number where p is a prime number.
3.3	Necessary conditions for a rational number p/q to be a root of a polynomial with integer coefficients, simple consequences such as $\sqrt{p}$ is not a rational number where p is a prime number.
3.4	Complex numbers - DeMoivres Theorem, roots of unity, primitive roots of unity, solutions of the equation $w^n = z$. Fundamental theorem of algebra, roots of polynomials over R.

Main Reference:

- Elementary Number Theory, David M. Burton, Second Edition, UBS, New Delhi.
- Discrete Mathematics, Norman L. Biggs, Revised Edition, Clarendon Press, Oxford 1989.

Additional Reference Books:

- K.D. Joshi, Foundations in Discrete Mathematics, New Age Publishers, New Delhi, 1989.
- Kenneth H. Rosen, Discrete Mathematics and its applications, Mc-Graw Hill International Edition.
- Norman Biggs: Discrete Mathematics, Oxford Publishing House
- C.V. Sastry and Rakesh Nayak :A Textbook on Discrete Mathematics Wiley Publishing House
- Sussana S Epp: Discrete Mathematics with Applications – Cengage
- Bernard Kolman, Robert Busby, Sharon Ross :Discrete Mathematics Structures - Pearson
- T Veerarajan :Discrete Mathematics with Graph Theory – McGraw Hill

PRACTICAL **Course Title: Algebra**		**Course Code: SMAT233MNP**	
COURSE OUTCOMES: At the end of the course the learner will be able to 1. Comprehend and apply the concepts of binary operators, relations, functions, prime number congruence's, division of integers, and GCD. 2. Prove mathematical propositions and develop mathematical ideas from the foundational axioms. 3. Identify and construct bijective and invertible functions. 4. Identify and compute factors of a polynomial with multiplicity over the set of real and complex numbers, and also identify irreducible polynomials.			
Lectures per week (1 Lecture is 60 minutes)		**2**	
Total number of Hours in a Semester		**30**	
Credits		**1**	
Evaluation System	**Semester End Examination**	**2 Hours**	**50 marks**
	Internal Assessment	**--**	

1	Principle of finite induction
2	Binomial theorem
3.	G.C.D of an integer
4	Equivalence relation and equivalence classes

5	Congruence modulo relation on integers
6	Functions and binary operations
7	GCD of polynomials
8	Root of a polynomial
9	Complex root of a polynomial

ASSESSMENT DETAILS:

I. **Internal Assessment (IA): 50 marks:** Two activity /test/assignment each of 25 marks.

II. **Semester End Examination (SEE):** Theory exam of 50 marks – Two hours duration

III. **Semester End Examination (SEE):** Practical exam of 50 marks – Two hours duration

Programme: Science Mathematics Minor		**Semester – 4**	
Course Title: Discrete Algebra		**Course Code: SMAT244MN**	

COURSE OBJECTIVES:

1. To provide the learner the necessary skills to work on the numerical applications of the concepts while understanding the process of counting in discrete sets.
2. To enable the learner become competent in the concepts of polynomials and create models using them.
3. To develop in the learner, an appreciation of the different applications of the permutation maps and derangements and apply them to find solutions to real-life problems.
4. To enable the learner to develop the capacity to comprehend, apply, and solve numerical problems involving the counting principles.

COURSE LEARNING OUTCOMES:

1. The learner will understand the properties of polynomials under the binary operations and solve them using the techniques
2. The learner will be able to use various counting principles, permutation and combination in numerical problems and solve them with interpretation.
3. The learner will apply the concepts of Permutation maps and derangements in understanding the various methods of placement.

Lectures per week (1 Lecture is 60 minutes)		**3**	
Total number of Hours in a Semester		**45**	
Credits		**3**	
Evaluation System	**Semester End Examination**	**2 Hours**	**50 marks**
	Internal Assessment	**--**	**50 marks**

UNIT 1	Counting Principles (15 Hours)
1.1	Addition and multiplication principles, distributions of distinct and non-distinct objects, Multinomial coefficients, combinatorial interpretations, Multinomial theorem (without proof), applications
1.2	Pigeonhole Principle (statement only) and its applications.
1.3.	Stirling number S(n, k) and its elementary properties.
UNIT 2	RECURRENCE RELATIONS AND COUNTING PROBLEMS (15 Hours)
2.1	Recurrence Relations, definition of homogeneous, non-homogeneous, linear, non- linear recurrence relation, obtaining recurrence relations of Tower of Hanoi, Fibonacci sequence, etc. in counting problems.
2.2	Solving homogeneous as well as non-homogeneous recurrence relations by using iterative methods, solving a homogeneous recurrence relation of second degree using algebraic method proving the necessary result..
2.3	Counting problems using tree diagrams.
UNIT 3	PERMUTATIONS, PRINCIPLE OF INCLUSION-EXCLUSION AND APPLICATIONS (15 Hours)
3.1	Permutations of {1,2,…..n}. Cycles and transpositions. Decomposition of a permutation as a product of disjoint cycles and as product of transpositions. Inversions in a permutation. Sign of a permutation. Even and odd permutations. Addition and multiplication of complex numbers, modulus and amplitude of a complex number, real and imaginary parts and the conjugate of a complex number
3.2	Principle of inclusion and exclusion, its applications, derangements, explicit formula for dn.

Main Reference:

- Elementary Number Theory, David M. Burton, Second Edition, UBS, New Delhi.
- Discrete Mathematics, Norman L. Biggs, Revised Edition, Clarendon Press, Oxford 1989.

Additional Reference Books:

- K.D. Joshi, Foundations in Discrete Mathematics, New Age Publishers, New Delhi, 1989.
- Kenneth H. Rosen, Discrete Mathematics and its applications, Mc-Graw Hill International Edition.
- C.V. Sastry and Rakesh Nayak :A Textbook on Discrete Mathematics Wiley Publishing House
- Sussana S Epp: Discrete Mathematics with Applications – Cengage
- Bernard Kolman, Robert Busby, Sharon Ross :Discrete Mathematics Structures - Pearson
- T Veerarajan :Discrete Mathematics with Graph Theory – McGraw Hill

PRACTICAL **Course Title: Discrete Mathematics**	**Course Code: SMAT244MNP**
COURSE OUTCOMES: At the end of the course the learner will be able to **1.** Understand the properties of polynomials under the binary operations and solve them using the techniques **2.** Use various counting principles, permutation and combination in numerical problems and solve them with interpretation. 3. Apply the concepts of Permutation maps and derangements in understanding the various methods of placement.	
Lectures per week (1 Lecture is 60 minutes)	**2**
Total number of Hours in a Semester	**30**
Credits	**1**
Evaluation System **2 Hours**	**50 marks**
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1	Counting principles
2	Pigeonhole principle
3	Stirling's numbers
4	Recurrence relations (homogeneous)
5	Recurrence relations (non-homogeneous)
6	Counting using trees
7	Permutation maps
8	Principle of inclusion and exclusion, derangements

ASSESSMENT DETAILS:

I. **Internal Assessment (IA): 50 marks:** Two activity /test/assignment each of 25 marks.

II. **Semester End Examination (SEE):** Theory exam of 50 marks – Two hours duration

III. **Semester End Examination (SEE):** Practical exam of 50 marks – Two hours duration