SOPHIA COLLEGE, (AUTONOMOUS)

Affiliated to

UNIVERSITY OF MUMBAI

Programme: Mathematics

Programme Code: SBSMAT

F.Y.B.Sc.

2022-23

(Choice Based Credit System with effect from the year 2018-19)

Programme Outline: FYBSc (SEMESTER I)

Course Code	Unit No	Name of the Unit	Credits
SBSMAT101		CALCULUS-1	2
	1	Real Number System	
	2	Limits of a real valued function	
	3	Continuous functions	
SBSMAT102		ALGEBRA & DISCRETE MATHEMATICS -1	2
	1	Integers and divisibility	
	2	Binary Operations, Equivalence Relations and Congruences	
	3	Recurrence Relations and Counting problems	
SBSMATP1		MATHEMATICS PRACTICALS	2
	1.	Calculus-1 based on the syllabus.	
	2.	Algebra And Discrete Mathematics -1 based on the syllabus.	

Programme Outline: FYBSc (SEMESTER II)

Course Code	Unit No	Name of the Unit	Credits
SBSMAT201		CALCULUS-2	2
	1	Differentiation of real valued function of one variable	
	2	Applications of differentiation	
	3	Mean Value Theorems and their Applications	
SBSMAT202		ALGEBRA AND DISCRETE MATHEMATICS -2	2
	1	Polynomials	
	2	Counting Principles	
	3	Permutation Maps, Principle of Inclusion-Exclusion and Applications	
SBSMATP1		MATHEMATICS PRACTICAL	2
	1.	Calculus-2 based on the syllabus.	
	2.	Algebra and Discrete Mathematics -2 based on the syllabus.	

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 F.Y.B.Sc. Mathematics syllabus for Semesters I and II have been designed to demonstrate to students the fundamental concepts of mathematics while exposing them to rigorous techniques systematically. Calculus is applied and necessary in every potential field of study. 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.

PROGRAMME OBJECTIVES

PO 1	To develop in the learner a scientific temperament, critical thinking and logical reasoning.
PO 2	Along with 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.
PO4	To enable the learners to comprehend a wide range of social and environmental challenges and develop solutions-oriented strategies to issues through numerical and analytical skills.

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 abstract mathematical concepts 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.

SEMESTER 1

NAME OF THE COURSE	CALCULUS-1	
CLASS	FYBSC	
COURSE CODE	SBSMAT101	
NUMBER OF CREDITS	2	
NUMBER OF LECTURES PER WEEK	3	
TOTAL NUMBER OF LECTURES PER SEMESTER	45	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	50	50
PASSING MARKS	20	20

COURSE OBJECTIVES:

CO 1.	To enable the learner to become familiar with the fundamental properties of the real number system and its subsets, which form the basis of real analysis.
CO 2.	To enable the learner to have a thorough understanding of functions, a key building block of all sciences, and the ability to assess a function's properties and draw its graph.
CO 3.	To enable the learner to comprehend the ideas of a function's limit and continuity, and to use the results of limits to find solutions to real-world issues.

COURSE LEARNING OUTCOMES:

CLO 1.	The learner will be able to recall the meanings of the terms supremum, infimum, bounded sets, neighbourhoods, interior points, limit points, intervals, and their attributes and compute the values for a subset of IR.
CLO 2.	The learner will be able to understand the various properties of the given function and draw the graph of the functions.
CLO 3.	The learner will be able to define the limit of a function and to gauge if the function is continuous or not. The learner will also apply the concepts and applications of the limits and continuous functions.

UNIT 1	Real Number System (15 LECTURES)
1.1	Real number system R and order properties of R, Absolute values and its properties.
1.2	AM-GM inequality, Cauchy-Schwarz inequality, Intervals and neighbourhoods, Hausdorff’s property.
1.3	Bounded sets, l.u.b and g.l.b, l.u.b. axiom and its consequences, Archimedean property and its applications, density of rationals and irrationals.
UNIT 2	Limits of a real valued function (15 LECTURES)
2.1	Definitions – Function, Domain and range of a function, direct image and inverse image of a function, injective function, surjective function, bijective function, composite of two functions (when defined), Inverse of a bijective function.

2.2	Graphs of some standard functions such as IxI; e^x; log x; ax^2+bx+c; 1/x, x^n (n < 4); sin x; cos x; tan x; x sin(1/x); x^2 sin(1/x), step functions over suitable intervals of R:
2.3.	Definition and examples of limit of a function, left-hand-limit, right-hand-limit, uniqueness of limit if it exists, algebra of limits, limit of composite function, sandwich theorem, non-existence of limits.
UNIT 3	Continuous functions: (15 LECTURES)
3.1	Continuity of a real valued function on a set in terms of limits, examples, Continuity of a real valued function at end points of domain.
3.2	Algebra of continuous functions, Discontinuous functions, examples of removable and essential discontinuity.
3.3	Intermediate value theorem and its applications, Bolzano- Weierstrass theorem (statement only); Continuity on closed and bounded intervals.

Main Reference:

- T. M. Apostol, Calculus Volume I, Wiley & Sons (Asia) Pte. Ltd.
- James Stewart, Calculus, Third Edition, Brooks/cole Publishing Company, 1994.
- Ajit Kumar-S. Kumaresan, A Basic Course in Real Analysis, CRC Press, 2014.

Additional Reference Books:

- R. R. Goldberg, Methods of Real Analysis, Oxford and IBH, 1964.
- K.G. Binmore, Mathematical Analysis, Cambridge University Press, 1982.
- R.G. Bartle- D.R. Sherbert, Introduction to Real Analysis, John Wiley & Sons, 1994.
- Richard Courant-Fritz John, A Introduction to Calculus and Analysis, Volume I, Springer.
- Ghorpade, Sudhir R.- Limaye, Balmohan V., A Course in Calculus and Real Analysis, Springer International Ltd, 2000.
- G.B. Thomas and R. L. Finney, Calculus and Analytic Geometry, Ninth Edition, Addison Wesley, 1998.

NAME OF THE COURSE	**ALGEBRA AND DISCRETE MATHEMATICS-1**	
CLASS	FYBSC	
COURSE CODE	SBSMAT102	
NUMBER OF CREDITS	2	
NUMBER OF LECTURES PER WEEK	3	
TOTAL NUMBER OF LECTURES PER SEMESTER	45	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	50	50
PASSING MARKS	20	20

COURSE OBJECTIVES:

CO 1.	To provide the learner the necessary skills to work on the numerical applications of the concepts using the structure of the natural number and integer systems.
CO 2.	To enable the learner become competent in numerical computations using division, GCD, prime number concepts, and congruence relations.
CO 3.	To develop in the learner, the ability to use binary operations, equivalence relations and associated features to differentiate between sets of numbers.
CO 4.	To enable the learner become competent in the concepts of polynomials and create models using them.

COURSE LEARNING OUTCOMES:

CLO 1.	The learner will be able to comprehend and apply the concepts of binary operators, relations, equivalence relations, congruences, division of integers, and GCD.
CLO 2.	Through logical inductions, the learner will be able to prove mathematical propositions and develop mathematical ideas from the foundational axioms.
CLO.3.	The learner will understand the properties of polynomials under the binary operations and solve them using the techniques.
CLO 4.	The learner will be able to apply the concepts of the counting principle to solve numerical models based on the concepts.

	PREREQUISITES
A	**Set Theory**: Set, subset, set union and intersection of two sets, empty set, universal set, complement of a set, De Morgan's laws, Cartesian product of two sets, relations.
B	**Complex Numbers**: Addition and multiplication of complex numbers, modulus, amplitude and conjugate of a complex number
UNIT 1	INTERGERS AND DIVISIBILITY (15 LECTURES)
1.1	Statements of well-ordering property of non-negative integers, Principle of finite induction (first and second) as a consequence of the 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	BINARY OPERATIONS, EQUIVALENCE RELATIONS AND CONGRUENCES (15 LECTURES)
2.1	Definition of relation and function, Binary operations as a function, properties and examples.
2.2	Equivalence relation, Equivalence classes, properties such as two equivalences classes are either identical or disjoint, Definition of partition, every partition gives an equivalence relation and vice versa.
2.3.	Congruence - definition, elementary properties and applications. Congruence as an equivalence relation on Z (set of integers), Residue classes and its properties. . Euler's φ function, Statements of Euler's theorem, Fermat's theorem and Wilson theorem and their applications
UNIT 1	POLYNOMIALS (15 LECTURES)
1.1	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,
1.2	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 √p is an irrational number where p is a prime number.
1.3	Necessary conditions for a rational number p/q to be a root of a polynomial with integer coefficients, simple consequences such as √p is not a rational number where p is a prime number.
1.4	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.
- A Foundation Course in Mathematics- Ajit Kumar, S. Kumaresan, Bhaba Sarma, Narosa

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 Printing Press.

NAME OF THE COURSE	MATHEMATICS PRACTICALS	
CLASS	FYBSC	
COURSE CODE	SBSMATP1	
NUMBER OF CREDITS	2	
NUMBER OF LECTURES PER WEEK	2	
TOTAL NUMBER OF LECTURES PER SEMESTER	30	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	20	80
PASSING MARKS	-	40

UNIT 1	Calculus-1 (15 LECTURES)
1.1	Application of Archimedean property, intervals, neighbour-hood.
1.2	Consequences of l.u.b. axiom, infimum and supremum of sets.
1.3	Limit of a function and Sandwich theorem.
1.4.	Left- and Right-hand limit
1.5.	Continuous and discontinuous functions.
1.6.	Applications of Intermediate Value theorem
UNIT 2	Algebra and Discrete Mathematics-1 (15 LECTURES)
2.1	Principle of finite induction
2.2	Binomial theorem
2.3.	G.C.D of an integer
2.4.	Equivalence relation and equivalence classes
2.5.	Congruence modulo relation on integers
2.6.	Functions and binary operations

ASSESSMENT DETAILS:

Internal Assessment (50 marks)

One written test of 25 mark and one project work of 25 mark will be conducted.

Semester End Examination – External Assessment (50 marks)

At the end of the semester, Theory examination of 2 hours duration and 50 marks based on the three units shall be held for each course.

Pattern of **Theory question** paper at the end of the semester for **each course**.

Questions	Sub-questions	Maximum marks
Q1	Part A: two theory sub-questions each one is of 6 marks and attempt any one. Part B: Three sub-questions, each one is of 4 marks and attempt any two.	14 each
Q2		
Q3		
Q4	There shall be 3 sub-questions each one is of 4 marks and attempt any 2.	8
Total marks		50

Practical Assessment (for papers with practicals)

- Practical exam will be held on two days. Each session will be of two hours.
- The students are allowed to write the paper if the attendance for practicals is more than 75%
- To appear in the practical exam, students must bring a properly certified journal.
- The practical paper will be of two sections. Section A will consist of 12 questions of 3 marks each. Section B will consist of 6 questions of 4 marks each. These questions will be based on the syllabus covered in the practicals. Students must attempt 8 questions from Section A and 4 questions from Section B.

SEMESTER 2

NAME OF THE COURSE	CALCULUS-2	
CLASS	FYBSC	
COURSE CODE	SBSMAT201	
NUMBER OF CREDITS	2	
NUMBER OF LECTURES PER WEEK	3	
TOTAL NUMBER OF LECTURES PER SEMESTER	45	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	50	50
PASSING MARKS	20	20

COURSE OBJECTIVES:

CO 1.	To develop in the learner, an understanding of the concepts of derivative of a function.
CO 2.	To impart knowledge of the methods of finding the higher order derivative of the given function.
CO 3.	To enable the learner understands the applications of the derivative of a function.
CO 4.	To develop an understanding of the concepts and application of Mean Value theorems.

COURSE LEARNING OUTCOMES:

CLO 1.	The learner can find the derivative of a function on the set of real numbers.
CLO 2.	The learner will be able to find the higher order derivatives of the functions.
CLO 3.	The learner will be able to apply the various concepts of differentiation on the functions to find the nature of the function.
CLO 4.	The learner will be able to apply the concepts of Mean Value theorems and find the approximate value of the function at a certain point.

UNIT 1	DIFFERENTIATION OF REAL VALUED FUNCTION OF ONE VARIABLE (15 LECTURES)
1.1	Definition of differentiation at a point of an open interval, examples of differentiable and non-differentiable functions, relation between continuity and differentiability.
1.2	Algebra of differentiable functions. Chain rule, Derivative of inverse functions, Implicit differentiation
1.3	Higher order derivatives, Leibnitz rule for higher order derivatives.
UNIT 2	Applications of differentiation: (15 LECTURES)

2.1	Increasing and decreasing functions, definition of local maximum and local minimum, stationary points, first and second derivative test, examples.
2.2	Graph of functions using first and second derivatives, concave functions, points of inflection.
2.3.	Geometric Interpretation of Derivatives- applications such as rate of change in area and volume.
UNIT 3	MEAN VALUE THEOREM AND THEIR APPLICATIONS (15 LECTURES)
3.1	Rolle's theorem, Lagrange's and Cauchy's mean value theorems, applications and examples.
3.2	L'Hospital's Rule (statement only) Examples of finding limits of indeteminate forms.
3.3	Taylor's Mean Value Theorem and the applications.

Main Reference:

1. James Stewart, Calculus, Third Edition, Brooks/cole Publishing Company, 1994.
2. G.B. Thomas and R. L. Finney, Calculus and Analytic Geometry, Ninth Edition, Addison-Wesley.

Additional Reference Books:

1. R. R. Goldberg, Methods of Real Analysis, Oxford and IBH, 1964.
2. K.G. Binmore, Mathematical Analysis, Cambridge University Press, 1982.
3. R.G. Bartle- D.R. Sherbert, Introduction to Real Analysis, John Wiley & Sons, 1994.
4. Richard Courant-Fritz John, A Introduction to Calculus and Analysis, Volume I, Springer.
5. AjitKumar-S. Kumaresan, A Basic Course in Real Analysis, CRC Press, 2014.
6. Ghorpade, Sudhir R.- Limaye, Balmohan V., A Course in Calculus and Real Analysis, Springer International Ltd, 2000.

NAME OF THE COURSE	**ALGEBRA AND DISCRETE MATHEMATICS-2**	
CLASS	FYBSC	
COURSE CODE	SBSMAT202	
NUMBER OF CREDITS	2	
NUMBER OF LECTURES PER WEEK	3	
TOTAL NUMBER OF LECTURES PER SEMESTER	45	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	50	50
PASSING MARKS	20	20

COURSE OBJECTIVES:

CO 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.
CO 2.	To enable the learner to develop the capacity to comprehend, apply, and solve numerical problems involving the principles of recurrence relations.
CO 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.
CO 4.	To enable the learner to develop the capacity to comprehend, apply, and solve numerical problems involving the counting principles.

COURSE LEARNING OUTCOMES:

CLO 1.	In order to fulfill the requirements of the numerical assignments, the learner will be able to identify, develop and find solutions to recurrence relations.
CLO 2.	The learner will be able to use various counting principles, permutation and combination in numerical problems and solve them with interpretation.
CLO.3.	The learner will apply the concepts of Permutation maps and derangements in understanding the various methods of placement.

UNIT 1	RECURRENCE RELATIONS AND COUNTING PROBLEMS (15 LECTURES)
1.1	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.
1.2	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..
1.3	Counting problems using tree diagrams
UNIT 2	COUNTING PRINCIPLES (15 LECTURES)
2.1	Addition and multiplication principles, distributions of distinct and non-distinct objects, Multinomial coefficients, combinatorial interpretations, Multinomial theorem (without proof), applications
2.2	Finite and infinite sets, countable and uncountable sets examples such as N, Z, N ×N, Q, (0, 1), R.
2.3.	Pigeonhole Principle and its applications.
UNIT 3	PERMUTATIONS, PRINCIPLE OF INCLUSION-EXCLUSION AND APPLICATIONS (15 LECTURES)
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 d_n.
3.3	Stirling number S(n, k) and its elementary properties.

Main Reference:

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

Additional Reference Books:

1. K.D. Joshi, Foundations in Discrete Mathematics, New Age Publishers, New Delhi, 1989.

2. Kenneth H. Rosen, Discrete Mathematics and its applications, Mc-Graw Hill International Edition.
3. Norman LBiggs: Discrete Mathematics, Oxford University Press, 2nd edition

NAME OF THE COURSE	MATHEMATICS PRACTICALS	
CLASS	FYBSC	
COURSE CODE	SBSMATP2	
NUMBER OF CREDITS	2	
NUMBER OF LECTURES PER WEEK	2	
TOTAL NUMBER OF LECTURES PER SEMESTER	30	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	20	80
PASSING MARKS	-	40

UNIT 1	Calculus-2 (15 LECTURES)
1.1	Differentiability of a function.
1.2	Higher order derivatives, Leibnitz theorem.
1.3	Maxima _ Minima and points of inflections
1.4.	Mean value theorems and its applications.
1.5.	Applications of Taylor’s theorem and Taylors polynomials.
1.6.	L’Hospitals Rule.
UNIT 2	Algebra and Discrete Mathematics-2 (15 LECTURES)
2.1	Division of polynomials and gcd
2.2	Root of a polynomial
2.3.	Pigeonhole principle
2.4.	Permutations and derangements
2.5.	Inclusion exclusion
2.6.	Stirling’s numbers.

ASSESSMENT DETAILS:
Internal Assessment (50 marks)
One written test of 25 mark and one project work of 25 mark will be conducted.

Semester End Examination – External Assessment (50 marks)
At the end of the semester, Theory examination of 2 hours duration and 50 marks based on the three units shall be held for each course.
Pattern of **Theory question** paper at the end of the semester for **each course**.

Questions	Sub-questions	Maximum marks
Q1	Part A: two theory sub-questions each one is of 6 marks and attempt any one. Part B: Three sub-questions, each one is of 4 marks and attempt any two.	14 each
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Q3		
Q4	There shall be 3 sub-questions each one is of 4 marks and attempt any 2.	8
Total marks		50

Practical Assessment (for papers with practicals)

- Practical exam will be held on two days. Each session will be of two hours.
- The students are allowed to write the paper if the attendance for practicals is more than 75%
- To appear in the practical exam, students must bring a properly certified journal.
- The practical paper will be of two sections. Section A will consist of 12 questions of 3 marks each. Section B will consist of 6 questions of 4 marks each. These questions will be based on the syllabus covered in the practicals. Students must attempt 8 questions from Section A and 4 questions from Section B.