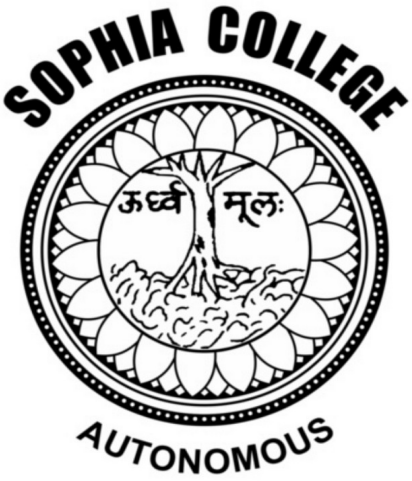

SOPHIA COLLEGE FOR WOMEN (EMPOWERED AUTONOMOUS)

Affiliated to the University of Mumbai

Programme: Science

Mathematics (Minor)

Theory Course Code: SMAT111

Practical Course Code: SMAT111P

Syllabus for the Academic Year 2024-2025

based on the National Education Policy 2020

SOPHIA COLLEGE (AUTONOMOUS)
DEPARTMENT OF MATHEMATICS & STATISTICS

COURSE DETAILS FOR MINOR:

	SEMESTER 1		SEMESTER 2
TITLE	**CALCULUS-1**		**CALCULUS-2**
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 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.

SOPHIA COLLEGE (AUTONOMOUS)

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.
PO4	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.

SOPHIA COLLEGE (AUTONOMOUS)

Programme: Science Mathematics Minor	**Semester – 1**
Course Title: Calculus-1	**Course Code: SMAT111**

COURSE OBJECTIVES:

To enable the learner to

1. Become familiar with the fundamental properties of the real number system and its subsets, which form the basis of real analysis.
2. 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.
3. Comprehend the ideas of a function's limit and continuity, and to use the many results of limits to find solutions to issues.

COURSE OUTCOMES:

At the end of the course the learner will be able to

1. Recall the meanings of the terms supremum, infimum, bounded sets, neighbourhoods, interior points, limit points, intervals, and their attributes.
2. Understand order relation in IR and compute supremum and infimum of a subset of IR.
3. Comprehend and apply the various results and properties of R.
4. Understand the concept of functions in R,their characteristics and plot the graphs of the standard functions' domains and ranges.
5. Define the limit of a function and to gauge if the function is continuous or not.
6. Understand the algebra of limits, continuous functions, and differentiable functions; express the property of intermediate value; and use it to identify function solutions.

Lectures per week (1 Lecture is 60 minutes)		**2**	
Total number of Hours in a Semester		**30**	
Credits		**2**	
Evaluation System	**Semester End Examination**	**1 Hour**	**30 marks**
	Internal Assessment	**--**	**20 marks**

UNIT 1	1.1	**REAL NUMBER SYSTEM:** Real number system R and order properties of R, Absolute values and its properties	10 hours
	1.2	AM-GM inequality, Cauchy-Schwarz inequality, Intervals and neighbourhoods, Hausdorff 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		**FUNCTIONS IN REAL NUMBER SYSTEMS:** Definitions – Function, domain and range of a	

	2.1	function, direct image and inverse image of a function *f*, bounded functions, injective function, surjective function, bijective function, composite of two functions (when defined), inverse of a bijective function.	10 hours
	2.2	Graphs of some standard functions such as $\|x\|$; e^x; log x; ax^2+bx+c; 1/x, x^n $(n \geq 3)$; sin x; cos x; tan x; $x \sin(1/x)$; $x^2 \sin(1/x)$, step functions over suitable intervals of R:	
UNIT 3	3.1	**LIMITS AND CONTINUITY:** 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.	10 hours
	3.2	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. Algebra of continuous functions, Discontinuous functions, examples of removable and essential discontinuity.	
	3.3	Intermediate value theorem and its applications, Bolzano-Weierstrass theorem; Continuity on closed and bounded intervals.	

Main Reference:

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

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. Ghorpade, Sudhir R.- Limaye, Balmohan V., A Course in Calculus and Real Analysis, Springer International Ltd, 2000.
6. G.B. Thomas and R. L. Finney, Calculus and Analytic Geometry, Ninth Edition, Addison Wesley, 1998.

PRACTICAL	**Course Code: SMAT111P**

SOPHIA COLLEGE (AUTONOMOUS)

Course Title: Calculus-1			
COURSE OUTCOMES: At the end of the course the learner will be able to 1. Understand order relation in IR and compute supremum and infimum of a subset of IR. 2. Comprehend and apply the various results and properties of R. 3. Understand the concept of functions in R, their characteristics and plot the graphs of the standard functions' domains and ranges. 4. Understand the algebra of limits, continuous functions, and differentiable functions; express the property of intermediate value; and use it to identify function solutions.			
Lectures per week (1 Lecture is 120 minutes)		**2**	
Total number of Hours in a Semester		**60**	
Credits		**2**	
Evaluation System	**Semester End Examination**	**2 Hours**	**50 marks**
	Internal Assessment	**--**	

1	Absolute value of real numbers.
2	Application of Archimedean property, intervals, neighbour-hood.
3	Consequences of l.u.b. axiom, infimum and supremum of sets.
4	Functions
5	Limits, finding the Left- and Right-hand limit of the function
6	Continuous and discontinuous functions
7	Applications of Intermediate Value theorem and Bolzano's theorem.

ASSESSMENT DETAILS:

I. **Internal Assessment (IA):** Any one activity / assignment / test of 20 marks

II. **Semester End Examination (SEE):** Theory exam of 30 marks – One hour duration

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

SOPHIA COLLEGE (AUTONOMOUS)

Programme: Science Mathematics Minor			**Semester – 2**	
Course Title: Calculus-2			**Course Code: SMAT122**	
COURSE OBJECTIVES: To enable the learner to 1. To develop in the learner, an understanding of the concepts of derivative of a function. 2. To impart knowledge of the methods of finding the higher order derivative of the given function. 3. To enable the learner understands the applications of the derivative of a function. 4. To develop an understanding of the concepts and applications of Mean Value theorems				
COURSE OUTCOMES: At the end of the course the learner will be able to 1. The learner can find the derivative of a function on the set of real numbers. 2. The learner will be able to find the higher order derivatives of the functions 3. The learner will be able to apply the various concepts of differentiation on the functions to find the nature of the function. 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.				
Lectures per week (1 Lecture is 60 minutes)			**2**	
Total number of Hours in a Semester			**30**	
Credits			**2**	
Evaluation System		**Semester End Examination**	**1 Hour**	**30 marks**
		Internal Assessment	**--**	**20 marks**
UNIT 1	1.1	Differentiation of real valued function of one variable: i. Definition of differentiation at a point of an open interval, examples of differentiable and non-differentiable functions, relation between continuity and differentiability. ii. Algebra of differentiable functions. Chain rule, Derivative of inverse functions, Implicit differentiation iii. Higher order derivatives, Leibnitz rule for higher order derivatives.		10 hours
UNIT 2	2.1	Applications of differentiation i. Increasing and decreasing functions, definition of local maximum and local minimum, stationary points, first and second derivative test, examples ii. Graph of functions using first and second		10 hours

		derivatives, concave functions, points of inflection. iii. Geometric Interpretation of Derivatives- applications such as rate of change in area and volume	
UNIT 3	3.1	Mean Value Theorems and their Applications : i. Rolle's theorem, Lagrange's and Cauchy's mean value theorems, applications and examples. ii. Taylor's theorem and its applications. iii. L-hospital's rule without proof, examples of indeterminate forms	10 hours

PRACTICAL **Course Title: Calculus-2**		**Course Code: SMAT122P**	
COURSE OUTCOMES: At the end of the course the learner will be able to 1. find the derivative of a function on the set of real numbers. 2. find the higher order derivatives of the functions 3. apply the various concepts of differentiation on the functions to find the nature of the function. 4. the concepts of Mean Value theorems and find the approximate value of the function at a certain point.			
Lectures per week (1 Lecture is 120 minutes)		**2**	
Total number of Hours in a Semester		**60**	
Credits		**2**	
Evaluation System	**Semester End Examination**	**2 Hours**	**50 marks**
	Internal Assessment	**--**	

1	Differentiability of a function
2	Higher order derivatives, Leibnitz theorem.
3	Maxima, Minima and points of inflections
4	L'Hospitals Rule
5	Mean value theorems and its applications.
6	Applications of Taylor's theorem and Taylor's polynomials.
7	Differentiability of a function

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, AddisonWesley.
3. Ajit Kumar, S. Kumaresan, A Basic Course in Real Analysis, CRC Press, 2014.

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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. Ghorpade, Sudhir R.- Limaye, Balmohan V., A Course in Calculus and Real Analysis, Springer International Ltd, 2000.

ASSESSMENT DETAILS:

I. **Internal Assessment (IA:** Any one activity / assignment / test of 20 marks

II. **Semester End Examination (SEE):** Theory exam of 30 marks – One hour duration

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