Syllabus of

Mathematics (UG) course

CONSOLIDATED LIST OF COURSES:

The following shall be the Courses of study in the B.Sc. Mathematics Programme from the academic year 2025-2026.

First Semester

1. Calculus – BSMTCS101
2. Practical I – BSMTPS101

Second Semester

1. Advanced Calculus and Differential equations - BSMTCS201
2. Practical II - BSMTPS201

SYLLABUS FOR MATHEMATICS:

UNDERGRADUATE COURSES

SEMESTER SCHEME 2025-26 ONWARDS

PREAMBLE

The B.Sc. Mathematics course aims to provide students with a comprehensive foundation in mathematical principles, theories, and applications. This program is designed to develop critical thinking, analytical skills, and problem-solving abilities essential for various scientific and technical careers.

- Equip students with a deep understanding of core mathematical concepts and methodologies.
- Improve the perspective of students on mathematics as per modern requirement and develop a spirit of inquiry and scientific temper in the student.
- Initiate students to enjoy mathematics, pose and solve meaningful problems, to use abstraction to perceive relationships and structure and to understand the basic structure of mathematics.
- Create a student-friendly learning environment by encouraging experimental, problem - solving, and discovery-based approaches to learning mathematics.
- To orient students towards relating mathematics applications and improve retention of mathematical concepts in the student.

SYLLABUS OF EACH SEMESTER

I SEMESTER

Course: Calculus – 3 Credits (56Hours, 4hours/week)

Course Objectives:

- To review and strengthen understanding of the fundamental concepts of differentiable functions, including properties of differentiation, and critical points.
- To provide a thorough understanding of key theorems in calculus such as Rolle's Theorem, Mean Value Theorem, and Cauchy's Mean Value Theorem.
- To apply calculus concepts to practical problems, including curve sketching, optimization problems, and evaluating integrals using various techniques.
- To develop proficiency in different integration techniques and their applications, including the use of reduction formulae.
- To introduce and explore the concepts of functions of several variables, including limits, continuity, partial derivatives, and their applications.

Course Outcomes:

- Students can understand and apply properties of differentiation, and solve problems involving local extrema and concavity.
- Students can understand and apply key theorems such as Rolle's Theorem, Mean Value Theorem, and Cauchy's Mean Value Theorem in various contexts.
- Students can solve applied optimization problems, sketch curves, and use asymptotes effectively in analysis.
- Students can evaluate definite and indefinite integrals using techniques such as reduction formulae, partial fractions, etc.
- Students can understand the behaviour of functions of several variables, and compute and interpret directional derivatives and gradients.
- Students can find and classify extreme values and saddle points for functions of two variables, using second derivative tests and other techniques.

Syllabus

Unit I:(14Hours)

Recapitulation: Definition and Examples of Differentiable functions, Properties of Differentiation, Increasing decreasing functions, critical points, local extrema. Rolle's Theorem, The mean value theorem. Concavity, Points of inflection, Second derivative test for concavity, Second derivatives test for local extrema, Asymptotes (horizontal, vertical and oblique), Sketching curves y=f(x), Applied Optimization Problems.

Unit II:(14Hours)

Indeterminate Forms (all types), L'Hospital's Rules (First form and stronger form), Cauchy's Mean Value Theorem, Taylor's and Maclaurin's series.

Vector Calculus: Directional Derivatives, Gradient of Functions of Two or Three Variables, Properties of Directional Derivatives, Gradients and Tangents to Level Curves, Level Surfaces, Tangent Planes and Normal Lines to Level Surfaces.

Unit III:(14Hours)

Integration: Techniques of integration, definite integrals, Mean value theorem for definite integrals, Fundamental theorem of calculus(Part 1 and 2).Derivation of reduction formulae for$\int sin^n xdx$, $\int cos^n xdx, \int tan^n xdx, \int log^n xdx, \int sec^n xdx, \int sin^n x cos^n xdx$,etc.

Evaluation of integrals using reduction formulae, Integration of rational functions by partial fractions, trigonometric integrals.

Unit IV:(14Hours)

Functions of several variables: Domain, Range, Interior points, Boundary points, Closed, Open, Bounded and unbounded regions in the plane, Level curves and Level surfaces. Limits and Continuity, Two-Path tests for non-existence of limits, Partial derivatives, Implicit partial differentiation, Partial derivatives and continuity, Higher order partial derivatives, Mixed derivative theorem, Differentiability, Chain rule for differentiation. Extreme value and saddle points for the functions of two variables, second derivative test for local extrema.

Text Book : Maurice D. Weir, George B. Thomas, Jr., Joel Hass, Frank R. Giordano, Thomas' Calculus, 11th Ed., Pearson, 2008.

References

1. Lipman Bers Calculus ,Holt, Rinehart & Winston of Canada Ltd.,1969.
2. Louis Leithold, Calculus with Analytic Geometry, 5th Ed., Harper and Row International, 1986.
3. George B. Thomas and Ross L. Finney, Calculus and Analytic Geometry, Addison-Wesley, 1992.
4. Joseph Edwards,Integral Calculus for Beginners,Arihant Publishers,2016(original1896).
5. Shanti Narayan and PK Mittal, Differential Calculus, S Chand and Company Ltd. New Delhi 2014.
6. Shanti Narayan and PK Mittal, Integral Calculus S Chand and Company Ltd. New Delhi 2005.

Course 2: Practical I – 2 Credits (56Hours,4hours/week)

Practical for I Semester Mathematics practical with Free and Open Source Software (FOSS) tools for computer programs

Course Objectives:

- To learn programming skills in Maxima through listed programs.
- To apply the programming skills in Science and Engineering problems.

Course Outcomes:

Students will have the knowledge and skills to implement the programs listed below in the Scilab / Maxima programming language. They can be expected to apply these programming skills of computation in science and Engineering.

Programs:

1. Finding the limit of a function and checking the continuity of a function at a point.
2. Checking the differentiability of conditional functions.
3. Plotting of standard Cartesian curves using Maxima.
4. Finding the solutions of optimization problems.
5. Verification of Rolle's theorem and Lagrange's theorem.
6. Verification of Cauchy's mean value theorem.
7. Generating Taylor's series and Maclaurin's series.
8. Finding the equation of the tangent plane to the surface $z = f(x,y)$ and plot them.
9. Finding the average value and verification of fundamental theorem.
10. Finding the area enclosed between two curves.
11. Find the definite integrals using the reduction formula manually and then verification using maxima command.
12. Finding the partial derivatives and verification of Laplace equation.
13. Euler's theorem and Illustration examples for its verification.
14. Finding the extreme values of functions of two variables.

II Semester

Course 3 : Advanced Calculus and Differential Equations - 3 Credits (56 Hrs, 4 hrs/week)

Course Objectives:

- To develop a comprehensive understanding of polar coordinates, their applications in graphing, and the analysis of conic sections.
- To gain proficiency in evaluating line integrals and multiple integrals, and understanding their applications in various coordinate systems.
- To provide a solid foundation in differential equations, including methods for solving first-order differential equations.
- To explore practical applications of differential equations in various fields, enhancing problem-solving skills.
- To understand more complex differential equations, including nonlinear equations and orthogonal trajectories, and their solutions.

Course Outcomes:

- Students can convert between polar and Cartesian coordinates, graph equations in polar coordinates, and calculate areas and lengths.
- Students will classify and analyze conic sections by eccentricity, and work with their polar equations to sketch and identify various conics.
- Students will evaluate line integrals over plane and space curves, understanding their applications and computations.
- Students will master double and triple integrals, including changing between Cartesian and polar coordinates, and apply these techniques to calculate volumes, areas,and averages.
- Students will understand and solve first-order differential equations using various methods, including separation of variables and integrating factors.
- Students will apply differential equations to model and solve real-world problems in physics, chemistry, and other fields.

Syllabus

Unit I:(14Hours)

Polar Co-ordinates: Definition, Polar equations and graphs, Relating Polar and Cartesian Co-ordinates, Graphing in Polar Co-ordinates, Areas and Lengths in Polar Co-ordinates, Area of a surface of revolution. Conic Sections: Classifying conic sections by eccentricity, Conic Sections in Polar Co-ordinates, Polar equation for lines ,ellipse, parabola and hyperbola with eccentricity. Identification by finding eccentricity, and drawing the sketch.

Unit II:(14Hours)

Line Integrals: Definition and Examples, Evaluating line integrals over plane curves and over space curves. Multiple Integrals Double Integrals over rectangles, Double integrals as volumes, Fubini's theorem for calculating double Integrals, Finding regions of Integration, Double integrals over bounded Nonrectangular regions, Volume of solids, Evaluating the double integrals, Finding regions, Reversing the order, Areas of bounded regions in the plane, Average, Volume of an

integrable function, Evaluating double integrals in Polar co-ordinates, Finding limits of function, Area in Polar co-ordinates. Changing Cartesian Integral to Polar Co-ordinates, Triple integrals in Rectangular co-ordinates, Evaluating triple integrals.

Unit III:(14Hours)

Recapitulation: Definitions, Families of Curves, Examples of Differential Equations, Definitions, Families of solutions, Equations of Order One, Separation of Variables. Equations with Homogeneous Coefficient, Exact Equations, The Linear Equation of Order One, The General Solution of a Linear Equation, Integrating factors found by inspection, The Determination of Integrating Factors, Substitution Suggested by the Equation, Bernoulli's Equations.

Unit IV:(14Hours)

Applications of Differential Equations Elementary Applications Velocity of Escape from the Earth, Newton's law of Cooling, Simple Chemical Conversion Logistic Growth and the Price of Commodities. Orthogonal Trajectories: Cartesian and Polar co-ordinates. Nonlinear Equations, Factoring the Left Member, Singular Solutions, Eliminating the Dependent Variable, Clairaut's Equation, Dependent Variable Missing, Independent Variable Missing.

TextBook

1. Maurice D. Weir, George B. Thomas, Jr., Joel Hass, Frank R. Giordano, Thomas Calculus, 11th Ed., Pearson, 2008 (for Unit-I and Unit-II).
2. Earl D Rainville and Philip E Bedient, Elementary Differential Equations, Pearson, 8th Ed., 2016. (For Unit III and Unit-IV.)
3. Narayanan and Manicavachagom Pillay, Differential Equations, Viswanathan (Printers and Publisher) PVT Ltd., 1991. (For Unit-IV.)

References

1. Maurice D. Weir, George B. Thomas, Jr., Joel Hass, Frank R. Giordano, Thomas' Calculus, 11th Ed., Pearson, 2008.
2. Louis Leithold, Calculus with Analytic Geometry, 5th Ed., Harper and Row International, 1986.
3. Lipman Bers Calculus,Holt, Rinehart & Winston of Canada Ltd.,1969.
4. Earl D Rainville and Philip E Bedient, A Short Course in Differential Equations, Macmillan Ltd., 4th Ed., 1969.
5. Narayanan and Manicavachagom Pillay, Differential Equations, Viswanathan (Printers and Publisher) PVT Ltd., 1991.
6. Joseph Edwards,Integral Calculus for Beginners, Arihant Publishers,2016(original1896).
7. M. D. Raisinghania, Ordinary Differential Equations & Partial Differential Equations, S. Chand & Company, New Delhi, 20th Edition - 2020.

Course 4: Practical II – 2 Credits (56 Hours, 4hours/week)

Practical for II Semester Mathematics practical with Free and Open Source Software (FOSS) tools for computer programs

Course Objectives:

- To learn programming skills in Scilab/Maxima through listed programs.
- To apply the programming skills in Science and Engineering problems.

Course Outcomes: Students will have the knowledge and skills to implement the programs listed below in the Scilab/Maxima programming language. They can be expected to apply these programming skills of computation in science and Engineering.

Programs:

1. General and Particular Solutions of ordinary differential equations of first order.
2. Solving the differential equations of manually.
3. Verification of the exactness of a differential equation.
4. Differential equations which are solvable for p.
5. Solving Differential equations of Clairaut's form.
6. Plotting the orthogonal trajectories.
7. Area and length of the polar curves.
8. Tracing the polar curves.
9. Identifying the conic and tracing the conic.
10. Evaluation of line integrals.
11. Evaluation of double integrals with constant and variable limits.
12. Evaluation of triple integrals with constant and variable limits.

Note: The above list may be changed annually with the approval of the BOS in UG (Mathematics).

2. Question Paper pattern

Course pattern and scheme of examination

Basis for internal assessment, pattern of theory question papers and practical examination in science subjects

1. Basis of Internal Assessment in Theory and Practical:

The internal assessment marks in theory papers shall be based on two tests. The tests shall be at least 1 hour duration each and to be conducted after 6 and 12 weeks after the start of a semester. The average of the two tests shall be taken as the internal assessment marks in theory papers.

The practical internal assessment marks shall be based on one test and continuous evaluation during the practical classes. The practical test shall be conducted after 10 weeks after the start of a semester. The average of the test and continuous evaluation shall be taken as the internal assessment marks in practical.

2. Theory Question Papers Pattern:

Theory Question Papers shall carry 80 marks. The Question Paper shall consist of Parts A and B, as detailed below.

Part A: Part A Shall contain 14 short answer type questions (Q. No 1 to 14) drawn from all the 4 units carrying 2 marks each. 10 questions are to be answered (10x2=20 marks.)

Part B: Part B shall contain Twenty questions carrying 15 marks each drawn from all the four units (5 questions per units). There shall be four divisions per question. The students are required to answer 3 questions, choosing one full question from each unit. (4x15=60 marks.)

The following Table outlines the course pattern and scheme of examination:

Particulars	Theory(T)/ Practical(P)	Instruction Hours/Week	Duration of Exam	Internal Assessment	Marks Semester End Exam	Total	Number of Credits
Semester-I							
Calculus	T	4	3	20	80	100	3
Practical-I	P	4	3	10	40	50	2
Semester-II							
Advanced Calculus and Differential Equations	T	4	3	20	80	100	3
Practical-II	P	4	3	10	40	50	2