ST JOSEPH'S UNIVERSITY
BENGALURU-27

DEPARTMENT OF MATHEMATICS

Syllabus for the Bachelor of Science

Under State Education Policy

For Batch 2024-2026

Name of the Degree Programme : B.Sc.
Discipline Core : Mathematics
Starting year of implementation : 2024-25

ST JOSEPH'S UNIVERSITY, BENGALURU

Syllabus for B.Sc. Mathematics

Name of the Degree Programme : B.Sc.
Discipline Course : Mathematics Starting Year of
Implementation : 2024-25

Programme Outcomes (PO)

By the end of the programme the students will be able to:

PO1	Disciplinary Knowledge: Bachelor's degree in mathematics is the culmination of in-depth knowledge of Algebra, Calculus, Geometry, Differential Equations and several other branches of pure and applied Mathematics. This also leads to a study in related areas.
PO2	Communication Skills: Ability to communicate various Mathematical concepts effectively using examples and their geometric visualization. The skills and knowledge gained in this programme will lead to the proficiency in analytical reasoning which can be used for modeling and solving real-life problems.
PO3	Critical thinking and analytical reasoning: The students undergoing this programme acquire the ability of critical thinking and logical reasoning and the capability of recognizing and distinguishing various aspects of real-life problems.
PO4	Problem Solving: The Mathematical knowledge gained by the students through this programme gives them an ability to analye the problems and identify or define appropriate computing techniques for their solutions. This programme enhances student's overall development.
PO5	Research related skills: Upon completing this programme the students will develop the capability of asking appropriate questions related to the Mathematical concepts in different areas of Mathematics.
PO6	Information / Digital Literacy: The completion of this programme will enable the learner to find, evaluate and effectively communicate knowledge related to certain mathematical topics using appropriate software.
PO7	Self–directed learning: The student completing this programme will develop an ability to work independently and to make an in-depth study of various notions of Mathematics.
PO8	Moral and ethical awareness / reasoning: The student, on completing this programme, will develop an ability to identify unethical behavior such as fabrication, falsification or misinterpretation of data and adopt objectives that are unbiased and truthful in all aspects of life in general and Mathematical Studies in particular.
PO9	Lifelong learning: This programme provides self-directed and lifelong learning skills. This programme helps the learner to think independently, develop algorithms and computational skills for solving real world problems.
PO10	Ability to pursue advanced studies and research in Pure and Applied Mathematical Sciences.

Syllabus for B.Sc. with Mathematics as Major Subject
SEMESTER– I

MT 124: Mathematics I - Foundations of Mathematics	
Teaching Hours: 3 Hours / Week	Credits: 3
Total Teaching Hours: 42 Hours	Max. Marks: 100

Course Learning Outcomes: This course will enable the students to

- Apply counting techniques to real world problems
- Familiarize themselves with the basics of sets and functions.
- Compute bounds of subsets of real numbers.
- Apply various properties of real numbers.

Unit 1: Counting, Binomial Coefficients:

Counting, Binomial Coefficients: The addition and multiplication principles with examples demonstrated (such as Factorials, Selections). Binomial coefficients and Pascal's Triangle. Important identities involving binomial coefficient, selection with repetition.

(7 hours)

Unit 2: Basic of Set Theory an function:

Basics of set theory: Sets, Subsets, Union and Intersection of Sets, Complement of a set, Set Difference, Properties (with proof) of set involving union, intersection, set-difference, De-Morgan's law, (No need to do symmetric difference, can be given as assignment), Family of sets, Cartesian product of sets,

(5 hours)

Basics of Function: Definition of a function, Domain, Codomian, Range of function with examples, Equality of functions with examples, One-one, Onto functions and bijective functions, understanding one-one, onto and bijective functions graphically, Composition of functions, Inverse of a function, Graph of inverse of inverse of functions, Image and inverse image of subsets under the function and its properties

(8 hours)

Cardinality of sets: Definition for sets with same cardinality with examples, Schroeder-Bernstein Theorem, Application of Schroder-Bernstein, Definition of Countable sets with examples.

(8 hours)

Unit 3: Basic of Real Number System:

Introduction to real numbers, Law of Trichotomy and its properties, Upper bound and lower bound and its properties, Achimedean property and its application, Density of Q in R, Nested Interval Property, Modulus function and its properties.

(14 hours)

Text Books:

1. Ian Anderson. A First Course in Discrete Mathematics by. Springer Undergraduate Mathematics Series, First Indian Reprint, 2008
2. S K Mapa. Higher Algebra. Levant Publication (1.1-1.6). 2014.
3. John M Howie. Real Analysis. Springer Undergraduate Mathematics Series. 2001.

Reference Books:

1. Ajit Kumar, S Kumaresan. A Basic Course in Real Analysis. CRC press. 2014.
2. Ajit Kumar, S Kumaresan, Bhaba Kumar Sharma. A foundation course in Mathematics. Narosa Publishing House. 2018.

PRACTICAL

MT 1P124: Mathematics Practical - I	
Practical Hours: 3 Hours/Week	Credits: 2
Total Practical Hours: 33 Hours	Max. Marks: 50

Course Learning Outcomes: This course will enable the students to

- Learn Free and Open-Source Software (FOSS) tools for computer programming
- Apply proof techniques

Practical/Lab Work to be performed in Computer Lab.
Suggested Software: Python.

1. Mathematical Statements: And, OR, Implication and it's negation
2. Converse and contrapositive of an implication. Predicates and quantifiers, Negation of quantified, importance of the order of quantifiers.
3. What is proof writing? Basics rules of proof writing, Grammar of proof writing, Finding mistakes in spoof proofs
4. Proof technique I: Direct Proof with examples. How to prove a statement of the form P implies Q or R. Proof by contradiction.
5. Proof technique II: Proof using contrapositive and exhaustion.
6. Proof technique III: By Induction: The induction principle, strong induction principle and well ordering principle. Example of False statement and counter example.
7. Basics of python programming - operations, data types and working with lists, tuples and sets.
8. Working with loops and conditionals
9. Plotting functions

SEMESTER – II

MT 224: Mathematics II - Real Analysis and Linear Algebra I	
Teaching Hours: 3 Hours/Week	Credits: 3
Total Teaching Hours: 42 Hours	Max. Marks: 100

Course Learning Outcomes: This course will enable the students to

- Understand concepts of sequences and series of real numbers.
- Compute the limit of a function.
- Understand systems of linear equations and their solutions through matrix techniques.
- Apply the methods of solving these systems to problems in chemistry, engineering etc.

Unit 1: Sequences and series

Sequences. Convergence of sequences. Sums, products and quotients of sequences. Bounded sequences. Sandwich principle. Monotonic sequences. Cauchy sequences. Series. The comparison test. Ratio test. Series of positive and negative terms. Problems.

(20 hours)

Unit 2: Limits

Limit of a function. Increasing and decreasing functions. General principle of convergence. Algebra of limits. Left and right limits. Problems.

(8 hours)

Unit 3: Linear algebra

Linear models in economics and engineering. System of linear equations. Row reduction and Echelon form. Vector equations. The matrix equation Ax=b. Solution sets of linear systems. Applications of linear systems. Matrix operations. The inverse of a matrix. Characterizations of invertible matrices.

(14 hours)

Text books:

1. John M Howie. Real Analysis. Springer Undergraduate Mathematics Series. 2001.
2. David C Lay. Linear Algebra and its Applications. Third edition. Pearson. 2006.

Reference Books:

1. R.G. Bartle, D.R. Sherbert. Introduction to Real Analysis. 3rd Edition. Wiley & Sons. 2000.
2. Ajit Kumar, S Kumaresan. A Basic Course in Real Analysis. CRC press. 2014.
3. S K Mapa. Introduction to Real Analysis. 8th edition. Levant books India. 2014.

PRACTICAL II

MT 2P124: Mathematics Practical - II	
Practical Hours: 3 Hours/Week	Credits: 2
Total Practical Hours: 33 Hours	Max. Marks: 50

Course Learning Outcomes: This course will enable the students to

- Learn Free and Open-Source Software (FOSS) tools for computer programming
- Solve problems on sequences, series, limits and linear algebra by using FOSS.
- Acquire knowledge of applications of real analysis and linear algebra through FOSS.

Practical/Lab Work to be performed in Computer Lab.
Suggested Software: Python.

1. Basic matrices in Python
2. Rank of a matrix through row reduction
3. Solving a system of linear equations
4. Convergence of sequences I
5. Convergence of sequences II
6. Convergence of series
7. Summation of series.
8. Differentiation and partial differentiation
9. Limits and integration

SEMESTER – III

MT 325: Mathematics III - Calculus and Differential Equations I	
Teaching Hours: 3 Hours/Week	Credits: 3
Total Teaching Hours: 42 Hours	Max. Marks: 100

Course Learning Outcomes: This course will enable the students to

- Understand concepts of continuity, differentiability and integrability of functions..
- Compute the limit of a function.
- Understand the methods of solving linear ODEs..

Unit 1: Continuity and Differentiability of Functions

Continuity. Uniform continuity. Inverse functions. The derivative. Mean value theorems. Higher derivatives. Taylor's Theorem. Related Problems.

(14 hours)

Unit 2: Integrability of Functions

The Riemann integral. Classes of integrable functions (continuous and monotonic functions). Properties of integrals. The fundamental theorem. Techniques of integration. Reduction formula.

(14 hours)

Unit 3: Linear Differential Equations

Definition of differential equations and formation. General remarks on solutions. Picard's theorem. Families of curves, orthogonal trajectories. Growth, decay, mixing. Homogeneous equations. Exact equations. Integrating factors. Linear equations. Reduction of order.

(14 hours)

Text books:

1. John M Howie. Real Analysis. Springer Undergraduate Mathematics Series. 2001.
2. George F. Simmons, Differential Equations and its applications with historical notes, Third Edition, McGraw-Hill Inc, 1991.

Reference Books:

1. Ajit Kumar, S Kumaresan. A Basic Course in Real Analysis. CRC press. 2014.
2. S K Mapa. Introduction to Real Analysis. 8th edition. Levant books India. 2014.
3. S. Narayanaswamy and Manickavasagam T. K. Pillai, Differential Equations and its applications, 2009.
4. V. Sundarapandian , Ordinary and Partial differential equations, McGraw-Hill Education, 2012.

PRACTICAL

MT 3P125: Mathematics Practical - III	
Practical Hours: 3 Hours/Week	Credits: 2
Total Practical Hours: 33 Hours	Max. Marks: 50

Course Learning Outcomes: This course will enable the students to

- Learn Free and Open-Source Software (FOSS) tools for computer programming
- Solve problems on calculus and linear differential equations by using FOSS.
- Acquire knowledge of applications of calculus and linear differential equations through FOSS.

Practical/Lab Work to be performed in Computer Lab.
Suggested Software: Python.

1. Checking if a function is continuous or differentiable
2. Computing nth derivative.
3. Computing upper and lower Riemann sums
4. Reduction formulae
5. Computing arc length using integrals
6. Computing surface area and volume using integrals
7. Homogeneous and exact differential equations
8. Solution to linear differential equations
9. Solution to differential equations by reducing the order

SEMESTER – IV

MT 425: Mathematics IV - Multivariable Calculus	
Teaching Hours: 3 Hours/Week	Credits: 3
Total Teaching Hours: 42 Hours	Max. Marks: 100

Course Learning Outcomes: This course will enable the students to

- Understand concepts of continuity, differentiability and integrability of functions..
- Compute the limit of a function.
- Understand the methods of solving linear ODEs..

Unit 1: Partial Derivatives

Functions of several variables. Limit and continuity in higher dimensions. Partial derivatives. Directional derivatives and gradient vectors. Extreme values and saddle points. Lagrange multipliers (with one constraint).

(14 hours)

Unit 2: Integrability of Functions

Double and Iterated Integrals over Rectangles, Double and Iterated Integrals over General Regions, Area by double integration, double integrals in polar form, Triple Integrals in rectangular coordinates, Triple Integral in Spherical and cylindrical coordinates.

(14 hours)

Unit 3: Line Integrals and Integral Theorems

Line integrals, Surface integrals, Greens' theorem on a plane, Stokes theorem, Gauss Divergence theorem. Related problems.

(14 hours)

Text books:

1. George B Thomas Jr, Maurice Weir and Joel Hass, Thomas' Calculus, 12th edition, Pearson, 2014.

Reference Books:

1.

PRACTICAL IV

MT 4P125: Mathematics Practical - IV	
Practical Hours: 3 Hours/Week	Credits: 2
Total Practical Hours: 33 Hours	Max. Marks: 50

Course Learning Outcomes: This course will enable the students to

- Learn Free and Open-Source Software (FOSS) tools for computer programming
- Solve problems on multivariable calculus by using FOSS.
- Acquire knowledge of applications of multivariable calculus through FOSS.

Practical/Lab Work to be performed in Computer Lab.
Suggested Software: Python.

1. Cylindrical and Spherical coordinates
2. Partial derivatives
3. Maxima and minima of functions of two variables
4. Double and triple integrals
5. Line integrals
6. Computing area and volume using multiple integrals
7. Computing surface area using multiple integrals
8. Verifying Green's Theorem
9. Verifying Stokes Theorem