Anekant Education Society's
Tuljaram Chaturchand College of Arts, Science and Commerce, Baramati
Autonomous

Course Structure for M.Sc. Mathematics

Semester	Course Code	Title of Course	No. of Credits	No. of Lectures
I	PSMT111	Measure Theory and Integration	4	64
	PSMT112	Advanced Calculus	4	64
	PSMT113	Group theory	4	64
	PSMT114	Numerical Analysis	4	64
	PSMT115	Ordinary Differential Equations	4	64
	PSMT116	Practical: Programming in C	4	64
II	PSMT121	Complex Analysis	4	64
	PSMT122	Topology	4	64
	PSMT123	Rings and Modules	4	64
	PSMT124	Linear Algebra	4	64
	PSMT125	Partial Differential Equations	4	64
	PSMT126	Practical: Programming in C++	4	64

Semester	Course Code	Title of Course	No. of Credits	No. of Lectures
III	PSMT231	Combinatorics	4	64
	PSMT232	Field Theory	4	64
	PSMT233	Functional Analysis	4	64
	PSMT234	Integral Equations	4	64
	PSMT235(A)	Astronomy	4	64
	PSMT235(B)	Graph Theory	4	64
	PSMT236	Practical: Python	4	64
IV	PSMT241	Number Theory	4	64
	PSMT242	Differential Geometry	4	64
	PSMT243	Fourier Analysis	4	64
	PSMT244	Lattice Theory	4	64
	PSMT245(A)	Coding theory	4	64
	PSMT245(B)	Cryptography	4	64
	PSMT246	Project	4	64

Equivalence of the old syllabus and new syllabus

Old Course		New Course	
MAT4101	Real Analysis	PSMT111	Measure Theory and Integration
MAT4102	Advanced Calculus	PSMT112	Advanced Calculus
MAT4103	Group theory	PSMT113	Group theory
MAT4104	Numerical Analysis	PSMT114	Numerical Analysis
MAT4105	Ordinary Differential Equations	PSMT115	Ordinary Differential Equations
MAT4106	Practical: Programming in C	PSMT116	Practical: Programming in C

SYLLABUS (CBCS) FOR M. Sc. I MATHEMATICS
Academic Year 2022-2023

Class: M. Sc. I (Semester- I)
Course Code: PSMT111
Course: I **Title of Course: Measure Theory and Integration**
Credit:4 **No. of lectures: 64**

A) Learning Objectives:

- To acquire knowledge of basic and advanced concepts in Measure Theory which are useful in Fourier analysis and Functional Analysis.
- To get familiar with concepts of measurable functions, Differentiation, and, Integration.
- To develop the ability to solve simple and complex problems.

B) Learning Outcome:

- Students will be able to understand the concept of Differentiation, Functions of Bounded Variation, and Absolutely Continuous Functions.
- Students will be able to apply the theory in the course to solve a variety of problems at an appropriate level of difficulty.

TOPICS/CONTENTS:

1. Measures on real line [12 *Lectures*]

1.1 Lebesgue Outer Measure

1.2 Measurable Sets

1.3 Measurable Functions

1.4 Borel and of Lebesgue Measurability

2. Integration of function on real variables [16 *Lectures*]

2.1 Integration of nonnegative function

2.2 General Integral

2.3 Integration of Series

2.4 Riemann and Lebesgue Integral

3. Differentiation [16 *Lectures*]

3.1 Functions of Bounded variation

3.2 Lebesgue Differentiation Theorem

3.3 Differentiation Theorem

3.4 Differentiation and Integration

4. Abstract Measure Space [10 *Lectures*]

4.1 Measure and outer measure

4.2 Uniqueness of extension

4.3 Completion of Measure

4.4 Measure Space

4.5 Integration with respect to measure

5. Inequalities and L^p Spaces [10 *Lectures*]

5.1 The L^p Spaces

5.1 Convex function

5.2 Jensen's Inequality

5.3 The Inequalities of Holder and Minkowski

5.4 Completeness of $L^p(\mu)$

Text Book:

G. de Barra, *Measure Theory and Integration*, New Age International Limited Publishers, 2000.

Unit 1 - sections 2.1, 2.2, 2.4, 2.5,

Unit 2 - sections 3.1 to 3.4,

Unit 3 – sections 4.3 to 4.6,

Unit 4 - section 5.1 to 5.6,

Unit 5 - section 6.1 to 6.5.

Reference Books:

1. Elias M. Stein and Rami Shakarchi, *Real Analysis,* Princeton University press.
2. Karen Saxe, *Beginning Functional Analysis*, Springer International Edition.
3. W. Rudin, *Principles of Mathematical Analysis*, Mc. Graw Hill.
4. H. L. Royden, P. M. Fitzpatrick, *Real Analysis (Fourth Edition),* Pearson publication Asia Ltd.

Class : M.Sc. I (Semester- I)
Course Code : PSMT112
Course: II **Title of Course: Advanced Calculus**
Credit: 4 **No. of lectures: 64**

A) Learning Objectives:

- To understand theory in Vector calculus
- To use important theorems such as Greens Theorem , Divergence , Stokes Theorem for problem-solving
- To learn multidimensional Integrals and Surface integrals.

B) Learning Outcome:

- To apply these concepts to solve practical problems that arise in physics and other related areas.
- Students will be able to understand change of variables by applying change of variable Theorems.

TOPICS/CONTENTS:

1. Differential Calculus of Scalar and Vector Field:

[16 *Lectures*]

1.1 Derivative of a scalar field with respect to a vector

1.2 Directional derivative, Gradient of a scalar field

1.3 Derivative of a vector field

1.4 Matrix form of the chain rule

1.5 Inverse function theorem and Implicit function theorem.

2. Line Integrals:

[12 *Lectures*]

2.1 Path and line integrals

2.2 The concept of work as a line integral

2.3 Independence of path

2.4 The first and the second fundamental theorems of calculus for line integral

2.5 Necessary condition for a vector field to be gradient.

3. Multiple Integrals:

[14 *Lectures*]

3.1 Double integrals

3.2 Applications to area and volume

3.3 Green's Theorem in the plane

3.4 Change of variables in a double integral

3.5 Transformation formula

3.6 Change of variables in an n-fold integral.

4. Surface Integrals:

[14 *Lectures*]

4.1 The fundamental vector product

4.2 Area of a parametric surface

4.3 Surface integrals

4.4 The theorem of Stokes

4.5 The curl and divergence of a vector field

4.6 Gauss divergence theorem and its applications

5. Application of Differential Calculus:

[8 *Lectures*]

5.1 Partial differential equation

5.2 a first order partial differential equation with constant coefficients

5.3 The one Dimensional wave equation**.**

Text Book:

T. M. Apostol, *Calculus*, Vol. II (2nd edition) , John Wiley and Sons, Inc.

Unit 1: Sections 8.1 to8.22

Unit 2: Sections 10.1 to 10.11 and 10.14 to 10.16

Unit 3: Sections 11.1 to 11.5 and 11.19 to 11.22 and 11.26 to11.34

Unit 4: Sections 12.1 to 12.15, 12.18 to 12.21

Unit 5: Sections 9.1 to 9.5
(For Inverse function theorem and Implicit function theorem refer the book "Mathematical Analysis" by T. M. Apostol)

Reference Books:

1. T. M. Apostol, *Mathematical Analysis*, Narosa publishing house.
2. W. Rudin, *Principles of Mathematical Analysis*, McGraw-Hill.
3. A. Devinatz, *Advanced Calculus*, Holt, Rinehart and Winston.

Class : M.Sc. I (Semester- I)
Course Code : PSMT113
Course: III **Title of Course: GroupTheory**
Credit: 4 **No. of lectures: 64**

A) Learning Objectives:

- Compute orders, powers, and inverses in concrete examples.
- Understanding of theoretical part of Groups and how to use them to solve problems.
- Be able to define and compute with cyclic groups, the additive group mod n, the multiplicative group mod p, the symmetric group, the dihedral group.

B) Learning Outcome:

- Students will be able to apply the Internal Direct Product Theorem in simple cases.
- Students are able to analyze the symmetry of a plane figure.

TOPICS/CONTENTS:

1. Groups [11 *Lectures*]

1.1 Semigroups and groups

1.2 Homomorphism

1.3 Subgroups and Cosets

1.4 Cyclic groups

1.5 Permutation groups

1.6 Generators and relations

2. Normal Subgroups [16 *Lectures*]

2.1 Normal subgroups and quotient groups

2.2 Isomorphism theorems

2.3 Automorphisms

2.4 Conjugacy and G-sets

3. Normal Series [11 *Lectures*]

3.1 Normal series

3.2 Solvable groups

3.3 Nilpotent groups

4. Permutation Groups [12 *Lectures*]

4.1 Cyclic decomposition

4.2 Alternating group A_n

4.3 simplicity of A_n

5. Structure theorems of groups [14 *Lectures*]

5.1 Direct products

5.2 Finally generated abelian groups

5.3 Invariants of a finite abelian group

5.4 Sylow theorems

5.5 Groups of orders p^2 and pq.

Text Book: P.B .Bhattacharya, S. K .Jain and S .R. Nagapaul – *Basic Abstract Algebra*, Cambridge University Press.

Unit 1: Section 4.1 to 4.6

Unit 2: Section 5.1 to 5.4

Unit 3: Section 6.1 to 6.3

Unit 4: Section 7.1 to 7.3

Unit 5: Section 8.1 to 8.5

Reference Books:

1. I.S. Luthar and I.B.S. Passi : Algebra (Volume 1) Groups (Narosa Publishing House)
2. I.N. Herstein : Topics in Algebra (Wiley-Eastern Ltd)
3. N.S. GopalaKrishnan : University Algebra (Wiley-Eastern Ltd)
4. Fraleigh : A First Course in Abstract Algebra
5. Dummit and Foote: Abstract Algebra (Wiley-Eastern Ltd).

Class: M. Sc. I (Semester- I)
Course Code: PSMT114
Course: IV **Title of Course : Numerical Analysis**

Credit:4 **No. of lectures: 64**

A) Learning Objectives:

- To solve problems numerically by various approximation methods
- To find the approximate area of some complex regions using Numerical Integration.
- Demonstrate understanding of common Numerical Methods and how they are used to obtain approximate solutions.

B) Learning Outcome:

- Student will be able to handle Machine Learning algorithms using Numerical Analysis
- Student will be able to construct a function which closely fits given n- points in the plane by using interpolation method.

TOPICS/CONTENTS:

1. Root of Nonlinear Equations [12 *Lectures*]

1.1 Introduction
1.2 Methods of Solution
1.3 Iterative methods
1.4 Evaluation of Polynomials
1.5 Bisection method
1.6 False Position method
1.7 Newton Raphson Method and Secant Method
1.8 Fixed Point Method, System of Nonlinear Equations and Roots of Polynomials.

2. Direct and Iterative Solution of Linear Equations [16 *Lectures*]

2.1 Existence of Solution
2.2 Solution by elimination
2.3 Basic Gauss Elimination method
2.4 Gauss elimination with pivoting and Gauss-Jordan Method
2.5 Triangular Factorization Methods and Round- off Errors and Refinement
2.6 Matrix Inversion Method and Jacobi Iterative method
2.7 Gauss-Seidel Method and Convergence of Iteration Methods.

3. Curve Fitting Interpolation: [8 *Lectures*]

3.1 Polynomial forms and linear interpolation
3.2 Lagrange Interpolation Polynomial
3.3 Newton Interpolation Polynomial and Interpolation with equidistant points.

4. Numerical Differentiation and Integration: [16 *Lectures*]

4.1 Differentiating Continuous functions
4.2 Forward difference quotient
4.3 Central difference quotient

4.4 Error analysis and Newton-Cotes Methods
4.5 Trapezoidal Rule, Simpsons 1/3 rule, Simpsons 3/8 rule.

5. Numerical Solution of Ordinary Differential Equations and Boundary-value Problems [12 *Lectures*]

5.1 Taylor Series Method
5.2 Euler's Method and Heun's Method
5.3 Polygon Method and Runge -Kutta Methods
5.4 Shooting Method
5.5 Finite Difference Method
5.6 Solving Eigenvalue Problems
5.7 Power method.

Text Book: E Balagurusamy, *Numerical Methods*, , McGraw Hill.

Unit 1: Section 6.1 to 6.3 and 6.5 to 6.10.

Unit 2: Section 7.1 to 7.8, and 7.10.

Unit 3: Section 8.1 to 8.5

Unit 4: Section 9.1 to 9.7

Unit 5: Section 11.1, 11.2, 13.2 to 13.6, 14.1 to 14.4.

Reference Books:

1. Brian Bradie, *A Friendly Introduction to Numerical Analysis,* PearsonPrentice Hall 2007.
2. S. S. Sastry, *Introduction Methods of Numerical Analysis (4th Edition),* Prentice.
3. John H. Mathews, Kurtis D. Fink , *Numerical Methods using Matlab ,4th Edition* , Pearson Education (Singapore) Ltd. Indian Branch , Delhi 2005.
4. K .E. Atkinson, *An Introduction to Numerical Analysis*, John Wiley and sons.
5. J. I. Buchman and P. R. Turner*, Numerical Methods and Analysis*, McGraw-Hill.
6. M.K. Jain, S.R.K. Iyengar, R.K. Jain, *Numerical Methods for scientific & engineering Computation, 5th Edition*, New Age International Publication.

Class: M. Sc. I (Semester- I)
Course Code: PSMT115
Course: V **Title of Course: Ordinary Differential Equations**
Credit: 4 **No. of lectures: 64**

A) Learning Objectives:

- To introduce the theory of linear and nonlinear ODE.
- To provide students with an introduction to the theory of ordinary differential equations through applications.
- Create and analyze mathematical models using higher order differential equations to solve application problems such as harmonic oscillator and circuits

B) Learning Outcome:

- Student will be able to find the complete solution of a nonhomogeneous differential equation as a linear combination of the complementary function and a particular solution.
- Student will be introduced to the complete solution of a nonhomogeneous differential equation with constant coefficients by the method of undetermined coefficients.

TOPICS/CONTENTS:

1. Linear equations with constant coefficients [14 *Lectures*]

1.1 Second order homogeneous equations

1.2 Initial value problems for second order equations

1.3 Linear dependence and independence

1.4 Formula for the Wronskian

1.5 Non homogeneous equations of order two and order n.

1.6 Homogeneous equations of order n.

1.7 Algebra of constant coefficients equations

2. Linear equations with variable coefficients [14 *Lectures*]

2.1 Initial value problems for the homogeneous equation

2.2 Solutions of the homogeneous equation

2.3 Wronskian and linear independence

2.4 Reduction of order of the homogeneous equation

2.5 Non homogeneous equations with analytic coefficients

2.6 Homogeneous equations

2.7Legendre equation,

3. Linear Equations with regular singular points [12 *Lectures*]

3.1 Euler equation

3.2 Second order equation with regular singular points

3.3 Exceptional cases

3.4 Bessel's equation

3.5 Regular singular point at infinity

4. Existence and uniqueness of solutions to first order equations [12 *Lectures*]

4.1 Equations with variables separated

4.2 Exact equations

4.3 Method of successive approximations

4.4 Lipschitz condition

4.5 Approximation and uniqueness to solution

5. Existence and uniqueness of solutions to systems and n^{th}order equations [12 *Lectures*]

5.1 Complex n-dimensional space
5.2 Systems as vector equations
5.3 Existence and uniqueness of solutions to systems
5.4 Existence and uniqueness for linear systems
5.5 Equations of order n

Text Book:

E. A. Coddington, *An Introduction to Ordinary Differential Equations,* Prentice- Hall, 1987.

Unit 1 - sections 2.2 to 2.12,

Unit 2 - sections 3.1 to 3.8,

Unit 3 – sections 4.1, 4.2, 4.3, 4.4, 4.7, 4.8, 4.9,

Unit 4 - section 5.1 to 5.5 and 5.8,

Unit 5 - section 6.4 to 6.8.

Reference Books:

1. G. F. Simmons, *Differential Equations with applications and Historical notes,* Tata- McGraw Hill.
2. G. Birkhoff and G.C. Rota, *Ordinary differential equations*, John Wiley and Sons.
3. S. G. Deo, V. Lakshmikantham, V. Raghvendra, *Text book of Ordinary Differential Equations*, Second edition, TataMc-Graw Hill.
4. G. F. Simmons and S. G. Krantz*, Differential Equations,* Tata- McGraw-Hill.

Class: M. Sc. I (Semester- I)
Course Code : PSMT116
Course:VI **Title of Course: Practical- Programming in C**
Credit: 4 **No. of lectures: 64**

A) Learning Objectives:

- To understand basic programming in C
- To study mathematics using programming.
- To use programming to make useful software in industry and use of Mathematics in them makes them more reliable and user friendly.

B) Learning Outcome:

- Student will be able to understand and visualize the working of computer system.
- Student will be able to use fundamentals of C programming to implement algorithms in mathematics.

TOPICS/CONTENTS:

1. Introductory concepts in C [8 Hours]
2. C Fundamentals [10 Hours]
3. Operators and Expressions [8 Hours]
4. Data input and outputs [8 Hours]
5. Preparing and running a program [10 Hours]
6. Control statements [6 Hours]
7. Functions [4 Hours]
8. Program Structures [4 Hours]
9. Arrays [3 Hours]
10. Pointers [3 Hours]

Text Book:

Yeshwant Kanetkar, *Let us C*, BPB Publications.

Reference Books:

1. Brian W. Kernighan and Dennis M. Ritchie, *The C Programming Language*, Prentice Hall.
2. Byrons S. Gottfried, Programming with C, Schaum's Outline Series.
3. S.A.Teukolsky**,** *Numerical recipes in C,* W. H. Press.
