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

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

Class: M. Sc I (Semester- II)
Paper Code: PSMT121

Paper	**: I**	**Title of Paper: Complex Analysis**
Credit	**: 4**	**No. of lectures: 64**

A) Learning Objectives:

- To provide a strong foundation in fundamental concepts of complex analysis which will enrich them to have a good knowledge of apply in real life problems.
- To study complex power series, classification of singularities, calculus of residues & its applications in evaluation of integrals & other concepts and properties.
- To study the techniques of complex variables & functions together with their derivatives, contour integration & transformations.

B) Learning Outcome:

- Students are able to calculate the image of circles & lines under mobius transformation.
- Students can apply problem-solving using complex analysis techniques applied to diverse situations in physics, engineering & other mathematical context.

Topics/Contents:

1. The complex number system **(4 Lectures)**

1.1 The field of complex numbers
1.2 The complex plane
1.3 Polar representation and roots of complex numbers
1.4 Lines and Half planes in the complex plane.

2. Elementary Properties and Examples of Analytic Functions **(15 Lectures)**

2.1 Power Series
2.2 Analytic Functions
2.3 Analytic functions as mapping, Mobius transformation.

3. Complex Integration: **(15 Lectures)**

3.1 Riemann-Stieltjes integrals
3.2 Power series representation of analytic functions
3.3 Zeros of analytic function
3.4 The index of a closed curve
3.5 Cauchy's Theorem and Integral formula
3.6 The homotopic version of Cauchy's Theorem and simple connectivity
3.7 Counting zeroes; the Open Mapping Theorem
3.8 Goursat's Theorem.

4. Singularities **(15 Lectures)**

4.1 Classification of singularities
4.2 Residues
4.3 The Argument Principle

5. The Maximum Modulus Theorem **(15 Lectures)**

5.1 The Maximum Principle
5.2 Schwarz's Lemma.

Text Book: John B. Conway: Functions of one complex variable (Narosa Publishing house) (Chapter: 1,3,4,5 & 6.)

Reference Books:

1. S. Ponnusamy: Foundation of Complex Analysis, Narosa Publications. (Second Edition).
2. Complex Analysis, E. Stein and Shakarchi, Overseas Press (India) Ltd., Princeton Lectures in Analysis.
3. Lars V. Ahlfors: Complex Analysis (McGrawHill).
4. Ruel V. Churchill / James Ward Brown: Complex Variables and Applications (McGraw Hill).
5. Anant R. Shastri, Basic Complex Analysis of One Variable, Macmillan publishers India,2010

M.Sc I (Semester- II)
Paper Code: PSMT122
Paper: II **Title of Paper: Topology**
Credit: 4 **No. of lectures: 64**

A) Learning Objectives:

- Understanding of terms, definitions and theorems in topology
- Use of continuous functions, homeomorphism to understand topological spaces.
- Demonstrate an understanding of the concepts of topological spaces and their role in mathematics

B) Learning Outcome:

- Use of topological concepts to solve problems in mathematics and real world.
- Students will be able to prove completeness, compactness, connectedness and convergence within these structure

Topics/Contents:

1. Countable and uncountable sets: (4 Lectures)
1.1 The axiom of choice
1.2 Well ordered sets

2. Topological spaces and continuous functions: (20 Lectures)
2.1Basis for topology
2.2Ordered topology
2.3 continuous functions
2.4 Product topology
2.5 Metric topology
2.6 Quotient topology.

3. Connectedness and compactness: (20 Lectures)
3.1 Connected spaces
3.2 Components and local connectedness
3.3 Compact spaces
3.4 Limit point compactness
3.5 Local compactness
3.6 One point Compactification.

4. Countability and separation axioms: (20 Lectures)
4.1 The countability axioms
4.2 Separation axioms
4.3 Normal spaces
4.4 The Urysohn lemma (Statement only)
4.5 The Urysohn metrization theorem (Statement only)
4.6 The Tietze extension theorem (Statement only).
4.7 Tychonoff theorem

Text Book: *Topology A first Course*, J. R. Munkres, Prentice Hall of India.
(Sections: 1.7, 1.9, 1.10, 1.11, 2.1 to 2.11, 3.1 to 3.8, 4.1 to 4.4, 5.1)

Reference Books:

1. *General Topology*, J. L. Kelley, Springer.
2. *Topology without Tears, Sidney A. Morris.*
2. *Topology*, J. Dugundji, Allyn and Bacon.
3. *General Topology*, S. Willard, Addison-Wesley Publishing Company
4. Counterexamples in Topology, L.A. Steen and J.A. Seebach Jr.

Class: M.Sc. I (Semester- (II)
Paper Code: PSMT123
Paper: III **Title of paper: Rings and Modules**
Credit: 04 **No. of Lectures: 64**

A) Learning Objectives:

- Importance of rings as a fundamental object in algebra
- Understanding concept of modules as a generalization of vector spaces
- To know the interrelationship between Euclidean domains, principal ideal domains, and unique factorization domains

B) Learning outcomes:

- To understand ring and modules as central concept in algebra and their applications Topics/content
- Students will be know how to add and multiply polynomials over arbitrary fields

Topics/Contents:

1. Rings **[12 lectures]**

1.1 Rings of continuous functions,
1.2 Matrix Ring,
1.3 Polynomial Rings,
1.4 Power series Rings,
1.5 Laurent Rings,
16 Boolean Ring,
1.7 Direct Products
1.8 Several Variables,
1.9 Opposite Rings,
1.10 Characteristic of a Ring.

2. Ideals **[12 lecture]**

2.1 Maximal Ideals,
2.2 Generators,
2.3 Basic Properties of Ideals,
2.4 Algebra of Ideals,
2.5 Quotient Rings,
2.6 Ideals in Quotient Rings,
2.7 Local Rings

3. Homomorphism of Rings **[12 lectures]**

3.1 Fundamental Theorems,
3.2 Endomorphism Rings,
3.3 Field of fractions,
3.4 Prime field

4. Factorization in Domains **[14 lectures]**

4.1Division in Domains,
4.2 Euclidean Domains,
4.3 Principal Ideal Domains,
4.4 Factorization Domains,
4.5 Unique Factorization Domains,
4.6 Eisenstein's Criterion.

5. Modules **[14 lectures]**

5.1 Direct Sum,
5.2 Free Modules,
5.3 Vector Spaces,
5.4 Quotient Module,
5.5 Homomorphism,
5.6 Simple Modules,
5.7 Modules over PID's.

Text Book: *Rings and Modules*, C. Musili, Narosa Publishing House.
(Section 1.1 to 1.12, 2.1 to 2.8, 3.1 to 3.5, 4.1 to 4.6, 5.1, 5.2, 5.4, 5.6, 5.7, 5.8).

Reference Books:

1. *Basic Abstract Algebra*, Bhattacharya, Nagpaul and Jain, Cambridge University Press.
2. *Rings and Modules*, C. Musili, Narosa Publishing House.
3. *Algebra II*, Luther and Passi, Narosa Publishing House.
4. *Abstract Algebra*, David S. Dummit and Richard M. Foote.

Class: M. Sc. I (Semester-I)
Course Code: PSMT124
Course: IV **Title of Course : Linear Algebra**

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

A) Learning Objectives:

- To find Eigen values, eigenvectors, Jordan form and their applications.
- Characterize linear transformations and express linear transforms in matrix equations.
- Understand Diagonalization, Orthogonally, Adjoint operator and Bilinear forms.

B) Learning Outcome:

- Students will be able apply linear algebra concepts to model, solve, and analyze real-world situations.
- Students will have a good knowledge of inner product spaces, and will be able to define and use the Adjoint of a linear map on a finite-dimensional inner product space.

Topics/Contents:

Unit 1. Vector Spaces **[16 Lectures]**

1.1 Subspaces
1.2 Basis and dimension
1.3 Linear Transformations
1.4 Quotient spaces
1.5 Direct sum
1.6 The matrix of a linear transformation.

Unit 2. Canonical Forms **[16 Lectures]**

2.1 Eigenvalues and eigenvectors
2.2 The minimal polynomial
2.3 Diagonalizable and triangulable operators
2.4 The Jordan Form
2.5 The Rational Form.

Unit 3. Inner Product Spaces **[16 Lectures]**

4.1 Inner Products
4.2 Orthogonality
4.3 The adjoint of a linear Transformation

4.4 Unitary operators
4.5 Self adjoint and normal operators.

Unit 4. Bilinear Forms **[16 Lectures]**

4.1 Definition and examples
4.2 The matrix of a bilinear form
4.3 Orthogonality
4.4 Classification of bilinear forms.

Text Book:-Vivek Sahai, Vikas Bist: Linear Algebra (Narosa Publishing House).
Chapters 2, 3, 4, and 5.

Reference Books:

i) Serge lang springer: Linear Algebra
ii) M. Artin: Algebra (Prentice - Hall of India private Ltd.)
iii) K. Hoffman and Ray Kunje: Linear Algebra (Prentice - Hall of India private Ltd.)
iv) S. Kumaresan: Linear Algebra (PHI Learning private Ltd.)
v) Charles W. Curtis: Linear Algebra, Springer.
vi) Gilbert Strang: Introduction to Linear Algebra, Wellesley Publishers.

Class: M. Sc. I (Semester- II)
Paper Code: PSMT125
Paper: V **Title of Paper: Partial Differential Equations**
Credit: 4 **No. of lectures: 64**

A) Learning Objectives:

- To apply a range of techniques to find solution of standard partial differential equations.
- To apply problem solving using concepts & techniques from partial differential equations & Fourier analysis applied to diverse situations in physics, engineering, financial mathematics & in other mathematical context.
- Applications of partial differential equations in other subject and real world problems

B) Learning Outcome:

- Students will use an adequate scientific language to formulate the basic concepts of the course.
- Student will able to derive partial differential equations from the underlying physical principles.

Topics/Contents:

1. First Order P.D.E. - I **(15 Lectures)**

1.1 Introduction,
1.2 Genesis of first order P.D.E.
1.3 Classification of integrals
1.4 Linear equations of the first order
1.5 Pfaffian differential equations

2. First Order P.D.E. - II **(15 Lectures)**

2.1 Compatible systems
2.2 Charpit's Method
2.3 Jacobi's Method
2.4 Quasi-Linear Equations
2.5 Non-Linear First Order P.D.E.

3. Second Order P.D.E. - I **(17 Lectures)**

3.1 Genesis of second order P.D.E.
3.2 Classification of second order P.D.E.
3.3 One Dimensional Wave Equation
3.4 Laplace Equation
3.5 Boundary Value Problems
3.6 The Cauchy Problem

4. Second Order P.D.E. - II **(17 Lectures)**

4.1 Dirichlet and Neumann Problem for different regions
4.2 Harnack's Theorem
4.3 Heat Conduction Problem
4.4 Duhamel's Principle
4.5 Classification of P.D.E. in the case of n-variables

4.6 Families of Equipotential Surfaces.
4.7 Kelvin's Inversion Theorem

Text Book

T. Amarnath: An Elementary Course in Partial Differential Equations (2nd edition) (Narosa Publishing House) [Section 1.1 to 2.9].

Reference Books:

1. K. Sankara Rao: Introduction to partial differential equation, third edition.
2. I.N. Sneddon: Elements of partial differential equations (Mc-Graw Hill Book Company)
3. An Introduction to Partial Differential equations, Yehud Pinchor & Jaco Rubinstein, (Cambridge university press)
4. W. E. Williams: Partial Differential equations (Clarendon press-oxford)
5. E. T. Copson : Partial differential equations (Cambridge university press).

Class : M.Sc I (Semester- II)
Paper code: PSMT126
Paper : VI **Title of Paper : 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 understand object oriented programming.

B) Learning Outcome:

- For making useful software in industries, education and mathematics.

Topics/Contents:

Unit1. Introduction: [06L]

1.1 What is object oriented programming?
1.2 Why do we need object oriented.
1.3 Programming characteristics of object-oriented languages C and C++.
1.4 C++ Programming basics: Output using cout. Directives.
1.5 Input with cin. Type bool.
1.6 The setw manipulator.
1.7 Type conversions.

Unit 2. Functions in C++: [10L]

2.1. Returning values from functions.
2.2 Reference arguments.
2.3 Overloaded function.
2.4 Inline function.
2.5 Default arguments.
2.6 Returning by reference.

Unit 3.Object and Classes: [16L]

3.1Making sense of core object concepts (Encapsulation, Abstraction, Polymorphism, Classes,Messages Association, Interfaces)
3.2 Implementation of class in C++,
3.3 C++ Objects as physical object,
3.4 C++ object as data types constructor. Object as function arguments.
3.5 The default copy constructor, returning object from function. Structures and classes. Classes objects and memory static class data. Const and classes.
3.5 Arrays and string arrays fundamentals.
3.6 Arrays as class Member Data : Arrays of object, string, The standard C++ String class Operator overloading : Overloading unary operations
3.7 Overloading binary operators, data conversion, pitfalls of operators overloading and conversion keywords.
3.8 Explicit and Mutable.

Unit4 Inheritance: **[16L]**

4.1 Concept of inheritance.
4.2 Derived class and based class.
4.3 Derived class constructors.
4.4 Member function, inheritance in the English distance class.
4.5 class hierarchies, inheritance and graphics shapes, public and private inheritance,
4.6 Aggregation: Classes within classes, inheritance and program development.
4.7 Pointer: Addresses and pointers. The address of operator and pointer and arrays.
4.8 Pointer and Faction pointer and C- types string.

Unit5. Memory management: **[16L]**

5.1 New and Delete, pointers to objects, debugging pointers.
5.2 Virtual Function: Virtual Function, friend function, Static function, Assignment and copy
5.3 Initialization, this pointer, dynamic type information.
5.4 Streams and Files : Streams classes, Stream Errors, Disk File I/O with streams, file pointers, error
5.5 handling in file I/O with member function, overloading the extraction and insertion operators,
5.6 Memory as a stream object, command line arguments, and printer output.
5.7 Templates and Exceptions: Function templates, Class templates Exceptions

Text Book **:** Let us C++, Yashwant Kanetkar

Reference Book :

1. Object Oriented Programming in C++ , E. Balgurusamy.
2. Schaum's series programming with C++ by Byron Gottfried.
