Anekant Education Society's

Tuljaram Chaturchand College of Arts, Science and Commerce, Baramati

Autonomous

Course Structure for M.Sc. Mathematics (2022 Pattern)

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 with New Syllabus:

Semester	Old Course		New Course	
	MSc I			
I	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
II	MAT4201	Complex Analysis	PSMT121	Complex Analysis
	MAT4202	Topology	PSMT122	Topology
	MAT4203	Rings and Modules	PSMT123	Rings and Modules
	MAT4204	Linear Algebra	PSMT124	Linear Algebra
	MAT4205	Partial Differential Equations	PSMT125	Partial Differential Equations
	MAT4206	Practical: Programming in C++	PSMT126	Practical: Programming in C++
	MSc II			
III	MAT5301	Combinatorics	PSMT231	Combinatorics
	MAT5302	Field Theory	PSMT232	Field Theory
	MAT5303	Functional Analysis	PSMT233	Functional Analysis
			PSMT234	Integral Equations
	MAT5305	Applied Mathematics I	PSMT235(A)	Astronomy
	MAT5304	Graph Theory	PSMT235(B)	Graph Theory
	MAT5306	Practical:Python	PSMT236	Practical:Python

Academic Year 2023-24 M.Sc.-II (Sem-III)

Class: M.Sc.-II (Semester – III)
Course Code: PSMT231 **Title of the Course: Combinatorics**
Course: I **Credit: 4**
No. of lectures: 64

A) Learning Objectives

- To introduce generating function models.
- To solve recurrence relations.
- To study inclusion/exclusion principle.

B) Learning Outcomes

- Student will be able to solve counting problems.
- Student will be able to use generating function to simplify recurrence relation.

TOPICS/CONTENT

Unit 1: General Counting Methods for Arrangements and Selections [18 Lectures]

1.1 Two basic counting principles
1.2 Simple Arrangement and Selections
1.3 Arrangements and Selections with Repetitions
1.4 Distributions
1.5 Binomial Identities

Unit 2: Generating Functions [18 Lectures]

2.1 Generating function models
2.2 Calculating coefficients of generating functions
2.3 Partitions
2.4 Exponential generating function
2.5 A Summation method

Unit 3: Recurrence Relations [16 Lectures]

3.1 Recurrence relation models
3.2 Divide and conquer relations
3.3 Solutions of linear Recurrence relations

Unit 4: Inclusion-Exclusion [12 Lectures]

4.1 Counting with venn diagrams
4.2 Inclusion-Exclusion Formula
4.3 Restricted Positions and Rook polynomials

Text Book:

Alan Tucker, *"Applied Combinations Fourth Edition*". (John Wiley and Sons, Inc).
Unit 1 – Sections 5.1 to 5.5
Unit 2 – Sections 6.1 to 6.5
Unit 3 – Sections 7.1 to 7.5
Unit 4 – Sections 8.1 to 8.3

Reference Books:

1. V.K. Balkrishnan: Schaum's outline series, Theory and Problems of Combinations (MsGraw Hill).
2. K.D. Joshi: Foundations of Discrete Mathematics (Wiley Eastern Limited).
3. Marshal Hall Jr.: Combinatorial Theory, Second Edition (Wiley Inter science Publications).

Class: M.Sc.-II (Semester – III)
Course Code: PSMT232 **Title of the Course: Field Theory**
Course: II **Credit: 4**
No. of lectures: 64

A) Learning Objectives

- To introduce algebraic extensions.
- To study separable and inseparable extensions.
- To construct Galois group for different Galois extensions.

B) Learning Outcomes

- Student will be able to explain field extension.
- Student will be able to recognize Galois extension.

TOPICS/CONTENT

Unit 1: Field Extensions **[32 Lectures]**

1.1 Basic Theory of Field Extensions
1.2 Algebraic Extensions
1.3 Classical Straightedge and Compass construction
1.4 Splitting Fields and Algebraic Closures
1.5 Separable and Inseparable Extensions
1.6 Cyclotomic Polynomials and Extensions

Unit 2: Galois Theory **[32 Lectures]**

2.1 Basic Definitions
2.2 The Fundamental Theorem of Galois Theory
2.3 Finite Fields
2.4 Composite Extensions and Simple Extensions
2.5 Galois Groups of Polynomials
2.6 Solvable and Radical Extensions: Insolvability of the Quintic

Text Book:

Dummit and Foote, *" Abstract Algebra"*, 2nd Edition, Wiley Eastern td.
Unit 1 – Sections 13.1 to 13.6
Unit 2 – Sections 14.1 to 14.4, 14.6, 14.7(statement)

Reference Book:

1. O. Zariski and P. Sammuel, Commutative Algebra, Vol. 1, Van Nostrand.
2. P. Bhattacharya and S. Jain, Basic Abstract Algebra, Second Edition.
3. I. S. Luthar and I. B. S. Passi, Algebra Vol. 4: Field Theory, Narosa.

Class: M.Sc.-II (Semester – III)
Course Code: PSMT233 **Title of the Course: Functional analysis**
Course: III **Credit: 4**
No. of lectures: 64

A) Learning Objectives

- To introduce Banach space and operators on Banach space.
- To study compact operators on normed space.
- To introduce Hilbert space and operators on Hilbert space.

B) Learning Outcomes

- Student will be able to examine boundedness of an operator on Banach/Hilbert space.
- Student will be able to discuss and explain compactness of an operator on normed space.

TOPICS/CONTENT

Unit 1: Banach space **[26 Lectures]**

1.1 The definitions and some Examples
1.2 Continuous Linear Transformations
1.3 The Hahn-Banach theorem.
1.4 The natural Embedding of N in N^{**}
1.5 Closed Graph and open Mapping theorems
1.6 The Conjugate of an operator

Unit 2: Hilbert space **[28 Lectures]**

2.1 The definition and some simple properties
2.2 Orthogonal complements
2.3 Orthonormal sets
2.4 The conjugate space H^*
2.5 The adjoint of an operator
2.6 Self adjoint operators
2.7 Normal and Unitary operators, Projections
2.8 Weak and Weak* convergence

Unit 3: Finite Dimensional Spectral Theory **[10 Lectures]**

3.1 Matrices
3.2 Determinants
3.3 The spectrum of an operator
3.4 The Spectral theory

Text Book:

G. F. Simmons, "Introduction to Topology and Modern Analysis".

Reference Book:

1. B. V. Limaye, Functional Analysis, Wiley Eastern Ltd.
2. Bachman and Narici, Functional Analysis, Narosa Publishing House, India.
3. John B Conway, Introduction to Functional Analysis, Springer.
4. W. Rudin, Functional Analysis, Tata McGraw Hill Edition.
5. Anant R. Shastri, Basic Complex Analysis of One Variable, Macmillan publishers India, 2010.

Class: M.Sc.-II (Semester – III)
Course Code: PSMT234 **Title of the Course: Integral Equations**
Course: IV **Credit: 4**
No. of lectures: 64

A) Learning Objectives

- To introduce various types of kernel in integrals transforms.
- To solve linear and non-linear integral equations by different methods.
- To study relationship between integral and differential equation.

B) Learning Outcomes

- Student will be able to learn and analyzed the concepts of Fredholm integral equation and Volterra integral equation.
- Student will be able to identify different types of kernels and evaluate the problems based on various integral transforms.

TOPICS/CONTENT

Unit 1: Introductory Concepts **[18 Lectures]**

1.1 Definitions
1.2 Classification of Linear Integral Equations
1.3 Solution of an Integral Equation
1.4 Converting Volterra Equation to ODE
1.5 Converting IVP to Volterra Equation
1.6 Converting BVP to Fredholm Equation

Unit 2: Fredholm Integral Equations **[18 Lectures]**

2.1 Introduction
2.2 The Decomposition Method
2.3 The Direct Computation Method
2.4 The Successive Approximation Method
2.5 The Method of Successive Substitutions
2.6 Comparison between Alternative Methods
2.7 Homogeneous Fredholm Equations

Unit 3: Volterra Integral Equations **[18 Lectures]**

3.1 Introduction
3.2 The Decomposition Method
3.3 The Series Solution Method
3.4 Converting Volterra Equation to IVP
3.5The Successive Approximation Method
3.6 Volterra Equation of the First Kind

Unit 4: Integro-Differential Equations **[10 Lectures]**

4.1 Introduction
4.2 Fredholm Integro-Differential Equations
4.3 Volterra Integro-Differential Equations

Text Book:

Abul-Majid Wazwaz, *"A First Course in Integral Equations-second edition*", World Scientific Publications.
Unit 1 – Chpater 1, *Unit 2* – Chapter 2, *Unit 3* – Chpater 3, *Unit 4* – Chapter 4

Reference Books:

1. R.P. Kanwal, "Linear Integral Equation Theory and Techniques", Academic Press, New York, 1971.
2. Shanti Swarup, Integral Equations, Krishna Prakashan Media (p) Ltd. 1997.

Class: M.Sc.-II (Semester – III)
Course Code: PSMT235(A) **Title of the Course: Astronomy**
Course: V(A) **Credit: 4**
No. of lectures: 64

A) Learning Objectives

- Students will learn spherical trigonometry.
- To familiarize students with the concept of celestial sphere and coordinate systems.
- To study effects of refraction on the observation of stars and planets in the sky.

B) Learning Outcomes

- Student will be able to understand the difference and similarities in plane and spherical trigonometry.
- Student will be able to understand various celestial phenomenon, like rising and setting of stars, motion of sun, twilight, and dip of horizon.

TOPICS/CONTENT

Unit 1: Spherical Trigonometry **[6 Lectures]**
1.1 Definitions
1.2 Fundamental Formulae

Unit 2: Right Angle Triangles **[18 Lectures]**

Unit 3: Spherical Astronomy **[22 Lectures]**
3.1 Cellestial Sphere
3.2 Coordinate Systems
3.3 Rising and Setting of Stars
3.4 Rate of Change of Zenith and Azimuth
3.5 Motion of Sun
3.6 Twilight
3.7 Dip of Horizon

Unit 4: Refraction **[18 Lectures]**

Text Book:
Spherical Astronomy by M. L. Khanna-Published by Jai Prakash Nath and Company Meerut(U.P).
Unit 1 – Chpater 1, *Unit 2* – Chapter 2, *Unit 3* – Chpater 3, *Unit 4* – Chapter 4

Reference Book:
Spherical Astronomy by Karr.

Class: M.Sc.-II (Semester – III)
Course Code: PSMT235(B) **Title of the Course: Graph Theory**
Course: V(B) **Credit: 4**
No. of lectures: 64

A) Learning Objectives

- Students will represent real-life situations with mathematical graphs.
- Students will become familiar with the major viewpoints and goals of graph theory: classification, algorithms and duality.
- To improve theoretical knowledge of graph theory to solve problems.

B) Learning Outcomes

- The students will be able to apply principles and concepts of graph theory.
- Students should be able to understand the concept of colorings and solve problems in practical situations.

TOPICS/CONTENT

Unit 1: Introduction **[4 Lectures]**
1.1 Definitions
1.2 Examples
1.3 Three puzzles

Unit 2: Paths and cycles **[10 Lectures]**
2.1 Connectivity
2.2 Eulerian graphs
2.3 Hamiltonian graphs
2.4 Some algorithms

Unit 3: Trees **[10 Lectures]**
3.1 Properties of trees
3.2 Counting trees
3.3 More applications

Unit 4: Planarity **[12 Lectures]**
4.1 Planar graphs
4.2 Euler's formula
4.3 Graphs on other surfaces
4.4 Dual graphs
4.5 Infinite graphs

Unit 5: Coloring graphs **[12 Lectures]**
5.1 **C**oloring vertices
5.2 Brooks' theorem
5.3 Coloring maps
5.4 Coloring edges
5.5 Chromatic polynomials

Unit 6: Digraphs **[8 Lectures]**
6.1 Definitions
6.2 Eulerian digraphs and tournaments
6.3 Markov chains

Unit 7: Matching, marriage and Menger's theorem **[8 Lectures]**
7.1 Menger's theorem
7.2 Network flows

Text Book:

Robin J. Wilson, *"Introduction to Graph Theory",* Fourth edition.
Unit 1 – Chpater 1, *Unit 2* – Chapter 2, *Unit 3* – Chpater 3, *Unit 4* – Chapter 4, *Unit 5* – Chpater 5, *Unit 6* – Chapter 6 and Chapter 7, *Unit 7* – Chpater 8

Reference Book:

1. Narsingh Deo, "Graph Theory: With Application to Engineering and Computer Science", Prentice Hall of India, 2003.
2. Douglas Brent west, "Introduction to Graph Theory", Prentice Hall 2001.

Class: M.Sc.-II (Semester – III)
Course Code: PSMT236 **Title of the Course: Practical: Python**
Course: VI **Credit: 4**
No. of lectures: 64

A) Learning Objectives

- To learn how to use lists, tuples, dictionaries and indexing in Python programs.
- To define the structure and components of a Python programs.
- To study relation between computer programming and mathematics and prepare students for advanced programming.

B) Learning Outcomes

- Student will be Capable of using functions like "if" and different types of loops.
- Student will be able to convert data types, to build lists, to know difference between running python programs on Mac and Windows.

TOPICS/CONTENT

Unit 1: Introduction, Variables and Data types in Python [6 Lectures]

1.1 History
1.2 First Python Program
1.3 Basic Syntax
1.4 Variable declaration
1.5 Declaration Rules

Unit 2: Operators in Python [4 Lectures]

2.1 Assignment operator
2.2 Logical Operator
2.3 Comparison Operator
2.4 Membership Operator

Unit 3: Arrays and string manipulations and Numbers [12 Lectures]

3.1 Arrays in Python
3.2 Accessing Strings
3.3 basic operations and String Slices
3.4 Functions and methods
3.5 Integer and Float
3.6 Complex

Unit 4: Lists and tuples [10 Lectures]

4.1 Accessing List
4.2 Working with lists and function
4.3 Accessing tuples
4.4 Operations
4.5 Functions and method

Unit 5: Dictionaries and Set [4 Lectures]

5.1 Accessing values in dictionaries
5.2 Properties and function
5.3 Introduction of sets

Unit 6: Conditional Statements, Looping and Control statements [4 Lectures]

6.1 If, If-else, Nested if-else
6.2 For , While, Nested Loop
6.3 Break, Continue, Paas

Unit 7: Functions, Numpy Library and operations **[8 Lectures]**

7.1 User functions
7.2 Filter and map function
7.3 Defining a function
7.4 Installation and introduction of Numpy
7.5 Array Creation

Unit 8: Python Object oriented programming-Oops **[8 Lectures]**

8.1 Introduction to Oops
8.2 Classes and Objects
8.3 Inheritance

Unit 9: Files, Exceptions and regular expression in Python **[8 Lectures]**

9.1 Readand write function
9.2 Exception handling
9.3 Expressions

Text Book:

Dr. R. Nageswara Rao, *"Core Python Programming- Second Edition",* dreamtech press, 2016.

Reference Book:

1. Wesley J. Chun, "Core Python Programming- Second Edition", Prentice Hall, 2006.
2. Beginning of Python: From Novice to Professional, Magnus Lie Hetland, Apress.
3. E-Books: python_tutorial.pdf, python-book_01.pdf.