**ST. JOSEPH’S COLLEGE FOR WOMEN**

**DEPARTMENT OF MATHEMATICS**

**M.Sc. MATHEMATICS**

**I-SEMESTER**

**M 101 ALGEBRA–I**

**(Revised w.e.f. 2018-19 admitted batch)**

**Objectives:**

1. Explain the concepts of algebra and their role in modern mathematics and applied contexts.
2. To study Group Theory and Ring Theory.
3. To learn in detail about Burnside theorem, Isomorphism theorems and Sylow theorems.
4. To study the concept of group action and theorems about group actions.
5. To understand the concept of polynomials rings.

**Outcomes:**

After studying this course, students should be able to:

1. Have a deep insight of Subgroups, normal groups and solvable groups.
2. Apply Burnside theorem to problems.
3. Apply the isomorphism theorems to describe the relationship between quotients, homomorphism, and sub objects. Applying these to solve problems.
4. Solving problems by applying the concept of group action.
5. Able to solve reducibility and irreducibility of polynomials over R[x] and Q[x].

**Syllabus:**

**UNIT I:**

Normal Subgroups: Normal subgroups and Quotient Groups-Isomorphism theorems– Automorphisms- Conjugacy and G-Sets Cyclic Decomposition- Alternating group An –Simplicity of An. (Chapters 5 and 7).

**UNIT II:**

Direct Products- finitely generated abelian groups-Invariants of a finite abelian group Sylow theorems- Groups of orders ,pq. (Chapter 8).

**UNIT III:**

Ideals, Homomorphisms, Sum and direct sum of ideals, Maximal and Prime Ideals. (Sections 10.1, 10.2, 10.3, 10.4 of Chapter 10)

**UNIT IV:**

Nilpotent and Nil Ideals, Zorn’s Lemma, unique factorization domains, Principal ideal domains, Euclidean domains, Polynomial rings over UFD.

(Sections 10.5 and 10.6 of Chapter 10 and Chapter 11).

**Prescribed Book:**

Basic Abstract Algebra: P. B. Bhattacharya, S. K. Jain and S. R. Nagapaul, second edition, reprinted in India 1997, 2000, 2001.

**Reference Books:**

1. Topics in Algebra: I. N. Herstein, 2nd Edition, John Wiley & Sons

2. Algebra: Thomas W. Hungerford, Springer

3. Algebra: Serge Lang, Revised Third Edition, Springer

4. Modern Algebra: Qazi Zameeruddin & Surjeet Singh, Eighth Edition, Vikas Publications.

**ST. JOSEPH’S COLLEGE FOR WOMEN**

**DEPARTMENT OF MATHEMATICS**

**M.Sc. MATHEMATICS**

**I-SEMESTER**

**M 102 REAL ANALYSIS-I**

**(Revised/ w.e.f. 2018-19 admitted batch)**

**Objectives:**

1. To introduce fundamental concepts of metric spaces.
2. To study compactness and connectedness in metric spaces.
3. To understand the concept of convergence of sequence and series in real numbers.
4. To study power series and absolute convergence.
5. To study existence of limit of functions, continuous function and existence of derivative of real valued functions.

**Outcomes:**

After studying this course, students should be able to:

1. Apply the concepts of real analysis and their applications in different fields.
2. Discuss about open set, closed set, limit point of set, Interior of set, Closure of a set in metric spaces.
3. Enumerate the limits of functions, infinite limits and limit at infinity.
4. Compute derivatives of certain functions.
5. Discuss in detail the Mean value theorem and Taylor’s theorem.

**Syllabus:**

**UNIT–I**

Basic Topology: Finite, Countable, and Uncountable Sets, Metric spaces, Compact sets, Connected sets.

(Chapter 2 of the textbook)

**UNIT–II**

Numerical Sequences and series: Convergent sequences, Subsequences, Cauchy sequences, Upper and Lower limits, Some special sequences, Series, Series of non-negative terms, number e, The Root and Ratio tests, Power series, Summation by parts, Absolute Convergence, Addition and Multiplication of series, Rearrangements.

(Chapter 3 of the text book)

**UNIT–III**

Continuity: Limits of Functions, Continuous Functions, Continuity and Compactness, Continuity and Connectedness, Discontinuities, Monotone Functions, Infinite Limits and Limits at Infinity.

(Chapter 4 of the text book)

**UNIT–IV**

Differentiation: The Derivative of a Real Function, Mean Value Theorems, The Continuity of Derivatives, L’ Hospital’s Rule, Derivatives of Higher order, Taylor’s theorem, Differentiation of Vector-valued Functions.

(Chapter 5 of the text book)

**Text Book:**

Principles of Mathematical Analysis by Walter Rudin, International Student Edition,3rd Edition,1985. Reference: Mathematical Analysis by Tom M. Apostol, Narosa Publishing House, 2nd Edition, 1985.

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**DEPARTMENT OF MATHEMATICS**

**M.Sc. MATHEMATICS**

**I-SEMESTER**

**M 103 TOPOLOGY-I**

**(Revised w.e.f. 2018-19 admitted batch)**

**Objectives:**

1. To understand the concept of metric spaces and topological spaces
2. To study in detail compact spaces and compactness in metric spaces.
3. Distinguish countable sets and uncountable sets.

**Outcomes:**

After studying this course, students should be able to:

1. Describe metric spaces and topological spaces with standard examples
2. Discuss the concepts and properties of open set, limit point of a set, closed set, interior of set, closure of a set, boundary point and boundary set in metric spaces and topological spaces.
3. Summarize the concept of convergence of a sequence, Cauchy sequence, completeness and their properties in metric spaces.
4. Explain the concept of continuity and uniform continuity in metric spaces and topological spaces.
5. Extend the Hein –Borel theorem to any finite dimensional Euclidean space .
6. Observe in any metric space, compactness, sequentially compactness and the Bolzano –Weierstrass property are all equivalent to each other.
7. Explain the basic difference between finite, infinite, countable, uncountable sets and their various properties
8. Explain the basic difference between finite, infinite, countable, uncountable sets and their various properties.
9. Describe Partial ordered set and lattices.

**Syllabus:**

**UNIT-I**

Sets and Functions: Sets and Set inclusion – The algebra of sets – Functions – Products of sets – Partitions and equivalence relations – Countable sets – Uncountable sets – Partially ordered sets and lattices.

(Chapter I: Sections 1 to 8).

**UNIT-II**

Metric spaces: The definition and some examples – Open sets – Closed sets – Convergence, Completeness and Baire’s theorem – Continuous mappings.

(Chapter 2: Sections 9 to 13).

**UNIT-III**

Metric spaces (Continued): Spaces of continuous functions – Euclidean and unitary spaces.

Topological spaces: The definition and some examples – Elementary concepts – Open bases and open subbases–Weak topologies–The function algebras C(X, R) and C(X,).

(Chapter 2: Sections 14, 15 and Chapter 3: Sections 16 to 20).

**UNIT-IV**

Compactness: Compact spaces – Product of Spaces – Tychonoff’s theorem and locally Compact spaces – Compactness for metric spaces – Ascoli theorem.

(Chapter 4: Sections 21 to 25).

**Prescribed book:**

Introduction to Topology by G. F. Simmons, Mc. Graw-Hill book company.

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**DEPARTMENT OF MATHEMATICS**

**M.Sc. MATHEMATICS**

**I-SEMESTER**

**M 104 DEFFERENTIAL EQUATIONS**

**(Revised w.e.f. 2018-19 admitted batch)**

**Objectives:**

1. The basic knowledge to solve differential equations with different forms of initial and boundary conditions.
2. Recognize and classify second order linear differential equations.
3. Solve Eigen values, Eigen functions and the vibrating string problems.
4. Applications of differential equations solve by using Laplace transforms.
5. Solve system of linear equations with constant coefficients.

**Outcomes:**

After studying this course, students should be able to:

1. Identify, analyze and subsequently solve physical situations whose behavior can be described by Differential equations.
2. Solve the problems choosing the most suitable method.
3. Determine the solution of differential equations with initial and boundary value problems.
4. Enhance and develop the ability of using the language of mathematics in analyzing the real-world problems of science and engineering.
5. Students will gain and understand to formulate and solve differential equations with techniques of Laplace transforms.
6. The end of the course to solve the majority of the problems with no external help.

**Syllabus:**

**UNIT-I**

Second order linear differential equations: Introduction-general solution of the homogeneous equation - Use of a known solution to find another - Homogeneous equation with constant coefficients - method of undetermined coefficients - method of variation of parameters, Vibrations in mechanical systems.

(Chapter 3, Sections 14-20 of prescribed text book)

**UNIT-II**

Oscillation theory and boundary value problems: Qualitative properties of solutions - The Sturm comparison theorem - Eigen values, Eigen functions and the vibrating string, Regular Sturm-Liouville problems.

(Chapter 4, Sections 22-24 and Appendix A of prescribed text book)

**UNIT-III**

Laplace transforms: Introduction, A few remarks on the theory, Applications to differential equations, Derivatives and integrals of Laplace transforms, Convolutions and Abel’s mechanical problem.

(Chapter 10, Sections 50 to 54 of the prescribed text book)

**UNIT-IV**

Systems of first order equations: General remarks on systems, Linear systems Homogeneous linear systems with constant coefficients – Nonlinear Systems – Volterra’s prey-predator equations.

(Chapter7, Sections 36-39 of prescribed text book)

Existence and Uniqueness of solutions: The method of successive approximations Picard’s theorem- Some examples.

(Chapter 11, Sections 55-56 of prescribed text book)

**Text book:**

George F. Simmons, Differential Equations, Tata McGraw-Hill Publishing Company Limited, New Delhi, 1994.

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**DEPARTMENT OF MATHEMATICS**

**M.Sc. MATHEMATICS**

**I-SEMESTER**

**M 105 LINEAR ALGEBRA**

**(Revised w.e.f. 2018-19 admitted batch)**

**Objectives:**

1. To improve ability to think logically, analytically and abstractly.
2. To study in detail characteristic polynomial and annihilating polynomials of linear operator T.
3. To understand the concept of diagonalizability of linear operator T.
4. Describe canonical forms.
5. To introduce bilinear forms and study its basic properties and characterizations.

**Outcomes:**

After studying this course, students should be able to:

1. Compute characteristic values and minimal polynomial of linear operator T.
2. Determine the linear operator T is diagonalizable.
3. Evaluate Jordon forms and rational forms of linear transformation.
4. Discuss cayley Hamilton theorem, primary decomposition theorem and cyclic decomposition theorem.
5. obtain matrix in the standard ordered basis and the rank for Bilinear forms.
6. Discuss symmetric Bilinear forms and Skew –symmetric Bilinear forms.

**Syllabus:**

**Unit-I**

Introduction, Characteristic Values, Annihilating Polynomials, Invariant Subspaces, Simultaneous Triangulation; Simultaneous Diagonalization.

(Sections 6.1-6.5 of Chapter 6 in the Prescribed Text Book)

**Unit-II**

Direct-Sum Decompositions, Invariant Direct Sums, The Primary Decomposition Theorem. Cyclic Subspaces and Annihilators, Cyclic Decompositions and Rational form.

(Sections 6.6-6.8 of Chapter 6 and sections 7.1-7.2 of Chapter 7 in the Prescribed Text Book)

**Unit-III**

The Jordan Form, Computation of Invariant Factors, Summary; Semi-Simple Operators.

(Sections 7.3-7.5 of Chapter7 in the Prescribed Text Book)

**Unit-IV**

Bilinear Forms, Symmetric Bilinear Forms, Skew-Symmetric Bilinear Forms, Groups Preserving Bilinear Forms.

(Sections 10.1-10.4 of Chapter 10 in the Prescribed Text Book)

**Prescribed Book:**

Linear Algebra by Kenneth Hoffman and Ray Kunze, prentice-Hall India Pvt. Ltd, 2nd Edition, New Delhi.

**ST. JOSEPH’S COLLEGE FOR WOMEN**

**DEPARTMENT OF MATHEMATICS**

**M.Sc. MATHEMATICS**

**II-SEMESTER**

**M 201 ALGEBRA–II**

**(Revised w.e.f. 2018-19 admitted batch)**

**Objectives:**

1. Explain accurate and efficient use of algebraic techniques.
2. To introduce basic notions in field extensions & Galois Theory.
3. To learn solving polynomial equations and understand the irreducibility concept of polynomials over finite fields.
4. Understanding the solvability of polynomials using Radicals notion.
5. To understand the theory of Galois groups, extensions and applications of Fundamental theorem of Galois theory.

**Outcomes:**

After studying this course, students should be able to:

1. Capable to solving polynomial equations utilizing formulas for roots and to obtain the roots of a polynomial equation having degree less than five.
2. Constructing the splitting fields of a polynomial.
3. Able to construct Finite fields of given number.
4. Employ Galois Theory to observe necessary and sufficient conditions for a polynomial over a field to be solvable by radicals.
5. Ability to construct a polynomial of degree 5 that is not solvable by radicals.

**Syllabus:**

**UNIT I**

Algebraic extension of fields:

Irreducible polynomials and Eisenstein’s criterion Adjunction of roots-Algebraic Extensions-Algebraically closed fields.

(Chapter 15–sections 15.1 –15.4)

**UNITII**

Normal and separable extensions: Splitting fields- Normal extensions-multiple roots-finite fields-separable extensions.

(Chapter 16–sections 16.1–16.5)

**UNIT III**

Galois Theory: Automorphism groups and fixed fields- fundamental theorem of Galois Theory-Fundamental theorem of algebra.

(Chapter 17–sections 17.1–17.3)

**UNIT IV**

Applications of Galois Theory to classical problems: Roots of unity and cyclotomic polynomials-cyclic extensions-polynomials solvable by radicals- symmetric functions.

(Chapter 18– sections 18.1–18.4)

**Prescribed Text Book:**

Basic Abstract Algebra: P. B. Bhattacharya, S. K. Jain and S. R. Nagpaul, second edition, Cambridge University Press, printed and bound in India at Replika Press Pvt. Ltd., 2001.

**Reference Books:**

1. Topics in Algebra: I. N. Herstein, 2nd Edition, John Wiley & Sons

2. Algebra: Serge Lang, Revised Third Edition, Springer

3. Algebra: Thomas W. Hungerford, Springer

4. Modern Algebra: Qazi Zameeruddin & Surjeet Singh, Eighth Edition, Vikas Publications

**ST. JOSEPH’S COLLEGE FOR WOMEN**

**DEPARTMENT OF MATHEMATICS**

**M.Sc. MATHEMATICS**

**II-SEMESTER**

**M 202 REAL ANALYSIS-II**

**(Revised w.e.f. 2018-19 admitted batch)**

**Objectives:**

1. To introduce the concept of Riemann Stieltjes integral of bounded functions.
2. To obtain the knowledge in point wise convergence of a sequence of functions defined on a metric space.
3. To study the concept of a function expanded in a power series about a point.
4. To understand the concept of equicontinuity of families of functions.
5. To introduce the concept of functions of several variables.

**Outcomes:**

After studying this course, students should be able to:

1. Expertise about upper and lower Riemann Stieltjes integrals.
2. Utilize theory of Riemann-Stieltjes integral in solving definite integrals arising in different fields of science and engineering.
3. Discuss the point wise convergence of a sequence of functions defined on a set X and examples.
4. Discuss the concept of functions which are expanded in a power series about a point.
5. Discuss Stone – Weierstrass theorem, implicit function theorem, inverse function theorem and Rank theorem.

**Syllabus:**

**UNIT-I**

Riemann-Stieltjes Integral: Definition and existence of the Riemann Stieltjes Integral, Properties of the Integral, Integration and Differentiation, the fundamental theorem of calculus – Integral of Vector valued Functions, Rectifiable curves.

(Chapter 6 of the prescribed text book)

**UNIT-II**

Sequences and Series of the Functions: Discussion on the Main Problem, Uniform Convergence, Uniform Convergence and Continuity, Uniform Convergence and Integration, Uniform Convergence and Differentiation.

(Chapter 7, Sections 7.1 to 7.18 of the prescribed textbook)

**UNIT-III**

Sequences and Series of the Functions (continued): Equicontinuous families of Functions, the Stone-Weierstrass Theorem.

(Chapter 7, Sections 7.19 to 7.33 of the prescribed text book)

Power Series

(Chapter 8, Sections 8.1 to 8.5 of the prescribed text book)

**UNIT-IV**

Functions of Several Variables: Linear Transformations, Differentiation, The Contraction Principle, The Inverse Function theorem, The implicit function theorem.

(Chapter 9, Sections 9.1 to 9.29 of the prescribed text book)

**TEXT BOOK:**

Principles of Mathematical Analysis by Walter Rudin, International Student Edition, 3rd Edition,1985.

**REFERENCE BOOK:**

Mathematical Analysis by Tom M. Apostol, Narosa Publishing House, 2nd Edition, 1985.

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**DEPARTMENT OF MATHEMATICS**

**M.Sc. MATHEMATICS**

**II SEMESTER**

**M 203 TOPOLOGY II**

**(Revised w.e.f. 2018-19 admitted batch)**

**Objectives:**

1. To understand the concept of Separation axioms.
2. To introduce concept of metrizability of a topological space.
3. To understand the concept of Connectedness, Components of a space, totally disconnected space, Locally connected space.
4. To study approximation theorems.
5. To study Compactification and Locally compact spaces.
6. To study in detail about Topological groups.

**Outcomes:**

After studying this course, students should be able to:

1. Discuss - space, Hausdorff space, Normal space, Completely regular space.
2. Discuss Uryshon’s lemma and Tietze extension theorem, Distinguish Urysohn’s lemma and the Tietze extension theorem.
3. Sketch the Separation properties using venn diagram.
4. Discuss Uryshon metrization theorem.
5. Give examples and counter examples for connected pace, maximal connected space and Totally disconnected space.
6. Discuss weierstrass approximation theorem, Real and Complex stone weierstrass theorem.

**Syllabus:**

**UNIT-I**

Separation: – space and Hausdorff spaces – Completely regular spaces and normal spaces – Urysohn’s lemma and the Tietze extension theorem – The urysohn imbedding theorem – The stone – chech compactification.

(Chapter 5: Sections 26 to 30 Prescribed textbook–1).

**UNIT-II**

Connectedness: Connected spaces – The components of a space – Totally disconnected spaces – Locally connected spaces.

(Chapter 6: Sections 31 to 34 Prescribed textbook–1).

**UNIT-III**

Approximation: The weierstrass approximation theorem – The stone-weierstrass theorems – Locally compact Hausdorff spaces – The extended stone-weierstrass theorems.

(Chapter 7: Sections 35 to 38 Prescribed text book–1).

**UNIT-IV**

Topological Groups: Neighborhoods of a point in topological group- Isomorphism and local isomorphisms - Subgroups- Quotient groups–Homomorphisms.

(Chapter 3, sections 1 and 2.1 to2.8, pages 219-237, of Prescribed text book 2.)

**Prescribed book:**

1. Introduction to Topology by G.F. Simmons, Mc. Graw-Hill book company.

2. General Topology by Bourbaki, Wesely publishing company.

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**DEPARTMENT OF MATHEMATICS**

**M.Sc. MATHEMATICS**

**II SEMESTER**

**M 204 COMPLEX ANALYSIS**

**(Revised/w.e.f.2018-19 admitted batch)**

**Objectives:**

1. To understand the concept of a Power series about a point in Complex plane and Analytic function and their properties.
2. To study harmonic functions and harmonic conjugate.
3. To understand the concept of a Mobius transformation and function of bounded variation.
4. To study Cauchy integral formula, Cauchy theorem and their applications.
5. To study in detail Singularities.

**Outcomes:**

After studying this course, students should be able to:

1. Obtain a formula to compute the radius of convergence for complex power series.
2. Utilize the Cauchy –Riemann equations to check whether the function is analytic or not.
3. Discuss about any function having a power series representation is analytic in the radius of convergence and its derivatives have a power series expansion.
4. Apply Cauchy’s integral formula and Cauchy’s theorem to compute line integrals.
5. Give examples for isolated singularity, removable singularity, Pole and essential singularity.
6. Compute Laurent series of a complex valued function about isolated singular point.
7. Evaluate Complex integrals using residue theorem.

**Syllabus:**

**UNIT-I**

Elementary properties and examples of analytic functions: Power series- Analytic functions- Analytic functions as mappings, Mobius transformations.

(1, 2, 3 of chapter III of prescribed text book)

**UNIT-II**

Complex Integration: Riemann - Stieltjes integrals - Power series representation of analytic functions- zeros of an analytic function -The index of a closed curve.

(1, 2, 3, 4 of chapter-IV of prescribed text book)

**UNIT-III**

Cauchy’s theorem and integral formula - the homotopic version of Cauchy’s theorem and simple connectivity- Counting zeros; the open mapping theorem.

(5, 6, 7 of chapter-IV of prescribed text book)

**UNIT-IV**

Singularities: Classifications of singularities- Residues- The argument principle.

(1, 2, 3 of chapter-V of prescribed text book)

**Prescribed text book:**

Functions of one complex variable by J. B. Conway: Second edition, Springer International student Edition, Narosa Publishing House, New Delhi.

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**DEPARTMENT OF MATHEMATICS**

**M.Sc. MATHEMATICS**

**II SEMESTER**

**M 205 DISCRETEMATHEMATICS**

**(Revised w.e.f. 2018-19 admitted batch)**

**Objectives:**

1. To understand the basic initial concepts of graph theory.
2. To study in detail Connectivity in graphs, trees, binary trees and spanning trees.
3. To understand the concepts of Eulerian graphs and Hamiltonian graphs.
4. To understand the concept of Posets, Boolean algebra and Boolean Polynomials and their Properties
5. To study algorithms to attain minimal spanning trees.

**Outcomes:**

After studying this course, students should be able to:

1. Explain Various types of graphs with examples and prove certain elementary results.
2. Discuss a necessary and sufficient condition a graph is bipartite.
3. Observe the eccentricity, radius, diameter and center of the connected graphs (Trees).
4. Determine whether graphs are Hamiltonian and/or Eulerian.
5. Utilize J. B. Kruskal’s Algorithm, R. C. Prim’s Algorithm to obtain minimal spanning trees
6. Discuss the concept of lattice ordered set and algebraic lattice same.
7. Discuss the necessary and sufficient conditions for a lattice L to be distributive (modular).
8. Determine prime implicants of a given Boolean polynomial.
9. Utilize Quine-Mc Clusky method to determine minimal form Boolean polynomial and simplify a given Boolean polynomial by Karnaugh Diagram
10. Discuss the applications of switching circuits

**Syllabus:**

**UNIT-I**

History, Initial Concepts, Summary, Introduction, Elementary Results, Structure Based on Connectivity, Summary, Characterizations, Theorems on Trees, Tree Distances, Binary trees, Tree Enumeration, Spanning trees, Fundamental Cycles, Summary.

(Chapters–1,2&3 of Text Book 1)

**Unit–II**

Introduction, Eulerian Graphs, Hamiltonian Graphs, Minimal Spanning Trees, J. B. Kruskal’s Algorithm, R. C. Prim’s Algorithm.

(Chapter 4 of Text Book 1 and Section 8.5 of Text Book 2)

**Unit–III**

Poset Definition, Properties of Posets, Lattice Definition, Properties of Lattices, Definitions of Modular and Distributive Lattices and its properties.

(Chapter1 of Text Book 3)

**Unit–IV**

Definition of Boolean Algebra, Basic properties, Boolean Polynomials, Ideals, Filters, Minimal forms of Boolean Polynomials, Applications of Lattices, Switching Circuits.

(Chapter 2 of Text Book 3)

**Text Book1:**

Graph Theory Applications by L. R. Foulds, Narosa Publishing House, New Delhi.

**Text Book2:**

Discrete Mathematical Structures by Kolman and Busby and Sharen Ross, Prentice Hall of India–2000, 3rd Edition

**Text Book3:**

Applied Abstract Algebra by RudolfLidl and GunterPilz published by Springer-Verlag

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**DEPARTMENT OF MATHEMATICS**

**M.Sc. MATHEMATICS**

**III Semester**

**M 301 Functional Analysis (Compulsory)**

**(Revised w.e.f. 2018-19 admitted batch)**

**Objectives:**

1. To understand the concept of Banach spaces and Hilbert spaces.
2. Explain the concept of Projection on Hilbert and Banach spaces.
3. To study in detail the concept of determinants and the spectrum of an operator.

**Outcomes:**

After studying this course, students should be able to:

1. Explain the concept of normed, Banach & Hilbert spaces with standard examples and relation between them.
2. Demonstrate the continuous linear transformations and the Hahn-Banach theorem
3. Describe uniform boundedness theorem, open mapping theorem and closed graph theorem and their applications.
4. Summarize orthogonal vectors in a Hilbert space, orthogonal complement of a subset of a Hilbert space, orthonormal set and a complete orthonormal set.
5. Classify different operators on Hilbert space, which commute with their adjoints.
6. Discuss Spectral theorem and its applications.

**Syllabus:**

**UNIT-I**

Banach spaces: The definition and some examples, continuous linear transformation, The Hahn Banach theorem, the natural imbedding of N in N\*\*, The open mapping theorem.

Sections 46-50, Chapter 9.

**UNIT-II**

The conjugate of an operator, Hilbert spaces: The definition and some simple properties, orthogonal complements, orthonormal sets.

Section 51, Chapter 9 and Sections 52-54, Chapter 10.

**UNIT-III**

(Self) Adjoint, Normal, Unitary Operators: The conjugate space H\*, the adjoint of an operator, Self-adjoint operators, Normal and Unitary operators, Projections.

Sections 55-59, Chapter 10.

**UNIT-IV**

Finite-dimensional spectral theory: Matrices, determinants and the spectrum of an operator, the spectral theorem. A survey of the situation.

Sections 60-63, Chapter 11.

**Text Book:**

Introduction to Topology and Modern Analysis by G. F. Simmons, McGraw Hill Book Company. Inc-International student edition.

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**DEPARTMENT OF MATHEMATICS**

**M.Sc. MATHEMATICS**

**III-SEMESTER**

**M 302(1)-NUMBER THEORY- I**

**(Revised/w.e.f. 2018-19 admitted batch)**

**Objectives:**

To study about the various Arithmetical functions and proving properties.

To learn about important subgroups of Arithmetical functions and Dirichlet product on functions.

To know the definition and basic properties of congruences, Residue classes and complete residue systems.

Important results about Euler Summation formula and its applications, some elementary theorems about distribution of primes.

To understand the behavior of various functions for a large value, the Big-oh notation and Asymptotic equality of functions.

Learning about Characters of finite abelian groups and Dirichlet’s theorem for primes.

**Outcomes:**

After studying this course, students should be able to:

1. Describe the important of arithmetical functions Mobius, Euler Totient, Mangold and divisor functions.
2. Explain prime number theorem and its equivalent conditions theorems, Abel’s identity.
3. Ability to solve applications of Euler- Fermat theorem, Lagrange’s theorem and Polynomial congruences with prime power moduli.
4. Discuss about The Chinese remainder theorem and Applications of the Chinese remainder theorem.
5. Ability to solve properties related to above mentioned functions and sums involving Dirichlet characters.

**Syllabus:**

**UNIT-I**

ARITHMETICAL FUNCTIONS AND DIRICHLET MULTIPLICATION:

Introduction- The Mobius function function µ (n) – The Euler totient function ϕ (n)- A relation connecting ϕ and µ - A product formula for ϕ (n)- The Dirichlet product of arithmetical functions- Dirichlet inverses and the Mobius inversion formula- The Mangoldt function Λ(n)- multiplicative functions- multiplicative functions and Dirichlet multiplication- The inverse of a completely multiplicative function-Liouville’s function - The divisor functions.

Chapter-2: - Articles 2.1 to 2.14

AVERAGES OF ARITHMETICAL FUNCTIONS:

Introduction- The big oh notation. Asymptotic equality of functions- Euler’s summation formula- Some elementary asymptotic formulas-The average order of d(n)- The average order of the divisor functions - The average order of ϕ (n). The partial sums of a Dirichlet product- Applications to µ (n) and Λ(n)- Another identity for the partial sums of a Dirichlet product.

Chapter -3: - Articles 3.1 to 3.7

**UNIT-II**

The partial sums of a Dirichlet product- Applications to µ (n) and Λ(n)- Another identity for the partial sums of a Dirichlet product.

SOME ELEMENTARY THEOREMS ON THE DISTRIBUTION OF PRIME NUMBERS:

Introduction- Chebyshev’s functions and - Relations connecting and - Some equivalent forms of the prime number theorem-Inequalities for π(n) and Shapiro’s Tauberian theorem- Applications of Shapiro’s theorem- An asymptotic formula for the partial sums - The partial sums of the Mobius function – The partial sums of the Mobius function.

Chapter -3: - Articles 3.10 &3.11 and Chapter-4: - Articles 4.1 to 4.9

**UNIT-III**

CONGRUENCES:

Definition and basic properties of congruences- Residue classes and complete residue systems- Linear congruences- Reduced residue systems and the Euler- Fermat theorem- Polynomial congruences modulo p. Lagrange’s theorem- Applications of Langrage’s theorem- Simultaneous linear congruences. The Chinese remainder theorem- Applications of the Chinese remainder theorem- Polynomial congruences with prime power moduli.

Chapter -5: - Articles 5.1 to 5.9

**UNIT-IV**

FINITE ABELIAN GROUPS AND THEIR CHARACTERS:

Characters of finite abelian groups- The character group- The orthogonality relations- for characters- Dirichlet characters- Sums involving Dirichlet characters-The nonvanishing of L (1, χ) for real nonprincipal χ .

DIRICHLET’S THEOREM ON PRIMES IN ARITHMETIC PROGRESSIONS:

Introduction- Dirichlet’s theorem for primes of the form 4n-1 and 4n+1- The plan of the proof of Dirichlet’s theorem- Proof of Lemma 7.4- Proof of Lemma 7.5- Proof of Lemma 7.6- Proof of Lemma 7.7- Proof of Lemma 7.8- Distribution of primes in arithmetic progressions.

Chapter 6: - Articles 6.5 to 6.10 and Chapter 7: - 7.1 to 7.9

**TEXT BOOK:**

Introduction to Analytic Number Theory- By T. M. APOSTOL-Springer Verlag-New York, Heidalberg-Berlin-1976.

**ST. JOSEPH’S COLLEGE FOR WOMEN**

**DEPARTMENT OF MATHEMATICS**

**M.Sc. MATHEMATICS**

**III-SEMESTER**

**M 303(1) LATTICE THEORY-I**

**(Revised w.e.f. 2018-19 admitted batch)**

**Objectives:**

1. To understand the concept of partially ordered sets.
2. To study the concept of lattices, complete lattices, Distributive and Modular lattices.
3. Explain the concept of Valuation of lattice.

**Outcomes:**

After studying this course, students should be able to:

1. Describe about the minimum and maximum conditions.
2. Discuss about the Jordan-Dedekind chain condition.
3. Draw the diagrams of POSETS and LATTICES.
4. Summarizing the importance of irreducible and prime elements of lattice.
5. Characterize complete lattices and conditionally complete lattices.
6. Discuss Dedekind’s modularity criterion.
7. Summarize the valuation of lattice, Metric and Quasi metric lattice.

**Syllabus:**

**UNIT-I**

Partially Ordered sets- Diagrams- Special subsets of a poset –length- lower and upper bounds- the minimum and maximum condition- the Jordan Dedekind chain conditions – Dimension functions.

Sections 1 to 9 of chapter I of the prescribed text book

**UNIT-II**

Algebras-lattices- the lattice theoretic duality principle- semi lattices- lattices as posets-diagrams of lattices- semi lattices, ideals-bound elements of Lattices-atoms and dual atoms-complements, relative complements, semi complements-irreducible and prime elements of a lattice- the homomorphism of a lattice-axioms systems of lattices.

Sections 10 to 21 of chapter II of the prescribed text book

**UNIT-III**

Complete lattices- complete sub lattices of a complete lattice- conditionally complete lattices- lattices – compact elements, compactly generated lattices- sub algebra lattice of an algebra-closure operations- Galois connections, Dedekind cuts- partially ordered sets as topological spaces.

Sections 22 to 29 of chapter III of the prescribed text book

**UNIT-IV**

Distributive lattices-infinitely distributive and completely distributive lattices-modular lattices characterization of modular and distributive lattices by their sub lattices- distributive sublattices of modular lattices- the isomorphism theorem of modular lattices, covering conditions-meet representations in modular and distributive lattices- some special subclasses of the class of modular lattices-preliminary theorems – modular lattices of locally finite length- the valuation of a lattice, metric and quasi metric lattices- complemented modular lattices.

Sections 30 to 40 of Chapters IV and V of the prescribed text book

**Prescribed Text Book:**

Introduction to Lattice Theory, by Gabor Szasz, Academic Press, New York.

**Book for reference:**

General Lattice Theory by G. Gratzer, Academic Press, New York.

**ST. JOSEPH’S COLLEGE FOR WOMEN**

**DEPARTMENT OF MATHEMATICS**

**M.Sc. MATHEMATICS**

**III-SEMESTER**

**M 304(1) COMMUTATIVE ALGEBRA- I**

**(Revised w.e.f. 2018-19 admitted batch)**

**Objectives:**

1. To study the theory classes and ideals in Commutative Rings.
2. To learn about operations on ideals, extension and contraction of ideals in commutative rings.
3. To Explain the concept of modules, operations on modules and tensor product of modules and algebras.
4. Describe the Important results concern tensor products and exact sequences of module, noetherian rings.
5. To understand the model Rings of fractions.
6. Learning about uniqueness on Primary decomposition of ideals.

**Outcomes:**

After studying this course, students should be able to:

1. A comprehensible clarifying of commutative rings and their properties.
2. A clear and brief illustration of proofs related to Commutative Rings, Modules and Ideals.
3. Describe tensor properties of modules, exact sequences and flat modules.
4. Have a clear model about localization of rings at a prime ideal.
5. Ability to solve the properties of extended and contracted ideals in ring of fractions.

**Syllabus:**

**UNIT-I**

Rings and ring homomorphism, ideals, quotient rings, zero divisors, Nilpotent elements, units, prime ideals and Maximal ideals, nil radical and Jacobson radical, operations on ideals, Extensions and contractions.

**UNIT-II**

Modules and module homomorphisms, Sub modules and quotient modules, operations on sub modules, Direct sum and product, finitely generated modules, exact sequences, Tensor product of modules, Restriction and extension of scalars, Exactness properties of the tensor product, algebras, tensor product of algebras.

**UNIT-III**

Local Properties, Extended and contracted ideals in rings of fractions.

**UNIT-IV**

Primary decompositions (Content and extent chapters 1 to 4 of the prescribed text book).

**Prescribed text book:**

Introduction to commutative algebra, By M. F. ATIYAH and I.G. MACDONALD, Addison-Wesley publishing Company, London.

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**III semester**

**M 305: Calculus of Variations (Compulsory)**

**(Revised w.e.f. 2018-19 admitted batch)**

**Objectives:**

1. Fully understand the concept of functional and Euler’s equations.
2. Describe the branchistochrone problem mathematically and solve it.
3. Solve simple initial and boundary value problems by using several variable calculus.
4. Compute one sided variations, moving boundaries, reflection and reflection of extremals.
5. Formulate important results and Clairaut’s theorem and Noether’s theorem.
6. Be through with methods for solving Elastic bodies and Electro statics problems.

**Outcomes:**

After studying this course, students should be able to:

1. Calculus of variations is a field in mathematics that deals with finding shortest path between two points.
2. The calculus of variations is a powerful technique for the solution of problems in dynamics of rigid bodies, optimization of orbits and vibration problems.
3. Calculus of variations helps to formulate geodesic problems on a plane and sphere.
4. They range from the problem in geometry of finding the shape of a soap bubble, a surface that minimized its surface area.
5. Obtain the configuration of piece of elastic that minimizes its energy.
6. Analyse the problems in which one wishes to find the minima of extrema of some quantity over a system that has functional degrees of freedom.

**Syllabus:**

**Unit 1**

Variational Problems with Fixed Boundaries – The Concept of variation and its properties- Euler’s equation-Variational problems for functionals- functionals dependent on higher order derivatives- functionals dependent on functions of several independent variables-Some application problems of Mechanics

(Sections 1.1-1.5,1.7 of Chapter 1).

**Unit 2**

Variational Problems with Moving Boundaries – Functionals involving first order derivative-Variational problem with a moving boundary for a functional dependent on two functions-one sided variations-reflection and reflection of extremals.

(Sections 2.1-2.4 of Chapter 2).

**Unit 3**

Sufficient conditions for an extremum – second variation-poisson bracket-The Hamilton-Jacobi equation-Clairaut’s Theorem-Noether’s theorem

(Sections 3.5,3.8,3.10-3.12 of Chapter 3).

**Unit 4**

Variational problems – Various constraints – Isoperimetric problems – Problems of Mayer and Bolza-Equilibrium problems for Elastic Bodies – problem of Electro statics

(Sections 4.1 – 4.5 of Chapter 4).

**Prescribed Text book:**

A.S. Gupta, Calculus of Variations with Applications, PHI Learning Private Limited, 2009.

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**IV-SEMESTER**

**M 401 MEASURE THEORY (Compulsory)**

**(Revised w.e.f. 2018-19 admitted batch)**

**Objectives:**

1. To introduce the concept of measure and integration with respect to a measure.
2. To study basic properties of measurable functions.
3. To Understand how lebesgue measure on R is defined.
4. To study the concept of Absolute continuity and convex functions.
5. To introduce the concept of Bounded linear functionals on the spaces.

**Outcomes:**

After studying this course, students should be able to:

1. Analyse measurable sets and lebesgue measure.
2. Construct lebesgue’s measure on the real line and in n-dimensional Euclidean space.
3. Discuss how measures may be used to construct integrals.
4. Distinguish the relation between differentiation and lebesgue integration.
5. Discuss littlewood’s three principles, Egoroff’s theorem, Fatou’s lemma and Monotone convergence theorem.

**Syllabus:**

**UNIT-I**

Lebesgue measure: Introduction, Outer measure, measurable sets and Lebesgue measure, A non-measurable set, measurable functions, Littlewood’s three principles.

Chapter 3 of the text book

**UNIT-II**

The Lebesgue Integral: The Riemann integral, The Lebesgue integral of a bounded function over a set of finite measure, the integral of nonnegative function, the general Lebesgue integral, convergences in measure.

Chapter 4 of the text book

**UNIT-III**

Differentiation and integration: Differentiation of monotone functions, Functions of bounded variation and differentiation of an integral, Absolute continuity, and convex functions.

Chapter 5 of the text book

**UNIT-IV**

The classical Banach spaces: The Lp-spaces, The Minkoswki and Holder inequalities, convergence and completeness, approximation in , Bounded linear functionals on the spaces.

Chapter 6 of the text book

**TEXT BOOK:**

Real Analysis by H. L. Royden, Macmillan Publishing Co. Inc. 3rd Edition, New York, 1988.

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**M.Sc. MATHEMATICS**

**IV-SEMESTER**

**M 402(1) NUMBER THEORY- II**

**(Revised w.e.f. 2018-19 admitted batch)**

**Objectives:**

1. To be taught about periodic arithmetical functions and Ramanujan’s sum and generalizations.
2. To learn the quadratic reciprocity law and Gauss Lemma.
3. To become skilled at Primitive roots, reduced residue systems, quadratic residues.
4. To deduct important theorems on Real-valued Dirichlet characters Primitive Dirichlet characters, Integral representation for the Hurwitz zeta function.
5. To understand the function defined by Dirichlet series, Multiplication of Dirichlet series, Euler Products, The half-plane of convergence of a Dirichlet series.

**Outcomes:**

After studying this course, students should be able to:

1. To prove a number of results on functions periodic modulo k and Quadratic residues- Legendre’s symbol and its properties.
2. Expertise on applications of the reciprocity law.
3. Able to prove the existence of primitive roots and p for odd primes p.
4. Discuss the analytic properties of Dirichlet series and the halfplane of absolute convergence of a Dirichlet series.
5. Ability to prove properties of the gamma function and Hurwitz’s formula for ζ(s, a).

**Syllabus:**

**UNIT-I**

PERIODIC ARITHMETIAL FUNCTIONS AND GAUSS SUMS:

Functions periodic modulo k- Existence of finite Fourier series for periodic arithmetical functions- Ramanujan’s sum and generalizations- Multiplicative properties of the sums Gauss sums associated with Dirichlet characters-Dirichlet characters with nonvanishing Gauss sums.

QUADRATIC RESIDUES AND THE QUADRATIC RECIPROCITY LAW:

Quadratic residues- Legendre’s symbol and its properties- Evaluation of (-1/p) and (2/p)- Gauss Lemma-The quadratic reciprocity law-Applications of the reciprocity law- The Jacobi symbol Applications to Diophantine equations- Gauss sums and the quadratic reciprocity law.

Chapter 8: - Articles 8.1 to 8.6 and Chapter 9: - Articles 9.1 to 9.9

**UNIT-II**

PRIMITIVE ROOTS:

The exponent of a number mod m. Primitive roots- Primitive roots and reduced residue systems-The nonexistence of primitive roots mod for α ≥ 3- The existence of primitive roots and p for odd primes p. Primitive roots and quadratic residues- The existence of primitive roots mod - The existence of primitive roots mod 2 - The nonexistence of primitive roots in the remaining cases- The number of primitive roots mod m. The index calculus- Primitive roots and Dirichlet characters-Real-valued Dirichlet characters mod Primitive Dirichlet characters mod .

**UNIT-III**

DIRICHLET SERIES AND EULER PRODUCTS:

The half- plane of absolute convergence of a Dirichlet series, the function defined by Dirichlet series, Multiplication of Dirichlet series, Euler Products, The half-plane of convergence of a Dirichlet series, Analytic properties of Dirichlet series, Dirichlet series with non-negative coefficients.

Chapter- 11: - Articles 11.1 to 11.7.

**UNIT-IV**

Properties of the gamma function, Integral representation for the Hurwitz zeta function, A contour integral representation for the Hurwitz zeta function, The analytic continuation of the Hurwitz zeta function, Analytic continuation of ζ(s), L(s, χ) , Hurwitz’s formula for ζ(s, a), The functional equation for Riemann zeta function.

Chapter- 12: - Articles 12.1 to 12.8.

**TEXT BOOK:**

Introduction to Analytic Number Theory- By T. M. APOSTOL- Springer Verlag-New York, Heidalberg-Berlin-1976.

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**IV-SEMESTER**

**M 403(1) LATTICE THEORY-II**

**(Revised/w.e.f. 2018-19 admitted batch)**

**Objectives:**

1. To understand the concept of Boolean Algebras.
2. To study in detail semi modular lattices and ideals of lattices.
3. Describe Congruence relations.

**Outcomes:**

After studying this course, students should be able to:

1. Illustrate the class of Boolean algebras and Boolean rings are same.
2. Describe the concept of linear dependence.
3. Characterize prime ideals and maximal ideals.
4. Discuss Boolean algebra is a field of sets.
5. Discuss the necessary and sufficient condition that the lattice is distributive related with ideals is the kernel of at least one congruence relation

**Syllabus:**

**UNIT-I**

Boolean algebras, De Morgan formulae- Complete Boolean algebras- Boolean algebras and Boolean rings- The algebra of relations- The lattice of propositions- Valuations of Boolean algebras.

Sections 42 to 47 of chapters VI of the prescribed text book

**UNIT-II**

Birkhoff lattices- Semi modular lattices- Equivalence lattices- Linear dependence- Complemented semi modular lattices.

Sections 48 to 52 of chapters VII of the prescribed text book

**UNIT-III**

Ideals and dual ideals, Ideal chains- Ideal lattices- Distributive lattices and rings of sets.

Sections 53 to 55 of chapters VIII of the prescribed text book

**UNIT-IV**

Congruence relation of an algebra- Permutable equivalence relations- The Schreier refinement theorem in arbitrary algebras- Congruence relations of lattices- Minimal congruence relations of some subsets of a distributive lattice- The connection between ideals and congruence relations of a lattice.

Sections 56 to 61 of chapters IX of the prescribed text book

**Prescribed text book:**

Introduction to Lattice Theory by Gabor Szasz, Academic Press, New York.

**Books for reference:**

General Lattice Theory by G. Gratzer, Academic Press, New York.

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**DEPARTMENT OF MATHEMATICS**

**M.Sc. MATHEMATICS**

**IV-SEMESTER**

**M 404(1) COMMUTATIVE ALGEBRA-II**

**(Revised w.e.f. 2018-19 admitted batch)**

**Objectives:**

1. To be taught the notion of Integral dependence.
2. To become skilled at the Chain Conditions on modules to establish strong theorems in commutative rings.
3. To deduct important theorems using Noetherian condition and proving Hilbert basis theorem.
4. To understand the importance of Artin rings and learning about a special kind of domains called Dedekind domains.

**Outcomes:**

After studying this course, students should be able to:

1. To prove a number of results on Integral dependence.
2. To learn Going-Up and Going-Down theorems concerning prime ideals in an integral extension.
3. To study valuation rings of a given field of fractions.
4. Discuss the basic results in the dimension theory for local rings.
5. Ability to establish important results on Noetherian domains of dimensions zero and Noetherian integral domains of dimension one.

**Syllabus:**

**UNIT-I**

Integral dependence, the going-up theorem-Integrally closed integral domains, the going down theorem, valuation rings.

**UNIT-II**

Chain Conditions

**UNIT-III**

Noetherian rings- Primary decomposition of Noetherian rings, Artin rings

**UNIT-IV**

Discrete valuation rings, Dedekind domains, Fractional ideals.

Content and extent of Chapters 5 to 9 of the prescribed text book.

**Prescribed Text Book:**

Introduction to commutative algebra by M. F. Atiya and I. G. Macdonald, Addison-Wesley Publishing Company, London.

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**IV-SEMESTER**

**M 405 PARTIAL DIFFERENTIAL EQUATIONS (Compulsory)**

**(Revised w.e.f. 2018-19 admitted batch)**

**Objectives:**

1. Understand basic properties of standard PDE’s.

2. Apply the range of technique to find solutions of standard PDE’s.

3. Demonstrate accurate and efficient use of Fourier analysis techniques and their applications in the theory of PDE’s.

4. Demonstrate capacity to model physical phenomena using PDE’s and Cauchy’s problems.

5. Apply problem solving using concepts and techniques from PDE’s and Fourier analysis applied to diverse situations in physics, engineering, financial mathematics and in other mathematical contexts.

**Outcomes:**

After studying this course, students should be able to:

1. Discuss the fundamental axioms in mathematics and capability of developing ideas based on them.

2. Apply specific methodologies, techniques and resources to conduct research and produce innovative results in the area of specialization.

3. Utilize techniques for solving mathematical models and their real implementation problems.

4. Nature problem solving skills, thinking creativity through assignments.

5. Expertise on a wide range of mathematical techniques and application of mathematical methods/tools in other scientific and engineering domains.

**Syllabus:**

**Unit-I**

First Order P.D.E.: Curves and Surfaces – Genesis of First Order P.D.E. – Classification of Integrals – Linear equations of the First Order - Pfaffian Differential Equations – Compatible Systems – Charpit’s Method- Jacobi’s Method.

(Chapter 1 – sections 1.1 – 1.8)

**Unit-II**

Second Order P.D.E.: Genesis of Second Order P.D.E. – Classification of Second Order P.D.E.,One Dimensional Wave equation: Vibrations of an Infinite String – Vibrations of Semi infinite String Vibrations of String of Finite Length – Riemann’s Method – Vibrations of a String of Finite Length (Method of Separation of Variables).

(Chapter 2 – section 2.1 – 2.3)

**Unit-III**

Laplace’s Equation: Boundary value Problems- Maximum and Minimum Principles- the Cauchy Problem-The Dirichlet Problem for the upper Half Plane- The Neumann Problem for the upper Half Plane- The Dirchilet Problem for a Circle- The Dirchilet Exterior Problem for a Circle- The Neumann Problem for a Circle- The Dirchilet Problem for a Rectangle

(Chapter 2 – section 2.4.1-2.4.9)

**Unit-IV**

Heat Conduction Problem: Heat Conduction – Infinite Rod Case - Heat Conduction –Finite Rod Case- Duhamel’s Principle: Wave Equation –Heat Conduction Equation. Integral Surfaces through a Given Curve- Quasi Linear Equations.

(Chapter 2 – sections 2.5, 2.6 and Chapter 1 –sections 1.9, 1.10)

**Text book:**

T. Amarnath, An Elementary Course in Partial differential equations, Second Edition, Narosa Publishing House.

**Reference Book:**

Ian Sneddon, Elements of Partial Differential Equations, McGraw-Hill International Editions.