**ST. JOSEPH’S COLLEGE FOR WOMEN, VISAKHAPATNAM**

**I SEMESTER MATHEMATICS**

**M 101 ALGEBRA–I MAX.MARKS:100**

**w.e.f. 2022-23 SYLLABUS CREDITS: 4**

**COURSE OUTCOMES:**

After studying this course, students should be able to:

CO 1: To introduce the basic concepts of group theory and study the structure of groups.

CO 2: To introduce the concepts of conjugacy and G sets and prove Cayley theorem. To introduce explicitly the properties of permutation groups.

CO 3: To determine structure of any abelian groups. To determine structure of finite nonabelian groups through Sylow theorems.

CO 4: To introduce concepts of ring theory. To introduce different types of ideals. To apply Zorn’s lemma on the set of ideals.

CO 5: To introduce prime elements and irreducible elements in a commutative integral domain. To study the domains UFD, PID and ED.

**UNIT I:**

**Groups:** Homomorphisms-Subgroups and cosets.

**Normal Subgroups:** Normal subgroups and Quotient Groups-Isomorphism theorems-Automorphisms.

18 Hours

(Sections 4.2, 4.3 of the Chapter 4 and sections 5.1 to 5.3 of the Chapter 5 in the Prescribed Text Book.)

**UNIT II:**

**Normal Subgroups:** Conjugacy and G-Sets

**Permutation Groups:** Cyclic Decomposition- Alternating group -Simplicity of .

18 Hours

(Section 5.4 of chapter 5 and sections 7.1 to 7.3 of the Chapter 7 in the Prescribed Text Book.)

**UNIT III:**

**Structure theorems of groups:** Direct Products- finitely generated abelian groups-Invariants of a finite abelian group Sylow theorems.

18 Hours

(Sections 8.1 to 8.4 of the Chapter 8 in the Prescribed Text Book.)

**UNIT IV:**

**Ideals and Homomorphisms:** Ideals, Homomorphisms, Sum and direct sum of ideals- Maximal and Prime Ideals-Nilpotent and Nil Ideals-Zorn’s Lemma.

18 Hours

(Sections 10.1 to10.6 of the Chapter 10 in the Prescribed Text Book.)

**UNIT V:**

**Unique factorization domains and Euclidean domains:** Unique factorization domains, Principal ideal domains, Euclidean domains, Polynomial rings over UFD.

18 Hours

(Sections 11.1 to 11.4 of the Chapter 11 in the Prescribed Text Book.)

**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.

**ST. JOSEPH’S COLLEGE FOR WOMEN, VISAKHAPATNAM**

**I SEMESTER MATHEMATICS**

**M 102 REAL ANALYSIS–I MAX.MARKS:100**

**w.e.f. 2022-23 SYLLABUS CREDITS: 4**

**COURSE OUTCOMES:**

After studying this course, students should be able to:

CO 1: To describe elementary concepts on metric spaces to get the general idea that is relevant to Euclidean spaces.

CO 2: To study the continuity and its properties of real valued functions in metric spaces.

CO 3: To describe the derivatives of real valued functions defined on intervals or segments, and study its properties.

CO 4: To introduce Riemann-Stieltjes integral as a generalization of Riemann integral and discuss the existence of this integral.

CO 5: To study differentiation of integrals and further the extension of integration to vector valued functions.

**UNIT I:**

**Basic Topology:** Metric spaces, Compact sets, Prefect sets, Connected sets.

18 Hours

Chapter 2, Sections 2.15 to 2.47 of the Prescribed Text Book.

**UNIT II:**

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

18 Hours

Chapter 4 of the Prescribed Text Book.

**UNIT III:**

**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 Prescribed Text Book.

**UNIT IV:**

**The Riemann-Stieltjes integral:** Definition and Existence of the Integral, Properties of the integral, Change of variable.

18 Hours

Chapter 6, Sections 6.1 to 6.19, of the Prescribed Text Book.

**UNIT V:**

**The Riemann-Stieltjes integral (continued):** Integration and Differentiation, The Fundamental theorem of Calculus, Integration by parts, Integration of vector-valued functions, Rectifiable curves.

18 Hours

Chapter 6, Sections 6.20 to 6.27, of the Prescribed Text Book.

**Prescribed 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.

**Reference Books:**

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

**ST. JOSEPH’S COLLEGE FOR WOMEN, VISAKHAPATNAM**

**I SEMESTER MATHEMATICS**

**M 103 TOPOLOGY–I MAX.MARKS:100**

**w.e.f. 2022-23 SYLLABUS CREDITS: 4**

**COURSE OUTCOMES:**

After studying this course, students should be able to:

CO 1: To get acquaintance with concepts of sets and functions and their properties which are basic tools to study Mathematics.

CO 2: To introduce metric spaces and some elementary concepts in metric spaces.

CO 3: To study the concept of continuous functions and their properties, Euclidean and Unitary spaces.

CO 4: To understand broader concept of topology and topological spaces, as a generalization of metric spaces and study some basic results in topological spaces.

CO 5: To study the concept of compactness and compact spaces. Some important theorems in compact spaces.

**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 of the prescribed text book).

20 Hours

**UNIT II:**

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

16 Hours

(Chapter 2: Sections 9 to 12 of the prescribed text book).

**UNIT III:**

**Metric spaces (Continued):** Continuous mappings, Spaces of continuous functions – Euclidean and unitary spaces. (Chapter 2: Sections 13 to15 of the prescribed text book)

**Topological spaces:** The definition and some examples – Elementary concepts.

(Chapter 3: Sections 16 to 17 of the prescribed text book). 18 Hours

**UNIT IV:**

**Topological spaces (Continued):** Open bases and open subbases–Weak topologies–The function algebras C (X, R) and C(X,). (Chapter 3: Sections 18 to 20 of the prescribed text book).

**Compactness:** Compact spaces- Heine-Borel theorem. (Chapter 4: Section 21). 18 Hours

**UNIT V:**

**Compactness (Continued):**  Product of Spaces – Tychonoff’s theorem and locally Compact spaces – Compactness for metric spaces – Ascoli theorem. (Chapter 4: Sections 22 to 25 of the prescribed text book). 18 Hours

**Prescribed book:**

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

**ST. JOSEPH’S COLLEGE FOR WOMEN, VISAKHAPATNAM**

**I SEMESTER MATHEMATICS**

**M 104 DIFFERENTIAL EQUATIONS MAX.MARKS:100**

**w.e.f. 2022-23 SYLLABUS CREDITS: 4**

**COURSE OUTCOMES:**

After studying this course, students should be able to:

CO 1: To familiarize with essential concepts of real function theory that help to grasp the theory of ordinary differential equations.

CO 2: To introduce basic theorems in theory of ordinary differential equations pertaining to existence, uniqueness, continuation of solutions.

CO 3: To understand dependence of solutions on initial conditions and parameters.

CO 4: To transform nth order differential equations in to differential systems and extend the theory to differential systems.

CO 5: To study the qualitative behaviour of solutions of homogeneous and nonhomogeneous linear equations and systems.

**UNIT I:**

Essential concepts from Real Function Theory – The basic problem -The fundamental

existence and uniqueness theorem –examples to demonstrate the theory- continuation of

solutions.

18 Hours

(Sections 10.1, 10.2 of the prescribed text book)

**UNIT II:**

Dependence of solutions on initial conditions – dependence of solutions on parameters

(causal function f) - Existence and Uniqueness theorems for systems – existence and

uniqueness theorems for Higher order equations – examples.

18 Hours

(Sections 10.3, 10.4 of the prescribed text book)

**UNIT III:**

Introduction to the theory of Linear differential systems – Theory and properties of

Homogeneous linear systems.

18 Hours

(Sections 11.1 - 11.3 of the prescribed text book)

**UNIT IV:**

Theory of non-homogeneous linear systems – Theory and properties of the nth order

homogeneous linear differential equations.

18 Hours

(Sections 11.4 - 11.6 of the prescribed text book)

**UNIT V:**

Theory of nth order Non-homogeneous Linear equations – Sturm theory – Sturm Liouville Boundary value problems.

18 Hours

(Sections 11.7, 11.8, 12.1 of the prescribed text book)

**Prescribed Text Book:**

Shepley L. Ross (2007). Differential Equations (3rd edition), Wiley India.

**Reference book:**

George F. Simmons (2017). Differential Equations with Applications and Historical Notes (3rd edition). CRC Press. Taylor & Francis.

**ST. JOSEPH’S COLLEGE FOR WOMEN, VISAKHAPATNAM**

**I SEMESTER MATHEMATICS**

**M 105 LINEAR ALGEBRA MAX. MARKS: 100**

**w.e.f. 2022-23 SYLLABUS CREDITS: 4**

**COURSE OUTCOMES:**

After studying this course, students should be able to:

CO 1: To introduce the essential concepts of linear transformations on finite dimensional vector spaces.

CO 2: To understand the utilization of ordered basis to represent linear transformations by matrices.

CO 3: To select a single linear operator on finite dimensional vector space and to take it apart to see what makes it tick.

CO 4: To characterise the smallest subspace of a vector space which is invariant under linear operator.

CO 5: To decompose a linear operator on a finite dimensional vector space into a direct sum of operators which are elementary.

**Unit I**:

Introduction, Characteristic Values, Similar Matrices, Diagonalizable Operators, Annihilating

Polynomials, Minimal Polynomials, Cayley – Hamilton Theorem.

18 Hours

**(**Sections 6.1 - 6.3 of Chapter 6 in the Prescribed Text Book)

**UNIT II:**

Invariant Subspaces, T-conductor of a vector, T-annihilator of a vector, Simultaneous

Triangulation; Simultaneous Diagonalization.

18 Hours

**(**Sections 6.4 - 6.5 of Chapter 6 in the Prescribed Text Book)

**Unit III:**

Direct-Sum Decompositions, Projections, Invariant Direct Sums, The Primary Decomposition Theorem.

18 Hours

(Sections 6.6 – 6.8 of Chapter 6 in the Prescribed Text Book)

**Unit IV:**

Cyclic Subspaces and Annihilators, T-cyclic Subspace Generated by a Vector, Companion

Matrices, Complementary Subspaces, I-admissible Subspaces, Cyclic Decompositions and

Rational form, Generalized Cayley – Hamilton Theorem Invariant Factors.

18 Hours

(Sections 7.1, 7.2 of Chapter 7 in the Prescribed Text Book).

**Unit V:**

The Jordan Forms, Elementary Jordan Matrix with Characteristic Value , Computation of

Invariant Factors, Elementary Matrices, Smith Normal Forms, Summary; Semi-Simple

Operators.

18 Hours

(Sections 7.3 – 7.5 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, VISAKHAPATNAM**

**II SEMESTER MATHEMATICS**

**M 201 ALGEBRA–II MAX. MARKS: 100**

**w.e.f. 2022-23 SYLLABUS CREDITS: 4**

**COURSE OUTCOMES:**

After studying this course, students should be able to:

CO 1: To understand the concept of extensions of a field, based on the study of irreducible polynomials.

CO 2: To understand the concept of normal extensions and separable extensions based on the study multiplicity of roots of a polynomial.

CO 3: To introduce the concept of group of automorphisms on a field. To introduce fixed fields. To prove the fundamental theorem of Galois theory.

CO 4: To apply Galois theory and prove the fundamental theorem of algebra. To study the properties of nth cyclotomic polynomial.

CO 5: To understand Galois theory and study its applications.

**UNIT I:**

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

18 Hours

(Sections 15.1 to 15.4 of the Chapter 15 in the prescribed text book.)

**UNIT II:**

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

18 Hours

(Sections 16.1 to 16.4 of the Chapter 16 in the prescribed text book.)

**UNIT III:**

**Normal and separable extensions:** separable extensions

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

18 Hours

(Section 16.5 of the Chapter 16 and Sections 17.1 to 17.2 of the Chapter 17 in the prescribed text book.)

**UNIT IV:**

**Galois Theory:** Fundamental theorem of algebra.

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

18 Hours

(Section 17.3 of the Chapter 17 and sections 18.1and 18.2 of the Chapter 18 in the prescribed text book.)

**UNIT V:**

**Galois Theory and Applications of Galois Theory to classical problems:** Polynomials solvable by radicals- symmetric functions-Ruler and compass constructions.

18 Hours

(Sections 18.3 and 18.4 of the Chapter 18 in the prescribed text book.)

**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

**ST. JOSEPH’S COLLEGE FOR WOMEN, VISAKHAPATNAM**

**II SEMESTER MATHEMATICS**

**M 202 REAL ANALYSIS–II MAX. MARKS: 100**

**w.e.f. 2022-23 SYLLABUS CREDITS: 4**

**COURSE OUTCOMES:**

After studying this course, students should be able to:

CO 1: Discuss the most important aspects of the problems that arise when limit processes are interchanged.

CO 2: Study the approximation of continuous complex function and its generalization and an introduction of power series.

CO 3: Study of exponential and logarithmic functions, the trigonometric functions and Fourier series and their properties.

CO 4: Discuss linear transformations on finite-dimensional vector spaces over any field of scalars and derivative of functions of several variables.

CO 5: Study the method of solving implicit functions. Interesting illustration of the general principle that the local behaviour of a continuously differentiable mapping near a point. Further study of derivatives of higher order and differentiation of integrals.

**UNIT I:**

**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.

18 Hours

Chapter 7, Section 7.1 to 7.18, of the Text Book.

**UNIT II:**

**Sequences and Series of the Functions (continued):** The Stone-Weierstrass Theorem

Power Series

18 Hours

Chapter 8, Sections 8.1 to 8.5, of the Text Book.

**UNIT III:**

**Some Special Functions:** The Exponential and Logarithmic Functions, The Trignometric

functions, Fourier Series, Parseval’s theorem.

18 Hours

Chapter 8, Sections 8.6 and 8.7, 8.9 to 8.16, of the Text Book.

**UNIT IV:**

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

18 Hours

Chapter 9, Sections 9.4 to 9.25, of the Text Book.

**UNIT V:**

**Functions of several variables (continued):** The implicit Function theorem, The Rank theorem, Determinants, Derivatives of higher order, Differentiation of integrals.

18 Hours

Chapter 9, Sections 9.4 to 9.25, of the Text Book.

**Prescribed 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.

**ST. JOSEPH’S COLLEGE FOR WOMEN, VISAKHAPATNAM**

**II SEMESTER MATHEMATICS**

**M 203 TOPOLOGY–II MAX. MARKS: 100**

**w.e.f. 2022-23 SYLLABUS CREDITS: 4**

**COURSE OUTCOMES:**

After studying this course, students should be able to:

CO 1: To study Separation properties of Topological spaces, Urysohn’s lemma, Tietze’s extension theorem.

CO 2: To understand the concept of metrizability of a topological space, Urysohn’s imbedding theorem and one-point compactification of a topological space.

CO 3: To understand the concept of connected spaces, locally connected spaces, and totally disconnected spaces and their properties.

CO 4: To Prove Weirstrass approximation theorem and Stone - Weirstrass theorems.

CO 5: To study locally compact spaces and generalise Stone - Weirstrass theorems.

**UNIT I:**

Separation: spaces and Hausdorff spaces – Completely regular spaces and normal spaces – Urysohn’s lemma and the Tietze’s extension theorem. (Chapter 5: Sections 26 to 28 Prescribed text book).

18 Hours

**UNIT II:**

Separation (continued): The Urysohn imbedding theorem – The Stone – Chech compactification. (Chapter 5: Sections 29 to 30 Prescribed text book).

Connectedness: Connected spaces– connectedness of and . (Chapter 6: Section 31 Prescribed text book).

18 Hours

**UNIT III:**

Connectednedness (continued): The components of a space – Totally disconnected spaces –Locally connected spaces. (Chapter 6: Sections 32 to 34 Prescribed text book)

18 Hours

**UNIT IV:**

Approximation: The Weierstrass approximation theorem - The Stone-Weierstrass theorems. (Chapter 7: Section 35 to 36 Prescribed text book).

18 Hours

**UNIT V:**

Approximation (continued): Locally compact Hausdorff spaces – The extended Stone-Weierstrass theorems. (Chapter 7: Sections 37 to 38 Prescribed text book ).

18 Hours

**Prescribed book:**

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

**ST. JOSEPH’S COLLEGE FOR WOMEN, VISAKHAPATNAM**

**II SEMESTER MATHEMATICS**

**M 204 COMPLEX ANALYSIS MAX. MARKS: 100**

**w.e.f. 2022-23 SYLLABUS CREDITS: 4**

**COURSE OUTCOMES:**

After studying this course, students should be able to:

CO 1: To learn basic properties of power series and utilise this knowledge to construct analytic functions. To understand the relation between the Cauchy - Riemann equations and analytic functions. Study the nature and properties of Mobius transformation.

CO 2: To know about Power series expansion of analytic functions, significant properties analytic functions, zeros of analytic functions - gain knowledge pertaining to Liouville theorem, fundamental theorem of algebra, maximum modulus theorem and to know about index of a closed curve.

CO 3: To understand the three versions of Cauchy integral formula, Cauchy's theorem and Study Morera's theorem and its significance.

CO 4: Be aware of some applications of Cauchy theorem to count zeros of an analytic function and the open mapping theorem as a property of analytic function.

CO 5: Recognise and classify singularities of an analytic function - learn about residue theorem.

CO 6: Be aware of three versions of maximum modulus theorem and also the Swartz's lemma.

**UNIT I:**

Power series- Analytic functions- Analytic functions as mappings, Mobius transformations.

18 Hours

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

**UNIT II:**

Power series representation of analytic functions- zeros of an analytic function -The index of a closed curve.

18 Hours

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

**UNIT III:**

Cauchy’s theorem and integral formula - Counting zeros; the open mapping theorem.

18 Hours

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

**UNIT IV:**

Classifications of singularities- Residues and related results.

18 Hours

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

**UNIT V:**

The maximum principle – Schwarz’s lemma and related results.

18 Hours

($1, $2 of chapter-VI of the 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.

**ST. JOSEPH’S COLLEGE FOR WOMEN, VISAKHAPATNAM**

**II SEMESTER MATHEMATICS**

**M 205 DISCRETE MATHEMATICS MAX. MARKS: 100**

**w.e.f. 2022-23 SYLLABUS CREDITS: 4**

**COURSE OUTCOMES:**

After studying this course, students should be able to:

CO 1: To understand The Four Colour Theorem and applications in chemistry and physics.

CO 2: To familiarize the basic concepts of graphs and different types of graphs.

CO 3: To learn the modelling of Konigsberg Bridge Problem and Hamilton’s Game by graphs.

CO 4: To characterize graphs which are both Eulerain and Hamiltonian.

CO 5: To understand specific difference between modular and distributive lattices.

CO 6: To learn the importance of diamond and pentagon lattices.

**UNIT I:**

Basic Ideas, History, Initial Concepts, Summary, Connectivity, Elementary Results, Structure Based on Connectivity.

18 Hours

(Chapters – 1 & 2 of Text Book 1)

**Unit II:**

Trees, Characterizations, Theorems on Trees, Tree Distances, Binary trees, Tree Enumeration, Spanning trees, Fundamental Cycles, Summary.

18 Hours

(Chapter – 3 of Text Book 1)

**Unit III:**

Traversability, 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 7.5 of Text Book 2)

18 Hours

**Unit IV:**

Poset Definition, Properties of Posets, Lattice Definition, Properties of Lattices.

18 Hours

(Chapter 1-A of Text Book 3)

**Unit V:**

Definitions of Modular and Distributive Lattices and its Properties.

18 Hours

(Chapter 1-B of Text Book 3)

**Prescribed Text Book:**

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

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

3. Applied Abstract Algebra by Rudolf Lidl and Gunter Pilz, Published by Springer- Verlag.

**ST. JOSEPH’S COLLEGE FOR WOMEN, VISAKHAPATNAM**

**III SEMESTER MATHEMATICS**

**M 301 FUNCTIONAL ANALYSIS MAX. MARKS: 100**

**w.e.f. 2021-22 SYLLABUS CREDITS: 4**

**COURSE OUTCOMES:**

After studying this course, students should be able to:

CO 1: To understand the concept of Banach space through which it helps to consider the combination of algebraic and metric structures opens up the possibility of studying linear transformations of one Banach space into another with the additional property of being continuous.

CO 2: To understand the algebraic and topological aspects of the continuous linear functionals.

CO 3: To study elementary theory of Hilbert spaces and their operators to provide an adequate foundation for the higher studies.

CO 4: To understand a natural correspondence between H and its conjugate space H\*, and the adjoint of an operator on a Hilbert space.

CO 5: To study the spectral resolution of an operator T on a Hilbert space H.

**UNIT I:**

Banach spaces: The definition and some examples, continuous linear transformation, The Hahn Banach theorem.

12 Hours

Chapter 9, Sections 46-48, of the Text Book.

**UNIT II:**

Banach spaces (continued): The natural imbedding of N in N\*\*, The open mapping theorem, The conjugate of an operator.

12 Hours

Chapter 9, Sections 49-51, of the Text Book.

**UNIT III:**

Hilbert spaces: The definition and some simple properties, orthogonal complements, orthonormal sets.

12 Hours

Chapter 10, Sections 52 to 54, of the Text Book.

**UNIT IV:**

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

12 Hours

Chapter 10, Sections 55 to 59, of the Text Book.

**UNIT V:**

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

12 Hours

Chapter 11 of the Text Book.

**Prescribed Text Book:**

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

**ST. JOSEPH’S COLLEGE FOR WOMEN, VISAKHAPATNAM**

**III SEMESTER MATHEMATICS**

**M 302 CALCULUS OF VARIATIONS MAX. MARKS: 100**

**w.e.f. 2021-22 SYLLABUS CREDITS: 4**

**COURSE OUTCOMES:**

After studying this course, students should be able to:

CO 1: To learn about method of variations with fixed boundaries.

CO 2: To learn about method of variations with moving boundaries.

CO 3: To gain knowledge on some specific variational problems such as those involving extremals with corners and one-sided variations.

CO 4: To understand about sufficient conditions for an extremum for variational problems.

CO 5: To learn about variational problems involving a conditional extremum.

**Unit I:**

Variation and its properties- Euler’s equation-Functionals of the form . Functionals dependent on higher order derivatives-Functionals dependent on the functions of several independent variables.

12 Hours

(Sections 1-5 of Chapter 6 of the prescribed textbook)

**Unit II:**

Variational problems in parametric form – some applications – An elementary problem with moving boundaries-Moving boundary problem for a functional of the form .

12 Hours

(Sections 6,7 of Chapter 6 and sections 1,2 of chapter 7 of the prescribed text book)

**Unit III:**

Extremals with corners –one sided variations and related problems.

12 Hours

(Sections 3,4 of Chapter 7 of the prescribed text book)

**Unit IV:**

Field of extremals – The function E(x,y,p,y’) – Transforming the Euler equations to the canonical form.

12 Hours

(Sections 1-3 of Chapter 8 of the prescribed text book)

**Unit V:**

Constraints of the form – Constraints of the form – Isoperimetric problems.

12 Hours

(Sections 1-3 of Chapter 9 of the prescribed text book)

**Prescribed Text book:**

Differential Equations and the Calculus of Variations, L. Elsgolts, 1977, Mir Publications.

**ST. JOSEPH’S COLLEGE FOR WOMEN, VISAKHAPATNAM**

**III SEMESTER MATHEMATICS**

**M 303 NUMBER THEORY- I MAX. MARKS: 100**

**w.e.f. 2021-22 SYLLABUS CREDITS: 4**

**COURSE OUTCOMES:**

After studying this course, students should be able to:

CO 1: To introduce arithmetical functions and explore their role in the study of distribution of primes.

CO 2: To study the averages of arithmetical functions and some related asymptotic formulas.

CO 3: To introduce the foundations of congruences and study the polynomial congruences.

CO 4: To understand the prime number theorem on distribution of primes and develop some equivalent forms.

CO 5: To introduce the characters of a group and apply to the Dirichlet Theorem on primes in a progression.

**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. Generalised convolutions.

12 Hours

(Sections 2.1 to 2.14 of the Chapter 2 in the Prescribed Text Book.)

**UNIT II:**

**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).

12 Hours

(Sections 3.1 to 3.12 of Chapter 3 in the Prescribed Text Book.)

**UNIT III:**

**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. Brief sketch of an elementary proof of prime number theorem.

12 Hours

(Sections 4.1 to 4.10 of the Chapter 4 in the Prescribed Text Book.)

**UNIT IV:**

**CONGRUENCES:** Definition and basic properties of congruences- Resudue classes and complete residue systems- Linear congruences- Reduced residue systems and the Euler- Fermat theorem- Polynomial congruences modulo p. Lagrange’s theorem- Applications of Lagrage’s theorem- Simultaneous linear congruences. The Chinese remainder theorem- Applications of the Chinese remainder theorem.

12 Hours

(Sections 5.1 to 5.8 of the Chapter 5 in the Prescribed Text Book.)

**UNIT V:**

**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.

12 Hours

(Sections 6.5 to 6.10 & 7.1 to 7.3 of the Chapters 6 and 7 in the Prescribed Text Book.)

**Prescribed Text Book:**

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

**Reference Books:**

1. An Introduction to the theory of numbers, 5th edition by Ivan Niven Herbert S. Zuckerman and Huge L. Montgomery, John Wiley & Sons INC. publications, U.K., 2008.

2. Elementary Number Theory, 7th edition by David M. Burton, 2011.

**ST. JOSEPH’S COLLEGE FOR WOMEN, VISAKHAPATNAM**

**III SEMESTER MATHEMATICS**

**M 305 LATTICE THEORY-I MAX. MARKS: 100**

**w.e.f. 2021-22 SYLLABUS CREDITS: 4**

**COURSE OUTCOMES:**

After studying this course, students should be able to:

CO 1: To familiarize the concepts of poset, chain conditions.

CO 2: To learn the lattice theoretic duality principle.

CO 3: To study complements, relative complements and semi-complements of elements of a bounded lattice.

CO 4: To learn the properties of compact elements and compactly generated lattices.

CO 5: To study the posets as topological spaces.

**UNIT I:**

Set Theoretical Notations, Relations, 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.

12 Hours

(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- Sublattices and ideals.

12 Hours

(Sections 10 to 16 of chapter II of the Prescribed Text Book)

**UNIT III:**

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.

12 Hours

(Sections 17 to 21 of Chapter II of the Prescribed Text Book)

**UNIT IV:**

Complete lattices- complete sub lattices of a complete lattice- conditionally complete lattices- lattices – compact elements, compactly generated lattices.

12 Hours

(Sections 22 to 25 of Chapter III of the Prescribed Text Book)

**UNIT V:**

Sub algebra lattice of an algebra-closure operations- Galois connections, Dedekind cuts- partially ordered sets as topological spaces.

12 Hours

(Sections 26 to 29 of chapter III of the Prescribed Text Book)

**Prescribed Text Book:**

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

**ST. JOSEPH’S COLLEGE FOR WOMEN, VISAKHAPATNAM**

**III SEMESTER MATHEMATICS**

**M 306 COMMUTATIVE ALGEBRA-I MAX. MARKS: 100**

**w.e.f. 2021-22 SYLLABUS CREDITS: 4**

**COURSE OUTCOMES:**

After studying this course, students should be able to:

1. CO 1: To familiarize the essential concepts of ideals, quotient rings and homomorphisms.
2. CO 2: To understand the difference between zero divisors, nilpotent elements and units.
3. CO 3: To study the properties of finitely generated modulus.
4. CO 4: To introduce tensor product of modulus and its exactness properties.
5. CO 5: To learn the concepts of extended and contracted ideals in ring of fractions.

**UNIT I:**

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

12 Hours

**UNIT II:**

Operations on ideals, Extensions and contractions.

12 Hours

**UNIT III:**

Modules and module homomorphisms, Sub modules and quotient modules, operations on sub modules, Direct sum and product, finitely generated modules.

12 Hours

**UNIT IV:**

Exact sequences, Tensor product of modules, Restriction and extension of scalars, Exactness properties of the tensor product, algebras, tensor product of algebras.

12 Hours

**UNIT-V:**

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

12 Hours

**Prescribed text book:**

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

**ST. JOSEPH’S COLLEGE FOR WOMEN, VISAKHAPATNAM**

**IV SEMESTER MATHEMATICS**

**M 401 MEASURE AND INTEGRATION MAX. MARKS: 100**

**w.e.f. 2021-22 SYLLABUS CREDITS: 4**

**COURSE OUTCOMES:**

After studying this course, students should be able to:

CO 1: To introduce a special theory on sets, called outer measure of a set and measurable sets, which are useful to get an idea on real number system.

CO 2: To understand measurable functions through the certain construction of measurable sets and their properties.

CO 3: To introduce and understand the Lebesgue integral of various measurable functions and their properties.

CO 4: To study differentiation of Lebesgue integral and convex functions.

CO 5: To study some spaces of functions of a real variable, the spaces.

**UNIT I:**

Lebesgue measure: Introduction, Outer measure, measurable sets and Lebesgue measure, Littlewood’s first principle.

12 Hours

Chapter 3, Sections 1 to 3, of the Text Book.

**UNIT II:**

Lebesgue measure (continued): A non-measurable set, measurable functions, Littlewood’s second principle, Littlewood’s third principle.

12 Hours

Chapter 3, Sections 4 to 6, of the Text Book.

**UNIT III:**

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.

12 Hours

Chapter 4, Sections 1 to 4 of the text book.

**UNIT IV:**

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

12 Hours

Chapter 5 of the text book.

**UNIT V:**

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

12 Hours

Chapter 6 of the text book.

**Prescribed Text Book:**

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

**Reference Book:**

Inder K.Rana, An Introduction to Measure and Integration, 2nd Edition, Narosa Publishing House, 2002.

**ST. JOSEPH’S COLLEGE FOR WOMEN, VISAKHAPATNAM**

**IV SEMESTER MATHEMATICS**

**M 402 PARTIAL DIFFERENTIAL EQUATIONS MAX. MARKS: 100**

**w.e.f. 2021-22 SYLLABUS CREDITS: 4**

**COURSE OUTCOMES:**

After studying this course, students should be able to:

CO 1: To be introduced to categorization of partial differential equations such as linear, quasi linear and nonlinear equations.

CO 2: To learn a few methods of solving linear, semi linear and quasi linear equations and construction of Cauchy problem for first order partial differential equations.

CO 3: To understand the classification pertaining to second order equation and learn the procedure of reducing equations to their canonical forms.

CO 4: To understand the structure of hyperbolic equation, know its properties and solve related problems.

CO 5: To understand the structure of elliptic equation, know its properties and solve related problems.

CO 6: To understand the structure of parabolic equation, know its properties and solve related problems.

**Unit I:**

First Order Partial Differential Equations – Quasi linear PDEs – Pfaff’s Equations.

12 Hours

(Sections 2.1, 2.2 of the prescribed text book)

**Unit II:**

Nonlinear first order PDEs-Classification of the second order PDEs in two independent variables – wave, potential and Heat equations.

12 Hours

(Sections 2.3, 3.1 and 3.3 of the prescribed text book)

**Unit III:**

Hyperbolic Equations – Cauchy problem for one dimensional wave equation – The Fourier method of Separation of variables.

12 Hours

(Sections 4.1, 4.3 of the prescribed text book)

**Unit IV:**

Elliptic equations – Dirichlet problems involving Cartesian coordinates.

12 Hours

(Section 5.1 of the prescribed text book)

**Unit V:**

Parabolic Equations – Cauchy problem – Mixed type problems.

12 Hours

(Sections 6.1, 6.2 of the prescribed text book)

**Prescribed Text Book:**

Partial Differential Equations through Examples and Exercises, Endre Pap, Arpad Takaci and Djurdjica Takaci, Kluwer Texts in Mathematical Sciences, Volume 18, 1997 Springer Science+Business Media, Dordrecht.

**Reference Book:**

Elements of Partial Differential Equations, Ian Sneddon, McGraw-Hill International editions, New Delhi.

**ST. JOSEPH’S COLLEGE FOR WOMEN, VISAKHAPATNAM**

**IV SEMESTER MATHEMATICS**

**M 403 NUMBER THEORY-II MAX. MARKS: 100**

**w.e.f. 2021-22 SYLLABUS CREDITS: 4**

**COURSE OUTCOMES:**

After studying this course, students should be able to:

CO 1: To introduce the concept of Quadratic residues. To define Legendre symbol and evaluate Quadratic residue. To generalize Legendre symbol to Jacobi symbol and to study applications of Quadratic residues.

CO 2: To introduce the concept of primitive roots. To understand the study on existence of primitive roots.

CO 3: To define Dirichlet Series and identify the plane of absolute convergence and convergence of Dirichlet series. To establish Euler products to Dirichlet series.

CO 4: To derive some analytic properties of Dirichlet series. To develop some expressions as exponential and integral form for Dirichlet series.

CO 5: To understand the analytic proof of prime number theorem based on the analytic properties of the particular Dirichlet series, Riemann Zeta function.

**UNIT I:**

**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.

12 Hours

(Sections 9.1 to 9.8 of the Chapter 9 in the Prescribed Text Book.)

**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.

12 Hours

(Sections 10.1 to 10.9 of the Chapter 10 in the Prescribed Text Book.)

**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.

12 Hours

(Sections 11.1 to 11.6 of the Chapter 11 in the Prescribed Text Book.)

**UNIT IV:**

**DIRICHLET SERIES AND EULER PRODUCTS:** Analytic properties of Dirichlet series, Dirichlet series with non-negative coefficients. Dirichlet series expressed as exponential of Dirichlet series-Mean value formulas for Dirichlet series-An integral formula for the coefficients of a Dirichlet series- An integral formula for the partial sums of a Dirichlet series.

12 Hours

(Sections 11.7 to 11.12 of the Chapter 11 in the Prescribed Text Book.)

**UNIT V:**

**Analytic proof the Prime Number Theorem:** The plan of the proof, lemmas, A contour integral representation of ,Upper bounds for |(s)| and |(s) | near the line =1, The non-vanishing of on the line (s) = 1, Inequalities for and Completion of the proof of the prime number theorem.

12 Hours

(Sections 13.1 to 13.7 of the Chapter 13 in the Prescribed Text Book.)

**Prescribed Text Book:**

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

**Reference Books:**

1. An Introduction to the theory of numbers, 5th edition by Ivan Niven Herbert S. Zuckerman and Huge L. Montgomery, John Wiley & Sons INC. publications, U.K., 2008.

2. Elementary Number Theory, 7th edition by David M. Burton, 2011.

**ST. JOSEPH’S COLLEGE FOR WOMEN, VISAKHAPATNAM**

**IV SEMESTER MATHEMATICS**

**M 405 LATTICE THEORY-II MAX. MARKS: 100**

**w.e.f. 2021-22 SYLLABUS CREDITS: 4**

**COURSE OUTCOMES:**

After studying this course, students should be able to:

CO 1: To study equivalent conditions for a lattice to become modular and distributive.

CO 2: To learn meet-representations of modular and distributive lattices.

CO 3: To understand the equivalent conditions for a complete Boolean algebra to become atomic.

CO 4: To study the properties of valuations of Boolean algebras.

CO 5: To learn the properties of rings of sets.

**UNIT I:**

Distributive Lattices, Infinitely Distributive and Completely Distributive Lattices, Modular Lattices, Characterization of Modular and Distributive Lattices by their Sublattices.

12 Hours

(Sections 30 to 33 of Chapter IV of the Prescribed Text Book)

**UNIT II:**

Distributive Sublattices of Modular Lattices, The Isomorphism Theorem of Modular Lattices, Covering Conditions, Meet Representations in Modular and Distributive Lattices.

12 Hours

(Sections 34 to 36 of Chapter IV of the Prescribed Text Book)

**UNIT III:**

Distributive Sublattices of Modular Lattices, The Isomorphism Theorem of Modular Lattices, Covering Conditions, Meet Representations in Modular and Distributive Lattices.

12 Hours

(Sections 42 to 44 of Chapter VI of the Prescribed Text Book).

**UNIT IV:**

Distributive Sublattices of Modular Lattices, The Isomorphism Theorem of Modular Lattices, Covering Conditions, Meet Representations in Modular and Distributive Lattices.

12 Hours

(Sections 45 to 47 of chapter VI of the Prescribed Text Book)

**UNIT V:**

Ideals and Dual Ideals, Ideal Chains, Ideal Lattices, Distributive Lattices and Rings of Sets.

12 Hours

(Sections 53 to 55 of chapter VIII of the Prescribed Text Book)

**Prescribed text Book:**

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

**Reference Book:**

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

**ST. JOSEPH’S COLLEGE FOR WOMEN, VISAKHAPATNAM**

**IV SEMESTER MATHEMATICS**

**M 406 COMMUTATIVE ALGEBRA-II MAX. MARKS: 100**

**w.e.f. 2021-22 SYLLABUS CREDITS: 4**

**COURSE OUTCOMES:**

After studying this course, students should be able to:

CO 1: To learn the decomposition of ideals into primary ideals.

CO 2: To learn Going-Up and Going-Down theorems concerning prime ideals in an integral extension.

CO 3: To study valuation rings of a given field of fractions.

CO 4: To characterise Noetherian rings and Artin rings.

CO-5: To study primary decomposition in Noetherian rings and to learn The Structure Theorem for Artin rings.

**UNIT I:**

Primary Decomposition, The First Uniqueness Theorem, The Second Uniqueness Theorem.

12 Hours

**UNIT II:**

Integral Dependence, The Going-Up Theorem, Integrally Closed Integral Domains, The Going- Down Theorem, Valuation Rings.

12 Hours

**UNIT III:**

Chain Conditions. 12 Hours

**UNIT IV:**

Noetherian Rings, Hibert’s Basis Theorem, Primary decomposition of Noetherian rings.

12 Hours

**UNIT V:**

Artin Rings. 12 Hours

**Prescribed Text Book:**

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