

**DEPARTMENT OF MATHEMATICS,
PALAMURU UNIVERSITY**
(Choice Based Credit System)
(w.e.f. the academic year 2019-2020)

M. Sc. MATHEMATICS

SEMESTER – I

| Subjects | Code | Paper | Hours/ Week | Theory | T* | Max. Mark s | Credits |
|----------|-------|--|----------------|--------|----|-------------------|---------|
| Core | M 101 | Abstract Algebra | 6 | 5 | 1 | 100 | 5 |
| Core | M 102 | Mathematical Analysis | 6 | 5 | 1 | 100 | 5 |
| Core | M 103 | Ordinary and Partial Differential Equations | 6 | 5 | 1 | 100 | 5 |
| Core | M 104 | Elementary Number Theory | 6 | 5 | 1 | 100 | 5 |
| Core | M 105 | Discrete Mathematics | 5 | 4 | 1 | 100 | 4 |
| | | Seminar | 2 | | | 25 | 1 |
| | | | 31 | | | | 25 |

T* - Tutorial Class for problems solving session.

SEMESTER – II

| Subjects | Code | Paper | Hours/ Week | Theory | T* | Max. Mark s | Credits |
|----------|-------|--|----------------|--------|----|-------------------|---------|
| Core | M 201 | Galois Theory | 6 | 5 | 1 | 100 | 5 |
| Core | M 202 | Lebesgue measure & Integration | 6 | 5 | 1 | 100 | 5 |
| Core | M 203 | Complex Analysis | 6 | 5 | 1 | 100 | 5 |
| Core | M 204 | Topology | 6 | 5 | 1 | 100 | 5 |
| Core | M 205 | Theory of Ordinary Differential Equations | 5 | 4 | 1 | 100 | 4 |
| | | Seminar | 2 | | | 25 | 1 |
| | | | 31 | | | | 25 |

T* - Tutorial Class for problems solving session.

**DEPARTMENT OF MATHEMATICS
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M.Sc. Mathematics

M 101

Semester-I

Paper-I: **Abstract Algebra**

Unit-I

Automorphisms - Conjugacy and G - sets - Normal series Solvable groups - Nilpotent groups. (Pages 104 to 128 of [1])

Unit-II

Structure theorems of groups: Direct product - Finitely generated abelian groups - Invariants of a finite abelian group - Sylow's theorems - Groups of orders p^2 , pq . (Pages 138 to 155)

Unit-III

Ideals and homomorphisms - Sum and direct sum of ideals, Maximal and prime ideals - Nilpotent and nil ideals - Zorn's lemma (Pages 179 to 211).

Unit-IV

Unique factorization domains - Principal ideal domains - Euclidean domains - Polynomial rings over UFD - Rings of Fractions.(Pages 212 to 228)

Text Book:

Basic Abstract Algebra by P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul.

Reference:

- [1] **Topics in Algebra** by I.N. Herstein.
- [2] **Elements of Modern Algebra** by Gibert & Gilbert.
- [3] **Abstract Algebra** by Jeffrey Bergen.
- [4] **Basic Abstract Algebra** by Robert B Ash.

**DEPARTMENT OF MATHEMATICS
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M.Sc. Mathematics

M 102

Semester - I

Paper - II: **Mathematical Analysis**

Unit-I

Metric spaces - Compact sets - Perfect sets - Connected sets.

Unit-II

Limits of functions - Continuous functions - Continuity and compactness, Continuity and connectedness - Discontinuities - Monotone functions.

Unit-III

Riemann - Steiltjes integral - Definition and Existence of the Integral - Properties of the integral - Integration of vector valued functions - Rectifiable curves.

Unit-IV

Sequences and series of functions: Uniform convergence - Uniform convergence and continuity - Uniform convergence and integration - Uniform convergence and differentiation - Approximation of a continuous function by a sequence of polynomials.

Text Book:

Principles of Mathematical Analysis (3rd Edition) (Chapters 2, 4, 6) By Walter Rudin, Mc Graw - Hill International Edition.

References:

- [1] The Real Numbers by John Stillwell.
- [2] Real Analysis by Barry Simon
- [3] Mathematical Analysis Vol - I by D J H Garling.
- [4] Measure and Integral by Richard L. Wheeden and Antoni Zygmund.

**DEPARTMENT OF MATHEMATICS
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M.Sc. Mathematics

M 103

Semester - I

Paper - III: Ordinary and Partial Differential Equations

Unit-I

Existence and Uniqueness of solution of $\frac{dy}{dx} = f(x, y)$ and problems there on. The method of successive approximations - Picard's theorem - Non - Linear PDE of order one - Charpit's method - Cauchy's method of Characteristics for solving non - linear partial differential equations - Linear Partial Differential Equations with constant coefficients.

Unit-II

Partial Differential Equations of order two with variable coefficients - Canonical form - Classification of second order Partial Differential Equations - separation of variables method of solving the one - dimensional Heat equation, Wave equation and Laplace equation - Sturm - Liouville's boundary value problem.

Unit-III

Power Series solution of O.D.E. – Ordinary and Singular points - Series solution about an ordinary point - Series solution about Singular point - Frobenius Method.

Legendre Polynomials: Legendre's equation and its solution - Legendre Polynomial and its properties - Generating function - Orthogonal properties - Recurrence relations - Laplace's definite integrals for $P_n(x)$ - Rodrigue's formula.

Unit-IV

Bessels Functions: Bessel's equation and its solution - Bessel function of the first kind and its properties - Recurrence Relations - Generating function - Orthogonality properties.

Hermite Polynomials: Hermite's equation and its solution - Hermite polynomial and its properties - Generating function - Alternative expressions (Rodrigue's formula) - Orthogonality properties - Recurrence Relations.

Text Books:

- [1] **Ordinary and Partial Differential Equations**, By M.D. Raisingania, S. Chand Company Ltd., New Delhi.
- [2] **Text book of Ordinary Differential Equation**, By S.G.Deo, V. Lakshmi Kantham, V. Raghavendra, Tata Mc.Graw Hill Pub. Company Ltd.
- [3] **Elements of Partial Differential Equations**, By Ian Sneddon, Mc.Graw - Hill International Edition.

Reference:

- [1] Worldwide Differential equations by Robert Mc Owen .
- [2] Differential Equations with Linear Algebra by Boelkins, Goldberg, Potter.
- [3] Differential Equations By Paul Dawkins.

**DEPARTMENT OF MATHEMATICS
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M.Sc. Mathematics

M 104

Semester - I

Paper - IV: **Elementary Number Theory**

Unit-I

The Fundamental Theorem of arithmetic: Divisibility, GCD, Prime Numbers, Fundamental theorem of Arithmetic, the series of reciprocal of the Primes, The Euclidean Algorithm.

Unit-II

Arithmetic function and Dirichlet Multiplication, The functions $\varphi(n)$, $\mu(n)$ and a relation connecting them, Product formulae for $\varphi(n)$, Dirichlet Product, Dirichlet inverse and Mobius inversion formula and Mangoldt function $\Lambda(n)$, multiplication function, multiplication function and Dirichlet multiplication, Inverse of a completely multiplication function, Liouville's function $\lambda(n)$, the divisor function is $\sigma_\alpha(n)$

Unit-III

Congruences, Properties of congruences, Residue Classes and complete residue system, linear congruences conversion, reduced residue system and Euler Fermat theorem, polynomial congruence modulo P , Lagrange's theorem, Application of Lagrange's theorem, Chinese remainder theorem and its application, polynomial congruences with prime power moduli

Unit-IV

Quadratic residue and quadratic reciprocity law, Quadratic residues, Legendre's symbol and its properties, evaluation of $(-1/p)$ and $(2/p)$, Gauss Lemma, the quadratic reciprocity law and its applications.

Text Book:

Introduction to analytic Number Theory by Tom M. Apostol. Chapters 1, 2, 5, 9.

References:

- [1] Number Theory by Joseph H. Silverman.
- [2] Theory of Numbers by K.Ramchandra.
- [3] Elementary Number Theory by James K Strayer.
- [3] Elementary Number Theory by James Tattusall.

**DEPARTMENT OF MATHEMATICS
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M.Sc. Mathematics

M 105

Semester - I

Paper - V: **Discrete Mathematics**

Unit-I

Mathematical Logic: Propositional logic, Propositional equivalences, Predicates and Quantifiers, Rule of inference, direct proofs, proof by contraposition, proof by contradiction. **Boolean Algebra:** Boolean functions and its representation, logic gates, minimizations of circuits by using Boolean identities and K - map.

Unit-II

Basic Structures: Sets representations, Set operations, Functions, Sequences and Summations. Division algorithm, Modular arithmetic, Solving congruences, applications of congruences. **Recursion:** Proofs by mathematical induction, recursive definitions, structural induction, generalized induction, recursive algorithms.

Unit-III

Counting: Basic counting principle, inclusion - exclusion for two - sets, pigeonhole principle, permutations and combinations, Binomial coefficient and identities, generalized permutations and combinations. **Recurrence Relations:** introduction, solving linear recurrence relations, generating functions, principle of inclusion - exclusion, applications of inclusion - exclusion. **Relations:** relations and their properties, representing relations, closures of relations, equivalence relations, partial orderings.

Unit-IV

Graphs: Graphs definitions, graph terminology, types of graphs, representing graphs, graph isomorphism, connectivity of graphs, Euler and Hamilton paths and circuits, Dijkstra's algorithm to find shortest path, planar graphs – Euler's formula and its applications, graph coloring and its applications. **Trees:** Trees definitions – properties of trees, applications of trees – BST, Haffman Coding, tree traversals: pre - order, in - order, post - order, prefix, infix, postfix notations, spanning tress – DFS, BFS, Prim's, Kruskal's algorithms.

Text Book:

Discrete Mathematics and its Applications by Kenneth H. Rosen,

References:

- [1] **Discrete and Combinatorial Mathematics** by Ralph P. Grimaldi
- [2] **Discrete Mathematics for Computer Scientists** by Stein, Drysdale, Bogart
- [3] **Discrete Mathematical Structures with Applications to Computer Science** by J.P. Tremblay, R. Manohar
- [4] **Discrete Mathematics for Computer Scientists and Mathematicians** by Joe L. Mott, Abraham Kandel, Theoder P. Baker

**DEPARTMENT OF MATHEMATICS
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M.Sc. Mathematics

M 201

Semester - II

Paper - I: **Galois Theory**

Unit-I

Algebraic extensions of fields: Irreducible polynomials and Eisenstein criterion - Adjunction of roots - Algebraic extensions - Algebraically closed fields (Pages 281 to 299).

Unit-II

Normal and separable extensions: Splitting fields - Normal extensions - Multiple roots - Finite fields - Separable extensions (Pages 300 to 321).

Unit-III

Galois theory: Automorphism groups and fixed fields - Fundamental theorem of Galois theory - Fundamental theorem of Algebra (Pages 322 to 339).

Unit-IV

Applications of Galois theory to classical problems: Roots of unity and cyclotomic polynomials - Cyclic extensions - Polynomials solvable by radicals - Ruler and Compass constructions. (Pages 340 - 364).

Text Book:

Basic Abstract Algebra by S.K. Jain, P.B. Bhattacharya, S.R. Nagpaul.

References:

- [1] **Topics in Algebra** by I.N. Herstein.
- [2] **Elements of Modern Algebra** by Gibert & Gilbert.
- [3] **Abstract Algebra** by Jeffrey Bergen.
- [4] **Basic Abstract Algebra** by Robert B Ash.

DEPARTMENT OF MATHEMATICS
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M.Sc. Mathematics

M 202

Semester - II

Paper - II: **Lebesgue Measure & Integration**

Unit-I

Algebra of sets - Borel sets - Outer measure - Measurable sets and Lebesgue measure - A non - measurable set - Measurable functions - Littlewood three principles.

Unit-II

The Riemann integral - The Lebesgue integral of a bounded function over a set of finite measure - The integral of a non - negative function - The general Lebesgue integral.

Unit-III

Convergence in measure - Differentiation of a monotone functions - Functions of bounded variation.

Unit-IV

Differentiation of an integral - Absolute continuity - The L_p - spaces - The Minkowski and Holder's inequalities - Convergence and completeness.

Text Book:

Real Analysis (3rd Edition)(Chapters 3, 4, 5) by H. L. Royden Pearson Education (Low Price Edition).

References:

[1] **Lebesgue measure and Integration** by G.de Barra.

[2] **Measure and Integral** by Richard L.Wheeden, Anotoni Zygmund.

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M.Sc. Mathematics

M 203

Semester - II

Paper - III: Complex Analysis

Unit-I

Regions in the Complex Plane - Functions of a Complex Variable - Mappings - Mappings by the Exponential Function - Limits - Limits Involving the Point at Infinity - Continuity - Derivatives - Cauchy – Riemann Equations - Sufficient Conditions for Differentiability - Analytic Functions - Harmonic Functions - Uniquely Determined Analytic Functions - Reflection Principle - The Exponential Function - The Logarithmic Function - Some Identities Involving Logarithms - Complex Exponents - Trigonometric Functions - Hyperbolic Functions

Unit-II

Derivatives of Functions $w(t)$ - Definite Integrals of Functions $w(t)$ - Contours - Contour Integrals - Some Examples - Examples with Branch Cuts - Upper Bounds for Moduli of Contour Integrals – Anti derivatives - Cauchy – Goursat Theorem - Simply Connected Domains - Multiply Connected Domains - Cauchy Integral Formula - An Extension of the Cauchy Integral Formula - Liouville’s Theorem and the Fundamental Theorem of Algebra - Maximum Modulus Principle.

Unit-III

Convergence of Sequences - Convergence of Series - Taylor Series - Laurent Series - Absolute and Uniform Convergence of Power Series - Continuity of Sums of Power Series - Integration and Differentiation of Power Series - Uniqueness of Series Representations - Isolated Singular Points - Residues - Cauchy’s Residue Theorem - Residue at Infinity - The Three Types of Isolated Singular Points - Residues at Poles - Examples - Zeros of Analytic Functions - Zeros and Poles - Behavior of Functions Near Isolated Singular Points.

Unit-IV

Evaluation of Improper Integrals - Improper Integrals from Fourier Analysis - Jordan’s Lemma - Indented Paths - Definite Integrals Involving Sines and Cosines - Argument Principle - Rouché’s Theorem - Linear Transformations - The Transformation $w = 1/z$ - Mappings by $1/z$ - Linear Fractional Transformations - An Implicit Form - Mappings of the Upper Half Plane.

Text Book:

Complex Variables with applications by James Ward Brown, Ruel V Churchill.

References:

- [1] Complex Analysis by Dennis G.Zill.
- [2] Complex Variables by Stevan G. Krantz.
- [3] Complex Variables with Applications by S.Ponnusamy, Herb Silverman.
- [4] Complex Analysis by Joseph Bak, Donald J. Newman.

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M.Sc. Mathematics

M 204

Semester - II

Paper - IV: **Topology**

Unit-I

Topological Spaces: The Definition and examples - Elementary concepts - Open bases and open subbases - Weak topologies.

Unit-II

Compactness: Compact spaces - Products of spaces - Tychonoff's theorem and locally compact spaces - Compactness for metric spaces - Ascoli's theorem.

Unit-III

Separation: T_1 - spaces and Hausdorff spaces - Completely regular spaces and normal spaces - Urysohn's lemma and the Tietze extension theorem - The Urysohn imbedding theorem.

Unit-IV

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

Text Book:

Introduction to Topology and Modern Analysis (Chapters 3,4,5,6) By G.F. Simmons's Tata Mc Graw Hill Edition.

References:

- [1] Introductory Topology by Mohammed H. Mortad.
- [2] Explorations in Topology by David Gay.
- [3] Encyclopedia of General Topology by Hart, Nagata, Vaughan.
- [4] Elementary Topology by Michael C. Gemignani.

M/AM 205

Semester - II

Paper - V: Theory of Ordinary Differential Equations

Unit-I

Linear differential equations of higher order: Introduction - Higher order equations - A Modelling problem – Linear Independence - Equations with constant coefficients Equations with variable coefficients - Wronskian - Variation of parameters - Some Standard methods.

Unit-II

Existence and uniqueness of solutions: Introduction - Preliminaries - Successive approximations - Picard's theorem - Continuation and dependence on initial conditions - existence of solutions in the large - existence and uniqueness of solutions of systems - fixed point method.

Unit-III

Analysis and methods of non - linear differential equations: Introduction - Existence theorem – Extremal solutions - Upper and Lower solutions - Monotone iterative method and method of quasi linearization - Bihari's inequality, Application of Bihari's inequality

Unit-IV

Oscillation theory for linear Differential Equation of Second order: The adjoint equation - Self adjoint linear differential equation of second order - Abel's formula - the number of zeros in a finite interval - The Sturm separation theorem - the Sturm comparison theorem – the Sturm-Picone theorem the Bocher Osgood theorem - A special pair of solution - Oscillation on half axis.

Text Book:

Text book of Ordinary Differential Equation, By S.G.Deo, V. Lakshmi Kantham, V. Raghavendra, Tata Mc.Graw Hill Pub. Company Ltd.

References:

- [1] **Text Book of Ordinary Differential Equations** by Earl A Coddington.
- [2] **Differential Equations** by Edward, Penny, Calvis.
- [3] **Differential Equation** by Harry Hochstardt.