DEPARTMENT OF MATHEMATICS, OSMANIA UNIVERSITY

(Choice Based Credit System)

(w.e.f. the academic year 2018-2019)

M. Sc. MATHEMATICS

SEMESTER – I

Subjects	Code	Paper	Hours/ Week	Theory	T*	Max. Marks	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. Marks	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/AM/MCS 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.

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M.Sc. Mathematics

M/AM/MCS 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 Internation Edition.

References:

[1] The Real Numbers by John Stillwel.

[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.

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DEPARTMENT OF MATHEMATICS
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M.Sc. Mathematics

M/AM 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.

Lagendre Polynomials: Lengendre's equation and its solution - Lengendre Polynomial and its properties - Generating function - Orthogonal properties - Recurrance 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 McOwen .

[2] Differential Equations with Linear Algebra by Boelkins, Goldberg, Potter.

[3] Differential Equations By Paul Dawkins.

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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 Arithemtic, the series of reciprocal of the Primes, The Euclidean Algorithm.

Unit-II

Arithmetic function and Dirichlet Multiplication, The functions $\phi(n)$, $\mu(n)$ and a relation connecting them, Product formulae for $\phi(n)$, 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.

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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 Applicationsby 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/AM 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.

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M.Sc. Mathematics

M/AM 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 Lp - 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/AM/MCS 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 - Rouche'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 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. Simmon'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, Vanghan.

[4] Elementary Topology by Michael C. Gemignani.

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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 intial 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 strum comparison theorem – the sturmpicone the Bocher Osgood theorem - A special pair of solution - Oscillation on half axis.

Text Book:

[2] **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.