Department of Mathematics  
Central University of Kashmir Srinagar.  
Course Structure And Syllabus for M.A/M.sc Mathematics

<table>
<thead>
<tr>
<th>S.No</th>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Marks(100)</th>
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<tr>
<td><strong>Semester I</strong></td>
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<td>01</td>
<td>MMT-C101</td>
<td>Algebra I</td>
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<td>02</td>
<td>MMT-C102</td>
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<td>03</td>
<td>MMT-C103</td>
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<td>04</td>
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<td>Theory of Numbers I</td>
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<td>Topology</td>
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<td>Differential Geometry</td>
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<td>Social Orientation Elective</td>
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<td>12</td>
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<td>Measure and Integration</td>
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<td>17</td>
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<td>18</td>
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<td>Ordinary and Partial Differential Equations</td>
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<td>23</td>
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<td>MMT-E403</td>
<td>Operations Research</td>
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<td>25</td>
<td>MMT-E404</td>
<td>Commutative Algebra</td>
<td>4</td>
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<td>26</td>
<td>MMT-E405</td>
<td>Category Theory and Infinite Abelian Groups</td>
<td>4</td>
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Algebra I (MMT-C101)

Unit-I
Review of basic concepts of groups and subgroups, cosets and their properties. Normal subgroups and quotient groups. Group homomorphisms and Isomorphisms. Cauchys and Sylows Theorems for abelian groups. Automorphisms, Caileys Theorem and its applications. Permutation groups, Simple groups.

Unit-II
Conjugacy, Normalizer and Center of a group. Class equation of finite group and its applications. Cauchys Theorem, Sylows Theorem and their applications. Direct products, Finite abelian groups and Fundamental Theorem for finite abelian groups. Solvable groups, Nilpotent groups and Jordan Holder Theorem.

Unit-III
Review of basic concepts of Rings, sub rings, Integral domains and Fields. Ring homomorphisms and quotient rings. Ideals and their properties. Rings and fields of fractions and embedding Theorems. The Chinese Remainder Theorem. Euclidean domains, Principal Ideal domains; examples and properties.

Unit-IV
Unique factorization domains; examples and properties, factorization in Gaussian Integers. Polynomial rings, Polynomial rings over a field, Gausss Lemma, Polynomial rings that are unique factorization domains. Irreducibility criteria, Hilbert’s basis Theorem.

Text Books:

1. I. N. Herstein, Topics in Algebra, 2nd Edition Wiley (Section 2.1-Section 2.14).
2. N.S. Gopalakrishnan, University Algebra. (Section 1.13-1.14).

Reference Books:

Real Analysis I (MMT-C102)

Unit-I

Unit-II
Improper Integrals: Integration of un-bounded functions with finite limit of integration. Comparison tests for convergence of improper integrals. Cauchy’s test for convergence. Absolute convergence. Infinite range of integration of bounded functions. Convergence of integrals of unbounded functions with infinite limits of integration. Integration as a product of functions. Abel’s and Dirichlet’s tests of convergence. Fourier Series: Euler Fourier Formula, piecewise montonic and piecewise continuous functions, periodic functions. Fourier series expansion of a function f(x) in the intervals \((-\pi, \pi), (-c, c), (a, b)\). Fourier series for even and odd functions. Fourier sine series expansion and Fourier cosine series expansion of f(x) in the intervals \((0, \pi), (0, c)\). Some theorems: if f(x) is bounded and integrable function on \((-\pi, \pi)\) and if \(a_n, b_n\) are its Fourier coefficients, then \(\sum_{n=0}^{\infty}(a_n^2 + b_n^2)\) converges. Riemann-Lebesgue theorem.

Unit-III
Uniform convergence of sequences and series of functions: Point wise convergence, uniform convergence on an interval, Cauchy’s criterion for uniform convergence, \(M_n\) test for uniform convergence of sequences, Weirestrass’s M-Test, Abel’s and Dirichlet’s tests for uniform convergence of series. Uniform convergences and continuity, uniform convergence and integration and uniform convergence and differentiation, Weirestrass’s Approximation Theorem.

Unit-IV
Functions of bounded variation and Rectifiable curves: Concave and convex functions, Properties of monotonic functions, Functions of bounded variations, Total variation, Additive property of total variation, Functions of bounded variation expressed as a difference of increasing functions, Continuous functions of bounded variation. Curves and paths, Rectifiable paths and arc length, Additive and continuity property of arc length, Change of parameter.

Text Books:


Reference Books:

2. S. Lang, Real Analysis, Addison, Wesley, 1969
3. R. Goldberg, Methods of Real Analysis, John Wiley and Sons, 1976
4. T.M. Apostol, Mathematical Analysis, Narosa, 2004
5. H.L. Royden, Real Analysis, MacMillan, 1988
Complex Analysis I (MMT-C103)

Unit-I

Unit-II
Moebious Transformations, their properties and classifications. Fixed points, Inverse points and Critical points of Moebious Transformations. Cross Ratio and its Preservation under Moebious Transformation. Bilinear Transformation carrying i) Circles to Circles, ii) Upper half Plane onto a unit Circle, iii) Right half Plane into a unit Circle, iv) Unit circle onto a Unit circle and v) Arbitrary Circle to Arbitrary circle. The Transformations \( w = \sqrt{z}, w = z^2 \) and \( w = \frac{1}{2}(z + \frac{1}{z}) \). Conformal Mapping. Necessary and sufficient Condition for a Mapping to be Conformal.

Unit-III

Unit-IV
Calculus of Residues. Cauchy-Residue Theorem. Jordan’s Lemma. Evaluation of Integrals by the method of Residues. Parseval’s Identity. Infinite products and their convergence. Necessary and sufficient Conditions for the Convergence of Infinite Products. Equivalence between Series and Infinite Products. Necessary and sufficient Conditions for the Absolute Convergence of Infinite Products. If \( \sum a_n \) and \( \sum a_n^2 \) are convergent, then so is \( \prod (1 + a_n) \).

Text Books:
5. Nihari Z, Conformal Mappings

**Reference Books:**

Number Theory I (MMT-C104)

Unit-I
Divisibility, the Division Algorithm. Greatest Common Divisor and its properties, Least Common Multiple. Prime numbers, Euclid’s first Theorem, factorization in primes, Fundamental Theorem of Arithmetic, Linear Diophantine Equations; Necessary and Sufficient condition for solvability of linear Diophantine equations. Sequences of Primes: Euclid’s second theorem, infinitude of the primes of the form $4n+3$ and $6n+5$, No polynomial with integral coefficients, not a constant, can represent primes for all integral values. Fermat numbers and properties, Mersenne numbers, Arbitrary large gaps in the sequence of primes.

Unit-II
Congruences, Complete Residue Systems and Reduced Residue Systems and their properties, Eulers $\phi$ Function, $\phi(mn) = \phi(m)\phi(n), (m, n) = 1$. Fermat’s theorem and Euler’s Theorem. Wilson’s Theorem and its application to the solution of the congruence $x^2 = -1 (mod p)$, Solution of linear congruences, The necessary and sufficient for the solution of the congruence $a_1x_1 + a_2x_2 + \cdots + a_nx_n = c (mod m)$. Chinese Remainder Theorem, Congurences of higher degree.

Unit-III
Polynomial congruence $f(x) = 0 (mod m)$. Congruences with prime power moduli. Lagrange’s theorem; the polynomial congruence $f(x) = 0 (mod m)$ has at most n solutions, The criteria for the congruence $f(x) = 0 (mod m)$ of degree n having exactly n solutions. Factor Theorem and its generalization, Polynomial congruence $F(x_1, x_2, \cdots, x_n) = 0 (mod m)$ in several variables, Equivalence of polynomial congruences, number of solutions in polynomial congruences, Chevelley’s Theorem, Warnings Theorem.

Unit-IV
Quadratic form over the field of characteristic $\neq 2$; Equivalence of Quadratic forms Witts Theorem, Representation of field elements, Hermite’s Theorem on the minima of a positive definite quadratic form and its application to the sum of two squares. Integers belonging to a given exponent $mod p$ and related results. Converse of Fermat’s Theorem. If $d | (p-1)$, the Congruence $x^d = 1 (mod p)$ has exactly d-solutions. If any integer belongs to t (mod p), then exactly $\phi(t)$ incongruent numbers belong to t (mod p). Primitive roots. Existence of $\phi(p-1)$ primitive roots for a given odd prime p. The function $\lambda(m)$ and its properties. Primitive root of m. The number of primitive roots of 1, 2, 4, $p^\alpha$ and $2p^\alpha$.

Text Books:

2. Leveque, Topics in Number Theory, Springer.
4. T.M. Apostol *Theory of Numbers*, Springer

**Reference Books:**

1. E. Landau *Elementary Number theory* AMS Chelsea publishing
2. J. P. Serre *A course in Arithmetic* gtm Vol Springer
Algebra II (MMT-C201)

Unit-I

Unit-II
Characteristic of a field, Prime subfield of a field. Field Extensions, Simple extensions, Algebraic, transcendental and finite extensions. Classical Straightedge and Compass constructions.

Unit-III

Unit-IV
Automorphism group of a field, Fixed field of a field; their properties and examples. Galois extensions, Galois groups. Fundamental Theorem of Galois Theory and examples on this theorem. Finite fields and their properties.

Text Books:

Reference Books:
1. I. N. Herstein, Topics in Algebra, 2nd Edition Wiley (Section 2.1-Section 2.14).
Real Analysis II (MMT-C202)

Unit-I
Multivariable Differential Calculus: The directional derivative, The total derivative, The total derivative expressed in terms of partial derivatives, The matrix of linear transformation, The Jacobian matrix, The Chain rule, The matrix form of chain rule, The mean value Theorem for differentiable functions, A sufficient condition for differentiability, A sufficient condition for equality of mixed partial derivatives, Taylor’s Theorem for function from \( \mathbb{R}^n \) to \( \mathbb{R} \).

Unit-II
Implicit Functions and Extremum Problems: Functions with non-zero Jacobian determinant, The inverse function Theorem, The implicit function Theorem, Extrema of real valued functions of one variable, Extrema of real valued functions of several variables, Extremum problem with side conditions.

Unit-III
Measurable sets : Definitions of outer and inner measure of a set, some basic properties. Outer measure of an interval as its length, measurability of the union of two measurable sets, measurability of the countable union of pair wise dis-joint bounded measurable sets, inequality concerning countable additivity of an outer measure. Borel measurable sets, sets of measure zero and non- measurable sets. Measure of the outer and inner limiting sets, measurable functions and their structures.

Unit-IV
Riemann integral and its deficiency, Lebesgue integral of bounded function, comparison of Riemann and Lebesgue integrals, properties of Lebesgue integral for bounded measurable function, the Lebesgue integral for unbounded functions, integral of non-negative measurable functions, general Lebesgue integral, improper integral.

Text Books:
1. H.L. Royden, **Real Analysis**, MacMillan, 1988
4. D.V. Widder, **Advanced Calculus**, 2/e, Prentice Hall of India, New Delhi

Reference Books:
1. R. Goldberg, **Methods of Real Analysis**, John Wiley and Sons, 1976
2. T.M. Apostol, **Mathematical Analysis**, Narosa, 2004
Topology (MMT-C203)

Unit-I
Review of countable and uncountable sets, Schroeder-Bernstein theorem, Axiom of Choice and its various equivalent forms, Definition and examples of metric spaces, Open and Closed sets, completeness in metric spaces, Baires Category theorem, and applications to the (i) Non-existence of a function which is continuous precisely at irrationals (ii) Impossibility of approximating the characteristic of rationals on [0, 1] by a sequence of continuous functions.

Unit-II
Completion of a metric space, Cantor’s intersection theorem with examples to demonstrate that each of the conditions in the theorem is essential, Uniformly continuous mappings with examples and counter examples, Extending Uniformily continuous maps, Banach’s contraction principle.

Unit-III
Topological spaces; Definition and examples, elementary properties, Kuratowskis axioms, continuous mappings and their characterizations, pasting Lemma, Nets in topological spaces, convergence of nets and continuity in terms of nets, Bases and sub-bases for a topology, Lower limit topology, concepts of first countability, second countability, separability and their relationships, counterexamples and behavior under subspaces, weak topology generated by a family of mappings, product topology.

Unit-IV
Compactness and its various characterizations, Heine-Borel theorem, compactness, sequential compactness and total boundedness in metric spaces. Lebesgues covering lemma, continuous maps on a compact space. Tychnoffs product theorem, Separation axioms Ti (i=1,2,3,1/2,4) and their permanence properties, connectedness, local connectedness, their relationship and basic properties, Connected sets in R. Urysohns lemma. Urysohns metrization theorem. Tietizes extension theorem, one point compactification.

Text Books:
1. G.F.Simmons : Introduction to topology and Modern Analysis
3. K.D. Joshi : Introduction to General topology
4. J.L.Kelley : General topology
5. Murdeshwar ; General topology

Reference Books:


Differential Geometry (MMT-C204)

Unit-I

Unit-II
Surfaces and Regular surfaces with examples, coordinate charts or curvilinear coordinates, change of coordinates. Critical Value, Regular value and Regular surface. Tangent plane at a regular point, normal to the surface, orient able surface, differentiable mapping between regular surfaces and their differential. Fundamental form or a metric of a surface, line element, invariance of a line element under change of coordinates, angle between two curves, condition of orthogonality of coordinate curves. Area of bounded region, invariance of area under change of coordinates.

Unit-III

Unit-IV
Christoffel symbols. Expressing Christoffel symbols in terms of metric coefficients and their derivative. Theorema egregium (Gaussian curvature is intrinsic). Isometric surfaces have same Gaussian curvatures at corresponding points. Gauss equations and Manardi Codazzi equations for surfaces. Fundamental theorem for regular surface. (Statement only).

Text Books:


Reference Books:

1. W. Klingenberg: A course in Differential Geometry (Spring Verlag)
Theory of Rings and Modules (MMT-C301)

Unit-I
Definition and simple properties of rings, sums direct sums and products of ideals. Complete matrix rings and ideals in complete matrix rings. Direct and subdirect sums of rings, subdirectly irreducible rings, Boolean rings. Prime radical and prime rings.

Unit-II
Rings of endomorphisms, irreducible rings of endomorphisms, R-modules and rings of endomorphisms. Irreducible rings and vector spaces, dense rings of linear transformations, subspaces and descending chain conditions. The Wedderburn-Artin Theorem.

Unit-III
Modules and submodules, sum and intersection of submodules, Linear combinations and spanning sets, Homomorphisms, Isomorphism Theorems, Inverse image of submodules, Annihilator, Order of elements.

Unit-IV
Direct summands, split homomorphisms, projections, idempotent endomorphisms, essential and superfluous submodules, semi-simple modules, socle and radical of modules, basis and rank free modules.

Text Books:
2. Anderson and Fuller: Rings and Categories of Modules

Reference Books:
1. Joachim Lambek Lectures on Rings and Modules. AMS Chelsea Publishing.
2. T. Y Lam Lectures on Rings and Modules. Graduate Texts in Mathematics, springer.
Functional Analysis I (MMT-C302)

Unit-I
Normed Linear Spaces and Banach spaces: Definition and examples, Continuous Linear Transformation and their Characterization, Completeness of the Space $B(X,Y)$ of Bounded Linear Operators, Isometric Isomorphism, Dual of a Normed Linear Space, Computing the Dual of well known Banach Spaces, Equivalence of Norms of Finite Dimensional space, Hahn Banach Theorem and its Applications.

Unit-II
The Natural Embedding of a Normed Linear Space $N$ in $N^{**}$, Reflexive Normed Linear Spaces, weak and Weak * Topologies, characterization of Reflexive Banach spaces, Open Mapping Theorem, Projection on a Banach Space, Closed Graph Theorem and Banach Steinhaus Theorem (Uniform Boundedness Principle), Conjugate of a Continuous Linear Operator and its Properties.

Unit-III
Definition and examples of Hilbert Spaces, Cauchys Schwartz Inequality and Parallelogram Law, Orthogonal Complements, Orthogonal Decomposition of Hilbert Space, Orthonormal Systems, Bessels Inequality, Gram Schmidt Process, Application of G-S process to certain Linearly Independent Sequences in $L^2[0,2\pi]$, Orthonormal Basis in Separable Hilbert Spaces.

Unit-IV

Text Books:

Reference Books:


Complex Analysis II (MMT-C303)

Unit-I

Unit-II

Unit-III

Unit-IV

Text Books:

Reference Books:
1. Morris marden, Geometry of polynomials.


Probabilty and Statistics (MMT-E301)

Unit-I
The probability set function, its properties, probability density function, the distribution function and its properties. Mathematical Expectations, some special mathematical expectations, Inequalities of Markov, Chebyshev and Jensen.

Unit-II
Conditional probability, independent events, Bayes theorem, Distribution of two and more random variables, Marginal and conditional distributions, conditional means and variances, Correlation coefficient, stochastic independence and its various criteria.

Unit-III
Some Special Distributions, Bernoulli, Binomial, Trinomial, Negative Binomial, Poisson, Gamma, Chi-square, Beta, Cauchy, Exponential, Geometric, Normal and Bivariate Normal Distributions.

Unit-IV

Text Books:
1. Hogg and Craig: An Introduction to the Mathematical Statistics
2. S C Gupta and V K Kapoor: Mathematical Statistics,

Reference Books:
1. Mood and Grayball: An Introduction to the Mathematical Statistics
Measure and Integration (MMT-E302)

Unit-I
Semiring, algebra and σ algebra of sets, Borel sets, measures on semirings, outer measure associated with a set function and basic properties, measurable sets associated with an outer measure as a σ algebra, construction of the Lebesgue measure on $\mathbb{R}^n$.

Unit-II
For $f \in L_1[a,b], F = f.a.e$ on $[a,b]$. If $f$ is absolutely continuous on (a, b) with $f(x) = 0$ a.e, then $f = \text{constant}$. Characterization of an absolutely continuous function as an indefinite Lebesgue integral. Non-Lebesgue integrability of $f$ where $f(x) = x^2sin(\frac{1}{x^2}), f(0) = 0$ on [0, 1]. Fundamental theorem of calculus for the Lebesgue integral. A brief introduction to Lp spaces. Holder’s and Minkowki’s inequalities.

Unit-III
Improper Riemann integral as a Lebesgue integral, calculation of some improper Riemann integrable functions, space of Lebesgue integrable functions as completion of Riemann integrable functions on [a,b], change of variables formula and simple consequences, Riemann Lebesgue lemma.

Unit-IV
Product measures and iterated integrals, example of non-integrable functions whose iterated integrals exist (and are equal), Fubini theorem, expressing a double integral as an iterated integral, Tonelli-Hobson theorem as a converse to Fubini theorem, differentiation under the integral sign.

Text Books:
1. C.D. Aliprantis and O. Burkinshaw, *Principles of Real Analysis*

Reference Books:
1. Rana, J.K.: *An Introduction to Measure and Integration*, Narosa
Descrete Mathematics (MMT-E303)

Unit-I
Elementary Set theory: The sum rule and the product rule, two-way counting, permutations and combinations, Binomial and multinomial coefficients, Pascal identity, Binomial and multinomial theorems. Arithmetic functions.

Unit-II
Advanced counting: Types of occupancy problems, distribution of distinguishable and indistinguishable objects into distinguishable and indistinguishable boxes (with condition on distribution) Stirling numbers of second and first kind, Inclusion Exclusion Principle and its application to derangement, Mobius inversion formula.

Unit-III

Unit-IV
Partially ordered set, Lattices, Distributive and Modular Lattices, complements, Boolean Algebra. Basic definitions, Duality, Basic Theorems. Boolean algebra and Lattices. Sum of products form for Boolean Algebra, logic gates and Circuits

Text Books:
1. V. Krishnamurthy, Combinatorics: Theory and applications, Affiliated East-West
2. Richard A. Brualdi, Introductory Combinatorics-I, Pearson
Number Theory II (MMT-E304)

Unit-I
Quadratic Residues, Quadratic Reciprocity, The Jacobi symbol. Greatest integer function, Arithmetic functions and their properties. The Mobius inversion formula and Recurrence functions.

Unit-II
Farey Fractions and Irrational numbers: Farey sequences, Rational approximation, Irrational numbers, The geometry of numbers. Simple Continued Fraction: The Euclidean Algorithm, Uniqueness, Infinite continued fraction, Irrational numbers, Approximation to irrational numbers, Best possible approximation, Periodic con (Ch. 1- Ch. 3)tinued fraction.

Unit-III
Primes and Multiplicative Number theory: Elementary prime number estimates, Dirichlet series, Estimates of Arithmetic functions, Primes in Arithmetic Progression.

Unit-IV
Algebraic Numbers: Polynomials, Algebraic numbers, Algebraic number field, Algebraic integers, Quadratic fields, Units in Quadratic Fields, Primes in Quadratic field, Unique Factorization, Primes in Quadratic Fields having unique factorization property, The equation \( x^3 + y^3 = z^4 \).

Text Books:
4. LApostol *Analytic Number theory*, Springer

Reference Books:
1. E. Landau *Elementary Number theory* AMS Chelsea publishing
2. J. P. Serre *A course in Arithmetic* GTM Vol Springer

Theory of Semigroups and Non Commutative rings (MMT-E305)

Unit-I
Basic definitions, group with zero, monogenic semigroups, ordered sets, semilattices and lattices, binary relations, equivalences.

Unit-II
Congruences, free semigroups and monoids, presentation of semigroups, ideals and Rees congruences, lattices of equivalences and congruences.

Unit-III
Wedderburn-Artin Theory, Basic terminology and examples, Jacobson radical theory, Some commutativity problems in rings, Wedderburn Theorem on finite division rings, Jacobson's theorem, Jacobson Herstein Theorem, Kaplansky Theorem.

Unit-IV
Rings of quotients, Goldie rings, Ore domains, Prime Goldie rings, First Goldie theorem, faith Utumi theorem, Semi prime Goldie rings, Prime left ideal rings, nil rings satisfying ascending chain conditions, Nil Goldie rings.

Text Books:

Reference Books:
1. T.Y. Lam: *A First Course in Non-commutative rings*.
Linear Algebra (MMT-C401)

Unit-I

Unit-II
Characteristic Values, Annihilating Polynomials, Invariant subspaces. Simultaneous Triangulation; Simultaneous Diagonalization, Direct-sum decompositions, Invariant direct sums. The primary Decomposition Theorem, cyclic subspaces and Annihilators, Cyclic decompositions and the rational Form.

Unit-III
The Jordan Form, Computation of Invariant Factors, Semi-simple Operators. Inner Product Spaces, Linear functionals and Adjoints, Unitary and Normal Operators, Forms on Inner Product spaces. Positve forms and some more results on forms.

Unit-IV
Spectral Theory, Further properties of Normal operators. Bilinear Forms, Symmetric bilinear forms, Skew-Symmetric Bilinear forms and Groups Preserving Bilinear Forms.

Text Books:

Reference Books:
Functional Analysis II (MMT-C402)

Unit-I
Relationship between analytic and geometric forms of Hahn-Banach Theorem, Applications of Hahn-Banach Theorem: Banach limits, Markov-Kakutani theorem for a commuting family of maps, Complemented subspaces of Banach spaces, Complementability of dual of a Banach space in its bidual, uncomplementability of $C_0$.

Unit-II
Dual of Subspace, Quotient space of a normed space. Weak and weak* topologies on a Banach space, Goldstines theorem, Banach-Alaoglu theorem and its simple consequences. Banachs closed range theorem, injective and surjective bounded linear mappings between Banach spaces.

Unit-III
$l_\infty$ and $C[0,1]$ as universal separable Banach spaces, $l_1$ as a quotient universal separable Banach space, Reflexivity of Banach spaces and weak compactness, Completeness of $L^p[a,b]$, Extreme points, Krein-Milman theorem and its simple consequences, Banach Stone Theorem.

Unit-IV
Duals of $l_\infty$, $C(X)$ and $L^p$ spaces. Applications of fundamental theorems to Radon-Nikodym Theorem, Laplace transform. Mazur-Ulam theorem on isometries between real normed spaces, Muntz theorem in $L^2[a,b]$.

Text Books:
1. Ballobas, B; Linear Analysis (Camb. Univ.Press).
2. Beauzamy, B; Indroduction to Banach Spaces and their geometry (North Holland).
5. C. Goffman and G.Pedrick; A first course in functional Analysis (Prentice Hall).
Ordinary and Partial Differential Equations (MMT-C403)

Unit-I
First order ODE, singular solutions, p-discriminate and c-discriminate, initial value problems of first order ODE, general theory of homogenous and non-homogenous linear ODE, Picards theorem of the existence and uniqueness of solutions to an initial value problem, factorization of operator, variation of parameters, numerical approximation to the solution of differential equations.

Unit-II
Solution in series: Methods of Frobenius (i) Roots of an indicial equation, unequal and differing by quantity not an integer (ii) Roots of an indicial equation, which are equal (iii) Roots of an indicial equation differing by an integer making coefficient infinite (iv) Roots of an indicial equation differing by an integer making a coefficient indeterminate. Simultaneous equations \( \frac{dx}{P} = \frac{dy}{Q} = \frac{dz}{R} \) and its solutions by use of multipliers and a second integral found by the help of the first. Total differential equation \( Pdx + Qdy + Rdz = 0 \). Necessary and sufficient condition than an equation may be integrable. Geometric interpretation of the total differential equation. Partial differential equation: Partial differential equation of the first order, Lagranges linear equation \( Pp + Qq = R \), Charpits Method.

Unit-III

Unit-IV

Text Books:
2. G.F. Simmons, Ordinary Differential Equations with Applications and His-


Reference Books:


Graph Theory (MMT-E401)

Unit-I

Unit-II

Unit-III

Unit-IV

Text Books:
1. R. Balakrishnan, K. Ranganathan, A Text Book of Graph Theory, Springer-Verlag, New York.
2. F. Harary, Graph Theory, Addison-Wesley.
3. Narsingh Deo, Graph Theory with Applications to Engineering and Computer Science, Prentice Hall.

Reference Books:
1. B. Bollobas, Extremal Graph Theory, Academic Press.
2. JW. T. Tutte, Graph Theory, Cambridge University Press.
Probability and Measure (MMT-E402)

Unit-I
Measure theory, semi algebra, sigma-algebra, monotone class theorem, Dynkin pi lambda theorem, probability measures, finite measure, sigma finite measure, complete measure, statement of Caratheodory extension theorems. Integration: measurable functions, simple functions etc., monotone convergence theorem, dominated convergence theorem, Fatou’s lemma.

Unit-II

Unit-III
Tchebychev’s inequality, Markov’s inequality. Various modes of convergence, Weak and Strong law of large numbers. Characteristic functions, statements of the uniqueness, inversion formulae and Levy cramér continuity theorems.

Unit-IV
Convergence in distribution, convergence with probability 1, Laws of large numbers, CLT for i.i.d. random variables (finite variance case).

Text Books:
1. Petric, Billingsley, Probability and Measure, Wiley.
3. Athreya and Lahiri, Measure and Probability, CRC Press Inc.
Operations Research (MMT-E403)

Unit-I
Definition and Scope of operations Research (OR). Main Phases of OR Study. Linear Programming problems (LPP), Applications to Industrial Problems and Marketing, Convex Sets and Convex Functions. Simplex Method and Extreme point Theorems. Big M and two Phase methods of Solving an LPP. Revised Simplex method.

Unit-II

Unit-III
Sequencing and Scheduling problems. 2-Machine n-Job and 3-Machine n-Job Problems with identical Machine sequence for all jobs. 2-job n-Machine Problem with different routings. Project Management PERT and CPM. Probability of Completing a project.

Unit-IV

Text Books:


Reference Books:

Commutative Algebra (MMT-E404)

Unit-I

Unit-II
Tensor product of modules, basic properties. Exact sequences, Projective Injective and Flat modules. Restriction and extension of scalars, exactness properties of the tensor and Hom-modules. Algebras, and tensor product of algebras.

Unit-III
Rings and modules of fractions, Localization of a ring at a prime ideal. Properties of rings and modules of fractions, extended and contracted ideals in rings of fractions. Primary decomposition of ideals 1st and 2nd uniqueness Theorems.

Unit-IV
Chain conditions, Noetherian and Artinian modules. Noetherian rings, Hilbert basis theorem, Primary decomposition in Noetherian rings. Artin rings and Structure Theorem for Artin rings.

Text Book:

Reference Books:
3. David Eisenbud, Commutative Algebra with a view towards Algebraic Geometry, Springer.
Category Theory and Infinite Abelian Groups (MMT-E405)

Unit-I
Definition and examples of a category, small category, sub-category, full sub-category, dual category, monomorphism, epimorphism, bimorphism, section, retraction, isomorphism, balanced category, Initial object, terminal object, zero object connected category, Products and coproducts, Equalizers and coequalizers, Pullbacks and Pushouts, Intersection.

Unit-II
Factorization of morphisms, kernel and cokernel of a morphism, normal, conormal and bi-normal category, Exact sequence semi additive and additive category, Abelian category, Functors, covariant and contravariant Functors, Natural transformation.

Unit-III
RiMaps and diagrams, Direct sums and Direct Products, Direct summands, Free abelian groups, Projective groups, Finitely generated groups.

Unit-IV
Divisibility, Injective groups, The structure of divisible groups, The divisible hull, Purity, Bounded pure subgroups, Quotient groups module Pure subgroups.

Text Books:
1. T.S. Blyth, Categories.
2. B. Pareiar: Categories and Functors.

Reference Books:
2. Freyd, Abelian Categories.