Semester wise Syllabus For Post Graduate Classes (Regular)
Subject - Mathematics

Meeting held on : 11-12 Feb 2020 – Session 2020-21 & Onwards

Class : M.Sc./M.A. (Semester-III)

	Paper	Title of Paper	Max. Marks		Min. Marks		Total Marks
			Theory	CCE	Theory	CCE	
Compulsory Paper							
		Functional Analysis	40	10	15	04	50
Four papers out of the following have to be chosen, opting not more than one from each group.							
Group I	1	Advanced Functional Analysis - I	40	10	15	04	50
	2	Partial Differential Equations - I					
	3	Operator Theory on Banach Algebra					
Group II	1	Algebraic Topology - I	40	10	15	04	50
	2	Spherical Trigonometry & Astronomy - I					
	3	Advanced Graph Theory - I					
Group III	1	Mechanics - I	40	10	15	04	50
	2	Fuzzy Sets & Their Applications - I					
	3	Advanced Numerical Analysis - I					
Group IV	1	Operations Research - I	40	10	15	04	50
	2	Divergent Series					
	3	Integral Equations & Boundary Value Problems - I					
Group V	1	Integral Transform - I	40	10	15	04	50
	2	Theory of Linear Operators - I					
	3	Approximation Theory					
Grand Total					250		

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2. Dr. Rajesh Tiwari

3. Kamal

4. 12/02/2020 (Dr. D.K Maitre)

5. A. C. Lambo

The Scheme of examination and the allotment of marks shall be as under : -

Sections/Part	Questions Type	Marks Distribution	Remark
Section - A	Objective Type Questions (One question to be set from each unit)	1 x 5 = 5 Marks	
Section - B	Short Answer Type Questions (Two questions to be set from each unit and one from each unit to be attempted)	2 x 5 = 10 Marks	
Section - C	Long Answer Type Questions (Two questions to be set from each unit and one from each unit to be attempted)	5 x 5 = 25 Marks	
	Total	40 Marks	Passing Marks 15

Note 1 : The Optional paper chosen by candidates in M.Sc./M.A. Third Semester can not be changed in Fourth Semester. The same optional paper must be selected in Fourth Semester.

Note 2 : Walk-out paper will not be held again.

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Class	:	M.Sc./M.A. (Semester-III)	Max. Marks - 40
Subject	:	Mathematics	Min. Pass. Marks - 15
Paper	:	I	
Title	:	Functional Analysis	
Compulsory/Optional	:	Compulsory	

Unit-I: Convergence, Completeness and Baire's Theorem, Cantors intersection Theorem, Continuous mappings, Uniformly continuous mapping, Spaces of continuous functions.

Unit-II: Euclidean and Unitary spaces, Cauchy, Minkowski and Holders inequalities, Normed linear spaces, Examples and elementary properties, Equivalence of norms, Banach space and examples, Continuous linear transformations.

Unit-III: Functionals and their extensions, related Lemma, Hahn-Banach Theorem for normed linear spaces, Conjugates of normed linear spaces, The natural embedding of normed linear space in its second conjugate space, Reflexive Banach spaces, open mapping theorem, Closed graph theorem.

Unit-IV: Conjugate of an operator, Uniform boundedness principle and its applications, Inner product spaces and their elementary properties, Parallelogram law, Schwartz inequality and polarization identity, Hilbert Space and examples, orthogonal complements in Hilbert spaces.

Unit-V: Orthonormal sets, Bessel's inequality, Gram Schmidt orthonormalization process, Conjugate Space of Hilbert Space, Riesz representation theorem, Adjoint of an operator, Properties.

Text Book:

G.F. Simmons, Topology and Modem Analysis, McGraw Hill International Edition, 1963.

Reference Books:

1. E. Kreyszig, Introductory Functional Analysis with Applications, John Wiley & Sons, New York, 1978.
2. R.E. Edwards, Functional Analysis, Dover Publ., New York, 1995.P.K. Jain, O.P. Ahuja and Khalil Ahmed, Functional Analysis, New Age International (P) Ltd. Publ.

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Class	:	M.Sc./M.A. (Semester-III)	Max. Marks - 40
Subject	:	Mathematics	Min. Pass. Marks - 15
Paper	:	II / III / IV / V	
Title	:	Advanced Functional Analysis - I	
Optional : Group/Paper	:	Optional : Gr-I / I	

Unit-I:

Differentiation in normed spaces, Gateaux derivative, Fretchet Derivative, Sub differential.

Unit-II:

Fixed-point theorems and their applications, Banach contraction principle and its generalization.

Unit-III:

Application of Banach contraction principle.

Unit-IV:

Definition and examples of topological vector spaces, Convex, Balanced and absorbing sets and their properties, Minkowski's functional, Subspace

Unit-V:

Product space and quotient space of a topological vector space.

Text Book:

1. Functional Analysis with Applications by A.H. Siddiqi, Tala Mc. Graw Hill Publishing Company.

2. Liner Topological Spaces by Kelley J.L., Van Nostrand East West Press, New Delhi.

Reference Books:

1. Toposigical Vector spaes and Distributions by John Horvath, Addison- Wesley Publishing Company, 1966.

2. Modern methods in Topological vector spaces by albert Wilansky, Mcgraw-Hill, 1978.

3. Functional Analysis by K. Chandra Sekhar Rao, Narosa 2002.

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Class	:	M.Sc./M.A. (Semester-III)	Max. Marks - 40
Subject	:	Mathematics	Min. Pass. Marks - 15
Paper	:	II / III / IV / V	
Title	:	Partial Differential Equations - I	
Optional : Group/Paper	:	Optional : Gr-I / 2	

Unit-1

Transport Equation-Intial Value Problem, Non-homogeneous equations, Laplace's Equations - Fundamental Solution

Unit-2

Mean value Formula properties of Harmonic functions, Green's Functions. Energy Methods.

Unit-3

Heat Equation - Fundamental Solution,

Unit-4

Mean Value Formula for heat equations, Properties of Solutions, Energy Methods

Unit-5

Wave Equation - Solution by Spherical Means, Non – homogeneous Equations, Energy Methods.

Text Books :

L.C. Evans, Partial Differential Equations, 1998.

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Class	:	M.Sc./M.A. (Semester-III)	Max. Marks - 40
Subject	:	Mathematics	Min. Pass. Marks - 15
Paper	:	II / III / IV / V	
Title	:	Operator Theory on Banach Algebra	
Optional : Group/Paper	:	Optional : Gr- I / 3	

Unit I:

The Banach Algebra of Continuous functions, Abstract Banach Algebras, Abstract Index in a Banach Algebra, Gelf and Mazur Theorem, Spectral radius formula.

Unit II:

Ston Weierstrass theorem, The Disk algebra , Algebra of functions with absolutely convergent Fourier series.

Unit III:

Adjoint operator, Normal and self adjoint operators, Projections and subspaces, Multiplication operators.

Unit IV:

C* algebras, Gelfand Naimark theorem, Spectral theorem, Functional calculus, square root of positive operators.

Unit V:

Weak and strong operator topology, W* algebras, Isomorphism of L$^\infty$ spaces , Maximal abelian W* algebras.

Text Book

R. G. Douglas, Banach Algebra Techniques in Operator Theory, Academic Prese, 1972.

Reference Book

1. R. Larsen , Banach algebras. Marcel Dekker Inc., New York, 1973.
2. B. V. Limaye, Functional Analysis, Wiley Eastern Limited, New Delhi, 1996

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Class	:	M.Sc./M.A. (Semester-III)	Max. Marks - 40	
Subject	:	Mathematics	Min. Pass. Marks - 15	
Paper	:	II / III / IV / V		
Title	:	Algebraic Topology - 1		
Optional :Group/Paper	:	Optional : Gr-II / 1		

Unit I:

Geometric Complexes and Polyhadra: Geometrically independent set, k simplex, face of a simplex, properly joined simplexes, Simplicial Complex, Triangulation of Sphere, Mobius band, Torus and Klein bottle.

Unit II:

Oriented simplex, Incidence number, Chains, Cycles, Boundaries and Homology Groups, Elementary p-chain, Homologous Cycles, homology group of oriented Complexes, Examples of Homology groups.

Unit III:

Structure of homology groups, connected simplex, combinational Component, Euler-Poincare theorem, Euler's theorem.

Unit IV:

n-pscudomanifold, Examples, Minimal triangulation of sphere and Projective plane, Coherent orientation, Homology group of n-dimensional sphere, Theorem 2.11 (Statement only).

Unit V:

Simplicial approximation: Chain map, Simplicial map, Examples, Star related Complexes, Simplicial approximation of a simplicial map, Mesh of a Complex, Simplicial approximation theorem. Fred H. Croom, Basic Concepts of Algebraic Topology, Springer Verlag, 1978.

Text Book

Fred H. Croom, Basic Concepts of Algebraic Topology, Springer Verlag, 1978.
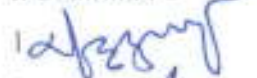
Reference Book

Satya Deo, Algebraic Topology, A primer, Hindustan Book Agency, New Delhi, 2003

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Class	:	M.Sc./M.A. (Semester-III)
Subject	:	Mathematics
Paper	:	II / III / IV / V
Title	:	Spherical Trigonometry and Astronomy - I
Optional : Group/Paper	:	Optional : Gr-II / 2

Max. Marks - 40

Min. Pass. Marks - 15

Unit-I:

Fundamental of Spherical Trigonometry

Unit-II:

Relation between sides & angles of a Spherical triangle.

Unit-III:

Properties of Right angle spherical triangle

Unit-IV:

Solution of right angled spherical triangle.

Unit-V:

Application of Spherical triangle & Examples.

(Chapters as per Text Book)

TEXT BOOKS:-

A text book of spherical Astronomy : Gorakh Prasad.

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Class	:	M.Sc./M.A. (Semester-III)	Max. Marks - 40
Subject	:	Mathematics	Min. Pass. Marks - 15
Paper	:	II / III / IV / V	
Title	:	Advanced Graph Theory-I	
Optional : Group/Paper	:	Optional : Gr-II / 3	

Unit-I:

Revision of graph theoretic preliminaries, Operations on graphs. Graph Isomorphism Disconnected graph and their Components. Traveling salesman problem, round table problem.

Unit-II:

Eulerian and Hamiltonian Paths and circuits.

Unit-III:

Properties of trees, Distance centre, radius, diameter eccentricity and related theorems, Graph as Metric space Rooted and binary trees.

Unit-IV:

Labelled graph and trees spanning tree, weighted spanning tree, Shortest path.

Unit-V:

Fundamental cut sets. Rank and nullity, cut sets and cut vertices, fundamental cut sets.

Text Book:

Graph Theory with Application to Engineering and Computer Science
By Narsingh Deo.

Reference Books:

Graph Theory by Harary.

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Class	:	M.Sc./M.A. (Semester-III)	Max. Marks - 40
Subject	:	Mathematics	Min. Pass. Marks - 15
Paper	:	II / III / IV / V	
Title	:	Mechanics - I	
Optional : Group/Paper	:	Optional : Gr-III / I	

Unit-I:

Constraint and its classification, Possible and virtual displacements Generalized Cordinates. Holonomic and Non- Holonomic systems.

Unit-II:

Scleronomic and Rheonomic system, generalized potential. Larange's equation of first kind.

Unit-III:

Langrange's equation of second Kind. Uniqueness of solution. Energy equation for conservation fields.

Unit-IV:

Hamilton's variables. Donkin's theorem. Hamilton's canonical equations. Cyclic coordinates, routh's equation, Poisson's bracket, Poisson's Identity. Jacobi- Poisson theorem. Motivating problem Problems of calculus of variations

Unit-V:

Shortest distance. Minimum surface of revolution. Brachistochrone problem. Isoperimetric problem, problems of Geodesic.

Text Books:

1. F. Gantmacher, Lectures in Analytic Mechanics MIR Publishers.

2. H. Goldstein Classical Machanics (2nd Edition), Narosa Publishing House, New Delhi.

3. J.C. Upadhyaya – Classical Mechanics. (Himalaya Publication House)

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Class	:	M.Sc./M.A. (Semester-III)
Subject	:	Mathematics
Paper	:	II / III / IV / V
Title	:	Fuzzy Sets and Their Application-I
Optional :Group/Paper	:	Optional : Gr-III / 2

Max. Marks - 40

Min. Pass. Marks - 15

Unit-1

Idea of fuzzy set and membership function, Definition of a fuzzy set, membership function, representation of membership function, General definitions and properties of fuzzy sets, Support, height, equality of two fuzzy sets, containment, examples.

Unit-2

Union and Intersection of two fuzzy sets, Complement of a fuzzy set, normal fuzzy set, α-cut set of a fuzzy set, strong α-cut, convex fuzzy set, a necessary and sufficient condition for convexity of a fuzzy set (Theorem 1), Decomposition of fuzzy sets, Degree of sub sethood, Level set of a fuzzy set, Cardinality, fuzzy cardinality, examples.

Unit-3

Other important operations on fuzzy sets, Product of two fuzzy sets, Product of a fuzzy set with a crisp number, Power of a fuzzy set, Difference of two fuzzy sets, Disjunctive sum of two fuzzy sets, example.

Unit-4

General properties of operations on fuzzy sets, Commutativity, associativity, distributivity, Idempotent law, identities for operations, Transitivity, involution, Demorgans laws, proofs and examples, Some important theorems on fuzzy sets, set inclusion of fuzzy sets and corresponding α-cuts and strong α-cuts (Theorem 1).

Unit-5

Comparison of α-cut and strong α-cut, Order relation of scalars α is inversely preserved by set inclusion of corresponding α-cuts and strong α-cuts, α-cut of union and intersection of two fuzzy sets, α-cut of complement of a fuzzy set (Theorem 2), Examples, α-cuts and strong α-cuts of union and intersection of arbitrary collection of fuzzy sets.

Text Book:

Fuzzy Sets and their Applications by Pundir and Pundir, Pragati Prakashan (PP 30-76).

Reference Books :

1. Fuzzy sets and Fuzzy Logic by G.J. Klir and B. Yuan, Prentice Hall of India, New Delhi, 1995.
2. Fuzzy set Theory and its Applications by H.J. Zimmermann, Allied publishers Ltd, New Delhi 1991.

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Class	:	M.Sc./M.A. (Semester-III)	Max. Marks - 40
Subject	:	Mathematics	Min. Pass. Marks - 15
Paper	:	II / III / IV / V	
Title	:	Advanced Numerical Analysis - I	
Optional :Group/Paper	:	Optional : Gr-III / 3	

Unit-I:

Piece wise and spline interpolation: Piecewise Linear Interpolation, Piecewise Quadratic Interpolation, Piecewise cubic Interpolation, Piecewise cubic Interpolation using Hermite type data, Quadratic and cubic spline Interpolation, Bivariate interpolation.

Unit-II:

Approximation : Least squares Approximation, Gram-schmitt orthogonalization process, chebsyshev polynomials ,legendre polynomials.

Unit-III:

Uniform approximation : Uniform norm , uniform polynomial approximation, best Approximation, best Uniform approximation condition for uniform best approximation.

Unit-IV:

Rational approximation, choice of method, Runge's example.

Unit-V:

Numerical differentiation: Methods based on interpolation Method, Methods based on finite difference operators , methods based on undetermined coefficients, optimum choice of step length.

Text Book:

Numerical Method for scientific and Engineering computation by M.K. Jain, S.R.K. Iyenger, R.K. Jain south Edition (2003) New Age.
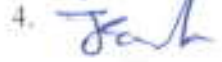
Reference Books :

1. Finite Differences and numerical analysis, H.C. Saxena – S Chand Publication. Atkinson, K. Elementary Numerical Analysis, Wiley New York, 1985

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Class	:	M.Sc./M.A. (Semester-III)	Max. Marks - 40
Subject	:	Mathematics	Min. Pass. Marks - 15
Paper	:	II / III / IV / V	
Title	:	Operations Research -I	
Optional :Group/Paper	:	Optional : Gr - IV / I	

Unit-1

Operations Research and its scope, Origin and Development of Operations Research, Characteristics of Operations Research.

Unit-2

Model in Operations Research, Phase of Operations Research, Uses and Limitations of Operation Research, Linear Programming Problems.

Unit-3

Graphical procedure, Graphical solution of property behaved L.P problems. Graphical solution in some exceptional cases.

Unit-4

General Linear Programming Problem : Simplex Method exceptional cases, artificial variable techniques ; Big M method, two phase Method and problem of degeneracy.

Unit-5

Concept of Duality : Definition of Primal-dual problems ,Symmetric Primal-dual problems, Unsymmetric Primal-dual problems, General rules for converting any primal into its dual. Fundamental theorem of duality.

Text Book:

Kanti Swarup, P.K. Gupta and Manmohan, Operations Research. Sultan Chand & Sons, New Delhi

Reference Books :

1-S.D. Sharma, Operation Research.
2-F.S. Hiller and G.J. Lieberman, Industrial Engineering Series, 1995
3-G. Hadley , Linear Programming, Narosa Publishing House. 1995.
4-G. Hadley, Linear and Dynamic programming, Addison - Wesley Reading Mass.
5-H.A. Taha, Operations Research - An introduction, Macmillan Publishing co. Inc. New york.
6-Prem Kumar Gupta and D.S. Hira, Operation Reasearch, an Introdution, S. Chand & Company Ltd. New Delhi.
7-N.S. Kambo, Mathematical Programming Techniques, Affilated East - West Pvt. Lt

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Class	:	M.Sc./M.A. (Semester-III)	Max. Marks - 40
Subject	:	Mathematics	Min. Pass. Marks - 15
Paper	:	II / III / IV / V	
Title	:	Divergent Series ·	
Optional : Group/Paper	:	Optional : Gr- IV / 2	

Unit-1

Definitions and Examples of Order Relations (big 0, little 0), Asymptotic Relation, The method of Arithmetic means, Holder means, Abel means, The Transformation matrix and regularity theorem for each mean.

Unit-2

Abel's Transformation and its applications, Cesaro means, Definition and examples, Identities relating Cesaro sums, change of order of summation, Relation between Cesaro and Abel's Summability: Theorems 55, 56, and 57.

Unit-3

Consistency theorem for Cesaro Summability, Regularity Theorems for Cesaro's method, Cesaro means of both integral and non-integral orders.

Unit-4

Limitation Theorems, Tauberian conditions and Tauberian Theorems, Littlewood's extension of Tauber's first Theorem.

Unit-5

Abelian method (A, X) of summability, Regularity of Abelian means, Inclusion theorem, Euler mean, Regularity theorem.

Text Book:

G.H. Hardy, Divergent Series, Oxford, University Press, 1948.

Reference Books :

A. Dold and B. Eckmann (eds.) Absolute Summability of Fourier Series, Lecture Notesin Math. Springer-Verlag, 1984.

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Class	:	M.Sc./M.A. (Semester-III)	Max. Marks - 40
Subject	:	Mathematics	Min. Pass. Marks - 15
Paper	:	II / III / IV / V	
Title	:	Integral Equations & boundary value problems - I	
Optional : Group/Paper	:	Optional : Gr- IV / 3	

Unit - I

Initial value problem for ODEs Methods of existence and uniqueness of the solution of the ordinary differential equation of the first order and their examples.

Unit - II

Two point Boundary Value Problems, Sturm Liouville BVP, Non homogeneous BVP, Singular Sturm Liouville BVP.

Unit- III

Classification of Linear integral Equations. Solution of an integral equation. Converting Volterra Integral equation to an ODE. Converting IVP to Volterra Integral Equations.

Unit - IV

Classification of non linear integral equations, Singular Integral equations. Abel's problem, The generalized Abel's Integral Equation.

Unit - V

Fredholm Integral equations, The Adomian Decomposition Method, The Vatiational Iteration method, The direct computation method, The successive approximations method.

Text Book:

1. **A-M Wazwaz,** A first course in Integral Equations, Worls Scientific Singapoore.
2. **S.G. Mikhlin:** Integral equations, (Vol 4) (Translation), Pergamon Press,London.
3. **L. G. chambers** , Integral equations- A short course International Suggested Books company East kilbridge. Scotland.
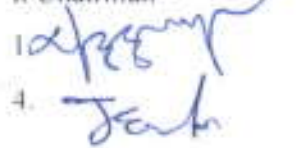
Reference Books :

1. **V. I. Smirnov** A course of higher Mathematics. Vol.IV. (Translation);.Pergamon Press. Oxford
2. **C.Corduneanu,** Integral equations & Applications, Cambridge University Press, Cambridge.
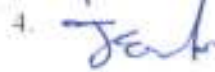3. **BP Parashar,** Differential & Integral Equations, CBS Publishers & Distribution, Delhi.

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Class	:	M.Sc./M.A. (Semester-III)	Max. Marks - 40
Subject	:	Mathematics	Min. Pass. Marks - 15
Paper	:	II / III / IV / V	
Title	:	Integral Transforms - I	
Optional : Group/Paper	:	Optional : Gr-V / I	

Unit-I:

Problem related to Laplace transform Initial and bounding value problems, simultaneous ordinary differential equations. Problem related to solution of partial differential equations. Application of Laplace Transformed in Differential Equations .

Unit-II:

Two dimensional Laplace's Equation (Cartesian and Polar form). Three dimensional Laplace's Equation to related problems

Unit-III:

Notion of wave Equation. General solution of wave Equations. Solution by separation of variables. Solution of two dimensional wave equation , three dimensional wave equation.

Unit-IV:

Definition: Integral Equations, problems related to Integral Equations of convolution type. Integral differential equation . Abel's differential equation.

Unit-V:

Notion of Heat Equations. One and two dimensional heat conduction equation. Solution by separation of variables and problems based on it.

Texts Books :-

1. Integral Transforms by Goyal & Gupta.
2. Integral Transforms by Sneddon.

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Class	:	M.Sc./M.A. (Semester-III)	Max. Marks - 40
Subject	:	Mathematics	Min. Pass. Marks - 15
Paper	:	II / III / IV / V	
Title	:	Theory of linear Operators - 1	
Optional : Group/Paper	:	Optional : Gr- V / 2	

Unit-1

Spectral theory in normed linear spaces, resolvent set and spectrum.

Unit-2

Spectral properties of bounded linear operators.

Unit-3

Properties of resolvent and spectrum. Spectral mapping theorem for polyonmials.

Unit-4

Spectral radius of a bounded linear operator on a complex banach space. Elementary theory of Banach algebras.

Unit-5

General properties of compact linear operators.

Text Books:

E. Kreyszig Introductory functional analysis with applications, Jhon wiley & Sons, New York, 1978.

Reference Books.

1 P. R. Halmos Introduction to Hilbert space and the theory of Spectral Multiplicity, Second edition, Chelsea publishing co. N.Y. 1957.

2 N. Dundford and J.T. Schwartz, linear operator -3 part, Interscience / Wiley, New York 1958-71.

3 G.Bachman and L. Narci, Functuional analysis, Academic press New York, 1966.

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Class	:	M.Sc./M.A. (Semester-III)	Max. Marks - 40
Subject	:	Mathematics	Min. Pass. Marks - 15
Paper	:	II / III / IV / V	
Title	:	Approximation Theory	
Optional : Group/Paper	:	Optional : Gr- V / 3	

Unit-1
Linear Operators, Examples- Bernstein Polynomials, Fourier series.

Unit-2
Approximation theorems, Bohmanand Korvokin's theorems and its applications, Theorem of Stone.

Unit-3
Existence of polynomials of best approximation, characteristics of polynomials of best Approximation.

Unit-4
Applications of convexity, chebyshev system, Uniqueness of polynomial of Best Approximation.

Unit-5
Chebyshev theorem, Chebyshev polynomial, Interpolation, Algebraic polynomials, Trigonometric polynomials.

Text Books:
1. G.G. Lorentz, Approximation of Functions; Holt Tinehart and Winston, Inc. 1966.

Reference Books:
1. Hrushikesh N., M haskar and D.V. Pai, Fundamentals of Approximation theory, Narosa Publishing House, 2000.
2. Timan A.F., Theory of Functions of Real Variable, New York, mackillan, 1963.
3. G. Meinnardus, Approximation of Functions Theory and Numerical Methods.

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