### Name of the Papers (Choose any five)

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<td><strong>Paper I</strong> : Abstract Harmonic Analysis</td>
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<td><strong>Paper II</strong> : Algebraic Topology</td>
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<td><strong>Paper III</strong> : Approximation by Trigonometric and Algebraic Polynomials</td>
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<td><strong>Paper IV</strong> : Fuzzy Sets and their Applications - II</td>
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<td><strong>Paper VIII</strong> : Operations Research</td>
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<td><strong>Paper IX</strong> : Programming in C (Theory and Practical) –II</td>
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<td><strong>Paper X</strong> : Sobolev Spaces</td>
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<td><strong>Paper XI</strong> : Theory of Linear Operators</td>
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<td><strong>Paper XII</strong> : Wavelets Analysis</td>
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**Note:**
- In attendance 10 marks is allocated as per ordinance No. 79 of R.D. University Jabalpur.
- The students, whose attendance is less as per ordinance No. 79 of R.D. University Jabalpur, will not allow to appear in the examination at the close of semester and he/she would be declared having failed in that semester.
- In project 40 marks is allocated. Out of 40 marks, 15 marks is allocated for project file, 15 marks is allocated for presentation of their project work and 10 marks is allocated for project Viva-Voce examination.
- At the end of IV semester a Project Viva-Voce is to be conducted by a board of at least three examiner which includes at least one external examiner.
- At the end of IV semester a Comprehensive Viva-Voce is to be conducted by a board of at least three examiner which includes at least one external examiner.
M.A./M.Sc. (Mathematics) Fourth Semester  
Paper I: Abstract Harmonic Analysis

Max. Marks: 35  
Min. Pass. Marks: 12

Unit I  
The concept of usual metric topology and the real line as a locally compact Hausdorff  
topological abelian group and circle group, Translates of functions and characters, Banach  
space of continuous function and Lp space \((1 \leq p < \infty)\), Fourier transform in L1 and its  
properties.

Unit II  
Denseness of the set \(T\) of trigonometric polynomials in \(C\) and \(L^p\) space \((1 \leq p < \infty)\), Definition  
and properties of convolutions, The space \(L^1\) as a commutative Banach algebra with respect to  
convolution as multiplication, Approximate identities and their properties.

Unit III  
The Haar covering function Existence and properties of Haar covering function Definition and  
properties of the function \(Ig(f)\). Existence and Uniqueness of the Haar integral.

Unit IV  
Translation in \(L^p(G)\), uniform continuity of translation character properties of characters  
Examples of characters, character group or dual group. Locally compact abelian group non –  
trivial complex homomorphism.

Unit V  
The Fourier transform, convolution of function set \(A(\Gamma)\) of all Fourier transforms invariance,  
of \(A(\Gamma')\), Fourier Stieltjes transform set \(B(\Gamma)\) of all Fourier Stieltjes transform, invariance of  
\(B(\Gamma')\).

Text Books:

2. Taqdir Hussain Introduction to Topological Group W.D. Saudss Company 1966 to ok W.O. (unit III)
3. W.Rudin, Fourier Analysis on Groups, Interscience Publication, New York, 1987 (For IV and Unit  
V).

Reference Books:

1) Hans Reiter and Jan D. Stegman, Classical Harmonic Analysis and Locally Compact Groups, Oxford  
Science Publication, 2000  
M.A./M.Sc. (Mathematics) Fourth Semester
Paper II: Algebraic Topology

Max. Marks: 35
Min. Pass. Marks: 12

Unit I
The Fundamental Group: Introduction, Homotopy, Definition and Examples, Contractible space, Homotopy Equivalence and Homotopy Type, Comb space, Retract, Deformation retract, and Strong deformation retract.

Unit II
Fundamental Group and its properties: Path and path homotopy, Path homotopy is an equivalence relation, Homotopy class, The set $\pi_1(X,x_0)$ is a group, Properties of fundamental groups, Homomorphism induced by a continuous map, Properties of induced homomorphism.

Unit III
Simply connected space, $S^n$ is simply connected for $n \geq 2$, Results for computing fundamental groups of Disk $D^n$ and the product space $X \times Y$, Path Lifting and Homotopy Lifting Property, Theorem 2.6.3 (Statement only), Fundamental group of Circle, Punctured plane, Torus, and Cylinder.

Unit IV
Covering Projections: Definition and Examples, Properties of Covering Projections, Lift of a map, Uniqueness of lifts, Path Lifting and Homotopy Lifting Property (Statement only).

Unit V
Applications of Homotopy Lifting Theorem: The Monodromy Theorem, Proposition 5.3.2 (Statement only), Lifting Theorem, Covering homomorphism, Group of Deck Transformations, Necessary and sufficient conditions for homomorphism and isomorphism of covering spaces.

Text Book:

Reference Books:
M.A./M.Sc. (Mathematics) Fourth Semester
Paper III: Approximation by Trigonometric and Algebraic Polynomials

Max. Marks: 35
Min. Pass. Marks: 12

Unit I
Fourier Series, Preliminaries, convergence of Fourier series, summability convergence of
trigonometric series. ([1] Page 203 to 220).

Unit II
The degree of approximation by trigonometric polynomial Generalities, Theorem of Jackson,
The degree of approximation of differentiable functions, Inverse theorems, Differential
functions. ([2] Page 54 to 62).

Unit III
The degree of approximation by Algebraic polynomials, Preliminaries, The approximation
theorems, Inequalities for the derivatives of polynomials, Inverse theorems. ([2] Page 63 to
75).

Unit IV
Approximation by linear polynomials operators, sums of de la Vallee Poussin-positive
operators, The principle of uniform boundedness, operators that preserve trigonometric
polynomials, Trigonometric saturation classes. ([2] Page 92 to 102).

Unit V
Least First Power of Approximation, Approximation on an Interval, Some computational
aspects ([3] Page 66 to 83).

Text Books:
1. Hrushikesh N Mhaskar and D.V. Pai; Fundamentals of Approximation Theory, Narosa Publishing
3. T.J. Rivlin, An Introduction to the Approximation of Functions.

Reference Books:
2. G. Meinrnandus, Approximation of Functions, Theory and Numerical Methods, Springer Verlag Vol-
   13, 1967.

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M.A./M.Sc. (Mathematics) Fourth Semester
Paper IV: Fuzzy Sets and their Applications - II

Max. Marks: 35
Min. Pass. Marks: 12

Unit - I
Fuzzy sets: Basic Definitions, α-level sets, Convex fuzzy set, Basic operations on fuzzy sets, types of fuzzy sets, Extensions: Types of fuzzy sets, Further operations on fuzzy sets, Cartesian product, Algebraic products, Bounded sum and Difference, t-norm & τ-conorm.

Unit – II
Extension principle and applications, Zadeh extension principle, image and inverse image of fuzzy sets, fuzzy numbers, algebraic operations with fuzzy numbers, extended operation and its properties, Special extended operation, addition, subtraction, product and division of fuzzy numbers.

Unit - III
Fuzzy relations on fuzzy sets, The union & intersection of fuzzy relations, Composition of fuzzy relations, max-* and max-product compositions, min-max composition and its properties, reflexivity, symmetry, transitivity, and their examples, special fuzzy relations, similarity relation.

Unit - IV
Fuzzy graphs: Definition and Examples, Fuzzy sub-graph, Spanning sub-graph, path in a fuzzy graph, strength and length of a path, -length and -distances, connected nodes, fuzzy forest, fuzzy tree, Examples, Fuzzy Analysis: Fuzzy functions on fuzzy sets, classical function, fuzzy function, Examples.

Unit - V
Fuzzy Logic; classical logic an overview, multi-valued logic, Fuzzy proposition unconditional and unqualified proposition, unconditional and qualified propositions conditional and unqualified proposition, conditional and qualified proposition, Fuzzy qualifiers, Linguistic hedges An overview of classical logic, Its connectives, Tautologies, Contradiction, Fuzzy.

Text Books:


Reference Books:

1. Fuzzy Logic with Engineering Applications by T.J. Ross, John Wiley & Sons, IInd Ed., 2005
M.A./M.Sc. (Mathematics) Fourth Semester
Paper V: Infinite Matrix and Divergent Series

Max. Marks: 35
Min. Pass. Marks: 12

Unit I

Unit II
Reciprocal of Infinite matrices Reciprocal of lower semi-metrics and some simple general results, The bound of a matrix, two general theorems on reciprocal Exercise-2 (cf. Text book 1)

Unit III

Unit IV
Inclusion of Norlund method, Theorem 21, 22, 23, 24 of G.H. Hardy, Examples, \((N, 1/n+1) \subseteq (C, K) \subseteq (N, e^{1/n})\). (cf. Text book 2)

Unit V
Limitation Methods, Examples of Limitation methods, Matrix Limitation methods, Theorem 1.3.2 (Without proof), Norlund and Riesz Means, Theorems 1.4.6, 1.4.7, 1.4.8 (Without proof), Schur Matrices, Theorems 1.5.2, 1.5.4 (Without proof). (cf. Text book 3)

Text Book:

1. R.G. Cooke, "Infinite Matrices and Sequence Spaces".

Reference Books

M.A./M.Sc. (Mathematics) Fourth Semester
Paper VI: Spline Theory

Unit I
Polynomial Interpolation: Lagrange form, Divided difference and Newton form, K-th divided difference, Osculatory interpolation, Limitation of polynomial approximation, Runge example.

Unit II
Piecewise linear approximation: Broken line interpolation is nearly optimal, Least-squares approximation by broken lines, Good meshes, square root example.

Unit III
Piecewise cubic interpolation: Cubic Hermite interpolation, Cubic Bessel interpolation, Akima interpolation, Cubic spline interpolation, Boundary conditions, Best approximation properties of complete cubic spline and its error, Truncated power function, Pythagoras theorem, smoothest interpolation property, Best approximation property.

Unit IV
Parabolic spline interpolation: Difference of two parabolic splines, interpolation of data values given at mid points of mesh intervals, Existence and uniqueness of parabolic splines, Piecewise polynomial representation for $P_{k,\xi}$.

Unit V
The space $P_{k,\xi,v}$ and truncated power basis: The smoothing of a histogram by parabolic splines, truncated power basis, truncated power function, representation of a function of $P_{k,\xi,v}$. The representation of pp function by B-splines, The support of B-splines, Partition of unity by B-splines, Spline function as a combination of B-splines.

Text Book:


Reference Books:

M.A./M.Sc. (Mathematics) Fourth Semester
Paper VII: Integration Theory

Max. Marks: 35
Min. Pass. Marks: 12

Unit 1: General measures Examples, Semifinite and σ finite measures, Completion of a measure, Measurable functions.

Unit 2: Signed measures, Hahn Decomposition Theorem, Mutually Singular Measures Jordan Decomposition theorem.

Unit 3: Radon - Nikodym Theorem, Lebesgue Decomposition Theorem, Caratheodary Extension Theorem.

Unit 4: Baire sets, Baire measures, Regularity of measures on locally compact spaces, Product measures, Fubini's theorem.

Unit 5: Integration of continuous functions with compact support on locally compact spaces, Riesz - Markov theorem.

Recommended Books:

Reference Books:
1. P.R. Halmos, Measure theory, Van Nostrand

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M.A./M.Sc. (Mathematics) Fourth Semester
Paper VIII: Operations Research

Max. Marks: 35
Min. Pass. Marks: 12

Unit I

Unit II
Inventory theory: Inventory models on economic lot size system with uniform and non uniform demand, Economic leet size with finite rate of replenishment, A simple order level system with constant rate of demand with shortage, Generalized economic leet size model, Multi items deterministic models, Probabilistic model, Instantaneous demand, no setup cost model, Uniform demand, no setup cost model

Unit III
Waiting lines, distribution theorem, classification of queuing model: models: (M/M/1):(∞/FCFS), (M/M/1)(N/FCFS), General Erlang queuing model, (M/M/S):(∞/FCFS), (M/M/S):(N/FCFS), (M/Ek/1):(∞/FCFS).

Unit IV
Network analysis, constraints in Network, Construction of network, critical Path Method (CPM)PERT, PERT Calculation, Resource Leveling by Network Techniques and advances of network (PERT/CPM), Replacement problem: Replacement problem when money value does not change/changes with Time, Group replacement policy, Mortality theorem.

Unit V
Game theory- Two persons, Zero-sum Games, Maximin - Minimax principle, games without saddle points- Mixed strategies, Graphical solution of 2xm and mx2 games, Solution by Linear Programming, Non-Linear programming Techniques-Kuhn-Tucker Conditions, Non-negative Constrains.

TEXT BOOKS:

REFERENCE BOOKS:
M.A./M.Sc. (Mathematics) Fourth Semester
Paper IX: Programming in C (Theory and Practical)

Max. Marks: 25
Min. Pass. Marks: 09

Unit 1-
An overview of programming languages. Classification.

Unit 2-
Enumeration Types. the void data type , Typedefs, Pointers.

Unit 3-
Control Flow - Conditional Branching, the Switch Statement. Looping. nested loops. the Break and Continue statement . the goto statement infinite loops.

Unit 4-

Unit 5-
Arrays and multidimensional Arrays. Storage Classes - fixed vs. Automatic. Duration Scope, global variable The Register Specifier Structures and Unions.

Recommended Books:

Reference Books:
M.A./M.Sc. (Mathematics) Fourth Semester
Paper X: Sobolev Spaces

Max. Marks: 35
Min. Pass. Marks: 12

Unit I
Distribution; Introduction, Test functions and distributions, The Dirac Distribution, some operations with distributions, Heveside functions on R, Supports and singular supports of distributions, convolution of functions.

Unit II

Unit III
The space $L^p(\Omega)$ Definition and Basis properties, Holder’s inequality, Minkowskis inequality, completeness of $L^p(\Omega)$. Approximation by continuous functions separability, Mollifiers, Approximation by smooth Functions pre compact –sets in $L^p(\Omega)$, The uniform convexity of $L^p(\Omega)$ Clarkson’s inequalities.

Unit IV
The Sobolev spaces $W^{m,p}(\Omega)$, Definitions and Basic properties, duality, the space $W^{-m,p}(\Omega)$ Approximation by smooth Functions on Meyers and Serrin theorem, Approximation by smooth Functions on $\mathbb{R}^n$.

Unit V

Text Books:

Reference Books:
M.A./M.Sc. (Mathematics) Fourth Semester
Paper XI: Theory of Linear operators

Max. Marks: 35
Min. Pass. Marks: 12

Unit 1-

Unit 2-

Unit 3-
Spectral properties of compact linear operators on normed spaces. Behaviours of Compact linear operators with respect to solvability of operators equation.

Unit 4-

Unit 5-
Positive operators Monotonic sequence theorem for bounded self-adjoint operators on a complex Hilbert space. Square roots of a positive operator. Projection operators.

Recommended Books:

Reference Books:
M.A./M.Sc. (Mathematics) Fourth Semester
Paper XII: Wavelets Analysis

Max. Marks: 35
Min. Pass. Marks: 12

Unit I
Haar's simple wavelets, Haar Wavelet transforms, Inverse Haar Wavelet transforms,
Multi Dimensional wavelets, Two - dimensional Haar Wavelets.

Unit II
Application of wavelets, Noise reduction Data compression, Edge detection, Daubechies
wavelet (DW), approximation of samples with D wavelets, Fast DW transform and its inverse.

Unit III
Inner products and orthogonal projection, Applications of orthogonal projection to
computer graphics, Computation of functions and wavelets, Discrete and fast Fourier
transform with inverse and applications.

Unit IV
Fourier series for periodic functions its convergence and inversion, uniform
convergence of Fourier series, Bessel's inequality, Parseval's inequality.

Unit V
The Fourier transform Convolution and inversion of Fourier transform Weight
functions, Approximate identities.

Text Books:-
1- Wavelets made easy by Y. Nieveregelt
2- A first Course on Wavelets by E. Hernandez and G. Weiss.

Reference Books:
1- An Introduction to Wavelets by Chui, Academic Press.