RANI DURGAVATI UNIVERSITY, JABALPUR

SYLLABUS OF M.A./M.Sc. MATHEMATICS SEMESTER SYSTEM SEMESTER – IV (Session 2017-18 and onwards)

Syllabus opted by the board of studies in Mathematics, R. D. University in the meeting held on 30-04-2016.

Choose any **five Papers** from the list of twelve papers.

Name of the Papers (Choose any five)	Theory (MM)	Min. Pass. Mark	C. C. E	Min. Pass. Mark	Practical M .M.	Min. Pass mark	Total
Paper I : Abstract Harmonic Analysis	35	12	15	05	--	--	50
Paper II: Algebraic Topology	35	12	15	05	--	--	50
Paper III: Approximation by Trigonometric and Algebraic Polynomials	35	12	15	05	--	--	50
Paper IV: Fuzzy Sets and their Applications - II	35	12	15	05	--	--	50
Paper V: Infinite Matrices and Divergent Series	35	12	15	05	--	--	50
Paper VI: Spline Theory	35	12	15	05	--	--	50
Paper VII : Integration Theory	35	12	15	05	--	--	50
Paper VIII: Operations Research	35	12	15	05	--	--	50
Paper IX: Programming in C (Theory and Practical) –II	25	09	10	04	15	06	50
Paper X: Sobolev Spaces	35	12	15	05	--	--	50
Paper XI: Theory of Linear Operators	35	12	15	05	--	--	50
Paper XII: Wavelets Analysis	35	12	15	05	--	--	50
Job- Oriented Project Work & Attendance (Compulsory)							50 =40+10
Comprehensive Viva-Voce (Compulsory)							50
Grand Total							**350**

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 on 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.**

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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 Hausdroff 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 Lp space ($1 \leq p < \infty$), Definition and properties of convolutions, The space L1 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 Lp(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 (Γ) of all Fourier transforms invariance, of A (Γ), Fourier Stieltjes transform set B(Γ) of all Fourier Stieltjes transform, invariance of B(Γ).

Text Books:

1. R.E. Edwards, Fourier Series: A Modern Introduction,V ol.I Springerverlag, 1979 (For Units I & II).
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
2) Hewitt and Ross -Abstract Harmonic Analysis I, Springer-Verlag, 1979.
3) John J. Benedetto -Harmonic Analysis and Application, CRC Press New York, 1997.

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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:

1. Satya Deo, Algebraic Topology - A Primer, Hindustan Book Agency, TRIM Series # 27, New Delhi, 2003.

Reference Books:

1. Fred H. Croom, Basic Concepts of Algebraic Topology, Springer Verlag, 1978.
2. James R. Munkres, Topology, 2nd Edition, PHI, 2002.

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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 Poussion-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 House, 2000.
2. G.G., Lorentz, Approximation of Functions, Holt, Rinehart and Wiston, Inc. 1966.
3. T.J. Rivilin, An Introduction to the Approximation of Functions.

Reference Books :

1. Timan, A.F., Theory of Functions of Real Variable, New York, Mackmillan, 1963.
2. G. Meinnardus, 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 & t-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 un qualified 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:

1. Fuzzy set theory and its Applications by H.J. Zimmermann, Allied Publishers Ltd., New Delhi, 1991 (For Units I to IV).
1. Fuzzy sets and Fuzzy Logic Theory & Application by G.J. Klir and B. Yuan, Prentice Hall of India, New Delhi, (2000) (For Unit V).

Reference Books:

1. 1. Fuzzy Logic with Engineering Applications by T.J. Ross, John Wiley & Sons, IInd Ed., 2005

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M.A./M.Sc. (Mathematics) Fourth Semester
Paper V: Infinite Matrix and Divergent Series

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

Unit I Difference between finite and infinite matrices, Basic Properties, Kojima matrix, Toeplitz matrix, some special type of matrices, The structure, The exponential function of an infinite matrix, Semi continuous and continuous matrices. Exercise-1 **(cf. Text book 1)**

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

Unit III Norlund summability, transformation matrix for Norlund means, Regularity, Consistency, Equivalence theorem 21, Inclusion theorem 19. **(cf. Text book 2)**

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 ".
2. GH Hardy, " Divergent Series", Oxford 1948.
3. G.M Petersen, "Regular Matrix Transformations", McGraw Hill Publishing Company Ltd., 1966.

Reference Books

1. Konrad Knopp, " Theory and Application of infinite Series " London and Glasgow 1921.
2. W. L. Ferrar, "A text book of convergence " Oxford, Clarendon Press 1937.
3. P.L. Bhatnagar and C.N. Shrinivasiengar, "Theory of Infinite Series, " National Publicating House, 1964.

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

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

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 $\mathbf{P}_{k,\xi}$.

Unit V The space $\mathbf{P}_{k,\xi,v}$ and truncated power basis: The smoothing of a histogram by parabolic splines, truncated power basis, truncated power function, representation of a function of $\mathbf{P}_{k,\xi,v}$. 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:

1. C. De Boor, A Practical Guide to Splines, Springer-Verlag, New York, 1978.

Reference Books:

2. L.L. Shumaker, Spline Functions Basic Theory, John Wiley & Sons, New York, 1981.
P.J. Davis, Interpolation and Approximation, Dover Publications, INC, New York, 1975.

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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 Jordon 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 - Makov theorem.

Recommended Books:

1- H.L. Royden Real Analysis, macmillan publishing co. Inc. Newyork, 4th Edition, 1993.

Referance Books:

1- P.R. Halmos, Measure theory, Van Nostrand

2- I.K. Rana, Introduction to measure and integration, Narosa Publishing House, New Delhi.

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

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

Unit I Operations Research and its scope. Origin and Development of Operations Research, Characteristics of Operations Research, Model in Operations Research, Phase of Operations Research, Uses and Limitations of Operations Research, Linear Programming Problems, Mathematical Formulation, Graphical Solution Method.

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 queueng 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:

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

REFERENCE BOOKS:

1. S.D. Sharma, Operations Research.
2. F.S. Hiller and G.J. Lieberman, Industrial Engineering Series, 1995(This book comes with a CD containing software)

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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.
C Essentials – Programs development, Functions. Anatomy of a Function. Variables and Constants Expressions. Assignment Statements. Formatting Source files Continuation Character. the Preprocessor.

Unit 2-

Scalar Data types – Declarations, Different Types of integers. Different kinds of Integer Constants Floating – point type Initialization. mixing types Explicit conversions – casts.
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-

Operators and Expressions - Precedence and associatively. Unary plus and Minus operators. Binary Arithmetic operators arithmetic assignment operators. Increment and decrement operators. Comma Operator Relational operators logical operators bit- Manipulation operators Bitwise assignment operators. Cast operators size of Operators , Conditional Operators , memory operator.

Unit 5-

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

Recommended Books:

1 Peter A Darnell and Philip E. Margolis, C; A Software Engineering Approched narosa Publishing House (Springer International Student Edition) 1993.

Reference Books:

1 Samuel P. Harkison and Gly L Steele Jr. C; A Reference manual , 2an Edition Prentice hall 1984.
2 Brain W Kernigham & Dennis M Ritchie the C Programmed Language 2nd Edition (ANSI features), Prentice Hall 1989.

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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 Convolution of Distributions, Fundamental solutions, The Fourier Transform, The Schwartz Space, Riemann Lebesgue Lemma, The Fourier inversion formula strong parseval relation, Plancherel theorem.

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 R^n.

Unit V Interpolation and Extension theorem, Geometrical properties of Domains, Gagliardo theorem, Interpolations inequalities for Intermediate Derivatives, Ehrling, Nirenberg, Browder theorem, Interpolation inequality Involving compact subdomains.

Text Books:

1. R.A. Adams, sobolev Spaces, Academic Press, Inc 1975. (Unit III, IV & V).
2. S. Kesavan, Topics in Functional Analysis and Applications, Willey Limited, 1989. (Unit I & II).

Reference Books:

1. A. Kufner, Weighted soblev Spaces, John Wiley & Sons. Ltd. 1985.
2. R.S. Pathak, A Course in Distribution Theory and Applications, Narosa Publishing House. 2001.

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

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

Unit 1-

Spectral theory in normed linear spaces, resolvent set and spectrum, Spectral properties of bounded linear operators. Properties of resolvent and spectrum. Spectral mapping theorem for polynomials.

Unit 2-

Spectral radius of a bounded linear operator on a complex banach space. Elementary theory of Banach algebras. General properties if compact linear operators.

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-

Fredholm type theorems. fredholm alternative theorem. Fredhoml alternative for integral equation. spectral properties of bounded self – adjoint linear operator on complete Hilbert space..

Unit 5-

Positive operators Monotone sequence theorem for bounded self – adjoint operators on a complex Hilbert space. square roots of a positive operator. projection operators.

Recommended Books:

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

Referance 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, Functional analysis, Academic press New York, 1966.

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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.

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