DIRECTORATE OF DISTANCE EDUCATION
KURUKSHETRA UNIVERSITY.
KURUKSHETRA - 136 119

Syllabus & Examination

for

M.Sc. (FINAL) Mathematics

Session 2019-20, 016-17, 2017-18, 2018-19

1. There will be five theory papers.
2. Each theory paper will consist of four sections.
3. Paper setter will set ten questions.
4. The candidate will be required to attempt five questions in all, selecting at least one from each section. All the questions will be of equal marks.
5. Duration of examination of each theory paper will be three Hours.
6. Max. Marks of each paper will be 100, 80 Marks for External Theory Examination and 20 Marks for Internal Assessment.
7. Paper VI MM-501 and Paper VII MM-502 will be compulsory papers. A student can opt one paper from paper MM-503 opt.(i) and MM-503 opt.(ii). Like wise, one paper can be opted from MM-504 opt.(i) and MM-504 opt.(ii) and one paper can be opted from MM-505 opt.(i) and MM-505 opt.(ii).
8. In the paper VII MM-502, there will be a practical test of 20 marks in place of internal assessment test.

Scheme of Examination for M.Sc. Final Mathematics

Through Distance Education

with effect from the session 2014-15

Paper Code	Paper Name	Marks		Time
		External Theory	Internal Assessment	
Paper VI-MM 501	Partial Differential Equations & Mechanics	80	20	3 hrs
Paper VII-MM 502	Discrete Mathematics & Computer Programming	80	20 (Practical)	3 hrs
Paper VIII-MM 503	Any one of the followings:			
	503 opt (i) Mechanics of Solids	80	20	3 hrs
	503 opt (ii) Number Theory	80	20	3 hrs
Paper IX-MM 504	Any one of the followings:			
	504 opt (i) Fluid Mechanics and Seismology	80	20	3 hrs
	504 opt (ii) Fuzzy Sets & Wavelets	80	20	3 hrs
Paper X -MM 505	Any one of the followings:			
	505 opt (i) Integral Equations & Boundary Value Problems	80	20	3 hrs
	505 opt (ii) Coding Theory & Non-Commutative Rings	80	20	3 hrs

Note : In the paper VII MM-502, there will be a practical test of 20 marks in place of internal assessment test.

Paper VI- MM 501 : Partial Differential Equations & Mechanics

External Theory Marks: 80
Internal Assessment Marks: 20
Time: 3 Hours

NOTE : The examiner is requested to set ten questions by dividing the paper into the sections as indicated in the syllabus. The candidates are required to attempt five questions, selecting at least one from each section.

SECTION-I (Two Questions)

Partial differential equations (PDE) of first order. Origin of first order partial differential equations and their classification, classification of integrals. The Cauchy problem. Integral surfaces passing through given curve. Compatible system. Charits method, Jacobs method, Quasi linear equations.

PDE of k^{th} order: Definition, examples and classifications. Transport equations. Initial value problems. Non-homogeneous equations, Laplace's Equation-Fundamental solutions, Mean value Formulas, properties of Harmonic functions. Green's functions. Energy method.

Heat Equations-Fundamental solution. Mean value formula. Properties of solutions. Energy methods.

SECTION-II (Three Questions)

Wave equation - Solution by spherical means. Non-homogeneous equations. Energy methods.

Non-linear first order PDE – complete integrals, envelopes, Characteristics Hamilton Jacob equations (calculus of variations Hamilton's ODE, Legendre Transform, Hopf-Lax formula, weak solutions, Uniqueness). Conservative Laws (Shocks, entropy conditions, Lax-Oleinik formula, weak solutions uniqueness. Riemann's problem, long time behavior.

Representation of Solutions – Separation of variables, Similarity solutions (Plane and traveling waves, solitones, similarity under Scalling) Fourier Transform, Laplace Transform, Hop-Cole Transform, Potential functions Hodograph and Legendre transforms.

SECTION-III (Two Questions)

Motivating problems of calculus of variations, shortest distance. Minimum surface of revolution. Brahistochrone problem, Isopertimetric problem Geodesic. Fundamental Lemma of calculus of variation. Euler's equation fo one dependent function and its generalization to (i) 'n' dependent functions

(ii) higher order derivatives. Conditional extremum under geometric constraints and under integral constraints.

SECTION-IV (Three Questions)

Generalised coordinates. Holonomic and Non-Holonomic systems. Scleronomic and rheonomic systems. Generalised Potential, Lagrange's equations of first kind, Lagrange equations of second kind. Uniqueness of solution. Energy equation for conservative fields.

Hamilton's variables. Donkin's theorem. Hamilton canonical equations. Cyclic coordinates. Routh's equations. Poisson's Bracket. Poisson's Identity. Jacobi-Poisson theorem. Hamilton's Principle. Principle of least action. Poincare integral invariant. Whittaker's equations. Jacobi's equations. Statement of Lee Hwa Chung's theorem.

Hamilton-Jacobi equation. Jacobi theorem. Method of separation of variables. Lagrange brackets. Conditions of canonical character of a transformation in terms of Lagrange brackets and Poisson brackets. Invariance of Lagrange brackets and Poisson brackets under canonical transformations.

Books:

1. L.C. Evans, Partial Differential Equations, Graduate Studies in Mathematics, Volume 19, AMS, 1998.
2. Books with the above title by I.N. Snedden, F. John, P. Prasad and R. Ravindran, Amarnath etc.
3. A.S. Ramsey, Dynamics Part-II, The English Language Book Society and Cambridge University Press, 1972.
4. F.Gantmacher, Lectures in Analytic Mechanics, MIR Publishers, Moscow, 1975.
5. H. Goldstein, Classical Mechanics (2nd edition), Narosa Publishing House, New Delhi.
6. I.M. Gelfand and S.V. Formin, Calculus of Variations, Prentice Hall.
7. S.L. Lonely, An Elementary Treatise on Statics, Kalyani Publishers, New Delhi, 1979.
8. A.S. Ramsey, Newtonian Gravitation, The English Language Books Society and Cambridge University Press, 1972.
9. Narayan Chandra Rana & Pramod Shared Chandra Joag. Classical Mechanics, Tata McGraw Hill, 1991.
10. Louis N. Hand and Janet D. Finch, Analytical Mechanics, Cambridge University Press, 1998.

Paper VII-MM 502 : Discrete Mathematics and Computer Programming

External Theory Marks: 80
Internal Assessment Marks: 20
Time: 3 Hours

NOTE : The examiner is requested to set ten questions by dividing the paper into the sections as indicated in the syllabus. The candidates are required to attempt five questions, selecting at least one from each section.

Section - I (Two Questions):

Partially ordered sets and lattices. Lattice as an algebraic system. Sublattices. Isomorphism of lattices. Distributive and modular lattices. Lattices as intervals. Similar and projective intervals. Chains in lattices. Zassenhaus's Lemma and Schreier Theorem, Composition chain and Jordan Holder Theorem. Chain conditions. Fundamental dimensionality relation for modular lattices. Decomposition theory for lattices with ascending chain conditions, i.e. reducible and irreducible elements. Independent elements in lattices.

Points (atoms) of a lattice. Complemented lattices. Chain conditions and complemented lattices. Boolean algebras. Conversion of a Boolean algebra into a Boolean ring with unity and vice-versa. Direct product of Boolean algebras. Uniqueness of finite Boolean algebras. Boolean functions and Boolean expressions. Application of Boolean algebra to switching circuit theory. (Relevant portion of the chapter 7 and chapter 12 of the books given at Sr. No. 2 & 3, Relevant portion of the chapter 7 and chapter 12 of the books given at Sr. No. 2 & 3)

Section - II (Three Questions):

Graphs, Konisberg seven bridges problem. Finite and infinite graphs. Incidence vertex. Degree of a vertex. Isolated and pendant vertices. Null graphs. Isomosphism of graphs. Subgraphs, walks, paths and circuits Connected and disconnected graphs. Components of a graph. Euler graphs Hamiltonian paths and circuits. The traveling salesman problem. Trees anc their properties. Pendant vertices in a tree. Rooted and binary tree. Spanning tree and fundamental circuits. Spanning tree in a weighted graph.

Cutsets and their properties. Fundamental circuits and cutsets. Connectivity and separability. Network flows. Planner graphs. Kuratowski's two graphs. Representation of planner graphs. Euler formula for planner graphs. Vector space associated with a graph. Basis vectors of a graph. Circuit and cutset subspaces. Intersection and joins of W_C and W_S. Incidence matrix A(G) of a graph G, Submatrices of A(G), Circuit matrix, Fundamental circuit matrix, and its rank, Cutset matrix, path matrix and adjacency matrix of a graph. (Chapter 1,2,3 of the book given at Sr. No. 1, Chapter 4, Theorems 5.1 to 5.6 of chapter 5, chapter 6 & 7 of the book given at Sr. No. 1).

Section - III (Two Questions):

Data types, operations and Expressions.

Input and output operations; Decision making:

Branching : if/else, ?, switch, goto;

Looping : while, do-while, for; break and continue; nested structures;

Section – IV (Three Questions):

Arrays : one-dimensional, two- dimensional, initializing two dimensional arrays.

Strings : declare, initialize, read, write, write, arithmetic operations; String-handling functions;

User-defined functions : need, arguments, calling, nesting, recursion;

Structure and union : definition, initialization, size, arrays, nested :

Pointer : declaration, initialization, arithmetic operations; pointers for arrays, strings

File Management: Opening/ Closing, I10 operating, ramdam access.

Recommended Texts:

1. Narsingh Deo — Graph Theory with application to Engineering and Computer Science, Prentice Hall of India.

2. Nathan Jacobson — Lectures in Abstract Algebra Vol.I, D.Van Nostrand Company, Inc.

3. L.R. Vermani and — A course in discrete Mathematical structures (Imperial College Shalini Press London 2011)

4. E. Balagurusamy — Programming in ANSI C ; Tata Mcgraw-Hill Co. Ltd., New Delhi

5. Peter A. Darnell and Phi ip E. C : A Software Engineering Approach, Narosa Publishing House.(Springer International Student Edition), 1993.

6. Samuel R. Harkison and Gly L.: Steele Jr., C: A Reference Manual, 2nd Edition, Preentice-Hall, 1984

7. Brian W. Kernighan & Dennis M. Ritchie, : The C Programming Langurage, 2nd Edition, (ANSI features) Prentice Hall, 1989.

Paper VIII-MM 503 opt.(i) : Mechanics of Solids

External Theory Marks: 80
Internal Assessment Marks: 20
Time: 3 Hours

NOTE: The examiner is requested to set ten questions by dividing the paper into the sections as indicated in the syllabus. The candidates are required to attempt five questions, selecting at least one question from each section.

Section - I (Three Questions):

Cartesian Tensor : Coordinate-transformation, Cartesian Tensor of different order, Sum, difference and product of two tensors. Contraction theorem. Quotient Law. Symmetric and skew-symmetric tensors. Kronecker and alternate tensor and relation between them.

Scalar invariants of a second order tensor. Eigen values and eigen vectors of a symmetric second order tensor. Gradient, divergence and curl of a tensor field.

(Relevant portion of Chapter II and Art 3,4,1,3,5,2,3,5,4 of book D.S. Chandrasekharaiah and L Debnath).

Analysis of Strain : Affine transformation, Infinitesimal affine deformation. Geometrical Interpretation of the components of strain. Strain quadric of Cauchy. Principal strains and invariance, General infinitesimal deformation. Equations of compatibility. Finite deformations.

Analysis of Stress : Stress tensor, Equations of equilibrium, Transformation of coordinates, Stress quadric of Cauchy, Principal stress and invariants. Maximum normal and shear stresses.

(Relevant portions of Chapter I & II of I.S. Shokolnikoff).

Section - II (Three Questions):

Equations of Elasticity : Generalised Hooks Law, Homogeneous isotropic media, Elasticity moduli for Isotropic media. Equilibrium and dynamical equations for an isotropic elastic solid. Strain energy function and its connection with Hooke's Law, Uniqueness of solution, Beltrami Michell compatibility equations. Saint-Venant's Principle.

(Relevant portions of Chapter III of I.S. Shokolnikoff).

Extension of beams by Longitudinal forces, Bean stretched by its own weight, Bending of beams by terminal couples. Bernouli – Euler Law.

Torsion of a circuiar shaft, Torsion of cylindrical bars. Stress functions. Simple Torsion problem related to circle, rectangle and equilateral triangle.

(Relevant portions of Chapter IV of I.S. Shokolnikoff).

Section - III (Two Questions):

Two dimensional problems : Plane Stress. Plane elastostatic problems. Generalized plane stress. Airy stress function. General solution of Biharmonic equation. Stresses and displacements in terms of complex potentials.

The structure of functions of $\varphi(z)$ and $\psi(z)$. First and Second boundary –value problems in plane elasticity. Existence and uniqueness of the solutions.

(Sections 65-74 of Chapter V of I.S. Sokolnikoff)

Section - IV (Two Questions):

Waves : Propagation of waves in an infinite isotropic elastic solid medium. Waves of dilatation and distortion. Plane Waves.

(Sections 204 of A.E.H. Love , Sections 7, 7-8, 10 of Y.C.Fung).

Variational methods : Variational problems and Euler's equation. Theorem of minimum potential energy. Theorem of minimum complementary energy. Reciprocal theorem of Betti and Rayleigh. Deflection of elastic string, central line of a beam and elastic membrane.

Variational problem related to the biharmonic equation. Solution of Euler's equation by Ritz, Galerkin and Kantorovich methods.

(Sections 106-113, 115 & 117 of Chapter VII of I.S.Sokolnikoff).

Books :

1. I.S.Sokolnikoff, Mathematical Theory of Elasticity, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1977.
2. A.E.H. Love, A Treatise on the Mathematical Theory of Elasticity L. Dover Publishing, New York.

3. Y.C. Fung. Fundation of Solid Mechanics, Prentice Hall, New Delhi 1965.

4. D.S. Chandrasekharaiah and L Debnath, Continuum Mechanics, Academic Press, 1994.

5. Shanti Narayan, Text Book of Cartesian Tensor, S.Chand & Co., 1950.

6. S. Timeshenki and N. Croodier. Theory of Elasticity, McGraw Hill, New Delhi, 1970.

7. I.H. Shames, Introduction to Solid Mechanics, Prentice Hall, New Delhi, 1975.

Paper VIII-MM 503 opt.(ii) : Number Theory

External Theory Marks: 80

Internal Assessment Marks: 20

Time: 3 Hours

NOTE: The examiner is requested to set ten questions by dividing the paper into the sections as indicated in the syllabus. The candidates are required to attempt five questions, selecting at least one question from each section.

Section - I (Three Questions):

The equation ax+by = c, simultaneous linear equations, Pythagorean triangles, some assorted examples, ternary quadratic forms, rational points on curves.

Farey sequences, rational approximations, Hurwitz theorem, irrational numbers, Geometry of Numbers, Blichfeldt's principle, Minkowski's Convex body theorem, Lagrange's four square theorem.

Scope as 5.1 to 5.6 and 6.1 to 6.4 of Book at Sr. no. 1

SECTION-II (Two Questions)

Euclidean algorithm, infinite continued fractions, irrational numbers, approximations to irrational numbers, Best possible approximations, Periodic continued fractions, Pell's equation, Numerical Computation, Partitions, Ferrers Graphs, Formal power series, generating functions and Euler's identity, Euler's formula, bounds on P(n), Jacobi's formula, a divisibility property.

Scope as 7.1 to 7.9 and 10.1 to 10.6 of Book at Sr. no. 1

SECTION-III (Three Questions)

Algebraic numbers and algebraic integers. Transcendental Numbers. Liouville's Theorem for real Algebraic numbers. Thue Theorem and Roth's theorem (statement only). Algebraic number field K. Theorem of Primitive elements. Liouville's Theorem for complex algebraic numbers. Minimal polynomial of an algebraic integer. Primitive m-th roots of unity. Cyclotomic Polynomials. Norm and trace of algebraic numbers and algebraic integers. Bilinear form on algebraic number field K.

Integral basis and discriminant of an algebraic number field. Index of an element of K. Ring O_K of algebraic integers of an algebraic number field K. Ideals in the ring of algebraic number field K. Integrally closed domains. Dedekind domains. Fractional ideals of K. Factorization of ideals as a product of prime ideals in the ring of algebraic integers of an algebraic number field K. G.C.D. and L.C.M. of ideals in O_K. Chinese Remainder theorem.

Scope as 3.1 to 3.4, 4.1 to 4.5 and 5.1 to 5.3 Book at Sr. no. 2

SECTION-IV (Two Questions)

Different of algebraic number field K. Dedekind theorem. Euclidean rings. Hurwitz Lemma and Hurwitz constant. Ideal class group and its finiteness. Quadratic reciprocity Legendre Symbol. Gauss sums. Law of quadratic reciprocity. Quadratic fields. Primes in special progression.

Scope as 5.4 to 5.6, 6.1, 6.2, & 7.1 to 7.6 of Book at serial No 2

Recommended Text:

1. An Introduction to the Theory of Numbers
   Ivan Niven
   Herbert S. Zuckerman
   Hugh L: Montgomery
   John Wiley & Sons(Asia)Pte.Ltd.
   (Fifth Edition)

2. Jody Esmonde and M.Ram Murty
   Problems in Algebraic Number Theory
   (Springer Verlag, 1998)

Paper IX- MM 504 opt (i) : Fluid Mechanics & Seismology

External Theory Marks: 80
Internal Assessment Marks: 20
Time: 3 Hours

NOTE: The examiner is requested to set ten questions by dividing the paper into the sections as indicated in the syllabus. The candidates are required to attempt five questions, selecting at least one from each section.

Section - I (Three Questions):

Kinematics of fluid in motion : Velocity at a point of a fluid. Lagrangian and Euerian methods. Stream lines, path lines and streak lines, Vorticity and circulation, Vortex lines, Acceleration and Material derivative, Equation of continuity (vector or Cartesian form). Reynolds transport theorem.

General analysis of fluid motion. Properties of fluids-static and dynamic pressure. Boundary surfaces and boundary surface conditions. Irotational and rotational motions. Velocity potential.

Equations of Motion : Lagrange's and Euler's equations of Motion (vector or in Cartesian form). Bernoulli's theorem. Applications of the Bernoulli Equation in one – dimensional flow problems.

Section - II (Two questions)

Kelvins circulation theorem, vorticity equation. Energy equation for incompressible flow. Kinetic energy of irrotational flow. Kelvins minimum energy theorem, Mean potential over a spherical surface. Kinetic energy of infinite liquid. Uniqueness theorems.

Stress components in a real fluid. Relations between rectangular components of stress. Connection between stresses and gradients of velocity. Navier – Stoke's equations of motion. Steady flows between two parallel plates. Plane Poiseuille and Couettee Flows.

Section - III (Three questions)

General form of progressive waves, Harmonic waves, Plane waves. Wave equation. Principle of superposition. Special types of solutions: Progressive and Stationary type solutions of wave equation. Spherical waves. Exponential form of harmonic waves. D' Alembert's formula.

(Relevant articles from the book "*Waves*" by Coulson & Jefferey)

Reduction of equation of motion to wave equations. P and S waves and their characteristics. Polarisation of plane P and S waves. Snell's law of reflection. Reflection of plane P and SV waves at a free surface.

Reflection and refraction of plane P, SV and SH waves at an interface.

(Relevant articles from the book, "*Elastic waves in Layered Media*" by Ewing et al).

SECTION-IV (Two Questions)

Dispersion. Relation between phase velocity and group velocity.

Surface waves : Rayleigh waves, Love waves and Stoneley waves.

Two dimensional Lamb's problems in an isotropic elastic solid: Area sources and Line Sources in an unlimited elastic solid. A normal force acting on the surface of a semi-infinite elastic solid. A normal line source acting on the surface of a semi-infinite elastic solid. Tangential area and line sources acting on the surface of a semi-infinite elastic solid. (Relevant articles from the book "*Mathematical Aspects of Seismology*" by M. Bath)

Introduction to Seismology: Location of earthquakes, Earthquake magnitude, Energy released by earthquakes, observation of earthquakes, interior of the earth. (Relevant articles from the book "*The Solid Earth*" by C.M.R.Fowler)

References :

1. W.H. Besant and A.S. Ramsey, A Treatise on Hydromechanics, Part-II, CBS Publishers, Delhi, 1988.
2. F. Chorlton, Text-book of Fluid Dynamics, C.B.S. Publishers, Delhi, 1985.
3. Michael E.O. Neill and F. Chorlton, Ideal and Incompressible Fluid Dynamics, John Wiley & Sons, 1986.
4. G.K. Batchelor, An Introduciton to Fluid Mechanics, Foundation Books, New Delhi, 1994.
5. A.J. Chorin and A. Marsden, A Mathematical Introduction to Fluid Dynamics Springer-Verlag, New York, 1993.

6. L.D. Landau and E.M. Lipschitz, Fluid Mechanics Pergamon Press, London, 1985.
7. R.K. Rathy. An Introduction to Fluid Dynamics, Oxford and IBH Publishing Company, New Delhi. 1976.
8. A.D. Young, Boundary Layers, AIAA Education Series, Washington DC, 1989.
9. C.M.R. Fowler, *The Solid Earth*, Cambridge University Press, 1990.
10. C.A. Coulson and A. Jefferey, *Waves*, Longman, New York, 1977.
11. M. Bath, *Mathematical Aspects of Seismology*, Elsevier Publishing Company, 1968.
12. W.M.Ewing, W.S. Jardetzky and F. Press, *Elastic Waves in Layered Media*, McGraw Hill Book Company, 1957.

Paper IX- MM 504 opt. (ii) Fuzzy Sets and Wavelets

External Theory Marks: 80
Internal Assessment Marks: 20
Time: 3 Hours

NOTE : The examiner is requested to set ten questions by dividing the paper into the sections as indicated in the syllabus. The candidates are required to attempt five questions, selecting at least one question from each section.

SECTION-I (Two Questions)

Fuzzy Sets: Basic definitions, α-cuts, strong α-cuts, level set of a fuzzy set, support of a fuzzy set, the core and height of a fuzzy set, normal and subnormal fuzzy sets, convex fuzzy sets, cutworthy property, strong cutworthy property, standard fuzzy set operations, standard complement, equilibrium points, standard intersection, standard union, fuzzy set inclusion, scalar cardinality of a fuzzy set, the degree of subsethood (Scope as in relevant parts of sections 1.3-1.4 of Chapter 1 of the book mentioned at Serial No. 1).

Additional properties of α-cuts involving the standard fuzzy set operators and the standard fuzzy set inclusion, Representation of fuzzy sets, three basic decomposition theorems of fuzzy sets Extension principle for fuzzy sets: the Zedah's extension principle, Images and inverse images of fuzzy sets, proof of the fact that the extension principle is strong cutworthy but not cutworthy (Scope as in relevant parts of Chapter 2 of the book mentioned at Serial No. 1).

Operations on fuzzy sets: types of operations, fuzzy complements, equilibrium of a fuzzy complement, equilibrium of a continuous fuzzy complement, first and second characterization theorems of fuzzy complements. Fuzzy intersections (t-norms), standard fuzzy intersection as the only idempotent t-norm, standard intersection, algebraic product, bounded difference and drastic intersection as examples of t-norms, decreasing generator, the Pseudo-inverse of a decreasing generator, increasing generators and their Pseudo-inverses, convertion of decreasing generators and increasing generators to each other, characterization theorem of t-norms(statement only). Fuzzy unions (t-conorms), standard union, algebraic sum, bounded sum and drastic union as examples of t-conorms, characterization theorem of t-conorms (Statement only), combination of operations, aggregation operations (Scope as in relevant parts of Chapter 3 of the book mentioned at Serial No. 1).

SECTION-II (Three Questions)

Fuzzy numbers, relation between fuzzy number and a convex fuzzy set, characterization of fuzzy numbers in terms of its membership functions as piecewise defined functions, fuzzy cardinality of a fuzzy set using fuzzy numbers, arithmetic operations on fuzzy numbers, extension of standard arithmetic operations on real numbers to fuzzy numbers. lattice of fuzzy numbers, (R, MIN, MAX) as a distributive lattice, fuzzy equations, equation A+X = B, equation A.X = B (Scope as in relevant parts of Chapter 4 of book mentioned at Serial No. 1).

Fuzzy Relations: Crisp and fuzzy relations, projections and cylindrical extensions, binary fuzzy relations, domain, range and height of a fuzzy relation, membership matrices, sagittal diagram, inverse of a fuzzy relation, composition of fuzzy relations, standard composition, max-min composition, relational join, binary relations on a single set, directed graphs, reflexive irreflexive, antireflexive, symmetric, asymmetric, antisymmetric, transitive (max-min transtitive), non transitive, antitransitive fuzzy relations. Fuzzy equivalence relations, fuzzy compatibility relations, α-compatibility class, maximal α-compatibles, complete α-cover, reflexive undirected graphs, fuzzy ordering relations, fuzzy upper bound, fuzzy pre ordering, fuzzy weak ordering, fuzzy strict ordering, fuzzy morphisms. Sup-i compositions of Fuzzy relations, Inf-i compositions of Fuzzy relations. **(Scope as in the relevant parts of Chapter 5 of the book mentioned at Serial No. 1).**

Possibility Theory : Fuzzy measures, continuity from below and above, semicontinuous fuzzy measures, examples and simple properties; Evidence Theory, belief measure, superadditivity, monotonicity, plausibility measure, subadditivity, basic assignment, its relation with belief measure and plausibility measure, focal element of basic assignment, body of evidence, total ignorance, Dempster`s rule of combination, examples; Possibility Theory, necessity measure, possibility measure, implications, possibility distribution function, lattice of possibility distributions, joint possibility distribution.

Fuzzy sets and possibility theory, Possibility theory versus probability theory **(Scope as in relevant parts of Chapter 7 of the book mentioned at Serial No. 1)**

SECTION-III (Two Questions)

Fourier Transform: Fourier transform in $L^1(\mathrm{R})$, properties of Fourier Transforms, Fourier transform in $L^2(\mathrm{R})$, Parseval Identities, Change of roof, Inversion formula, Plancherel Theorem, Duality Theorem, Poission summation formula, Sampling theorem, Heisenberg's uncertainty principle, Heisenberg's inequality.

Discrete Fourier transform, the DFT in matrix form, inversion theorem for DFT, DFT map as a linear bijection, Fast Fourier transform for N=2k, Buneman's Algorithm, FFT for N=RC, FFT factor form.

Wavelet Transform: Gabor transform, Parseval formula, Inversion formula, Continuous wavelet transform, Maxican hat wavelet, Properties of wavelet transforms, Discrete wavelet transform

(Scope of this section is indicated as in the relevant parts of the books mentioned at Serial No. 2 & 3.)

SECTION-IV (Three Questions)

Multi-resolution Analysis: Definition and examples of Multi-resolution Analysis, construction of Mother wavelet, Haar wavelet, Shannon wavelet,

wavelet Meyer wavelet, Franklin wavelet, from scaling function to MRA, Orthonormal spline wavelets, the construction of Compactly supported wavelets.

Construction of Wavelets : Biorthogonal wavelets, Wavelets in several variables, Wavelet packets, Multiwavelets, Wavelet frames.

Applications of Wavelets : Applications in Statistics, Neural Networks, Differential equations, Turbulance ,Medicine, Economics and Finance

(Scope of this section is indicated as in the relevant parts of the books mentioned at Serial No. 2 & 3.)

Books Recommended

1. G. J. Klir and B. Yuan : Fuzzy Sets and Fuzzy : Logic Theory and Applications, Prentice Hall of India, 2008
2. G. Bachman, L. Narici and E. Beckenstein : Fourier and Wavelet Analysis, Springer, 2000
3. K. Ahmad and F. A. Shah: Introduction to Wavelets with Applications, World Education Publishers, 2013

Reference Books

1. H. J. Zimmermann : Fuzzy Set Theory and Its Applications, Springer (Fourth Edition) 2001.
2. Hernandez and G. Weiss : A first course on wavelets, CRC Press, New York, 1996
3. C. K. Chui: An introduction to Wavelets, Academic Press, 1992
4. I. Daubechies : Ten lectures on wavelets, CBMS_NFS Regional Conferences in Applied Mathematics, 61, SIAM, 1992
5. V. Meyer, Wavelets, algorithms and applications SIAM, 1993
6. M.V. Wickerhauser: Adapted wavelet analysis from theory to software, Wellesley, MA, A.K. Peters, 1994
7. D. F. Walnut: An Introduction to Wavelet Analysis, Birkhauser, 2002

Paper X- MM 505 opt.(i) : Integral Equations & Boundary Value Problems

External Theory Marks: 80
Internal Assessment Marks: 20
Time: 3 Hours

NOTE : The examiner is requested to set ten questions by dividing the paper into the sections as indicated in the syllabus. The candidates are required to attempt five questions, selecting at least one from each section.

Section - I (Three Questions):

Definition of Integral Equations and their classifications. Eigen values and Eigen functions. Special kinds of Kernel Convolution Integral. The inner or scalar product of two functions. Reduction to a system of algebraic equations. Fredholm alternative. Fredholm theorem. An approximate method.

(Relevant portions from the Chapters 1 & 2 of the book "Linear Integral Equations, Theory & Techniques by R.P.Kanwal").

Method of successive approximations, Iterative scheme for Fredholm and Volterra Integral equations of the second kind. Conditions of uniform convergence and uniqueness of series solution. Some results about the resolvent Kernel. Application of iterative scheme to Volterra integral equations of the second kind.

(Relevant portions from the Chapters 3 of the book "Linear Integral Equations, Theory & Techniques by R.P.Kanwal").

Section - II (Two questions)

Symmetric Kernels, Introduction, Complex Hilbert space. An orthonormal system of functions, Riesz-Fisher theorem, A complete two-Dimensional orthonormal set over the rectangle $a \le s \le b, c \le t \le d$. Fundamental properties of Eigen values and Eigen functions for symmetric Kernels. Hilbert-Schmidt theorem and some immediate consequences. Solution of a symmetric Integral Equation.

(Relevant portions from the Chapter 7 of the book "Linear Integral Equation, Theory and Techniques by R.P.Kanwal").

The Abel Intergral Equation. Inversion formula for singular integral equation with Kernel of the type h(s)-h(t), $0<\alpha<1$, Cauchy's principal value for integrals solution of the Cauchy-type singular integral equation, closed contour, unclosed contours and the Riemann-Hilbert problem.

(Relevant portions from the Chapter 8 of the book "Linear Integral Equation, Theory and Techniques by R.P.Kanwal").

Section - III (Three questions)

Applications to Ordinary Differential Equations; Initial value problems, Boundary Value Problems. Dirac Delta functions. Green's function approach to reduce boundary value problems of a self-adjoint-differential equation with homogeneous boundary conditions to integral equation forms.

(Relevant portions from the Chapter 5 of the book "Linear Integral Equation, Theory and Techniques by R.P.Kanwal").

Applications to partial differential equations: Integral representation formulas for the solution of the Laplace and Poisson Equations. Interior and Exterior Dirichlet problems, Interior and Exterior Neumann problems. Green's function for Laplace's equation in a free space as well as in a space bounded by a ground vessel. Integral equation formulation of boundary value prolems for Laplace's equation. Poisson's Integral formula.

(Relevant portions from the Chapter 6 of the book "Linear Integral Equation, Theory and Techniques by R.P.Kanwal").

SECTION-IV (Two Questions)

Integral Transform methods: Introduction, Fourier transform. Laplace transform. Convolution Integral. Application to Volterra Integral Equations with convolution-type Kernels. Hilbert transform. Applications to mixed Boundary Value Problems: Two-part Boundary Value problems, Three-part-Boundary Value Problems, Generalized Three-part Boundary Value problems.

(Relevant portions from the Chapter 9 and 10 of the book "Linear Integral Equation, Theory and Techniques by R.P.Kanwal").

References:

1. R.P.Kanwal, Linear Integral Equations, Theory and Techniques, Academic Press, New York.
2. S.G.Mikhlin, Linear Integral Equations (translated from Russian) Hindustan Book Agency, 1960.
3. I.N.Sneddon, Mixed Boundary Value Problems in potential theory, North Holland, 1966.
4. I, Stakgold, Boundary Value Problems of Mathematical Physics Vol.I, II, Mac.Millan, 1969.
5. Pundir and Pundir, Integral Equations and Boundary value problems, Pragati Prakashan, Meerut.

Paper IX- MM 505 (ii) : Coding Theory and Noncommutative Rings

External Theory Marks: 80

Internal Assessment Marks: 20

Time: 3 Hours

NOTE : The examiner is requested to set ten questions by dividing the paper into the sections as indicated in the syllabus. The candidates are required to attempt five questions, selecting at least one from each section.

Section - I (Two Questions):

Block Codes. Minimum distance of a code. Decoding principle of maximum likelihood. Binary error detecting and error correcting codes. Group codes. Minimum distance of a group code (m, m+1) parity check code. Double and triple repition codes. Matrix codes. Generator and parity check matrices. Dual codes. Polynomial codes. Exponent of a polynomial over the binary field.

Finite fields. Construction of finite fields. Primitive element of a finite field. Irreducibility of polynomials over finite fields. Irreducible polynomials over finite fields. Primitive polynomials over finite fields. Automorphism group of $GF(q^n)$. Normal basis of $GF(q^n)$. The number of irreducible polynomials over a finite field. The order of an irreducible polynomial. Generator polynomial of a Bose-Chaudhuri-Hocqhenghem codes (BCH codes) construction of BCH codes over finite fields. (Chapter 1,2,4 of the book given at Sr. No.1).

SECTION – II (Three Questions)

Binary representation of a number. Hamming codes. Minimum distance of a Hamming code. Linear codes. Generator matrices of linear codes. Equivalent codes and permutation matrices. Relation between generator and parity-check matrix of a linear codes over a finite field. Dual code of a linear code. Self dual codes. Weight distribution of a linear code. Weight enumerator of a linear code. Hadamard transform. Macwilliams identity for binary linear codes.

Maximum distance separable codes. (MDS codes). Examples of MDS codes. Characterization of MDS codes in terms of generator and parity check matrices. Dual code of a MDS code. Trivial MDS codes. Weight distribution of a MDS code. Number of code words of minimum distance d in a MDS code.

Reed solomon codes. Hadamard matrices. Existence of a Hadamard matrix of order n. Hadamard codes from Hadamard matrices.

Cyclic codes. Generator polynomial of a cyclic code. Check polynomial of a cyclic code. Equivalent code and dual code of a cyclic code. Idempotent generator of a cyclic code. Hamming and BCH codes as cyclic codes. Perfect codes. The Gilbert-varsha-move and Plotkin bounds. Self dual binary cyclic codes. (Chapter 3,5,6,9,11 of the book given at Sr. No. 1).

SECTION – III (Three Questions)

Basic terminology and examples of non-commutative rings i.e. Hurwitz's ring of integral quaternions, Free k-rings. Rings with generators and relations. Hilbert's Twist, Differential polynomial rings, Group rings, Skew group rings, Triangular rings, D.C.C. and A.C.C. in triangular rings. Dedekind finite rings. Simple and semi-simple modules and rings. Spliting homomorphisms. Projective and Injective modules. Ideals of matrix ring $M_n(R)$.

Structure of semi simple rings. Wedderburn-Artin Theorem Schur's Lemma. Minimal ideals. Indecomposable ideals. Inner derivation δ. δ-simple rings. Amitsur Theorem on non-inner derivations. Jacobson radical of a ring R.Annihilator ideal of an R-module M. Jacobson semi-simple rings. Nil and Nilpotent ideals. Hopkins-Levitzki Theorem. Jacobson radical of the matrix ring $M_n(R)$. Amitsur Theorem on radicals. Nakayama's Lemma. Von Neumann regular rings. E. Snapper's Theorem. Amitsur Theorem on radicals of polynomial rings. (Section 1.1 to 1.26 and Section 2.1 to 2.9, Section 3.1 to 3.19, Sections 4.1 to 4.27, Section 5.1 to 5.10 of the book given at Sr. No. 3).

SECTION – IV (Two Questions)

Prime and semi-prime ideals. m-systems. Prime and semi-prime rings. Lower and upper nil radical of a ring R Amitsur theorem on nil radical of polynomial rings. Brauer's Lemma. Levitzki theorem on nil radicals. Primitive and semi-primitive rings. Left and right primitive ideals of a ring R. Density Theorem. Structure theorem for left primitive rings.

Sub-direct products of rings. Subdirectly reducible and irreducible rings. Birchoff's Theorem. Reduced rings. G.Shin's Theorem. Commutativity Theorems of Jacobson, Jacobson-Herstein and Herstein Kaplansky. Division rings. Wedderburn's Little Theorem. Herstein's Lemma. Jacobson and

Frobenius Theorem. Cartan-Brauer-Hua Theorem. Herstein's Theorem. (Section 10.1 to 10.30, Section 11.1 to 11.20, Sections 12.1 to 12.11 and Sections 13.1 to 13.26 of the book given at Sr. No. 3).

Recommended Text:

1. L.R. Vermani : Elements of Algebraic Coding Theory (Chapman and Hall Mathematics)
2. Steven Roman: Coding and Information Theory (Springer Verlag)
3. T.Y. Lam : A First Course in Noncommutive Rings, (Springer Verlag 1990)
4. I.N. Herstein : Non-Commutative Rings carus monographs in Mathematics Vol.15. Math Asso. of America 1968.