Scheme of Examination-Semester System
For
M.Phil. Mathematics(Semester – I, II)
(*w.e.f. Session 2009-10*)

SEMESTER-I

Paper	Title of the Paper	Theory Marks	Internal-Assessment Marks	Total Marks	Time
MPM: 611 (Compulsory)	Advanced Functional Analysis	80	20	100	3 Hours
MPM: 612*	One paper either from Group P_1 or Group A_1	80	20	100	3 Hours
MPM: 613*	One paper either from Group P_1 or Group A_1	80	20	100	3 Hours
TOTAL MARKS OF SEMESTER-I				300	
*Students are required to opt. papers MPM: 612 and MPM: 613 both either from Group P_1 or Group A_1 in ascending order of the suffixes.					

Group P_1

Option(P_{11}): Advanced Topology
Option(P_{12}): Fuzzy Set Theory
Option(P_{13}): Algebraic Coding Theory
Option(P_{14}): Algebraic Number Theory

Group A_1

Option(A_{11}): Advanced Solid Mechanics
Option(A_{12}): Waves and Viscoelasticity
Option(A_{13}): Computational Biology
Option(A_{14}): Mathematical Modelling
Option(A_{15}): Computational Elasticity

Note 1: The marks of internal assessment of each paper shall be split as under :

Two Assignments(5 Marks each)	:	10 marks
Seminar	:	10 marks
Total	:	20 marks

Note 2: The syllabus of each paper will be divided into **three or four** sections of **two or three** questions each. The question paper will consist of **eight** questions divided into sections as indicated in the syllabus. The students shall be asked to attempt **five** questions selecting atleast **one** question from each section.

Note 3: As per UGC recommendations, the teaching program shall be supplemented by tutorials and problem solving sessions for each theory paper.

Note 4: Optional papers can be offered subject to availability of requisite resources/ faculty.

SEMESTER-II

Paper	Title of the Paper	Theory Marks	Internal-Assessment Marks	Total Marks	Time
MPM: 621*	One paper either from Group P_2 or Group A_2	80	20	100	3 Hours
MPM: 622*	One paper either from Group P_2 or Group A_2	80	20	100	3 Hours
TOTAL MARKS OF SEMESTER-II				200	
*Students are required to opt. papers MPM: 621 and MPM: 622 both either from Group P_2 or Group A_2 in ascending order of the suffixes.					

Group P_2(Pre-requisite : Group P_1)

Option(P_{21}): Fuzzy Sets and Logic
Option(P_{22}): Non Linear Functional Analysis
Option(P_{23}): Fixed Point Theory
Option(P_{24}): Fuzzy Topology
Option(P_{25}): Theory of Operators
Option(P_{26}): Cyclic and MDS Codes

Group A_2(Pre-requisite : Group A_1)

Option(A_{21}): Theoretical Seismology
Option(A_{22}): Advanced Mathematical Methods
Option(A_{23}): Bio-Fluid Dynamics
Option(A_{24}): Magnetic Hydrodynamics
Option(A_{25}): Computational Fluid Dynamics

Note 1: The marks of internal assessment of each paper shall be split as under :

Two Assignments(5 Marks each)	:	10 marks
Seminar	:	10 marks
Total	:	20 marks

Note 2: The syllabus of each paper will be divided into **three or four** sections of **two or three** questions each. The question paper will consist of **eight** questions divided into sections as indicated in the syllabus. The students shall be asked to attempt **five** questions selecting atleast **one** question from each section.

Note 3: As per UGC recommendations, the teaching program shall be supplemented by tutorials and problem solving sessions for each theory paper.

Note 4: Optional papers can be offered subject to availability of requisite resources/ faculty.

DISSERTATION

In addition to papers of Semester-I and Semester-II, there will be a paper on Dissertation, during the course of study. The Dissertation (Theory) and the Viva Voce examination on the Dissertation will be of 150 and 50 marks respectively.

Division of Marks	Total Marks
TOTAL MARKS OF SEMESTER-I	300
TOTAL MARKS OF SEMESTER-II	200
TOTAL MARKS OF DISSERTATION AND VIVA VOCE	200
GRAND TOTAL	700

SEMESTER-I

MPM611 : Advanced Functional Analysis

Max. Marks : 80
Time : 3 hours

Section – I (Three Questions)

Contraction mapping theorem and its applications to differential equation, integral equation and system of linear equations. Equicontinuity, Arzla-Ascoli theorem and its application to differential equations. Weierstrass's Approximation Theorem, Stone-Weierstrass's Approximation Theorem. Semi-continuity and its applications to Arclength.

Section-II (Three Questions)

Definition of normed and Banach algebras with identity. Haar measure. Regular points and spectrum. Compactness of spectrum. Resolvent function and its analyticity in the set of regular points. Gelfand's theorem about isomorphism between Banach algebras and complex numbers. Spectral radius and the spectral mapping theorem for polynomial Ideals and Maximal ideals in commutative Banach algebras with identity. The set C(M) of complex functions on the set M of maximal ideals in a Banach algebra. Gelfand representation for algebras with identity.

Section – III (Two Questions)

Bilinear Mappings, Bounded bilinear mappings, sesquilinear mappings, Hermitian form, bounded sesquilinear mappings, bounded sesquilinear forms in Hilbert space.

Note: Question Paper will consist of **eight** questions divided into **three** Sections as indicated in the syllabus. Candidates are required to attempt **five** questions, selecting at least one question from each Section.

Books Recommended:

1. Bachman, G. and Lawrerie Narici, Functional Analysis, Academic Press.
2. Goffman, C. and G. Pedrick, First Course in Functional Analysis .
3. Berberian, S.K., Introduction to Hilbert Spaces, (Chelsea Publishing Co. N.Y.).
4. Babu Ram, Metric Spaces, Vinayaka Publications, New Delhi.

Group A_1:(Option (A_{11})) : Advanced Solid Mechanics

Max. Marks : 100
Time : 3 Hours

Section-I (Three Questions)

Non-Linear Theory

Deformation gradient tensor. Decomposition of a deformation stretch and rotation. Strain tensors. Strain-displacement relations. Principal stretches. Strain invariants. Length and angle changes. Deformation of volume and surface elements. Homogeneous deformation-dilation, simple extension and simple shear plane strain.

Material derivative. Velocity and acceleration fields. Principle of conservation of mass-equation of continuity. Principles of balance of linear and angular momentum. Equations of motion in spatial coordinates. Principle of conservation of energy. Piola stresses. Equations of motion in material co-ordinates.

Section-II (Three Questions)

General Solution of the equilibrium equations

Papkovitch-Neuber solution. Lame's strain potential Galerkin vector. Love's strain function. Applications to the solution of the Kelvin problem for an unbounded medium and the boussinesq problem for a semi-infinite medium.

Exact solution of some linear elastic problems

Spherical shall subject to a internal and external pressures. Gravitating elastic sphere. Generalized Hooke's law including the effect of thermal expansion. Navier's equation, thermal stresses in a long circular cylinder. Thermal stresses in a sphere.

Section-III (Two Questions)

Theory of Plasticity

The stress and strain derivations, Yield conditions, Stress-strain relations, Solution of plastic-elastic problems, Compression of a rectangular beam, Pure bending of a rectangular beam, Plastic-elastic torsion of a beam, Circular cross-section, Residual stresses in case of pure bending of a rectangular beam, Torsion of a circular beam.

Note: Question Paper will consist of **eight** questions divided into **three** Sections as indicated in the syllabus. Candidates are required to attempt **five** questions, selecting at least one question from each Section.

Books Recommended:

1. Atkin, R.J. and N. Fox, An Introduction to the Theory of Elasticity.
2. Bath, M., Mathematical Aspects of Seismology, Elsevier.
3. Bullen, K.E. and A. Bolt, An Introduction to the Theory of Seismology, Cambridge University Press.
4. Fung, Y.C., Foundations of Solid Mechanics.
5. Gubbins, D., Seismology and Plate Tectonics, Cambridge University Press.
6. Mal, A.K. and Singh, S.J., Deformation of Elastic solids, Prentice Hall.
7. Hoffman, O. and Sachs, G., Introduction to Theory of Plasticity for Engineers, McGraw Hill Book Co.
8. Godfrey, D. E. R., Theory of Plasticity and Plasticity for Engineers, Thames and Hudson, London

Group A_1:(Option (A_{12})) : Waves and Viscoelasticity

Max. Marks : 100
Time : 3 Hours

Section-I (Two Questions)

Waves on Strings

Free vibrations of an infinite string. Reflection at a change of density. Reflection at a concentrated load. Strings of finite length-normal modes. String plucked at its mid-point. String with load at its mid point. (Coulson: Waves, Secs. 13-23).

Lamb's Problem : A periodic line or normal point force acting on the surface of a semi-infinite elastic solid (formal solution only).

Section-II (Three Questions)

Liquid Waves

Types of liquid waves, Gravity waves, Particle path, Waves in deep water, Wave energy, Rate of transmission of energy for harmonic wave, Group velocity, Effect of surface tension, Stationary waves, Waves in a canal, rectangular tank, cylindrical tank. Complex potential for a simple harmonic progressive wave, Waves on the surface of a uniform stream, Waves at the interface between fluids and effect of surface tension, Circular waves.

Section-III (Three Questions)

Viscoelasticity

Spring and dashpot. Maxwell and Kelvin models. Three parameter solid. Constitutive equations for generalized Maxwell and Kelvin models. Creep compliance and relaxation modulus. Hereditary integrals. Vibrations-complex compliance dissipation, application to specific materials, the simple spring-mass system, forced vibrations. Stress-strain relations for viscoealstic body. Correspondence principle and its application to the deformation of a viscoelastic thick-walled tube in plane strain. (Relevent Sections of Flugge's book "Viscoelasticity").

Note: Question Paper will consist of **eight** questions divided into **three** Sections as indicated in the syllabus. Candidates are required to attempt **five** questions, selecting at least one question from each Section.

Books Recommended:

1. Atkin, R.J. and N. Fox, An Introduction to the Theory of Elasticity.
2. Bath, M., Mathematical Aspects of Seismology, Elsevier.
3. Ben-Menahem, A. and S.J. Singh, Seismic Waves and Sources, Springer.
4. Bullen, K.E. and A. Bolt, An Introduction to the Theory of Seismology, Cambridge University Press.
5. Coulson, C.A., Waves, Longman.
6. Flugge, W., Viscoelasticity.
7. Fung, Y.C., Foundations of Solid Mechanics.
8. Besant, W. H. and Ramsey, A. S., A Treatise on Hydrmechanics.

Group A_1:(Option (A_{13})) : Computational Biology

Max. Marks : 100
Time : 3 Hours

Section I (3 Questions)

Basic concepts of molecular biology. DNA and Proteins. The Central Dogma. Gene and Genome Sequences.

Restriction Maps - Grphas, Interval graphs. Measuring Fragment sizes.

Section II (2 Questions)

Algorithms for double digest problem (DDP) - Algorithms and complexity, approaches to DDP. Integer Programming. Partition problems. Travelling Salesman Problem (TSP) simulated annealing.

Section III (3 Questions)

Sequence Assembly – Sequencing strategies. Assembly in practices, fragment overlap statistics, fragment alignment, sequence accuracy.

Sequence comparisons Methods - Local and global alignment. Dynamic programming method. Multiple sequence alignment.

Note: Question Paper will consist of **eight** questions divided into **three** Sections as indicated in the syllabus. Candidates are required to attempt **five** questions, selecting at least one question from each Section.

Books Recoimmended:

1. M.S. Waterman, Introduction to Computational Biology, Chapman & Hall, 1995.
2. A. Baxevanis and B. Quelette, Bioinformatics, A Practical Guide to the analysis of Genes and Proteins, Wiley Interscience (1998).

Group A_1:(Option (A_{14})) : Mathematical Modelling

Max. Marks : 100
Time : 3 Hours

(Syllabi to be Framed Later on)

Group A_1:(Option (A_{15})) : Computational Elasticity

Max. Marks : 100
Time : 3 Hours

(Syllabi to be Framed Later on)

Group P_1:(Option (P_{11})) : Advanced Topology

Max. Marks : 80
Time : 3 Hours

Section-I (Three Questions)

Definition of uniform structures, Fundamental system of entourages, Topology of uniform spaces, Characterization of uniform space in terms of Hausdorff space, Uniform continuous functions, Inverse image of uniformity, Complete spaces, and Cauchy criteria, Minimal Cauchy filters. Subspaces of complete spaces, Uniformity of compact spaces, Compactness in a uniform space. Pre-compact uniform space.

Section-II (Three Questions)

Covering of spaces, paracompact spaces, Michael Theorem on characterization of paracompactness in regular spaces, Metric spaces as paracompact spaces, Michael Theorem on invariance of paracompactness under continuous closed surjection, Types of refinements, Barycentric refinements, Star refinements, Stone's Theorem of characterization of paracompact spaces by Barycentric refinements, Nagata Smirnov Metrization Theorem, Characterizaton of paracompact spaces in regular and normal spaces, Countably paracompact spaces.

Section-III (Two Questions)

Definition of topological vector spaces, Types of Topological vector spaces, Convex and balanced neighbourhoods, Continuity properties of linear mappings, Finite dimensional spaces, Locally compact topological vector space, Metrizability, Cauchy sequences, Boundedness, Bounded linear transformations, Seminorms and local convexity, Space of measurable functions.

Note: Question Paper will consist of **eight** questions divided into **three** Sections as indicated in the syllabus. Candidates are required to attempt **five** questions, selecting at least one question from each Section.

Books Recommended:

1. Engelking, R., Outline of General Topology
2. Nagata, J., Modern General Topology
3. Willards, S., General Topology
4. Kelley, J.L., General Topology.
5. Introduction to General Topology, K.D. Joshi, Wiley Eastern Limited.
6. Nicolar Bourbaki, Elements of Mathematics General Topology, Springer.

Group P_1:(Option (P_{12})) : Fuzzy Set Theory

Max. Marks : 80
Time : 3 hours

Section-I (3 Questions)

Definition of Fuzzy Set, Expanding Concepts of Fuzzy Set, Standard Operations of Fuzzy Set, Fuzzy Complement, Fuzzy Union, Fuzzy Intersection, Other Operations in Fuzzy Set, T- norms and T- conorms. (Chapter 1of [1])

Product Set, Definition of Relation, Characteristics of Relation, Representation Methods of Relations, Operations on Relations, Path and Connectivity in Graph, Fundamental Properties, Equivalence Relation, Compatibility Relation, Pre-order Relation, Order Relation, Definition and Examples of Fuzzy Relation, Fuzzy Matrix, Operations on Fuzzy Relation, Composition of Fuzzy Relation, α - cut of Fuzzy Relation,

Section-II (3 Questions)

Projection and Cylindrical Extension, Extension by Relation, Extension Principle, Extension by Fuzzy Relation, Fuzzy distance between Fuzzy Sets. (Chapter 2,3 of [1])

Graph and Fuzzy Graph, Fuzzy Graph and Fuzzy Relation, α - cut of Fuzzy Graph, Fuzzy Network, Reflexive Relation, Symmetric Relation, Transitive Relation, Transitive Closure, Fuzzy Equivalence Relation, Fuzzy Compatibility Relation, Fuzzy Pre-order Relation, Fuzzy Order Relation, Fuzzy Ordinal Relation, Dissimilitude Relation, Fuzzy Morphism, Examples of Fuzzy Morphism. (Chapter 4 of [1])

Section-III (2 Questions)

Interval, Fuzzy Number, Operation of Interval, Operation of α - cut Interval, Examples of Fuzzy Number Operation,, Definition of Triangular Fuzzy Number, Operation of Triangular Fuzzy Number, Operation of General Fuzzy Numbers, Approximation of Triangular Fuzzy Number, Operations of Trapezoidal Fuzzy Number, Bell Shape Fuzzy Number.

Function with Fuzzy Constraint, Propagation of Fuzziness by Crisp Function, Fuzzifying Function of Crisp Variable, Maximizing and Minimizing Set, Maximum Value of Crisp Function, Integration and Differentiation of Fuzzy Function. (Chapter 5,6 of [1])

Note: Question Paper will consist of **eight** questions divided into **three** Sections as indicated in the syllabus. Candidates are required to attempt **five** questions, selecting at least one question from each Section.

Books Recommended:

1. Kwang H. Lee, First Course on Fuzzy Theory and Applications, Springer International Edition, 2005.
2. H.J. Zimmerman, Fuzzy Set Theory and its Applications, Allied Publishers Ltd., New Delhi, 1991.
3. John Yen, Reza Langari, Fuzzy Logic - Intelligence, Control and Information, Pearson Education.

Group P_1:(Option (P_{13})) : Algebraic Coding Theory

Max. Marks : 80
Time : 3 hours

Section -I (3 Questions)

The communication channel. The Coding Problem. Types of Codes. Block Codes. Error-Detecting and Error-Correcting Codes. Linear Codes. Hamming Metric. Description of Linear Block Codes by Matrices. Dual Codes. Hamming Codes, Golay Codes, perfect and quasi-perfect codes.

Section -II (3 Questions)

Modular Representation. Error-Correction Capabilities of Linear Codes. Tree Codes. . Description of Linear Tree. Bounds on Minimum Distance for Block Codes. Plotkin Bound. Hamming Sphere Packing Bound. Varshamov-Gilbert – Sacks Bound. Bounds for Burst-Error Detecting and Correcting Codes.

Section -III (2 Questions)

Convolutional Codes and Convolutional Codes by Matrices. Standard Array. Bounds on minimum distance for Convolutional Codes. V.G.S. bound. Bounds for Burst-Error Detecting and Correcting Convolutional Codes. The Lee metric, packing bound for Hamming code w.r.t. Lee metric.

Note: Question Paper will consist of **eight** questions divided into **three** Sections as indicated in the syllabus. Candidates are required to attempt **five** questions, selecting at least one question from each Section.

Books Recommended:

1. Ryamond Hill, A First Course in Coding Theory, Oxford University Press, 1986.
2. Man Young Rhee, Error Correcting Coding Theory, McGraw Hill Inc., 1989.
3. W.W. Petersona nd E.J. Weldon, Jr., Error-Correcting Codes. M.I.T. Press, Cambridge Massachuetts, 1972.
4. E.R. Berlekamp, Algebraic Coding Theory, McGraw Hill Inc., 1968.
5. F.J. Macwilliams and N.J.A. Sloane, Theory of Error Correcting Codes, North-Holand Publishing Company.
6. J.H. Van Lint, Introduction to Coding Theory, Graduate Texts in Mathematics, 86, Springer, 1998.
7. L.R. Vermani, Elements of Algebraic Coding Theory, Chapman and Hall, 1996.

Group P_1:(Option (P_{14})) : Algebraic Number Theory

Max. Marks : 100
Time : 3 Hours

Section-I (2 Questions)

Algebraic numbers, algebraic integers, countability of set of algebraic numbers, Liouville's theorem and generalizations, transcendental numbers, algebraic number fields, Liouville's Theorem of Primitive elements, ring of algebraic integers, Theorem of Primitive Elements(Chapter 3 of book at Sr. No. 1).

Section-II (3 Questions)

Norm and trace of an algebraic number, non degeneracy of bilinear pairing, existence of an integral basis, Discriminant of an algebraic number field, Ideals in the ring of algebraic integers, explicit construction of integral basis, Sign of the discriminant, cyclotomic fields, calculation for quadratic and cubic cases (Chapter 4 of book at Sr. No. 1).

Section-III (3 Questions)

Integral closure, Noetherian ring, characterizing Dedekind domains, fractional ideals and unique factorization, g.c.d. and L.C.M. of Ideals, Chinese remainder theorem, Dedekind's theorem, ramified and unramified extensions. Different of an algebraic number field, factorization in the ring of algebraic integers (Chapter 5 of book at Sr. No. 1).

Note: Question Paper will consist of **eight** questions divided into **three** Sections as indicated in the syllabus. Candidates are required to attempt **five** questions, selecting at least one question from each Section.

Books Recommended:

1. Esmonde and M Ram Murty, Problems in Algebraic Number Theory, GTM Vol. 190, Springer Verlag, 1999.
2. Leveque, W.J., Topics in Number Theory – Vols. I, III Addition Wesley.
3. Narasimhan and others, Algebraic Number Theory, TIFR Pamphlet No. 4
4. Pollard, H., The Theory of Algebraic Number, Carus Monogrpah No. 9, Mathematical Association of America.
5. Riebenboim, P., Algebraic Numbers – Wiley Inter-science.
6. Weiss, E., Algebraic Number Theory, McGraw Hill.

SEMESTER-II

Group A_2:(Option (A_{21})): Theoretical Seismology

Max. Marks : 100
Time : 3 Hours

Section-I(3 Questions)

Basic seismological theory: Waves on a string; Theory, Harmonic wave solution, Reflection and transmission. Energy in a harmonic wave, Normal modes of a string. Seismic Waves: The seismic wave equation, plane waves, spherical waves, P and S Waves. Energy in a plane wave. Snell's Law: The layered medium, approximation, plane wave potentials for a layered medium. Angle of incidence and apparent velocity. Snell's law, Critical angle, Snell's law for SH waves. Ray parameter and slowness. Waveguides, Fermat's principle and geometric Ray Theory. Hygen's Principle and diffraction

Section-II(3 Questions)

Plane wave reflection and transmission coefficients: Introduction, SH Wave reflection and transmission coefficients. Energy flux for reflected and transmitted SH waves. Post critical SH wave, P-SV waves at a free surface. Solid-solid and solid-liquid interfaces.

Surface waves: Introduction, Rayleigh waves in a homogeneous half space, Love waves in a layer over a half space. Dispersion: Phase and group velocity, Dispersive signals, Surface wave dispersion studies, Love wave Dispersion.

Section-III(2 Questions)

Normal modes of the earth: Motivation, Modes of a sphere, Spherical harmonics, Tortional modes, Spheroidal modes.

Seismic Sources: Faulting sources, Equivalent Body forces, Elastostatics: Static displacement field due to a single force. Static displacement field due to a force couple, Static displacement field due to a double couple.

Note: Question Paper will consist of **eight** questions divided into **three** Sections as indicated in the syllabus. Candidates are required to attempt **five** questions, selecting at least one question from each Section.

Books Recommended:

1. Seth Stein and Michael Wysession; An Introduction to Seismology, Earthquakes and Earth Structure, Blackwell Publishing Ltd., 2003.
2. Thorne Lay and Torey C. Wallace; Modern Global Seismology, Academic Press, 1995.
3. Peter M. Shearer; Introduction to Seismology, Cambridge University Press, 1999.
4. K. E. Bullen and B. A. Bolt; Introduction to the Theory of Seismology, Cambridge University, Press, 1985.
5. W. M. Ewing, W. S. Jardetzky and F. Press; Elastic Waves in Layered Media, McGraw Hill Book Co.

Group A_2:(Option (A_{22})): Advanced Mathematical Methods

Max. Marks : 100
Time : 3 Hours

Section-I (3 Questions)

Modified Bessel functions, Ber and Bei functions, Kelvin functions, Hankel and Spherical Bessel functions, Modified spherical Bessel functions, Legendre's associated differential equations, Legendre's associated functions $P_n^m(x)$ and $Q_n^m(x)$, Recurrence relations and integral expression for associated Legendre functions.

Dirac delta function, Heaviside's unit step function and relation between them. Integral representation of delta function. Signum function, Boxar function and impulsive function.

Section-II (Three Questions)

Hankel transform of elementary functions. Operational properties of the Hankel transform. Applications of Hankel transforms to PDE.

Mellin Transform of elementary functions and its basic operational properties. Application of Mellin transform to BVP, integral equations and summation of series.

Definition and basic properties of finite Fourier sine and cosine transforms, its applications to the solutions of BVP's and IVP's.

Section-III (Two Questions)

Hilbert transform and its basic properties. Hilbert transform in the complex plane. Applications of Hilbert transform.

Stieltjes transform and its basic operational properties, Inversion theorem. Applications of Stieltjes transform.

Note: Question Paper will consist of **eight** questions divided into **three** Sections as indicated in the syllabus. Candidates are required to attempt **five** questions, selecting at least one question from each Section..

Books Recommended:

1. E. D. Rainville; Special Functions.
2. Peter V. O'Neil; Advanced Engineering Mathematics, An International Thomson Publishing Company.
3. J. W. Dettman; Mathematical Methods in Physics and Engineering, McGraw Hill Book Company, 1962.
4. I. N. Sneddon; Special function of Mathematical Physics and Chemistry.
5. Lokenath Debnath; Integral Transforms and their Applications, CRC Press, Inc., 1995.
6. Sneddon, I.N., The Use of Integral Transform.

Group A_2:(Option (A_{23})): Bio-Fluid Dynamics

Max. Marks : 100
Time : 3 Hours

Section I (Three Questions)

Introduction: Viscosity, Laminar and Turbulent flow, Compressible and Incompressible flow Basic equation of fluid mechanics : Continuity equation, Equation of motion, Simplification of basic equations, Initial and boundary conditions, Dimensional analysis in fluid mechanics.

Circulatory Bio-Fluid Mechanics : General Introduction, The circulatory system : Introduction, Systematic and Pulmonary circulations. The circulation in the heart, Diseases relative to circulation.

Section II (Two Questions)

Blood Rehology properties of flowing blood : General Introduction, Blood composition, Structure of Blood. Flow properties of blood: Viscosity of blood, Yield stress of blood. Blood vessel structure: Arteries and Arterioles, Veins and Venules, Capillary, Diseases related to obstruction of blood flow: Thrombus formation, Embolus, Compieression, Structural defect.

Section III (Three Questions)

Models of bio-fluid flows : Flows in pipes and duct, Models of blood flows: Introduction, Poiseuilles, flow, Consequences of Pioseuilles's flow: Applications of Poiseuilles flow, Law for study of blood flow, Pulsatile flow, Discussion on pulsatile flow, The pulse wave. Mones-Korteweg expression for wave velocity in an inviscid fluid filled elastic cylindrical tube. Application in the cardiovascular system, Wave propagation, Accounting for viscosity and its applications to cardiac out put determination. Flow through a covering and diverging duct.

Note: **Question Paper will consist of** eight **questions divided into** three **Sections as indicated in the syllabus. Candidates are required to attempt** five **questions, selecting at least one question from each Section.**

Books Recommended:

1. Bio-Fluid Mechanics by Jagan N. Mazumdar published by World Scientific Publisher.
2. Blood flow in artery By Donald A. McDonald Published by Edward Arnold Press.
3. Bio-Dynamics by Y.C. Fung published by Springer Verlag.
4. Blood viscosity, hyperviscosity and hyper viscoseamia by L. Dintenfass published by MTP Press USA.

Group A_2:(Option (A_{24})): Mathematical Modelling

Max. Marks : 100
Time : 3 Hours

(Syllabi to be Framed Later on)

Group A_2:(Option (A_{25})): Computational Elasticity

Max. Marks : 100
Time : 3 Hours

(Syllabi to be Framed Later on)

Group P_2:(Option (P_{21})) : Fuzzy Sets and Logic

Max. Marks : 80
Time : 3 hours

Section-I(2 Questions)

Probability Theory, Probability Distribution, Comparison of Probability and Possibility, Fuzzy event, Crisp Probability of Fuzzy Event, Fuzzy Probability of Fuzzy Event, Uncertainty Level of Element, Fuzziness of Fuzzy Set, Measure of Fuzziness, Measure using Entropy, Measure using Metric Distance. (Chapter 7 of book at serial no. 1)

Section-II(3 Questions)

Proposition Logic, Logic Function, Tautology and Inference Rule, Predicate Logic, Quantifier, Fuzzy Expression, Operators in Fuzzy Expression, Some Examples of Fuzzy Logic Operations, Linguistic Variable, Fuzzy Predicate, Fuzzy Modifier, Fuzzy Truth Values, Examples of Fuzzy Truth Quantifier, Inference and Knowledge Representation, Representation of Fuzzy Predicate by Fuzzy Relation, Representation of Fuzzy Rule.

Extension Principle and Composition, Composition of Fuzzy Sets, Composition of Fuzzy Relation, Example of Fuzzy Composition, Fuzzy if-then Rules, Fuzzy Implications, Examples of Fuzzy Implications, Decomposition of Rule Base, Two-Input/ Single-Output Rule Base, Compositional Rule of Inference, Fuzzy Inference with Rule Base, Inference Methods, Mamdani Method, Larsen Method, Tsukamoto Method, TSK Method. (Chapter 8,9 of book at serial no. 1)

Section-III(3 Questions)

Advantage of Fuzzy Logic Controller, Configuration of Fuzzy Logic Controller, Choice of State Variables and Control Variables, Fuzzification Interface Component, Data Base, Rule Base, Decision Making Logic, Mamdani Method, Larsen Method, Tsukamoto Method, TSK Method, Mean of Maximum Method, Center of Area Method(COA), Bisector of Area, Lookup Table, Design Procedure of Fuzzy Logic Controller, Application Example of FLC Design, Fuzzy Expert Systems. (Chapter 10 of book at serial no. 1)

Applications of Fuzzy Set Theory in Natural, Life and Social Sciences, Engineering, Medicine, Management and Decision Making, Computer Science, System Sciences. (Chapter 6 of book at serial no. 2)

Note: Question Paper will consist of **eight** questions divided into **three** Sections as indicated in the syllabus. Candidates are required to attempt **five** questions, selecting at least one question from each Section.

Books Recommended:

1. Kwang H. Lee, First Course on Fuzzy Theory and Applications, Springer International Edition, 2005.
2. George J. Klir and Tina A. Folger, Fuzzy Sets, Uncertainty and Information, Prentice Hall of India Private Limited, New Delhi-110 001, 2005.
3. H.J. Zimmerman, Fuzzy Set Theory and its Applications, Allied Publishers Ltd., New Delhi, 1991.
4. John Yen, Reza Langari, Fuzzy Logic - Intelligence, Control and Information, Pearson Education.

Group P_2:(Option (P_{22})) : Non Linear Functional Analysis

Max.Marks : 80
Time : 3 hours

Section-I(3 Questions)

Normed Spaces, Banach Spaces, Notions of convergence, Isomorphism and equivalence of Norms in Normed Linear Spaces, Continuous Linear and Multi-Linear Mappings, Natural Isometry, Gautex and Frechet differentiable mappings in Banach Spaces.

Section-II(3 Questions)

Differentiable Mappings, Derivative of a Compound Function, Derivative of a Bilinear Continuous mapping, Functions with Values in a Product of Banach spaces, Mean Value theorems and applications. Local inversion of mappings in C, Implicit Functions Theorem, Derivatives of higher order and Taylor's theorem.

Section-III(2 Questions)

Monotone Operators, Sufficient Conditions for monotonicity of a Operator in Banach Spaces, Continuity and boundedness property of monotone operators, Maximal monotone operator and its properties, characterization of maximality for single valued and multi-valued monotone operators, Kirzbraum Theorem and surjectivity Theorems for monotone operators. Subdifferential and monotonicity

Note: Question Paper will consist of **eight** questions divided into **three** Sections as indicated in the syllabus. Candidates are required to attempt **five** questions, selecting at least one question from each Section.

Books Recommended:

1. Carten, N., Differential Calculus
2. Flett, T.M., Differential Analysis
3. Joshi, M.C. and Bose, R.K., Some Topics in Non-linear Functional Analysis

Group P_2:(Option (P_{23})) : Fixed Point Theory

Max. Marks : 80
Time :3 hrs

Section-I(3 Questions)

Banach Contractions Principle and some consequences of Contraction Principle, A converse of contraction Principle. Retraction mappings, Computation of fixed points of locally Contractive, ε-Contractive and Contractive mappings as defined by Boyd and Wong, Caristi Fixed Point Theorem, Fixed points of local power Contraction. Local radial Contraction and Hardy Roger's type mappings in a Complete metric space, Convex Contraction of order n.

Section-II(3 Questions)

Non expansive mappings, Some general properties of nonexpansive mappings. Approximation of Fixed Points of non expansive and generalized non-expansive mappings, Normal Structure, Some general properties of non expansive mappings in Hilbert and Banach spaces, Fixed points of Pseudo Contractive, Quasi nonexpansive and asymptotically nonexpansive mappings. Fixed point Theorems for mappings on PM spaces, Contraction mappings in PM spaces, (ε, λ) Chainable mappings Probabilistic Measure of Non-Compactness, sequence of mappings and fixed points.

Section-III(2 Questions)

Fixed point Property, Brouwer's Fixed point Theorems and applications, Schauder's Fixed point Theorem and Consequences of Schauder's Theorem. Schauder Tychonoff and Krsnoselkii's fixed point theorems.

Note: Question Paper will consist of **eight** questions divided into **three** Sections as indicated in the syllabus. Candidates are required to attempt **five** questions, selecting at least one question from each Section.

Books Recommended:

1. Istratescu, V.I., Fixed Point Theory
2. Joshi, M.C. and Bose, R.K., Some Topics in Non-linear Functional Analysis

Group P_2:(Option (P_{24})) : Fuzzy Topology

Max. Marks : 80
Time : 3 Hours

Section I (2 Questions)

Fuzzy sets-Basic Concepts, Union and intersection of Fuzzy sets, Fuzzy topological spaces, concept of a fuzzy point and its neighbourhood structure, fuzzy points and level sets, local base, closure and Kuratowski's Theorem, Accumulation points, generalization of C. T.Yang's Theorem, Fuzzy subspace, Fuzzy continuity.

Section II (3 Questions)

Fuzzy metric spaces, fuzzy pseudo metric space, Fuzzy Metrization Theorem, Fuzzy Continuous functions,Quasi- Fuzzy compact spaces, weakly fuzzy-compact spaces, a-compact spaces, strong fuzzy compact spaces, fuzzy compact spaces.

Initial fuzzy topologies, Fuzzy Product Topology, Final Fuzzy Topologies, A comparison of different compactness notions in fuzzy topological spaces.

Section III (3 Questions)

Connectedness in fuzzy topological spaces, fuzzy connectedness, fuzzy separation axioms, separated sets, separation in fuzzy neighbourhood spaces, separation properties, Regularity and Normality.

Note: Question Paper will consist of **eight** questions divided into **three** Sections as indicated in the syllabus. Candidates are required to attempt **five** questions, selecting at least one question from each Section.

Books Recommended :

1. Fuzzy topology, Liu Xing Ming and Luo Mao Kang, World Scientific (1979).
2. Fuzzy Topology, N. Palaniappan, Narosa Publishing House (2002).

Group P_2:(Option (P_{25})) : Theory of Operators

Max. Marks: 80
Time : 3 hours

Section-I(3 Questions)

Spectral theory in normed spaces, resolvent set and spectrum, Special properties of bounded linear operators, Properties of resolvent and spectrum, Spectral mapping theorem for polynomials, Spectral radius of a bounded linear operator on a complex Banach space.

Compact linear operators on normed spaces. The separability of the range and spectral properties of compact linear operators on normed spaces, Operator equations involving compact linear operators, Fredholm type theorems. Fredholm alternative theorem. Fredholm alternative for integral equations. (scope as in Chapter -7 and 8 of Functional Analysis with Applications by E.Kreyszig).

Section-II(3 Questions)

Spectral properties of bounded self-adjoint linear operators on a complex Hilbert space. Positive operators, Square roots of a positive operator, Projection operators Spectral families, Spectral families of a bounded self-adjoint linear operator, Spectral representation of bounded self adjoint linear operators, Extension of the Spectral theorem to continuous functions, Properties of the spectral family of a bounded self adjoint linear operator. (scope as Chapter -9 of Functional Analysis with Applications' By E.Kreyszig).

Section-III(2 Questions)

Unbounded linear operators and their Hilbert-adjoint operators, Hellinger - Teoplitz theorem. Symmetric and self adjoint linear operators. Closed linear operators and theirs closures. Spectral properties of self adjoint linear operators. Spectral representation of unitary operators. Wecken's lemma, spectral theorem for unitary operators. Spectral representation of self adjoint linear operators. Cayley transform, spectral theorem for self adjoint linear operators. Multiplication operator and differentiation operators.

Unbounded linear operators in quantum mechanics. Basic ideas, States, Observables, position operator. Momentum operator, Heisenberg uncertainty principle, Time independent Schorordinger equation. Hamilton operator. (The scope as in Chapter 10 and 11 of E.Kreyszig: Introductory Functional Analysis with Applications, John Willey & Sons, 1978).

Note: Question Paper will consist of **eight** questions divided into **three** Sections as indicated in the syllabus. Candidates are required to attempt **five** questions, selecting at least one question from each Section.

Books Recommended:

1. G. Bachman and L.Narici, Functional Analysis, Academic Press, New York, 1966.
2. P.R.Halmos, Introduction to Hilbert Space and the Theory of Spectral, Multiplicity, Second Edition, Chelsea Pub. Co., New York, 1957.
3. N. Dunford and J.T. Schwartz, Linear Operator 3 Parts, Interscience / Wiley, New York, 1958-71.
4. Akhiezer, N.I and I.M.Glazmant : Theory of Linear Operators in Hilbert space, Freerick Ungar, Pub. Co., New York Vol.-I (1961) and Vol.-II (1963).

5. P.R.Halmos, A.Hilbert Space Problem Book, D.Van Nostreavd Co. Incl., 1967.
6. M.Schecter, Principles of Functional Analysis, Academic Press, Students Edition, 1971.

Group P_2:(Option (P_{26})): Cyclic and MDS Codes

Max. Marks : 80
Time : 3 hours

Section-I(3 Questions)

Cyclic Codes. Cyclic Codes as ideals. Matrix Description of Cyclic Codes. Hamming and Golay Codes as Cyclic Codes. Error Detection with Cyclic Codes. Error-Correction procedure for Short Cyclic Codes. Short-ended Cyclic Codes. Pseudo Cyclic Codes. Quadratic residue codes of prime length.

Section-II(3 Questions)

Hadamard Matrices and non-linear Codes derived from them. Product codes. Concatenated codes. Code Symmetry. Invariance of Codes under transitive group of permutations. Bose-Chaudhary-Hoquenghem (BCH) Codes.
BCH bounds. Reed-Solomon (RS) Codes. Majority-Logic Decodable Codes. Majority- Logic Decoding. Singleton bound. The Griesmer bound.

Section-II(2 Questions)

Maximum – Distance Separable (MDS) Codes. Generator and Parity-check matrices of MDS Codes. Weight Distribution of MDS code. Necessary and Sufficient conditions for a linear code to be an MDS Code. MDS Codes from RS codes. Abramson Codes. Closed-loop burst-error correcting codes (Fire codes). Error Locating Codes.

Note: Question Paper will consist of **eight** questions divided into **three** Sections as indicated in the syllabus. Candidates are required to attempt **five** questions, selecting at least one question from each Section.

Books Recommended:

1. Ryamond Hill, A First Course in Coding Theory, Oxford University Press, 1986.
2. Man Young Rhee, Error Correcting Coding Theory, McGraw Hill Inc., 1989.
3. W.W. Petersona nd E.J. Weldon, Jr., Error-Correcting Codes. M.I.T. Press, Cambridge Massachuetts, 1972.
4. E.R. Berlekamp, Algebraic Coding Theory, McGraw Hill Inc., 1968.
5. F.J. Macwilliams and N.J.A. Sloane, Theory of Error Correcting Codes, North-Holand Publishing Company.
6. J.H. Van Lint, Introduction to Coding Theory, Graduate Texts in Mathematics, 86, Springer, 1998.
7. L.R. Vermani, Elements of Algebraic Coding Theory, Chapman and Hall, 1996.