M.Phil (Mathematics) Annual System

Time : 3 hours
Theory : 80 marks
Int. Assessment: 20 marks

1. MPH-601 Research Methodology (Compulsory Paper)

Optional Papers: A student will opt two papers either from Stream– A or from Stream– B.

Stream-A	**Stream-B**
MPH-602(A)	MPH-602(B)
(ii) Continuum Mechanics and Seismology	(ii) Advanced Functional Analysis
MPH-603(A)	MPH-603(B)
(iii) Advanced Mathematical Methods	(iii) Theory of Groups and Homological Algebra

Teaching :

(i) Four hour per week per paper.

Note :

(i) There will be four sections in each paper (compulsory as well as optional paper).

NOTE :- Each paper of M.Phil. Mathematics will be of 100 marks. Theory of 80 marks and Internal Assessment of 20 marks in each paper.

There will be eight questions for each paper and course contents of each paper will be divided into four sections.

The paper-setter will set 8 questions for each paper with details as given in the respective syllabi. The examinees will be required to attempt 5 questions in all selecting at least one question from each section.

Each student will be required to give two seminars each of 50 marks on a topic to be chosen by a student in consultation of his/her M.Phil. Supervisor (who will be assigned to the student by the department).

Note :- Duration of each paper will be 3 Hours.

Pass Percentage :	Internal Assessment	50%
	Theory	50%
	Seminars	50%
	Total	50%

M.Phil. (Mathematics)

MPH 602-A : Continuum Mechanics and Seismology

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

Note : Question paper will consist of eight questions divided into four 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)

Solution of Elasticity problems by potential : The Homogenous Equations of Elasticity and the particular solutions. The Scalar and vector potential. Lame's strain potential. The Galerkin Vector. Love's Strain Function. Kelvin and Cerruate's problems. The Neuber-Papkovich Representation. Boussinseq's problem.

Thick Cylinder and Spheres : Hollow Cylinder with Internal and External Pressures with Free and Fixed Ends. Hollow Spheres subjected to Internal and External Pressures. Thermal Stresses in Long Cylinders: The Cylinder is not free to deform longitudinally in case of Solid and Hollow Cylinder. Thermal Stresses for a Solid and Hollow Sphere.

Section – II (Two Questions)

Straight Simple Beams: The elementary theory of Beams, Pure Bending of Prismatical Bars, Bending of a Narrow Rectangular Centilever by an end load, Bending of a narrow rectangular Beam by a Uniform load, Centilever Prismatic Bar of irregular cross section subjected to a Transverse end force, curved Beams:

Uniform Pressure Distributed over a Circular Area on the Surface of a Semi-Infinite Solid. Uniform Pressure Distributed over a Rectangular Area. Uniformly Distributed Vertical Pressure on Part of the Boundary of a Semi-Infinite Elastic Medium. Uniformly Distributed Vertical Pressure on Part of the Boundary of a Semi-Infinite Elastic Plate

Section – III (Two Questions)

Refraction seismology; Flat layer method, Dipping layer method, crusted structure. Reflection Seismology; Travel Time curves for reflections, intercept-slowness formulation for travel times, multichannel data geometry.
Seismic waves in spherical earth, Ray paths and travel times, velocity distributions, travel time curve inversion, Body wave travel time studies, body wave phases, core phases.
Anisotropic earth structure; Transverse isotropy & azimuthal anisotropy, anisotropy of minerals & rocks, anisotropy of composite structures, anisotropy in the lithosphere and the asthenosphere, anisotropy in mantle and core.
Attenuation and anelasticity; wave attenuation, geometric spreading, multipathing, scattering, intrinsic attenuation, quality factor (Q), physical diffusion due to anelasticity, physical models for anelasticity. Density & temperature within earth, composition of mantle & core.

Section – IV (Two Questions)

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.

Elastodynamics, Seismic moment tensor, Determination of faulting orientation: Stereographic projections, Focal mechanisms from surface waves.
(Articles 8.1 to 8.6 from the book 'Modern Global Seismology' By T.Lay and T.C. Wallace).

Recommended Books:

1. A.S. Saada, Elasticity Theory and Applications. Pergamon Press. Inc. 1974, Relevant portion of Chpater IX and X, XII & XIII.
2. Y.C. Fung, Foundations of Solid Mechanics, Prentice Hall of India Pvt. Ltd., New Delhi, 1969.
3. T.M. Atanackovic and A.Guran. Theory of Elasticity for Scientists and Engineers, Birkhauser, Boston, 1999.
4. An Introduction to Seismology, Earthquakes and Earth Structure, Seth Stein and Michael Wysession. Blackwell Publishing Ltd., 2003.
5. Modern Gobal Seismology, Thorne Lay and Torey C. Wallace, Academic Press, 1995.
6. Introduction to Seismology, Peter M. Shearer, Cambridge University Press, 1999.

M.Phil. (Mathematics)

MPH 603-A : Advanced Mathematical Methods

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

Note: -Question paper consists of eight questions divided over four sections of the syllabus. The candidates are required to attempt five questions selecting at least one question from each section.

Section-I (Two questions)

Bessel functions review, Hankel's function, modified Bessal functions, Ber and Bei functions, Kelvin functions, spherical Bessel functions, modified spherical Bessel functions.

Legendre's associated differential equations. Legendre's associated functions $P_n^m(x)$ and $Q_n^m(x)$, relations between $P_n(x)$ and $P_n^m(x)$, recurrence relations and integral expression for associated Legendre functions.

Dirac-delta function $\delta(x)$: various definitions and simple properties;
Discontinuous functions related to delta function: unit step function, Heaviside unit step functions, signum function, boxcar function, impulse function.

Section-II (Two questions)

Solving non-homogeneous BVPs: Eigen-functions approach, Green's functions: one-dimensional, GFs in higher dimensions, generalized functions, problems in unbounded regions.

Solving nonlinear BVPs: Asympotic expansions; asymptopic sequences, expansions and series; method of matched expansions; method of multiple scales; perturbation, singularity, boundary layer, transition points.

Section-III (Two questions)

Classification of differential equations; Finite difference methods and approximations: Simple methods, general methods, higher order derivatives, multi-dimensional finite difference formulae; Basic concepts of finite difference theory: formulation, strategies,; Mixed derivatives, non-uniform mesh, higher order accuracy schemes for first & second order derivatives;
Solution methods of finite difference equations: Elliptic equations, parabolic equations, hyperbolic equations and Burger's equation.

Section-IV (Two questions)

Variational formulation and approximation of Boundary and initial value problems,;variational methods of approximation : Ritz method, method of weighted residuals, Galerkin method, the least-square method, the collocation method, the courant method;

Finite element analysis of one dimensional problems : steady flow in a channel, problem of Couette flow, heat conduction problem. One dimensional fourth-order equation. Finite element analysis of two-domensional problems, using interpolation functions for the three-node triangular problems, two-dimensional finite elements and interpolation functions.

Recommended Books:

1. E.D.Rainville, Special Functions
2. J.W.Dettman (1962) Mathematical Methods in Physics and Engineering, McGraw Hill Book Company.
3. J.D.Murray (1984) Asymptotic Analysis, Springer Verlag
4. A.H.Nayfeh (1973) Perturbation Methods, Wiley, New York.
5. J.D.(Cole (1968)) Perturbation Methods in Applied Mathematics, Blaisdell Waltham, Mass.
6. An Introduction to the finite element method, J.N.Reddy Mc Graw Hill International Editions –1985.
7. Computational Fluid Dynamics, T.J.Chung, Cambrige University Press.
8. Principles of Computational Fluid Dynamics; P.Wesseling, Springer-Verlag, 2000.

M.Phil (Mathematics)

MPH-602 (B) Advanced Functional Analysis

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

Section-I (Two Questions)

Completely continuous operators, finite dimensional operators, a transformation that is bounded but not completely continuous, a type of transformation that is always completely continuous, further properties of completely continuous transformations (scope as in sections 17.5, 17.6 of the book by Bachman and Narici)

Spectral Notions: spectra and the resolvent set, the spectra of two particular transformations, approximate proper values (scope as in Chapter 18 of the book by Bachman and Narici)

Section -II (Two Questions)

Introduction to Banach Algebras: Analytic vector-valued functions, Normed and Banach algebras, Banach algebras with identity, compactness of the spectrum, an analytic function –the resolvent operator, spectral radius and the spectral mapping theorem for polynomials, the Gelfand theory, weak topologies and the Gelfand topology ,topological vector spaces and operator topologies (scope as in Chapter 19 of the book by Bachman and Narici)

Section-III (Two Questions)

Adjoints and sesquilinear functionals: the Adjoint operator, Adjoints and closures, Adjoints of bounded linear transformations in Hilbert spaces, the Cayley transform, sesquilinear functionals, bounded sesquilinear functionals (scope as in Chapter 20 of the book by Bachman and Narici)

Some spectral results for normal and completely continuous operators: A new expression for the norm of $A \in L(X,X)$,normal transformations, some spectral results for completely continuous operators, numerical range, the Fredhlom alternative theorem and the spectrum of a completely continuous transformation (scope as in Chapter 21 and Appendix to Chapter 21 of the book by Bachman and Narici)

Orthogonal Projections and Positive Definite operators: properties of Orthogonal Projections, product of Projections, Positive operators, sums and differences of Orthogonal Projections, the product of positive operators (scope as in Chapter 22 of the book by Bachman and Narici)

Section-IV (Two Questions)

Square root and Spectral Decomposition theorem: Square root of Positive operators, Spectral theorem for bounded, normal, finite dimensional operators(scope as in chapter 23 of the book by Bachman and Narici)

Spectral Decomposition theorem for Completely continuous normal operators ,Spectral theorem for bounded self –adjoint operators, Spectral theorem for bounded normal operators, , Spectral theorem for unbounded self –adjoint operators (scope as in relevant parts of Chapters 24,25,28 and 29 of the book by Bachman and Narici)

Recommended text:

Bachman,G. and Narici,L. : Functional Analysis, Academic Press,1966

References:

1. Kreyszig,E.: Introductory Functional Analysis with Applications,John Wiley And Sons,New York 1978
2. Simmons,G.F . : Introduction to Topology and Modern Analysis, McGraw Hill Book Co., New York, 1963

3. Maddox, I.J. : Elements of Functional Analysis, Cambridge University Press, Second Edition, 1988

4. Taylor, A.E. : Introduction to Functional Analysis, John Wiley & Sons, 1958

M.Phil. (Mathematics)

MPH-603 (B) Theory of Groups and Homological Algebra

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

Section-I (2/10)

Linear groups. Degree of a linear group. Reducible and irreducible linear groups. Decomposable and indecomposable linear groups. Equivalent linear groups. Masche's Theorem. The ring of linear transformations. Schur's Lemma. Representation of groups. Character of a representation. Equivalent and inequivalent representations. Irreducible characters. The degree of an irreducible character. Orthoginality of irreducible characters. The number of irreducible characters. The centre of a group algebra of a finite group G.

Section-II (2/10)

Hall subgroups. Schur-splitting Theorem. Huppert Theorem. Sylow basis of a finite solvable group. Normalizer of a Sylow basis. The p^iq^j theorem. Representations of direct sums. Induced representations. Frobenius Reciprocity Theorem. Generalized induced characters. Character tables of finite groups.

Section-III (3/10)

Direct sums and direct products and their universal property. Free modules. Exact sequences. Commutative diagrams of R-module homomorphism. Five Lemma for commutative diagrams. Modules of the homomorphisms. Tensor product of modules. Additive and Abelian categories. Functors. Covariant and contravariant funtors. Additive functors. Left exact, right exact and exact functors. The functor Hom and Tensor. Projective modules and projective basis theorem. Injective modules. Baer's criterion for an R-module to be injective. Divisible R-modules. Imbedding of an R-module into an injective R-module.

Section-IV (3/10)

Ker-coker sequences. Homology of the complexes. Snake's Lemma. Connecting homomorphisms. Homotopy and chain maps. Projective and injective resolutions and comparison Theorem. Derived functors. Horse-shoe Lemma for projective and injective resolutions. Torsion and extension functors.

Recommended Books:

1. W. R. Scott. Group Theory
2. L.R. Vermani An Elementary approach to Homological Algebra

Reference Books :

1. I.D. Macdonald — The Theory of Groups
2. P.J. Hilton and U. Stammbach — A course in Homological Algebra
3. D.G. Northcott — An introduction to Homological Algebra

MPH-601 (Research Methodology)

Note: Question paper consists of eight questions divided over four sections of the syllabus. The candidates are required to attempt five questions selecting at least one question from each section.

Time : 3 Hours
Theory : 80 Marks
Int. Assessment : 20

Section – I (2 Questions)

Introduction of Research Methodology: Meaning of research, objectives of research, types of research, significance of research, research and scientific method, research process.

Research Problem: Definition, necessity and techniques of defining research problem. Formulation of research problem. Objectives of research problem.

Research Design: Meaning, need and features of good research design. Types of Research Designs. Synopsis design for research topic.

Scientific Communications: Publishing Research Papers:

a) Preliminaries, Format, Choosing Journal, Study of General guidelines for authors
b) Title, Running Title
c) Authors: Single and Multi authorship
d) Writing Abstract
e) Introduction section
f) Formulation of problem, method of solution/Analytical proofs
g) Result Section
h) Figures; Design Principles, Legends, Table components, Graphs; Types, Style.
i) Discussion Section: Format, Grammar Style, Content
j) Acknowledgements
k) References: Citation and styles of listing
l) Selecting Keywords
m) Submission of manuscript: Communication with the Editor, Handling Referees' Comments, Galey Proofs
Writing Review Articles,

Section-II (Two Questions)

Web Search: Internet Basics, Internal Protocols, Pre-requisites, Search Engines, Searching Hints, Using advanced search techniques

Presentation: Poster and Oral. Presentation tools: Introduction to presentation tool, features and functions, creating presentation, customizing presentation, showing presentation.

Study of Mathematical & Scientific Websites & Databases

Writing of thesis: Format of a thesis; Review of literature, formulation; Writing methods, results; preparation of Tables, figures; writing discussion; writing conclusion; writing summary and synopsis; Reference citing and listing/Bibliography.

Avoiding Plagiarism.

Plan for an innovative project; plan for project proposal, compilation of proposal, selection of funding agency, submission of proposal, Report generation: significance, steps of report writing and its types.

Section – III (2 Questions)

Computer Applications: Introduction, operating System
MS Office 2007: Word Basics, Mail Merge, Macros, Math Type, Equation Editor.
MS Excel 2007: Excel Basics, Data Sort, Functions.
MS Power Point: Power Point Basics, Animations

LaTex
Introduction: Input file structure; commands.

Document preparation: class, type-size, type-style, footnote, section, bibliography, appendix, indexing.
Mathematical text: subscript, superscript, symbols, formulae, equations, arrays & tables, figures (pictures, graphs).

Presentation: fonts, environments, sizes, slides, output files (dvi, ps and pdf).

Section – IV (2 Questions)

MATLAB

Using Command window: Input, output; edit of command lines; recalls from command history.
Functions: User-defined functions: editing/saving codes (m files), arguments, compilation and execution, output/results, input, display.
Familiarity with keywords (default names), defining built-in functions,
Programming features and graphic characteristics.

Expressions: constants, variables, operators, precedence, expressions, functions.
Vectors, matrices & arrays: arithmetic and linear algebra.

Programming: Flow control (branching): logical expressions; Loops: for, while; data structures; evaluation; debugging.

Graphics: Plotting overview; editing plots; using plotting tools; basic plotting functions; mesh and surface plots; multiple plots, printing/exporting graphs.

Files: Saving-in, opening, reading-from, writing-in, closing

Interaction with MATLAB 7: practice through simple user-defined codes for common problems and developing programming skills.

Project: To write code for a published research problem involving the use of numerical methods.

Reference Books:

1. Hunt, B.R Lipsman, R.L and Rosenberg, J.M (2003), A Guide to MATLAB, CUP
2. Otto, S.R and Denier, J.P (2005), An Introduction to Programming and Numerical Methods in MATLAB; Springer
3. Lamport, L. (1994) LaTeX, User's Guide & Reference Manual, Addison-Wesley
4. Mittelbach, F. et al. (2004) The LaTeX Companion, Addison-Wesley
5. Gurumani, N. (2010), Scientific Thesis Writing and Paper Presentation, MJP Publishers
6. Kothari, C.R. (2010), Research Methodology (Methods and Techniques), New Age International Publishers.
7. Dahlberg, L. and McCaig, C. (2010), Practical Research and Evaluation, SAGE Publications India Pvt. Ltd.
8. Saxena, S. (2010), A first course in Computers, Vikas Publishing house Pvt. Ltd.