

SYLLABUS FOR PH.D. (MATHEMATICS) COURSE WORK, 2014

PAPER-I	ANALYSIS	100 MARKS
PAPER-II	TWO SEMINARS	100 MARKS
PAPER-III	DISSERTATION	100 MARKS
PAPER-IV	RESEARCH METHODOLOGY AND COMPUTER PROGRAMMING	100 MARKS

Detailed syllabus
(Each unit carries 20 marks)

PAPER-I(ANALYSIS)

Unit-I (Real Analysis and Calculus in \mathbb{R}^n)

Real Analysis : Elements of metric spaces, convergence, continuity, connectedness, compactness, Bolzano Weierstrass theorem, compact subsets of \mathbb{R} , Heine Borel theorem, continuity of functions in \mathbb{R} , Weierstrass approximation theorem, equicontinuity, Arzela-Ascoli theorem, Lebesgue measure, measurable functions, convergence in measure, Lebesgue integral, differentiation and integration.

Calculus in \mathbb{R}^n : Differentiability of functions from \mathbb{R}^m to \mathbb{R}^n , properties of differentials, partial and directional derivatives, continuously differentiable function, Taylor series for multivariable functions, inverse function theorem, implicit function theorem.

Unit-II (Complex Analysis and Functional Analysis)

Complex Analysis : Analytic Functions, power series representation of analytic functions, Cauchy's theorem for convex regions, Cauchy's integral formula, Liouville's theorem, fundamental theorem of algebra, open mapping theorem, singularities Laurent series, Casorati-Weierstrass theorem, residues, argument principle, maximum modulus theorem, Bilinear transformations, multivalued analytic functions.

Functional Analysis : Banach spaces, Hahn-Banach theorem, Open mapping and Closed graph theorem, principle of uniform boundedness, boundedness and continuity of linear transformations, spectrum of an operator, dual spaces, embedding in the second dual, Hilbert spaces, projections, orthonormal basis, Riesz-representation theorem, Bessel's inequality, Parseval's identity, Self-adjoint operators, normal operators, compact operators.

Unit-III (Topology)

Elements of topological space, continuity, convergence, homeomorphism, compactness, local compactness, locally connected, pair wise connected, separation axioms, first and second countability, separable topological spaces, product topological spaces, Quotient spaces, Tychonoff's theorem, Urysohn's lemma, Homotopy and fundamental group.

Unit-IV (Linear Algebra and Advanced Algebra)

Linear Algebra : Symmetric groups, alternating groups, simple groups, group homomorphisms, rings, maximal ideals, prime ideals, integral domains, Euclidean domains, principal ideal domains, unique factorization domains, quotient fields, finite fields, algebra of linear transformations, reduction of matrices to canonical forms, inner product spaces, orthogonality, quadratic forms, reduction of quadratic forms.



Advanced Algebra: Conjugate elements and class equations of finite groups, Sylow's theorem, Solvable groups, Jordan Holder theorem, direct products, Decomposition of matrices, Characteristics of field extension, elements of Galois Theory, solvability of radicals, Roots of unity and Cyclotomic Polynomials, Ruler and Compass Construction, Symmetric Functions and Cyclic extensions.

Unit-V (Numerical Analysis)

Finite differences, interpolation, numerical solution of algebraic equation, iteration. Numerical solution of algebraic equation, Newton-Raphson method, solution of linear system, direct method, Gauss elimination method, matrix inversion, Eigen value problems, numerical solution of ordinary differential equation, iteration method, Picards method, Picard numerical differentiation & integration, Euler method and improved Euler method.

BOOKS RECOMMENDED

1. W.Rudin : Mathematical Analysis, Mc-Graw Hill
2. G.D.Barra : Measure Theory and Integration, Willey Eastern Ltd.
3. J.B.Conway : Functions of one Complex Variable, Springer Student Edition
4. J.R.Munkres : Topology - A First Course, Prentice Hall of India
5. B.V.Limaye : Functional Analysis, Wiley Eastern Ltd.
6. I.N.Herstein : Topics in Algebra
7. Bhattacharjee, Jain & Nagpaul : Abstract Algebra
8. Khanna and Bhambri : Basic Abstract Algebra
9. Moderson, Sen & Mallik : Abstract Algebra
10. Hoffman and Kunze : Linear Algebra
11. S. Kesavan : Functional Analysis and Applications (Chapters-1 (1.1-1.6), 2 (2.1-2.4)
10. Davis and Rabinowitz : Methods of Numerical Integration (et) (Chapters-2(2.1-2.7, 2 11, 2.12), 4(4.1, 4.3, 4.6, 4.7), 5(5.1-5.7)
11. Jain. C. Strikwond : Finite Difference Scheme and Partial Diff. Equation (Wadsworth and Booke). Chapters-1-6.

PAPER-IV

Research Methodology and Computer Programming

UNIT-I

Foundation of Research: Meaning, objectives, motivation, importance and utility, Different types and styles of research, Critical thinking, Creativity and innovations, Hypothesis formulation of research plan, Art of reading, Understanding and writing scientific papers, Literature Review, Formulating the Research Problem, Developing the objectives, Topics specific to the writing of Mathematics, Exposition, Other types of writing, Modern writing environment, Methodology to write a technical paper/short communication, layout of a Research paper, research proposal/monograph, and abstract writing; preparation of the report and presentation of results- formal write ups of conclusion reached, Documentation and bibliography, Poster preparation and presentation, Research and Academic integrity: Plagiarism, Copyright issues, Ethics in research.

UNIT-II

Introduction to presentation tools, features and functions; latex typesetting, type setting for power point presentation (using beamer).



UNIT-III

Basic introduction to MATLAB language, system introduction, Command Window operation, Array Manipulation and Data handling, MATLAB Operators, Symbolic Math Toolbox, 2-D plotting, Script Files, Functions and Function files, MATLAB Programming, 3-D Plots.

UNIT-IV

C++ Language

Introduction: Constants, variables, operators, input and output functions, conditional statements, loops.

Arrays and pointers: Integers, float and character arrays, two dimensional arrays, use of pointers, pointer array.

Functions: Use of functions, function call and parameter passing.

UNIT-V

Numerical Computation using C++.

- (i) Solution of the equation $f(x) = 0$ by (a) Fixed point iteration method (b) Newton-Raphson method (c) Muller's method
- (ii) Solving a system of linear equations by (a) LU Factorisation Method. (b) Gauss-Seidel Method.
- (iii) Determination of eigen values of a matrix by Power method/QR method.
- (iv) Approximating a definite integral by (a) Newton-Cotes Rules. (b) Gauss-Legendre formula.
- (v) Solution of an initial value problem by Runge-Kutta Method of order 4.

BOOKS RECOMMENDED

1. Wolff-Michael Roth : Text Book on Qualitative Research and Methods/ Methodology: Toward a Praxis of Method, Forum qualitative social research, Volume 7, No. 1, Art. 11 – January 2006.
2. C.R. Kothari and Gaurav Garg.: Research Methodology: Methods and Techniques, New age international publisher, 2015.
3. Steven G. Krantz : A Primer of Mathematical Writing, American Mathematical Society, 1996.
4. J.H. Mathews: Numerical Methods for Mathematics, Science and Engineering (2nd edition), Prentice-Hall of India Pvt. Ltd., New Delhi.
5. B.W. Kernighan and D.M. Ritchie: Programming in ANSI C, Prentice-Hall of India Pvt. Ltd., New Delhi.
6. Brian R. Hunt, Ronald I. Lipsman Jonathan M, Rosenberg: A Guide to MATLAB: for beginners and experienced users, Cambridge University Press.

