Entrance Examination Syllabus

For Doctor of Philosophy (Ph.D.)

Department of Mathematics

Mohammad Ali Jauhar University

RESEARCH METHODOLOGY(50 Questions)

RESEARCH METHODOLOGY: AN INTRODUCTION

Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, ResearchApproaches, Significance of Research, Research Methods Versus Methodology, Research and ScientificMethod, Importance of Knowing How Research is Done, Research Process, Criteria of Good Research,Problems Encountered by Researchers in India

DEFINING THE RESEARCH PROBLEM

What is a Research Problem? Selecting the Problem, Necessity of Defining the Problem, Technique Involvedin Defining a Problem

RESEARCH DESIGN

Meaning of Research Design, Need for Research Design, Features of a Good Design, Important ConceptsRelating to Research Design, Different Research Designs, Basic Principles of Experimental Designs

PUBLICATIONS, PLAGIARISM, INTELLECTUAL PROPERTY RIGHTS

Quality of research work and papers –indexing, impact factor, H Index, citation index Meaning andprinciples of plagiarism, methods of plagiarism check, plagiarism checking software, Principles ofintellectual property rights, patents, copyrights, trademarks and their importance.

INTERPRETATION AND REPORT WRITING

Meaning of Interpretation, Why Interpretation? Technique of Interpretation, Precautions in Interpretation,Significance of Report Writing, Different Steps in Writing Report, Layout of the

Research Report, Types ofReports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing ResearchReports

(Subject specific 50 questions)

LINEAR ALGEBRA

Vector spaces, subspaces, linear dependence, basis, dimension, algebra of linear transformations. Algebraof matrices, rank and determinant of matrices, linear equations.Eigenvalues and eigenvectors, Cay ley-Hamilton theorem.Matrix representation of linear transformations. Change of basis, canonical forms,diagonal forms, triangular forms, Jordan forms. Inner product spaces, orthonormal basis. Quadratic forms,reduction and classification of quadratic forms.

COMPLEX ANALYSIS

Algebra of complex numbers, the complex plane, polynomials, Power series, transcendental functions suchas exponential, trigonometric and hyperbolic functions. Analytic functions, Cauchy-Riemann equations,Contour integral, Cauchy's theorem, Cauchy's integral formula, Liouville's theorem, Maximum modulusprinciple, Schwarz lemma, Open mapping theorem. Taylor series, Laurent series, calculus of residues.Conformal mappings, Mobius transformations.

ORDINARY DIFFERENTIAL EQUATIONS (ODES)

Existence and Uniqueness of solutions of initial value problems for first order ordinary differentialequations, singular solutions of first order ODEs, system of first order ODEs. General theory ofhomogenous and non-homogeneous linear ODEs, variation of parameters, Sturm-Liouville boundary valueproblem, Green's function.

PARTIAL DIFFERENTIAL EQUATIONS (PDES)

Lagrange and Charpit methods for solving first order PDEs, Cauchy problem for first order PDEs, Classification of second order PDEs, General solution of higher order PDEs with constant coefficients, Method of separation of variables for Laplace, Heat and Wave equations.

NUMERICAL ANALYSIS

Numerical solutions of algebraic equations, Method of iteration and Newton-Raphson method, Rate of convergence, Solution of systems of linear algebraic equations using Gauss elimination and Gauss-Seidelmethods, Finitedifferences, Lagrange, Hermite and spline interpolation, Numerical differentiation andintegration, Numerical solutions of ODEs using Picard, Euler, modified Euler and Runge-Kutta methods.

LINEAR PROGRAMMING PROBLEM

Simplex methods, duality. Elementary queuing and inventory models. Steady-state solutions of Markovianqueuing models:M/M/1, M/M/1 with limited waiting space, M/M/C, M/M/C with limited waiting space,M/G/1.

CALCULUS OF VARIATIONS

Variation of a functional, Euler-Lagrange equation, Necessary and sufficient conditions for extrema.Variational methods for boundaryvalue problems in ordinary and partial differential equations.

LINEAR INTEGRAL EQUATIONS

Linear integral equation of the first and second kind of Fredholm and Volterra type, Solutions with separablekernels,Characteristicnumbers and eigenfunctions, resolvent kernel.

CLASSICAL MECHANICS

Generalized coordinates, Lagrange's equations, Hamilton's canonical equations, Hamilton's principle andprinciple of least action, Two -dimensional motion of rigid bodies, Euler's dynamical equations for themotion of a rigid body about an axis, theory of small oscillations.