SYLLABUS OF COURSE WORK

Departments Mathematics

Of

DOCTOR OF PHILOSOPHY(Sc.)

Diamond Harbour Women's University

Important points to be noted:

1. *Duration of Course Work : One Semester (6 Months)*
2. *Total Marks : 200 (Two papers 100 marks each)*
3. *Duration of Examination: 4 Hrs. (2 Hrs. for each paper)*
4. *Paper I: Compulsory Units: Research Methodology & Review of Research Work: 100 Marks (2 hrs)*
   (a) Research Methodology: 50 Marks
   (b) Review of Research Work: 50 Marks
5. *Paper II : Elective Units: Subject Course Work: 100 Marks (4 hrs.)*
6. *Examination will be held at the end of the Semester.*
7. *Total Lecture Hour (periods) for Paper II (elective units): 40(Forty).*

SYLLABUS OF COURSE WORK OF PH. D(Sc.)

Courses	Subject	Full Marks	Number of Lectures
Compulsory Units	A. Research Methodology	50	40
	B. Review of Research Work	50	20
Elective Units	1. Advance Commutative Algebra and Algebraic Geometry	50	32
	2. Advance topic in Algebra	50	32
	3. Sequence Space and Topological Groups	50	32
	4. Advanced topics in Topology and Functional Analysis	50	32
	5. Ordinary Differential Equation and its application	50	32
	6. Advance topic in Partial Differential Equations	50	32
	7. Mathematical Methods and Application	50	32
	8. Advance Integral Equation	50	32
	9. Advance Theory of Bio-Mathematics	50	32
	10. Theory of Waves and Water Waves	50	32

N.B. : Students to option for any 2 elective units out of the elective units offered. 20x2 classes to be attended (100 marks)

Compulsory Units

A. Research Methodology:

Section-A

Definition of Problem: Necessity of defining problem, Technique involved in defining a problem, Surveying the available literature.

Techniques involved in solving the problem: Different methods used to solve a problem.

Research Design: Subject of study; Place of study; Reason of such study; Type of data required; Method of data collection; Periods of study; Style of data presentation.

Developing a research plan: Research objective; Information's required for solving the problem; Each major concept should be defined in operational terms; An overall description of the approach should be given and assumption if considered should be clearly mentioned in research plan; The details of techniques to be adopted.

Methods of data collection: Experimental methods.

Analysis of data: Various measures of relationship often used in research studies, Correlation coefficients.

Section-B

Computer:

Basic of Computer Operating System:

Using Windows – Directory structures – command structure (Document preparation, EXCEL, Power Point Presentation, Latex). Basics of Editing and Word processing. Usage of Webs as a tool for scientific literature survey. Some problems in programming language through software (Mathematica, Matlab etc.) Mathematica basics. 2 D and 3 D Graphs. Basic Calculus. Ordinary Differential Equations. Partial Differential Equations and Boundary Value Problems. Mathematica Programming. Linear and Nonlinear Integral Equations. Matrix Operations. Solution of Equations. Curve-fitting. Numeral Integration. MATLAB Programming.

B. Review of Research Work:

The relevance of the research work from the perspective of the subject – Possible ways to apply the research work in future.

ELECTIVE UNITS

1. Advance Commutative Algebra and Algebraic Geometry

Commutative Rings and Ideals, Ring Homomorphisms, Zero-divisors, Nilpotent elements, Nilradical and Jacobson radical, Nakayama's Lemma, Prime Avoidance, Chinese Remainder Theorem.
Modules and Module Homomorphisms, Tensor Products of modules, Exact Sequences, Projective, Injective and Flat Modules, Five Lemma, Projective Modules and Hom_R(M,-), injective modules and Hom_R(-,M), Flat modules and M $\otimes$R - ..
Local rings, Localisation, Applications.
Noetherian Modules, Primary Decomposition, Associated Primes, Artinian Modules, Length of a Module.
Integral Dependence, Lying-Over Theorem,Going-Up Theorem,
Integrally Closed Domains, Going-Down Theorem, Noether Normalization.
Transcendence Base, Separably Generated Extensions, Schmidt and Lüroth Theorems.

2. Advance topic in Algebra

Cayley's Theorem.Generalized Cayley's Theorem, Cauchy's Theorem, Group Action, Sylow Theorems and their applications. Normal and Subnormal Series, Composition Series, Solvable Groups and Nilpotent Groups, Jordan-Hölder Theoremand its applications.
Ideals and Homorphisms, Prime and Maximal Ideals, Quotient Field of an Integral Domain, Polynomial and Power Series Rings. Divisibility Theory : Euclidean Domain, Principal Ideal Domain, Unique Factorization Domain, Gauss' Theorem .Noetherian and Artinian Rings, Hilbert Basis Theorem,Cohen's Theorem.
Left and Right Modules over a ring with identity, Cyclic Modules, Free Modules, Fundametal Structure Theorem for finitely generated modules over a PID and its applications to finitely generated abelian groups.
Field Extensions: Algebraic and Transcendental Extensions, Finite Extension, Algebraic Closure of a field, Algebraically Closed Field, Splitting Field of a polynomial, Normal Extension, Separable Extension, Impossibility of someconstructions by straightedge and compass.Finite Fields and their properties, Galois Group of automorphisms and Galois Theory, Solution of polynomial equations by radicals, Insolvability of the general equation of degree 5(or more) by radicals.
Reduction to Triangular Forms. Nilpotent Transformations, Index of Nilpotency, Invariants of a nilpotent transformation, Jordan Blocks and Jordan Forms, Rational Canonical Form, Generalized Jordan Formover an arbitrary field.

3. Sequence Spaces & Topological Groups

Linear spaces, Linear metric spaces, paranorms, seminorms, norms, subspaces, dimensionality, factorspaces, basis, dimension, basic facts of normed linear spaces and Banach spaces (revision). Sequence spaces, Matrix and linear transformations, Algebras of matrices, summability, Tauberian Theorems.

Basic properties including translations in topological groups, neighbourhood system of identity, separation properties, uniform structure on topological groups. Locally compact groups, Lie groups, Measure and integration in locally compact spaces and then in locally compact groups, Haar measure, Haar integrals.

4. Advanced topics in Topology and Functional Analysis

Fixed point Theorem, Countability and Separation Axioms, The Urysohn metrization theorem, The Tietze extension theorem, The Tychonoff theorem, Completely regular spaces, Uniformity, characterization of Uniformly continuous functions in terms of compactness, C*-algebra, Banach algebra, Spectral theory, Unbounded linear operator.

5. Ordinary Differential equation and its Applications:

Linear differential equations: integrating factors and the D-operator method, Systems of linear differential equations: autonomous systems, bifurcations and the stability of equilibrium points. Linearization of non-linear systems, nonlinear autonomous system, phase plane analysis, critical points, stability, Linearization, Liapunov stability, undamped pendulum, Applications to biological system and ecological system. Special Functions Series Solution: Solutions of hypergeometric, Legendre, Laguerre and Bessel's equation as examples Legendre polynomial and Bessel's Polynomials and applications.

6. Advance topic in Partial Differential Equations:

Solution of Hyperbolic, Parabolic and Elliptic type equations. Domain of dependence of Hyperbolic equations. Applications in Physical Problem.

Green's function for the Laplace equation, in two and three dimensions. Applications. Spherical and cylindrical co-ordinate systems of parabolic equations.

Numerical methods for elliptic partial differential equations. Difference methods for linear PDE, quasi linear elliptic equations. Application in problem of Mathematical Physics.

7. Mathematical Methods and Applications:

Fourier Transforms. Inverse Fourier Transforms. Finite Fourier Transforms. Fast Fourier Transforms and their applications.

Laplace transforms. Inverse Laplace transforms. Bromwich contour. Finite Laplace transforms and its applications.

Hankel Transforms, Mellin Transforms and their applications.

Galerkin Methods, single term and multi termed Galerkin Methods. Application of Green's function in ordinary and partial differential equations. Wiener Hopf Methods and its application in partial differential equations.

8. Advance Integral Equations:

Basic definitions, regular, singular, Hypersingular integral equations, Occurrence of integral equations in classical mechanics, Ordinary differential equations, partial differential equations, Occurrence in continuum mechanics (elasticity, fluid mechanics).

Abel integral integral equation, Cauchy singular integral equations and solutions by different methods, Hypersingular integral equations and solutions of simple Hypersingular integral equations, applications in continuum mechanics.
Dual integral equations, solutions for trigonometric function kernel, applications.
Application of Bernstein polynomial for solving integral equations, singular integral equations with logarithmic kernel and Cauchy type, Hypersingular integral equations.
Application of Boundary Element Method in solving integral equations.

9. Advance theory of the Bio-Mathematics:

Difference Equation and its Application: Difference Calculus, Linear first – order difference equations, Nonlinear difference equations, Higher order linear difference equations, Systems of difference equations, Stability Theory, Applications.

Introduction to Control Theory and its Application–I: Systems of linear differential equations: autonomous systems, bifurcations and the stability of equilibrium points. Linearization of non-linear systems. Transfer functions and feedback, Controllability and observability

Stability: The Routh-Hurwitz criterion. The Hamiltonian-Pontryagin method, bounded control functions and Pontryagin's principle. A brief introduction to non-linear systems. Complex variable methods: The Nyquist criterion

10 Theory of Waves and Water Waves:

Basic Equations, Havelock's Expansion Theorem, Construction of Source Potentials, Basic Problems in the theory of Water Waves, Water wave scattering and radiation problems, Trapped Modes, Edge Waves, Construction of multipoles and wave-free potential and its applications in the theory of water waves. Multi-layer fluid, Multiple Scattering and radiation problems in water wave theory.