

**Concepts in Analysis**  
**(For Ph.D Coursework)**  
**Paper – I**

**Credits: 4**

**UNIT-I: Basic Topology**

Metric spaces – Compact sets – Perfect sets – Connected sets - Continuity.

**UNIT-II: Sequences & Series of Functions**

Pointwise & Uniform Convergence – Uniform Convergence and Continuity – Uniform Convergence and Integration - Uniform Convergence and Differentiation – Equicontinuous Families of Functions – Weierstrass Approximation Theorem.

**UNIT-III: Functions of Several Variables**

Linear Transformations – Differentiation – Contraction Principle – The Inverse Function Theorem – The Implicit Function Theorem – The Rank Theorem.

**UNIT-IV: Banach Spaces**

Vector space – Normed space – Banach space – Further properties of Normed spaces – Finite Dimensional Normed spaces and Subspaces – Compactness and Finite Dimension – Linear Operators – Bounded and Continuous Linear Operators – Linear Functionals – Linear Operators and Functionals on Finite Dimensional spaces – Normed spaces of Operators – Hilbert Spaces.

**UNIT-V: Fixed Points**

Fixed point – Banach Fixed Point Theorem – Application of Banach's Theorem to Linear Equations – Applications of Banach's Theorem to Differential Equations – Application of Banach's Theorem to Integral Equations.

**Text Books**

1. Principles of Mathematical Analysis –Walter Rudin – Third Edition- TMH.  
(Units - I, II & III)
2. Introductory Functional Analysis with Applications – E Kreyszig- WILEY.  
(Units – IV & V)

**References**

1. Introduction to Real Analysis – RG Bartle & DR Sherbert – 4<sup>th</sup> Edition – WILEY.
2. Mathematical Analysis – TM Apostol.
3. Introduction to Topology and Modern Analysis – GF Simmons – TMH.
4. A First Course in Functional Analysis – Goffman & Pedrick – PHI.



**Ordinary & Partial Differential Equations**  
(For Ph.D Coursework)

**Paper – II**

**Credits: 4**

**UNIT-I: Linear Equations with Variable Coefficients**

Introduction- Initial value problems for the homogeneous equation- Solutions of the homogeneous equation- The Wronskian and linear independence- Reduction of the order of a homogeneous equation- The non-homogeneous equation- Homogeneous equations with analytic coefficients- The Legendre equation.

**UNIT-II: Existence and Uniqueness of Solutions to First Order Equations**

Introduction- Equations with Variables separated- Exact equations- The method of successive approximations- The Lipschitz condition- Convergence of the successive approximations- Non-local existence of solutions- Approximations to, and uniqueness of, solutions- equations with complex-valued functions.

**UNIT-III: Existence and Uniqueness of Solutions to Systems and  $n$ -th Order Equations**

Introduction- An example- central forces and planetary motion – Some special equations – Complex  $n$ -dimensional space – system as vector equations – Existence and uniqueness of solutions to systems – Existence and uniqueness for linear systems – Equations of order  $n$ .

**UNIT-IV: Parabolic Partial Differential Equations**

Introduction – Basic concepts in finite difference methods – Explicit methods – Schmidt Methods – Dufort-Frankel method – Implicit Methods – Classical implicit method – Crank-Nicolson method – Weighted average implicit method – The concept of Stability – Methods for Two dimensional equations – Explicit methods – implicit methods – Alternate direction implicit method.

**UNIT-V: Elliptic partial Differential equations**

Introduction – Derivation of finite difference approximations – Iterative methods.

**Hyperbolic Partial Differential Equations:** Introduction- Explicit finite difference method.

**Text Books:**

1. An Introduction to Ordinary Differential Equations – Earl A. Coddington – PHI. (Units-I, II & III)
2. Numerical Methods for Scientists and Engineers – K. sankarrao – PHI. (Units – IV & V)

**References:**

1. Ordinary Differential Equations with historical notes – GF Simmons – TMH.
2. Ordinary and Partial Differential Equations – MD RaiSinghanian – S. Chand.
3. Elementary Differential Equations and Boundary Value Problems – wWilliam E. Boyce and Richard C. DiPrima – Wiley.
4. Partial Differential Equations – T Amarnath – Narosa.
5. Partial Differential Equations – K Sankarrao – PHI.