

# Vishwakarma University, Pune

PhD. Entrance Examination

Subject: Mathematics

Syllabus for Paper II

**Total marks: 50**

**1. Basic Concepts of Real and Complex Analysis:** Limits, Continuity, Uniform Continuity, Differentiability, Riemann Integral, Metric space, Sequence and series, Algebra of complex numbers, Analytic functions, Power series, Taylor's and Laurent's series, Conformal mapping.

**2. Basic Concepts of Linear Algebra:** Vector space, Subspace, Linear dependence, Basis, Linear transformation, Algebra of matrices, Rank of matrix, Determinants, Linear equations, eigen values and eigen vectors, Power method, Cayley-Hamilton Theorem, Quadratic forms.

**3. Discrete Mathematics:** Partially ordered sets, Lattices, Complete Lattices, Distributive lattices, Complements, Boolean algebra, Elements of Graph Theory, Eulerian and Hamiltonian graphs, Planar Graphs, directed graphs, Trees, Spanning trees, Fuzzy set theory

**4. Differential Equations:** First order ODE, singular solutions, initial value problem of first order ODE, and general theory of homogeneous and non-homogeneous linear ODE, variation of parameters.

**5. Basic concepts of probability:** Sample space, discrete probability, simple theorems on probability, independence of events, Bayes Theorem. Discrete and continuous random variables, Binomial, Poisson, Uniform, Exponential, Weibull and Normal distributions; Expectation and moments, independence of random variables.

**6. Vector Analysis:** Divergence and curl of a vector point function – solenoidal and irrotational functions – physical interpretation of divergence and curl of a vector point function. Integration of vector functions – Line, surface and volume integrals. Gauss - Divergence Theorem – Green's Theorem – Stoke's Theorem.

**7. Numerical Methods:** Bisection method, fixed-point iteration, Newton's method. Error analysis for Iterative Methods. Computing roots of polynomials. Interpolation: Lagrange Polynomial. Divided Differences. Numerical differentiation; numerical integration: Trapezoidal and Simpson rules; numerical solution of systems of linear equations: direct methods (Gauss elimination, LU decomposition); iterative methods (Jacobi and Gauss-Seidel); numerical solution of ordinary differential equations: initial value problems: Modified Euler's method, Runge-Kutta 4<sup>th</sup> order methods.