TUMKUR UNIVERSITY

DEPARTMENT OF STUDIES & RESEARCH IN MATHEMATICS

Syllabus for Ph. D. Entrance Test (2018 -19)

PART A: Research Methodology

1. Teaching: Nature, objectives, characteristics and basic requirements; Learner's characteristics; Factors affecting teaching; Methods of teaching; Teaching aids; Evaluation systems.
2. Research Aptitude: Research Meaning, characteristics and types; Steps of research; Methods of research; Research Ethics; Paper, article, workshop, seminar, conference and symposium; Thesis writing: its characteristics and format.
3. Reasoning (Including Mathematical).
4. Logical Reasoning.
5. Data Interpretation ,
6. Information and Communication Technology (ICT).

PART B: Cognate/Core subject

1. Algebra& linear algebra

Permutations, Combinations, Pigeon-hole principle, Inclusion-exclusion principle, Derangements.

Fundamental theorem of arithmetic, divisibility in Z, Congruences, Chinese remainder theorem, Euler'sϕ-function, primitive roots.

Groups, subgroups, normal subgroups, quotient groups, homomorphisms, cyclic groups, permutation groups, cayley's theorem, class equations, sylow theorems.

Rings, ideals,prime and maximal ideals, quotient rings, unique factorization domain, principal ideal domain, Euclidean domain, polynomial rings and irreducibility criteria.

Fields, finite fields, field extensions, Galois theory.

Vector space, subspace, linear dependence, basis, dimension, algebra of linear transformations, algebra of matrices, rank and determinant of matrices, linear equations, eigenvalues and eigenvectors, cayley-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.

2. Real & Complex Analysis

Elementary set theory, finite, countable and uncountable sets, real number system as a complete ordered field, Archimedean property, supremum, infimum.

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Sequences ans series, convergence, limsup,liminf. Bolzano Weiestrass theorem, Heine-Borel theorem. Continuity, uniform continuity, differentiability, mean value theorem, sequence and series of functions, uniform convergence, Riemann sums and Riemann integral, improper integrals. Monotonic functions, types of discontinuity, functions of bounded variation, lebesgue measure, lebesgue integrals. Functions of several variables, directional derivatives, partial derivative, derivative as a linear transformations, inverse and implicit function theorems.

Algebra of complex numbers, the comple plane, polynomials, power series, transcendental functions such as exponential, trigonometric and hyperbolic functions. Analytic functions, Cauchy-riemann equations, contour integrals, Cauchy theorems,Cauchy integral formal, liouville's theorem, maximum modulus principle, Schwarz lemma, open mapping theorem, Taylors series, Laurent series, calculus of residues, conformal mapping, mobius transformations.

3. **Topology & Functional Analysis**

Topology – basis, dense sets, subspace and product topology, separation axioms, connectedness and compactness.

Metric spaces, compactness, connectedness, normed linear spaces, spaces of continuous functions as examples.

Banach spaces.Hilbert spaces.

4. **Differential Equations**

Ordinary differential equations-Existence and uniqueness of solutions of initial value problems for first order ordinary differential, singular solutions of first order ODEs, system of first order ODEs.

General theory of homogeneous linear ODEs, variation of parameters, strum-liouville boundary value problem.

Partial differential equations- Lagrange and charpit method for solving first order PDEs, Cauchy problem for first order PDEs.

Classification of second order PDEs, General solution of higher orders with constant coefficients, Method of separation of variables for laplace, heat and wave equations.

Variation of a functional, euler-lagrange equation, Necessary and sufficient conditions for extrema.Variational methods for BVP in ODE and PDE.

5. **Numerical Analysis and Mathematical Methods**

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-seidel methods, finite differences, lagranges, hermite and spline interpolation, numerical differentiation and integration, numerical solutions of ODEs using picards, euler, modified euler and runge-kutta method.

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Linear integral equations of first and second kind of fredholm and volterra type, solutions with separable kernels. Characteristic numbers and eigenfunctions,resolvent kernel.

Integral transforms- laplace transform,fouriertransform ,hankeltransform and mellin transform, perturbation methods.

6. **Classical &Continuum Mechanics**

Generalized coordinates, lagrange's equations, hamilton's canonical equations, hamilton's principle and principle of least action, two-dimensional motion of rigid bodies, euler's dynamical equations for the motion of a rigid body about an axis, theory of small oscillations.

Co-ordinate transformations, calculus of tensor, continuum hypothesis, material derivative, stress tensor, basic conservation law of mass, momentum and energy, applications to solid mechanics and fluid mechanics.

7. **Differential and Riemannian Geometry:** Calculus on Euclidian space, frame fields calculus on surface, shape operators, differential manifolds, tensors and forms, Riemannian manifolds, hyper surfaces.

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