SYLLABUS

Subject: MATHEMATICAL SCIENCE

Note:

There are two Papers for each of the subjects. Paper – I on Teaching and Research aptitude, Paper – II based on the syllabus of concerned subjects. Details are furnished below:

PAPER – I

Subject : General Paper on Teaching & Research Aptitude

The Test is intended to assess the teaching/research aptitude of the candidate. They are supposed to possess and exhibit cognitive abilities like comprehension, analysis, evaluation, understanding the structure of arguments, evaluating and distinguishing deductive and inductive reasoning, weighing the evidence with special reference to analogical arguments and inductive generalization, evaluating, classification and definition, avoiding logical inconsistency rising out of failure to see logical relevance due to ambiguity and vagueness in language. The candidates are also supposed to have a general acquaintance with the nature of a concept, meaning and criteria of truth, and the source of knowledge. There will be 50 questions for Paper – I.

1. The Test will be conducted in objective mode. The Test will consist of two Papers. All the two Papers will consists of only objective type questions and will be held on the day of Test in two separate sessions as under:

<table>
<thead>
<tr>
<th>Session</th>
<th>Paper</th>
<th>Number of Questions</th>
<th>Marks</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>First</td>
<td>I</td>
<td>50 question</td>
<td>$50 \times 2 = 100$</td>
<td>1 Hours</td>
</tr>
<tr>
<td>Second</td>
<td>II</td>
<td>100 questions</td>
<td>$100 \times 2 = 200$</td>
<td>2 Hours</td>
</tr>
</tbody>
</table>

2. Candidates who appear in two Papers and secure at least 40% aggregate marks for candidates belonging to General Category and at least 35% aggregate marks for candidates belonging to reserved categories will be declared qualifies for Eligibility for Assistant Professor by following the reservation policy of the State Government.

3. The Syllabus of Paper – II and Paper – III will be combined for Paper – II of each subject.
MATHEMATICAL SCIENCE

SECTION - B

PAPER-II

General Information: Units 1, 2, 3 and 4 are compulsory for all candidates. Candidates with Mathematics background may omit units 10 -14 and units 17, 18. Candidates with Statistics background may omit units 6, 7 and 9. Adequate alternatives would be given for candidates with O. R. background.

1. Basic concepts of Real and Complex analysis-sequences and series, continuity, uniform continuity, Differentiability, Mean Value Theorem, sequences and series of functions, uniform convergence, Riemann integral-definition and simple properties. Algebra of Complex numbers, Analytic functions, Cauchy’s Theorem and integral formula, Power series, Taylor’s and Laurent’s series, Residues, contour integration.

2. Basic Concepts of Linear Algebra-Space of n-vectors, Linear dependence, Basic, Linear transformation, Algebra of matrices, Rank of a matrix, Determinants, Linear equations, Quadratic forms, Characteristic roots and vectors.

3. Basic concepts of probability-Sample space, discrete probability, simple theorem on probability, independence of events, Bayes Theorem. Discrete and continuous random variables, Binomial, Poisson and Normal distributions; Expectation and moments, independence of random variables, Chebyshev’s inequality.


5. Real Analysis-finite, countable and uncountable sets, Bounded and unbounded sets, Archimedean property, ordered field, completeness of R, Extended real number system, lmsup and limit of a sequence, the epsilon-delta definition of continuity and convergence, the algebra of continuous functions, monotonic functions, types of discontinuities, Infinite limits and limits at infinity, functions of bounded variation, elements of metric spaces.


9. Differential Equations-First order ODE, singular solutions, initial value Problems of First Order ODE, General theory of homogenous and non-homogeneous Linear ODE, Variation of Parameters, Lagrange’s and Charpit’s methods of solving First order Partel Differential Equations. PDE’s of higher order with constant coefficients.


11. Probability - Axiomatic definition of probability. Random variables and distribution functions (univariate and multivariate); expectation and moments; independent events and independent random variables; Bayes’ theorem; marginal and conditional distribution in the multivariate case, covariance matrix and correlation coefficients (product moment, partial and multiple), regression.
Moment generating functions; characteristic functions; probability inequalities (Tchebyshef, Markov, Jensen). Convergence in probability and in distribution; weak law of large numbers and central limit theorem for independent identically distributed random variables with finite variance.

12. Probability Distribution-Bernoulli, Binomial, Multinomial, Hypergeometric, Poisson, Geometric and Negative binomial distribution, Uniform, exponential, Cauchy, Beta, Gamma, and normal (univariate and multivariate) distributions. Transformations of random variables; sampling distributions, t, F and chi-square distributions as sampling distributions, Standard errors and large sample distributions. Distribution of order statistics and range.


15. Operational Research Modelling - Definition and scope of Operational Research. Different types of models. Replacement models and sequencing theory, inventory problems and their analytical structure. Simple deterministic of queueing system, different performance measures. Steady state solution of Markovian queueing models: M/M/1, M/M/1 with limited waiting space M/M/C, M/M/C with limited waiting space.


PAPER-III

1. Real Analysis: Riemann integrable functions; improper integrals, their convergence and uniform convergence. Euclidean space $\mathbb{R}^n$, Bolzano-Welerstrass theorem, compact Subsets of $\mathbb{R}^n$, Heine-Borel theorem, Fourier series.

Continuity of functions of $\mathbb{R}^n$, Differentiability of $\mathbb{F} : \mathbb{R}^n \rightarrow \mathbb{R}^m$, Properties of differential, partial and directional derivatives, continuously differentiable functions. Taylor’s series. Inverse function theorem, implicit function theorem.

Integral functions, line and surface integrants, Green’s theorem, Stoke’s theorem.


4. Advance Analysis: Element of Metric Spaces Convergence, continuity, compactness, Connectedness, Weierstrass’s approximation Theorem, Completeness, Bare category theorem, Labesgue measure, Labesgue integral, Differentiation and Integration.

5. Advanced Algebra: Conjugate elements and class equations of finite groups, Sylow theorem, solvable groups, Jordan Holder Theorem Direct Products, Structure Theorem for finita abelian groups, Chain conditions on Rings; Characteristic of Field, Field extensions, Elements of Galois theory, solvability by Radicals, Ruler and compass construction.


11. Mechanics: Generalised coordinates; Lagranges equation; Hamilton’s coronics equations; Variational principles least action; Two dimensional motion of rigid bodies; Euler’s dynamical equations for the motion of rigid body; Motion of a rigid body about an axis; Motion about revolving axes.

12. Elasticity: Analysis of strain and stress, strain and stress tensors; Geometrical representation; Compatibility conditions; Strain energy function; Constitutive relations; Elastic solids Hooke’s law; Saint-Venant’s principle, Equations of equilibrium; Plane problems-Airy’s stress function, vibrations of elastic, cylindrical and spherical media.

13. Fluid Mechanics: Equation of continuity in fluid motion; Euler’s equations of motion for perfect fluids; Two dimensional motion complex potential; Motion of sphere in perfect liquid and motion of liquid past a sphere; vorticity; Navier-Stokes’s equations for viscous flows-some exact solutions.

14. Differential Geometry: Space curves - their curvature and torsion; Serret Frehat Formula; Fundamental theorem of space curves; Curves on surfaces; First and second fundamental form; Gaussian curvatures; Principal directions and principal curvatures; Goedesics, Fundamental equations of surface theory.


16. Linear integral Equations: Linear integral Equations of the first and second kind of Fredholm and Volterra type; soluting by suc-
cessive substitutions and successive approximations; Solution of equations with separable kernels; The Fredholm Alternative; Holbert-Schmidt theory for symmetric kernels.

17. Numerical analysis: Finite differences, interpolation; Numerical solution of algebraic equations; Iteration; Newton-Raphson method; Solutions on linear system; Direct method; Gauss elimination method; Matrix-Inversion, eigenvalue problems; Numerical differentiation and integration. Numerical solution of ordinary differential equations; iteration method; Picard’s method; Euler’s method and improved Euler’s method.

18. Integral Transform: Place transform; Transform of elementary functions; Transform of Derivatives; Inverse Transform; Convolution Theorem; Application; Ordinary and Partial differential equations; Fourier transforms; sine and cosine transform; Inverse Fourier Transform; Application to ordinary and partial differential equations.


22. Distribution Theory: Properties of distribution functions and characteristic functions; continuity theorem; inversion formula; Representation of distribution function as a mixture of discrete and continuous distribution functions; Convolutions, marginal and conditional distributions of bivariate discrete and continuous distributions.

Relations between characteristic functions and moments: Moment inequalities of Holder and Minkowski.

23. Statistical Inference and Decision Theory: Statistical Decision problem; non-randomized, mixed and randomized decision rules; risk function; admissibility; Bayes’ rules, minimax rules, least favourable distributions; complete class and minimal complete class. Decision problem for finite parameter space. Convex loss function; Role of sufficiency.

Families of distributions with monotone likelihood property, exponential family of distributions. Test of simple hypothesis against a simple alternative from decision, theoretic viewpoint. Tests with Neyman structure. Uniformly most powerful unbiased tests. Locally most powerful tests; inference on location and scale parameters; estimation and tests. Equivariant estimators, invariance in hypothesis testing.


Inference on parameters of multivariate normal distributions; one population and two-population cases. Wishart distribution, Hotelling’s T2, Mahalobis D2; Discriminant Analysis, Principal components, Canonical correlations, Cluster analysis.

26. Linear Models and Regression: Standard Gauss Markov models; Estimability of parameters; best linear, unbiased estimates (Bell...);
Method of least squares and Gauss-Markov theorem; Variance-covariance matrix of BLUES. Test of linear hypothesis, One-way and two-way classifications. Fixed, random and mixed effects models (two-way classifications only); variance components, Bi-variable and multiple linear regression; Poly-normal regression; use of orthogonal poly-normals. Analysis of covariance. Linear and nonlinear regression, Outliers.


30. Stochastic Process : Markov chains with finite and countable state space, classification of states, limiting behaviour of n-step transition probabilities, stationary distribution; branching processes; Random walk; Gambler’s ruin. Markov processes in continuous time; Poisson processes, birth and death processes, Wiener process.


32. Industrial Statistics : Control charts for variables and attributes; Acceptance sampling by attributes; single, double and sequential sampling plans; OC and ASN functions, AOQL and ATI; Acceptance sampling by varieties. Tolerance limit. Reliability analysis : Hazard function, distribution with DFR and IFR; Series and parallel systems. Life testing experiments.
