

# Syllabus for Statistics Master's

## Section 1: Subject Knowledge

Please Note: A Total of 26 Questions will be asked, combining the following topics, with the difficulty level commensurate to a Master's Candidate.

### Unit I: Calculus

Finite, countable, and uncountable sets, Sequences and series: convergence, tests, and power series, Functions: limits, continuity, differentiability, mean value theorems, Taylor's theorem, maxima and minima, Riemann integration and improper integrals, Functions of several variables.

### Unit II: Matrix Theory

Subspaces, span, linear independence, basis, dimension, row/column space, rank, and nullity, Matrix operations: trace, determinant, inverse, and linear systems, Inner products, Gram-Schmidt process, eigenvalues, eigenvectors, Cayley-Hamilton theorem, matrix types, Matrix similarity, diagonalizability, positive definite matrices, quadratic forms, and singular value decomposition (SVD).

### Unit III: Probability

Axiomatic probability, properties, conditional probability, Bayes' theorem, and independence, Random variables, distributions (pmf, pdf), expectation, moments, and moment generating functions, Quantiles, distribution of functions, and inequalities (Chebyshev, Markov, Jensen).

### Unit IV: Standard discrete and continuous univariate distributions

Degenerate, Bernoulli, binomial, negative binomial, geometric, Poisson, hypergeometric, uniform, exponential, double exponential, gamma, beta, normal, and Cauchy distributions, Moment generating function (m.g.f.) and its properties, Markov and Chebyshev inequalities, Bivariate normal distribution.

### Unit V: Stochastic Processes

Markov chains with finite and countable state space, classification of states, limiting behavior of n-step transition probabilities, stationary distribution, Poisson process, birth-and-death process, pure-birth process, pure-death process, Brownian motion and its basic properties.

### Unit VI: Estimation

Sufficiency, minimal sufficiency, factorization theorem, completeness, and Basu's theorem, Unbiased estimation, UMVUE, Rao-Blackwell, Lehmann-Scheffe, and Cramer-Rao inequality, Estimation methods: moments and maximum likelihood, Interval estimation, pivotal quantities, and confidence intervals.

### Unit VII: Testing of Hypotheses

Unbiasedness, sufficiency, completeness, consistency, and relative efficiency of estimators, Maximum likelihood estimation, Confidence intervals for parameters of normal and exponential distributions, Null and alternative hypotheses, Test statistics, type I and type II errors, and power of a test.

### Unit VIII: Non-parametric Statistics

Empirical distribution function and its properties, goodness of fit tests, chi-square test, Kolmogorov-Smirnov test, sign test, Wilcoxon signed rank test, MannWhitney U-test, rank correlation coefficients of Spearman and Kendall.

#### Unit IX: Multivariate Analysis

Multivariate normal distribution: properties, conditional and marginal distributions, maximum likelihood estimation of mean vector and dispersion matrix, Hotelling's T<sup>2</sup> test, Wishart distribution and its basic properties, multiple and partial correlation coefficients and their basic properties.

#### Unit X: Regression analysis

Simple and multiple linear regression, R<sup>2</sup> and adjusted R<sup>2</sup> and their applications, distributions of quadratic forms of random vectors: Fisher-Cochran theorem, Gauss-Markov theorem, tests for regression coefficients, confidence intervals,.

### **Section 2: Fundamental Skills**

Please Note: A Total of 24 Questions will be asked, combining the following topics, with the difficulty level commensurate to a Master's Candidate.

Unit I: Data Analysis

Unit II: Math and Statistics

Unit III: Lab Skills

Unit IV: Reading and Writing

### **Section 3: Specific Skill Proficiency**

This section has more than 30 skills. You can select the ones you are proficient in from the enrollment form. You can choose a maximum of 4 skills. Each skill contains 10 questions.