# Faculty of Science

## M.Sc. / M.A. (Statistics)

### DEPARTMENT OF STATISITICS & OPERATIONS RESEARCH
### ALIGARH MUSLIM UNIVERSITY ALIGARH

Syllabus for M.A./M.Sc. Entrance Test in Statistics 2019-20 onward

**Descriptive Statistics:** Concepts of population and sample. Data: quantitative and qualitative, attributes, variables, scales of measurement- nominal, ordinal, interval and ratio. Measures of Central Tendency and Measures of Dispersions, Skewness and Kurtosis,. Bi-variate data, Correlation (simple, partial and multiple), rank correlation. and Regression Analysis. Principle of least squares and fitting of polynomials and exponential curves

**Probability and Probability Distributions:** Basics **of** Probability, conditional Probability, Bayes' theorem and its applications. Random variables, p.m.f., p.d.f. and c.d.f., illustrations and properties of random variables, uni-variate transformations with illustrations. Two dimensional random variables: joint, marginal and conditional p.m.f, p.d.f., and c.d.f., independence of variables. Mathematical expectation and generating functions, characteristic function. Conditional expectations. Standard probability distributions (discrete and continuous) with their properties. Central Limit Theorem. and Chebeshev's In-equality, Tests of significance based on *t, Z* , *F and Chi-square* distributions.

**Sampling Distributions:** Limit laws: convergence in probability, convergence in distribution and their inter relations, Chebyshev's inequality, W.L.L.N. and their applications, De-Moivre Laplace theorem, Central Limit Theorem (C.L.T.) for i.i.d. variates, applications of C.L.T. Order Statistics: Introduction, distribution of the *r*th order statistic, smallest and largest order statistics. Joint distribution of rth and sth order statistics. Definitions of random sample, parameter and statistic, sampling distribution of a statistic, sampling distribution of sample mean, standard errors of sample mean, sample variance and sample proportion. Exact sampling distributions: Student's *t*-distribution, Derivation of its p.d.f., nature of probability curve with different degrees of freedom, mean, variance, moments and limiting form of t distribution. Snedecore's *F*-distribution: Derivation of p.d.f., nature of p.d.f. curve with different degrees of freedom, mean, variance and mode.Distribution of 1/F($n_1, n_2$). Relationship between *t, F* and $\chi^2$ distributions. Test of significance based on *t* and *F*-distributions.

**Statistical Inference:** Estimation: Concepts of estimation, unbiasedness, sufficiency, consistency and efficiency. Factorization theorem. Complete statistic, Minimum variance unbiased estimator (MVUE), Rao-Blackwell and Lehmann-Scheffe theorems and their applications. Cramer-Rao inequality and MVB estimators(statement and applications).Methods of Estimation: Method of moments, method of maximum likelihood estimation, method of minimum Chi-square, basic idea of Baye's estimators. Principles of test of significance: Null and alternative hypotheses (simple and composite), Type-I and Type-II errors, critical region, level of significance, size and power, best critical region, most powerful test, uniformly most powerful test, Neyman Pearson Lemma (statement and applications to construct most powerful test

**Survey Sampling:** Concept of sample and population, complete enumeration versus sampling, sampling and non-sampling errors, requirements of a good sample, simple random sampling with and without replacement, estimates of population mean, total and

proportion, variances of these estimates, and estimates of theses variances and sample size determination. Stratified random sampling, estimates of population mean and total, variances of these estimates, proportional and optimum allocations and their comparison with SRS. Systematic Sampling, estimates of population mean and total, variances of these estimates. Ratio and regression methods of estimation, estimates of population mean and total (for SRS of large size), variances of these estimates and estimates of theses variances, variances in terms of correlation coefficient between X and Y for regression method and their comparison with SRS.

**Linear Models:** Gauss-Markov set-up: Theory of linear estimation, Estimiability of linear parametric functions, Method of least squares, Gauss-Markov theorem, Estimation of error variance. Regression analysis: Simple regression analysis, Estimation and hypothesis testing in case of simple and multiple regression models, Concept of model matrix and its use in estimation. Analysis of variance: Fixed, random and mixed effect models, analysis of variance and covariance in one-way classified data for fixed effect models, analysis of variance and covariance in two-way classified data with one observation per cell for fixed effect models Model checking: Prediction from a fitted model, Violation of usual assumptions concerning normality, Homoscedasticity and collinearity, Diagnostics using quantile-quantile plots.

**Design of Experiments:** Experimental designs: Role, historical perspective, terminology, experimental error, basic principles, Basic designs: Completely Randomized Design (CRD), Randomized Block Design (RBD),Latin Square Design (LSD) – layout, model and statistical analysis, relative efficiency, analysis with missing observations. Factorial experiments: advantages, notations and concepts, $2^2$, $2^3 \ldots 2^n$ and $3^2$ factorial experiments, design and analysis, Total and Partial confounding for $2^2$ ($n \leq 5$), $3^2$ and $3^2$.Factorial experiments in a single replicate, fractional factorial design and analysis of $2^k$. Balanced Incomplete Block Design and Analysis

**Calculus:** Real valued sequences and series, convergence / divergence of sequences and series, comparison test, real valued functions, limit and continuity, power series, Differential and Integral Calculus - Differentiability, Rolle's theorem, Mean value theorem and Taylor / Maclaurin expansions, higher order derivatives and partial derivatives, maxima and minima of functions of one variable.

**Elements of Linear Algebra**: Vector space, subspace, dimension of a vector space, real valued matrices, rank, determinant and inverse of a matrix, properties of square, diagonal and symmetric matrices, characteristic roots and vectors of a matrix, simultaneous linear equations.

**Operations Research:** Linear Programming Problem, Mathematical formulation of the L.P.P, graphical solutions of a L.P.P. Simplex method for solving L.P.P. Charne's M-technique for solving L.P.P. involving artificial variables. Special cases of L.P.P. Concept of Duality in L.P.P: Dual Simplex method. Post-optimality analysis**.** Transportation Problem: Initial solution by North West corner rule, Least cost method andVogel's approximation method (VAM), MODI's method to find the optimal solution, special cases of transportation problem. Assignment problem: Hungarian method to find optimal assignment, special cases of assignment problem. Game theory: Rectangular game, minimax-maximin principle, solution to rectangular game using graphical method, dominance and modified dominance property to reduce the game matrix and solution to rectangular game with mixed strategy.