



**NATIONAL BANK FOR AGRICULTURE AND RURAL DEVELOPMENT**  
**SYLLABUS FOR THE WRITTEN EXAMINATION FOR THE POST OF**  
**ASSISTANT MANAGERS IN GRADE 'A'**  
**STATISTICS**

(The syllabus is illustrative and not exhaustive. The syllabus should not be considered as the only source of information while preparing for the examination. Keeping in view the nature of examination, all matters falling within the realm of the subject concerned will have to be studied by the candidate as questions can be asked on all relevant matters under the subject. Candidates appearing for the examination should also prepare themselves for answering questions that may be asked on the current/latest developments/Acts taking place under the subject(s) although those topics may not have been specifically included in the syllabus.)

### **PROBABILITY THEORY**

*Important concepts in Probability:* Definition of Probability—Classical and relative frequency approach to Probability. Richard Von Mises, Cramer and Kolmogorov's approaches to Probability, merits and demerits of these approaches. Only general ideas to be given.

*Random Experiment:* Trial, sample point and sample space, definition of an event, operation of events, mutually exclusive and exhaustive events. Discrete sample space, properties of Probability based on axiomatic approach. Conditional Probability, independence of events, Bayes' theorem and its applications. Chebyshev's inequality and applications with problems.

*Random variables:* Definition of discrete random variables, Probability mass function, idea of continuous random variable, Probability density function, illustrations of random variables and its properties, expectation of a random variable and its properties. Moments, measures of location, dispersion, skewness and kurtosis, Probability generating function (if it exists), moment generating function, their properties and uses.

### **DESCRIPTIVE STATISTICS**

*Types of data:* Concepts of a statistical population and sample from a population; qualitative and quantitative data; nominal and ordinal data; cross sectional and time series data; discrete and continuous data; frequency and non-frequency data. Different types of scales—nominal, ordinal, ratio and interval. Primary data and Secondary data, Methods of data collection: Interview method, Questionnaire method,

Personal Observation method, designing a questionnaire and a schedule; checking their consistency, Pilot survey Controlled experiments, observational studies and Scrutiny of data for internal consistency and detection of errors of recording.

*Sample surveys and Population Census:* methods of conducting population census with special reference to Census in India.

*Analysis of Categorical data:* Consistency of categorical data. Independence and association of attributes. Various measures of association for two- way classification, Odds ratio.

*Presentation of data:* Construction of tables with one or more factors of classification, *Classification:* Geographical, chronological, qualitative and quantitative. Formation of frequency distribution of discrete and continuous type, relative frequency, frequency density and cumulative frequencies. Construction of Stem and leaf chart. Construction of tables and frequency distribution using MS-Excel (COUNT, COUNTIF, PIVOT TABLE etc.) and R commands Diagrammatic representation of data: Construction of Simple bar diagram, multiple bar diagram, subdivided bar diagram, percentage bar diagram, pie- diagram and pictogram.

*Graphical representation of grouped data:* Construction of Frequency bar diagram, frequency polygon, histogram, cumulative frequency diagrams and ogives.

Construction of graphs and diagrams by using MS-Excel and and R commands

## **Probability Distributions**

*Discrete distributions:* Bernoulli, Binomial, Poisson Finding (Mgf and pgf, Mean, Variance, mode, skewness and kurtosis, recurrence relation for central moments and for probabilities, additive property), Ms-Excel and R commands for fitting of these distributions Geometric (Finding Mgf and Mean, Variance, Lack of memory property, problems), Negative Binomial Distributions (Finding Mgf and Mean, Variance, problems), and Hypergeometric (Finding Mean, Variance, problems).

*Probability distributions:* Discrete Uniform (Finding Mean, Variance), Continuous Uniform (Finding Mgf and Mean, Variance), Normal.(Properties of normal distribution, Finding Mgf and Mean, mode, median, Variance, recurrence relation for central moments, skewness and kurtosis, additive property, standard normal variable and problems), Ms-Excel and R commands for fitting of Normal distributions Continuous Univariate distributions—Exponential (Finding Mgf and Mean, Variance, Lack of memory property), Gamma with one parameter and gamma with two parameters (Finding Mgf and Mean, Variance, Additive property), Beta distributions of both types (Finding rth moment, Mean and variance).

## **DESCRIPTIVE STATISTICS**

*Analysis of Quantitative data:* Uni-variate data - Concepts of central tendency and location, Measures of central tendency: Mean, Median and Mode, Geometric Mean and Harmonic mean (Definitions, merits and demerits, properties, theoretical

problems), weighted averages. Concepts of dispersion, Measures of dispersion: Range, Mean Deviation, Quartile deviation and standard deviation (Definitions, merits and demerits and properties)

*Measures of and relative dispersion:* coefficient of dispersion and coefficient of variation.

*Moments:* Raw and Central moments, expression for central moments in terms of raw moments, Sheppard's corrections for moments for grouped data (without derivation

Partition values: Quartiles, Deciles, Percentiles (definition, formulae and procedure for finding these values graphically), Concepts of skewness and kurtosis and their measures including those based on quantiles), Box plot, q-q plot and their use in describing data. R commands for Histogram, Box plot and q-q plot. MS-Excel and R commands for Computation of mean, mode and median, and measures of dispersion.

*Bivariate Data:* Scatter diagram, Product moment correlation coefficient and its properties. Coefficient of determination (ANOVA APPROACH). Concepts of error in regression (NORMALITY OF ERRORS). Principle of least squares. Fitting of linear regression and related results. Rank correlation—Spearman's and Kendall's measures.

MS-Excel and R command for plotting Scatter diagram, calculation of correlation coefficient, fitting of regression line.

## **STATISTICAL METHODS**

*Bivariate probability distributions (discrete and continuous):* Joint distribution, marginal and conditional distributions (Mean, Variance), moment generating function, stochastic independence, covariance, correlation coefficient and theoretical problems on these topics.

*Bivariate normal distribution:* marginal and conditional distributions (Mean, Variance), moment generating function, Multinomial Distribution (three variables' case): (Mean, Variance, moment generating function)

*Sampling from a distribution:* Definition of a random sample, Drawing random samples from standard distributions, Distribution of a function of random variables: Concept of a statistic and its sampling distribution, Transformation of variables technique: mgf and cdf techniques, univariate and bivariate transformations of discrete and continuous variables. Theoretical problems on these topics. R commands for drawing a random sample from binomial, Poisson, Uniform, exponential and Normal distributions

Sampling distribution of sum of binomial, Poisson variables and mean of normal variables, derivations Chi-square, t and F distributions (mgf, mean, variance, mode, additive property - if it exists), independence of sample mean and variance in random sampling from a normal distribution ( without derivation ).

## **Economic Statistics**

*Index number:* Its definition, applications of index numbers, price relatives and quantity or volume relatives, link and chain relatives, problems involved in computation of index numbers, use of averages, simple and weighted aggregative and simple and weighted average methods, Laspeyre's, Paasche's, Marshall Edgeworth's, Walsch's, Kelly's DrobishBowley's and Fisher's quantity and price index numbers, Time and Factor reversal tests of index numbers.

*Base shifting, Splicing of index number series, Consumer Price Index:* steps in its construction, methods and uses, Index of Industrial Production: method of construction and its uses, Wholesale price index number: method of construction and its uses, concept of purchasing power of money, inflation and deflation, Methods of computation of national income.

*Demand Analysis:* Demand and Supply function, Static laws of demand and supply, price elasticity of demand, price elasticity of supply, Income and cross elasticity of demand. Engel' law and Engel's curves, analysis of income and allied size distribution – Pareto distribution, fitting of Pareto's law, Lorenz curve and Gini's coefficient.

*Time Series Analysis:* Economic time series, its different components, illustrations, additive and multiplicative models, methods of determination of trend, analysis of seasonal fluctuations, methods of construction of seasonal indices.

## **STATISTICAL INFERENCE**

*Point Estimation:* Point estimate of a parameter, Unbiased estimator, concept of bias and standard errors of sample mean, sample proportion. Concept of UMVUE, Cramer – Rao Inequality (without proof) and simple problems on CRLB.

*Concepts of testing of hypothesis:* Statistical tests, Null and alternative hypothesis, Types of errors, Critical region, level of significance, p-values, power of a test, Two-tailed and one tailed tests. Simple problems on finding sizes of type-I and Type-II errors.

Test and construction of Confidence intervals for the mean of univariate normal distribution, Test and construction of confidence intervals for the difference of two means and two variances of two univariate normal distributions, confidence interval for ratio of two variances, Paired t10 test and the corresponding confidence interval, Testing for the significance of sample correlation coefficient in sampling from bivariate normal distribution MS-Excel and R commands for the test of single mean, difference of means and paired t- test, and R command for test of equality of variances.

*Chi-square tests:* Test and construction of Confidence intervals for variance of univariate normal distribution, Pearson's chi-square test for goodness of fit and for homogeneity for standard distributions, Contingency tables and test of independence of attributes. MS-Excel command for construction of contingency table (using Pivot table command), R command for goodness of fit test.

*Large Sample tests:* Use of central limit theorem for interval estimation of a single mean, single proportion and difference of two means and two proportions. Tests and construction of confidence intervals for a single mean, single proportion and difference of two means and two proportions. MS-Excel command for Large Sample test for difference of two means.

## **Applied Statistics**

*Demographic Methods:* Sources of demographic data – census, register, adhoc survey, hospital records, Measurement of mortality and life tables – crude death rates, age specific death rate, standardized death rate, infant mortality rates, death rate by cause, case fatality rate, complete life table – its main features, central mortality rate force of mortality, construction of life tables and uses of life tables.

*Measurement of fertility:* crude birth rate, general fertility rate, total fertility rate.

*Rates of population growth:* Pearl's vital index and crude rate of natural increase, gross reproduction rate, and net reproduction rate with relative merits and demerits.

*Psychological and Educational Statistics:* Scaling difficulty value, scaling of scores-Z-scores and standard scores, normalized scores, T scores, percentile scores, Comparison of T-scores and standard scores, Uses of T-scores and percentile scores, scaling of ranking and rating in terms of normal probability distribution.

Concept of Reliability of test scores, index of reliability, methods for estimating test reliability with relative merits and demerits: Test-retest method, parallel forms method, split half method, method of rational equivalence, Rulon and Kudar Richardson formulae of test reliability. Validity of test scores, validity and test length, comparison between reliability and validity, intelligence tests and their uses, intelligence quotient.

## **Statistical Quality Control and Linear Programming Problem**

*Statistical Quality Control:* Introduction, Chance and assignable causes of variation, Uses of SQC. Process and product control, Tools for SQC, Control charts, principles of control chart, 3-sigma control limits, Control charts for mean, standard deviation and range. Natural tolerance limits and specification limits, modified control limits.

Acceptance sampling by attributes, AQL, LTPD, consumer's risk, producer's risk, AOQL, ASN, OC, single & double sampling plans and their comparison, Continuous sampling inspection plans – CSP I, CSPII, CSP III.

*Linear programming problem:* Mathematical background, linear independence of vectors in  $E_n$ , Bases, linear inequalities, solution of simultaneous equations, lines and hyperplanes, convex sets. Linear programming problem, general and standard form, redundancy of constraints, slack and surplus variables. Feasible solution, basic feasible solution, non-degenerate basic feasible solution, optimum solution. Theorems related to extreme point solution, conversion of minimization problem to maximization problem. Graphical method of solving a Linear programming problem

Simplex method, generating extreme point solution, development of optimum solution, unbounded solution, alternative solution, computational procedure, simplex algorithm, artificial basis technique, case of non-feasible solution, degeneracy and breaking of ties, condensed simplex method.

### **Survey Sampling Techniques**

*Official Statistics:* Functions of Central Statistical Organization and its purpose, National sample survey organization, its purpose, functions and important aspects.

*Sample Survey:* complete enumeration versus sampling, requirements of a good sample, Planning, Execution and Analysis of a survey, Types of sampling, Sampling units, frames, sampling errors and Non-sampling errors.

*Sampling Designs:* Simple random sampling with and without replacement, sampling for proportions, and determination of sample size for estimating population mean and population proportions.

*Stratified Random sampling:* Method, various allocations and their comparisons, cost and variance analysis in stratified sampling, comparison with simple random sampling, Estimation of gain in precision due to stratification.

Cluster Sampling with equal sizes: Population mean, variance and their estimation, Efficiency of cluster sampling in terms of intra-class correlation. Comparison of Cluster sampling with SRSWOR, Clusters formed by random selection Estimation of efficiency and relative efficiency w.r.to SRS.

*Systematic sampling:* Resemblance of Systematic sampling with Stratified and cluster sampling, Estimation of population mean & variance, comparison of systematic sampling with stratified and simple, random sampling for population with linear trend.

### **Operations Research**

*Network analysis:* Introduction, basic concepts, construction of network diagram, (Rules of construction, errors, Fulkerson's rule), Time estimates, forward pass method, backward pass method, float of an activity, CPM, advantages and drawbacks of CPM, PERT, three time estimates, probability of completion of the project within scheduled time, distinction between PERT and CPM.

Project time-cost trade off, project crashing, Time-cost optimization algorithm.

*Duality:* Primal and dual problem, Rules for converting primal into dual, economic interpretation of dual, characteristics of the dual problem, advantages of duality, interpretation of primal-dual optimum solutions.

*Transportation problem:* General transportation problem, Linear programming formulation of Transportation problem, balanced and unbalanced transportation problem, existence of feasible solution, construction of basic feasible solution,, its properties. Solution procedure for Transportation problem: a) methods of finding

initial basic feasible solution, b) testing optimality of the solution, c) improving solution. Maximization Transportation problem.

*Assignment problem:* Definition, unbalanced assignment problem, Theorems related to solution of an assignment problem, solution method, maximization in an assignment problem, restriction on assignment.

*Game Theory:* Definition, two person zero sum game, pay-off matrix, minimax and maximin principle, pure- strategy, value of a game, saddle point, solution of a game with saddle point.