

Maharashtra Public Service Commission

Civil Services Exam – Mains Optional

Statistics

(Code No : 608)

Paper - I

Standard : Degree

Total Marks : 200

Nature of Paper : Conventional Type

Duration : 3 Hours

- Note:**
- 1) Answers to this paper must be written in English only
 - 2) This paper will test the candidate's ability to comprehend, to analyse, to interpret, to criticise and to appraise the subject matter related to the topics/sub topics mentioned below.
 - 3) It is expected from candidates to study the latest and recent developments and happenings pertaining to the topics/sub topics mentioned below.

Section - A (Marks : 50)

1) Probability :

- .01) continuous and discrete random Sample space, events, probability, variables, combinatorial theory, probability mass function, probability density function, distribution function, standard discrete and continuous univariate distributions.
- .02) Bivariate random variable, marginal and conditional distributions, independence of events and random variables, expectation and moments, conditional expectation.
- .03) Moment generating function, probability generating function, characteristic function. Chebychev's inequality and its applications.
- .04) Weak law of large numbers, central limit theorem and their applications. Finite Markov chains and their simple properties.

Section - B (Marks : 50)

2) Statistical Inference :

- .01) Sufficiency, factorization theorem, unbiasedness, Mean Square Error (MSE), minimum MSE estimators, Uniformly Minimum Variance Unbiased Estimators (UMVUE), Rao-Blackwell theorem and its applications, lower bound of the variance and related results.
- .02) Estimation by method of moments, maximum likelihood, least squares, minimum chi-square, consistent estimators, efficiency of estimators. Statistical hypothesis, hypotheses, statistical tests, critical region, simple and composite Type-I and Type-II errors, p-value, power of a test. Most Powerful test, Neyman Pearson Lemma and its applications.
- .03) Uniformly Most Powerful tests, Likelihood ratio tests, Z-test, t-test, F-test, Chi-square test. Concept of confidence interval and its application to the parameter of univariate normal and exponential distributions. Chi-square test for goodness

of fit.

- .04) Kolmogorov-Smirnov's test for goodness of fit, sign-test, Wilcoxon signed-ranks test, Wilcoxon-Mann-Whitney test, median test, run test.
- .05) Wald's Sequential Probability Ratio Test and its properties, Operating Characteristic and Average Sample Number functions.

Section - C (Marks : 50)

3) Multivariate Analysis :

- .01) **Bivariate Data** : Scatter diagram, frequency distribution, product moment correlation coefficient, concept of regression, principle of least squares, fitting of linear and quadratic regression and related results.
- .02) Notion of multiple linear regression (trivariate case). Fitting of regression plane by method of least squares, solution of normal equations, computation of partial regression coefficient, multiple correlation coefficient and partial correlation coefficient, rank correlation.
- .03) Multinomial distribution, its properties and applications. Bivariate normal distribution, its properties and applications.
- .04) **Analysis of Categorical Data** : Consistency of categorical data. Independence and association of attributes. Various measures of association for two-way and three-way classified data. Odds ratio.

Section - D (Marks : 50)

4) Sampling Theory :

- .01) An outline of fixed-population approach, distinctive features of finite population, simple random sampling with and without replacement, stratified random sampling and allocation problem, estimation of population mean, population proportion and population variance based on above sampling methods.
- .02) Systematic sampling, cluster sampling, two-stage sampling, estimation of population parameters using above sampling methods. Ratio and regression methods of estimation.
- .03) Non-sampling errors. Concept of survey sampling, design of questionnaire, determination of sample size, planning, execution and analysis of sample survey.
- .04) Present official statistical system (including National Sample Survey) in India relating to population, agriculture, industrial production, trade and prices. Methods of collection of official statistics, their reliability, limitations and principle publications containing such statistics, various official agencies responsible for data collection and their main function.

Paper - II

Standard : Degree

Total Marks : 200

Nature of Paper : Conventional Type

Duration : 3 Hours

- Note:**
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Section - A (Marks : 50)

1) Optimisation Techniques and Computer Applications :

- .01)** Linear Programming Problems (LPP), canonical and standard forms and dual of an LPP, graphical method to solve two variable LPP, solving LPP using Simplex procedure in presence of slack and/or surplus and/or artificial variables.
- .02)** Representation of transportation and assignment problems as LPP, solution of a transportation problem, solution of an assignment problem. Two-person zero-sum game, methods of solution (graphical and algebraic).
- .03)** Simulation techniques, generation of random samples from standard discrete and continuous univariate distributions (Algorithms are expected). Use of various statistical software for data representation and analysis.

Section - B (Marks : 50)

2 Industrial Statistics :

- .01)** Process and product control, seven statistical process control tools, general theory of control charts, different types of control charts for variables and attributes, X-bar, R, S, p, np, c and u charts. Cumulative sum chart.
- .02)** Single, double, multiple and sequential sampling plans for attributes, OC, ASN, AOQ and ATI curves, concepts of producer's and consumer's risks, AQL, LTPD and AOQL. Sampling plans for attributes and variables.
- .03)** **Process capability indices** : Cp, Cpk and Cpm. Estimation of process capability indices and their interpretation.
- .04)** Concept of reliability, reliability of series and parallel systems and other simple configurations thereof.

Section - C (Marks : 50)

3) Design of Experiments :

- .01)** Basic principles of design of experiments, randomization, replication, local control. Completely Randomized Design (CRD), Randomized Block Design (RBD), and Latin Square Design (LSD) with analysis.
- .02)** Balanced Incomplete Block Design (BIBD), missing plot technique.
- .03)** Factorial design, 2^2 and 2^3 designs. Confounding in factorial experiments.
- .04)** Analysis of covariance (with one concomitant variable). Introduction to Taguchi method, concept of loss function, robust design.

Section - D (Marks : 50)

4) Time Series, Index Number and Demography :

- .01)** **Components of time series** : trend, seasonal, cyclical and irregular variations. Additive and multiplicative models, methods of estimating trend and seasonal components.
- .02)** Meaning and utility of price index numbers. Unweighted and weighted price index numbers, commonly used index numbers. Time reversal, factor reversal and circular test. Consumer price index, index number using family budget method and aggregate expenditure method.
- .03)** **Sources of demographic data** : census, register, ad-hoc surveys, hospital records, demographic profiles of the Indian census. Measurement of mortality and life table, crude death rate, age-specific death rate, infant

mortality rate, death rate by cause, complete life table and its main features, uses of life table.

- .04) Measurement of fertility** : crude birth rate, general fertility rate, age-specific birth rate, total fertility rate, gross reproduction rate, net reproduction rate, standardised death rates, age pyramid of sex composition.
