



INSTITUTE OF STATISTICAL RESEARCH AND TRAINING (ISRT)  
UNIVERSITY OF DHAKA, DHAKA-1000, BANGLADESH

পরিসংখ্যান গবেষণা ও শিক্ষণ ইনস্টিটিউট, ঢাকা বিশ্ববিদ্যালয়, ঢাকা-১০০০, বাংলাদেশ

## **Admission for M.S. in Applied Statistics and Data Science**

The Institute of Statistical Research and Training (ISRT), University of Dhaka, invites applications for admission to its **regular full-time Master of Science (M.S.) program in Applied Statistics and Data Science for the vacant seats (limited) for the academic session 2024-25.**

### **Guidelines for Admission Procedures**

#### **Program Details**

- 1) **Program Name:** Master of Science in Applied Statistics and Data Science
- 2) **Academic Session:** 2024 - 25
- 3) **Duration:** One year and an additional 2 - 4 months for project/internship/thesis
- 4) **Course Fees and Facilities:** As per the rules of the University of Dhaka for the regular M.S. program.
- 5) **Curriculum:** For details about courses offered in the M.S. program, see the curriculum/syllabus downloadable from the provided link: <https://isrt.ac.bd/academics/graduate>

#### **Eligibility Criteria**

- 1) **Degree Requirement:** Applicants must hold a Bachelor's degree in Applied Statistics/ Statistics/CSE/EEE/Mathematics-related disciplines with a total credit range of 128-160 (minimum 128 credits) from a UGC-approved reputable university in Bangladesh. Additionally, during their undergraduate program, applicants must have sufficient knowledge on the following topics: Descriptive statistics, Probability theory, Probability and Sampling distributions, Statistical inference, Sampling techniques, Design of experiments, Linear regression models, Generalized linear models, and Statistical programming.
- 2) **CGPA Requirement:** Applicants must have a minimum CGPA of 3.50 on a scale of 4.00 (or equivalent) in the Bachelor's degree. Applicants should have a minimum GPA of 3.50 in both SSC and HSC exams with a total minimum GPA of 8.0.
- 3) **Academic Session of Bachelor's Degree:** Applicants must have completed their Bachelor's degree in or after the 2022-23 academic session. (i.e, Applicants who completed their Bachelor's degree before the 2022-23 academic session are not eligible to apply).
- 4) Applicants currently enrolled in a Master's program elsewhere are eligible to apply but must withdraw from their current program before commencing admission at this institution if selected.



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- 5) **Foreign Degree Holder:** Applicants with a Bachelor's degree in Applied Statistics or Statistics from a foreign university may apply with a prior equivalence certificate from the University of Dhaka. They must contact the institute before applying.
- 6) **Language:** Foreign applicants must have English as the medium of instruction in their Bachelor's degree.

### How to Apply

- 1) **Application Form:** Interested applicants are required to complete the prescribed application form available through the Google Form link provided on the admission page at: <https://isrt.ac.bd/academics/admission>
- 2) **Required Documents:** Applicants must submit the completed application form along with the following documents:
  - (i) SSC and HSC: Certificates and Marksheet
  - (ii) Bachelor's Degree: Marksheet and Certificate (if available)
  - (iii) A one-page statement of purpose with names (PDF format)
  - (iv) One passport-size photograph
  - (v) At the time of admission, the successful candidates must submit a release letter from his/her current or last academic institution (whichever applicable) and original documents.
  - (vi) Name of two referees with contact details.
- 3) **Application Fees:** BDT 2500. The fee must be paid before submitting the filled application form.
- 4) **Mode of Payment:** bKash number 01725356184 (personal). Applicants must mention his/her name as the transaction reference.
- 5) For further information, visit <https://isrt.ac.bd/academics/admission>

### Admission Procedure

- 1) **Admission Test:** Eligible candidates must appear for the admission test, which consists of a written exam and a viva-voce.
- 2) **Written Exam:** There will be a written exam of 80 marks, of a duration of about two hours. The written exam will contain conceptual short-answer questions on the following topics: descriptive statistics, probability theory, probability and sampling distributions, sampling techniques, statistical inference, experimental design, linear regression models, generalized linear models, statistical programming, and academic writing.



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- 3) **Viva Voce:** There will be a viva-voce of 20 marks, and only shortlisted candidates will be called for a viva voce.
- 4) **Merit Score:** The final merit list will be prepared based on a total score of 100 marks (written: 80 and viva-voce: 20).

### **Schedule for Admission Procedures**

- 1) Application Starts: July 07, 2025
- 2) Application Ends: July 24, 2025
- 3) Admission Test (Written): July 27, 2025
- 4) Viva Voce: July 28, 2025
- 5) Final Result: July 31, 2025
- 6) Admission Completion Deadline: August 10, 2025
- 7) Class Start: August 17, 2025

### **Contact**

ISRT office: Cell: 01615356184 (9.00 am to 5.00 pm), Email: [admission@isrt.ac.bd](mailto:admission@isrt.ac.bd)

### **Topics to be Covered in the Admission Test**

#### **Descriptive Statistics:**

Introduction to statistics: meaning of statistics; scopes and limitations; concepts of descriptive and inferential statistics; basic concepts: data, sources of data - primary and secondary data; population, sample, parameter, statistic; variables and types of variable: qualitative, quantitative discrete and continuous; scales of measurements; classification of variables by scales of measurements.

Producing data: approaches of producing data; the concept of experimental study and nonexperimental study to produce data; introduction to sample survey and questionnaire; the concept of electronically recorded data and hospital recorded data; the concept of data cleaning and checking before statistical analysis.

Organization and presentation of data: graphical presentation for qualitative and quantitative data; sorting data, grouping qualitative and quantitative data: construction of frequency distribution and



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relative frequency distribution; graphical presentation of frequency distribution histogram, frequency polygon, ogive.

Concept of distribution: location, scale (spread), and shape, illustration with stem-and-leaf diagram; descriptive measures of data; measures of location; measures of dispersion; moments and their interrelationship; measures of skewness and kurtosis; three- and five-number summary; box-plot and modified box-plot.

Description of bivariate data: bivariate frequency distribution; graphical presentation of bivariate data; contingency table; the concept of association between two variables; percentage table and interpretation of cell frequencies; measures of association for nominal and ordinal variables; measures of association for interval or ratio variables; correlation; the relationship between two variables: simple linear regression; basic issues in inferential statistics.

Data visualization and analysis using statistical software.

**Probability Theory:**

Combinatorial analysis: basic principles of counting, permutations, combinations; axioms of probability: sample space and events, axioms of probability, sample spaces having equally likely outcomes, probability as a measure of belief; conditional probability and independence: conditional probabilities, Bayes formula, independent events.

Random variables: introduction, discrete random variables, expectation, expectation of a function of a random variable, variance, Bernoulli and binomial random variables, Poisson random variable, other discrete random variables (geometric, negative binomial, hypergeometric); expected value of a sums of random variables; properties of cumulative distribution function; continuous random variables: expectation and variance of continuous random variable, normal random variable, normal approximation to binomial distribution, exponential random variables.

Jointly distributed random variables: joint distribution functions, independent random variables, sums of independent random variables, conditional distributions (discrete and continuous cases); properties of expectation: expectation of sums of random variables, covariance, variance of sums, correlations, conditional expectation, moment generating functions, probability generating function.

**Probability and Sampling Distributions:**

Generating function techniques: moment generating function, cumulant generating function, probability generating function, characteristic function; finding distributions of functions of random variables: change



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of variable technique, distribution function technique, and moment-generating function technique; probability integral transformation; statistic and sampling distribution; law of large numbers; central limit theorem; exact distribution of sample mean; chi-square distribution and its properties; F-distribution and its properties; t-distribution and its properties; non-central chi-square, F, and t distributions: definition and derivation; concept of order statistics, distributions of single order statistics, and joint distributions of two or more order statistics.

A brief review of some probability distributions and their properties: uniform, normal, exponential, gamma, beta, log-normal, Cauchy; definition of truncated distribution; definition of compound and mixture distribution; family of distributions:

Pearsonian distribution.

### **Sampling Techniques:**

Introduction: concept of sampling, and definition of related terms; role of sampling theory, requirements of a good sampling design, steps in a sample survey, probability and nonprobability sampling, selection (draw-to-draw) and inclusion probability, sampling weight, with and without replacement sampling, characteristics of estimate: bias, mean square error and variance (precision), errors in sample survey and census, sample size determination: basics and complex scenarios.

Simple random sampling (SRS): sample selection, estimation: mean, total, proportion, ratio of two quantities, unbiasedness and variances/standard errors (SEs) of the estimators, estimators of the SEs, confidence interval (normal approximation); finite population correction, estimation over subpopulation, computation: inclusion probabilities and sampling weights.

Systematic sampling: motivation, use and challenges, sample selection, different estimators and their unbiasedness and variances, estimator of the variances, comparison with SRS, sampling from an equal-sized population with linear trend or periodic variation.

Stratified random sampling: concept, reasoning and needs in heterogeneous population, number and formation of strata, sample selection, estimators (total, mean, proportion), variances of the estimators, estimators for the variances, different allocation techniques, comparison with SRS, design effect and its uses, poststratification, quota sampling.

Auxiliary information in estimation: ratio estimators (total, mean), different properties: unbiasedness, variance (approximate), estimated variance, confidence interval, comparison with mean per unit estimates, conditions for best linear unbiased ratio estimator, application in stratified sampling, unbiased ratio-type estimates; product estimator; regression estimator: linear regression estimate and its



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properties (unbiasedness, variance and estimated variance) under preassigned  $\$b\$$  and estimated  $\$b\$$ , comparison with mean per unit estimate, application in stratified sampling, relative merits and demerits.

Cluster sampling: motivation and reasoning, formation and size of clusters; cluster sampling with equal-sized clusters: estimators and their various properties (unbiasedness, variance and estimated variance), comparison with SRS and systematic sampling, optimum cluster size, stratification in cluster sampling: estimation and comparison with simpler sampling designs.

**Statistical Inference:**

Basic Concepts: Fundamental ideas of statistical inference; parametric and non-parametric inference; estimators, statistics, parameters, theory and reality; sampling distributions and uses in inference;

Estimation: Estimation of parameters and fitting of probability distributions; parameter estimation: method of moments, method of least squares, method of maximum likelihood - properties of maximum likelihood estimators, Bayes estimator; properties of a good point estimator; method of evaluating estimators: mean squared error; best unbiased estimator - efficiency and the Cramer-Rao lower bound; sufficiency - sufficient statistics, properties of sufficient statistics, exponential family and factorization theorem, the Rao-Blackwell theorem, minimal sufficient statistics, complete statistics.

Interval estimation: introduction; method of constructing confidence interval - pivotal quantity, exact and approximate confidence interval; large- and small-sample confidence intervals; selecting the sample size; simultaneous confidence region.

Test of Hypothesis: Elements of statistical hypothesis test; approaches to hypothesis testing: Neyman-Pearson approach, Fisher approach, and Jeffreys' approach; common tests based on normal distribution: one-sample settings, two-sample (independent and paired) settings, more than two sample settings; the duality of confidence intervals and hypothesis tests; exact and large sample test; evaluating statistical test procedure - the power of tests, optimal test - Neyman-Pearson lemma; most powerful tests; composite hypotheses; generalized likelihood ratio test; uniformly most powerful tests; unbiased tests; goodness-of-fit tests - probability plots, test for normality, chi-square goodness of fit test, Kolmogorov-Smirnov test; statistical tests applied to categorical data problems: introduction, Fisher's exact test, the chi-square test of homogeneity, chi-square test of independence.

Approximate and computationally intensive methods for statistical inference: the general problem of inference; likelihood functions; maximum likelihood estimation; optimization techniques-Newton type methods; EM algorithm-simple form, properties, uses in analyzing missing data, fitting mixture models and latent variable model; restricted maximum likelihood (REML) method of estimation; Multi-stage



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maximization; Efficient maximization via profile likelihood; confidence interval and testing hypothesis in these complex cases.

Bayesian method of inference: prior and posterior distribution, different types of prior, credible intervals and testing hypotheses; analytical approximations - asymptotic theory, Laplace approximation; numerical integral methods - Newton-Cotes type methods; Monte-Carlo methods; simulation methods - Markov chain Monte Carlo.

Exact tests: test for single proportion and comparison of two proportions.

Resampling techniques: bootstrap-confidence intervals, test, parametric bootstrap, advantages and disadvantages of parametric bootstrap; jackknife-confidence interval, test, and permutation test.

Nonparametric inference and robustness: introduction, inference concerning cumulative distribution function (cdf), quantiles and statistical functionals: empirical cdf, quantiles, estimating statistical functionals, influence functions, testing statistical hypothesis-one sample settings, two or more sample settings; tolerance limit; empirical density estimation- histograms, kernel, kernel density estimation.

### **Design of Experiments:**

Introduction to design of experiments: strategy of experimentation; some typical examples of experimental design; basic principles; guidelines for designing experiments.

Experiments with a single factor: the analysis of variance; analysis of fixed effects model; estimation of model parameters; unbalanced data; model adequacy checking; regression model, comparisons among treatment means, graphical comparisons of means, contrasts, orthogonal contrasts, multiple testing, Scheffe's method, comparing pairs of treatment means, comparing treatment means with a control; Determining sample size; operating characteristic curve, specifying standard deviation increase, confidence interval estimation method; discovering dispersion effects; regression approach to analysis of variance; least squares estimation of the model parameters, general regression significance test.

Randomized blocks, Latin squares, and related designs: the randomized complete block designs (RCBD); statistical analysis of RCBD, model adequacy checking; estimating model parameters; Latin square design; Graeco-Latin square design; balanced incomplete block design (BIBD); statistical analysis of BIBD; least squares estimation of BIBD; recovery of intra-block information in the BIBD.

Introduction to factorial designs: basic definition and principles; advantage of factorials; two-factor factorial design; statistical analysis of fixed effects model, model adequacy checking, estimating model parameters, choice of sample size, assumption of no interaction in a two-factor model, one observation per cell; general factorial design; fitting response curve and surfaces; blocking in a factorial design.



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$2^k$  factorial design: introduction;  $2^2$  design;  $2^3$  design; general  $2^k$  design; a single replicate in  $2^k$  factorial design; blocking in a  $2^k$  factorial design; confounding in  $2^k$  factorial design; confounding in  $2^k$  factorial design in two blocks; confounding in  $2^k$  factorial design in four blocks; confounding in  $2^k$  factorial design in  $2^p$  blocks; partial confounding.

Two-level fractional factorial designs: one-half fraction of  $2^k$  design; one-quarter fraction of  $2^k$  design; general  $2^{k-p}$  fractional factorial design; resolution III designs; resolution IV and V designs.

**Linear Regression:**

Simple linear regression model: model for conditional population mean, least squares estimation, assumptions related to errors, maximum likelihood estimation (MLE) of model, sampling distribution of MLEs of the model parameters, inferences concerning the model parameters (confidence intervals and t-test), confidence interval estimate of the estimated model (confidence band).

Model accuracy and diagnostics: goodness of fit test (F-test, coefficient of determination, R-square); prediction and prediction interval for a new Y at specific x, residual analysis: definition, normal probability plot, plots of residuals versus fitted values, residuals versus x, other residual plots, statistical tests on residuals; detection and treatment of outliers; concept of lack of fit and pure error, test for lack of fit, transformations as solution to problems with the model, weighted least squares.

Matrix representation of a simple linear regression model, inference and prediction.

Multiple linear regression models: formulation of multiple regression models, estimation of the model parameters: least squares estimation, maximum likelihood estimation, sampling distributions of the MLEs, confidence interval and hypothesis testing for concerning model parameters; model accuracy and diagnostics: goodness of fit test (F-test, R-square), prediction of a new observation; extra sum of squares principles and its application in testing general linear hypothesis, checking all assumptions concerning model and use of remedy measures when assumptions are not valid, detection and treatment of outliers, influential observations.

Polynomial regression model: introduction; polynomial models in one variable: basic principles, piecewise polynomial fitting; polynomial models in two or more variables; orthogonal polynomials.

Indicator variables: the general concept of an indicator variable, use of the indicator variables in linear regression, models with only indicator variables, the idea of regression models with an indicator response variable.





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Variable selection and model building: the model building problem, consequences of model mis-specification, criteria for evaluating subset regression models, computational techniques for variable selection.

Validation of regression models: concept, cross-validation.

**Generalized Linear Models:**

Generalized linear models: exponential family of distributions; estimation: method of maximum likelihood, method of least squares, estimation of generalized linear models; inference: sampling distribution for scores, sampling distribution for maximum likelihood estimators, confidence intervals for model parameters, adequacy of a model, sampling distribution for log-likelihood statistic, log-likelihood ratio statistic (deviance), assessing goodness of fit, hypothesis testing; multiple regression: maximum likelihood estimation, log-likelihood ratio statistic.

Models for binary responses: probability distributions, generalized linear models, dose response models, general logistic regression, maximum likelihood estimation and log-likelihood ratio statistic, other criteria for goodness of fit; multinomial distributions; nominal logistic regression models; ordinal logistic regression models.

Models for count data, Poisson regression and log-linear models: probability distributions, maximum likelihood estimation, hypothesis testing and goodness of fit.

**Statistical Programming:**

***R for Data Science***

Introduction to R: History and overview of R programming language, R objects, data structure (e.g. lists, data frames, etc.), reading and writing data files, subsetting R objects, vectorized operations, control structures, functions (both in-built and custom), simulation, and calling C function from R.

Exploratory data analysis with R: managing data with different tidyverse packages (e.g. dplyr, ggplot2, etc.), exploratory graphs (grammar of graphics), and generating summary statistics.

Application of R in optimizing non-linear functions using Newton-Raphson iterative procedure, numerical integration and differentiation.



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***Python for Data Science***

Fundamentals of Python: Installing Python and Jupyter Notebook; the basic syntax of a Python program, Python data types; expressions and variables; lists, tuples, sets, and dictionaries; writing conditions, loops, and functions.

Data analysis with NumPy and pandas: installing NumPy and pandas, NumPy arrays; indexing, slicing, and iterating NumPy arrays; arithmetic and matrix operations with NumPy; pandas objects– DataFrame, Series, and Index; data indexing and selection; handling missing data; combining and joining datasets, aggregation and grouping, exploratory data analysis.

Data visualization with matplotlib and seaborn: Bar plots, histograms, density plots, boxplots and scatterplots.

***Stata for Data Science***

Introduction to Stata: different windows and files, help file and searching for information; data entry, reading both stata and other format of data file, combining Stata files; exploring data: example commands-browse, edit, list, sort, describe, assert, codebook; data management: creating a new data set specifying subsets of data with in and if qualifiers, generating and replacing variables, using functions based on egen command, converting numeric and string formats, creating new categorical and ordinal variables, reshaping or collapsing data, weighting observations, creating random data and random samples; graphs: example commands- histograms, scatterplots, line plots, connected-line plots, two-way plots, box plots, combining graphs; exploratory data analysis: summary statistics and tables: example commands - summarize, tabstat, table; frequency tables and two-way cross tabulations, multiple tables and multi-way cross tabulations, tables of means, medians and other summary statistics.