



- Miller, I., Miller, M.; John E. Freund's Mathematical Statistics with Applications, 8th edition, Pearson, 2021.
- Indian Economy
  - Economic Survey, Government of India, Various Issues
  - India Development Report, Oxford University Press, Various Issues.
  - Uma Kapila, Indian Economy since Independence, Academic Foundation, Various Issues.
  - RBI Annual Report – Last two years.
  - RBI Report on Trends and Progress of Banking in India – Last two years.
  - Monetary Policy Reports – Last two years.
  - Financial Stability Report – Last two years

## B. Officers in Grade 'B' (DR) – DSIM- PY 2024- Job Requirement, Scheme of Selection and Syllabus

### (i) Job Requirements

To undertake collection, compilation, analysis and interpretation of data on banking, corporate and external sectors; Modelling and forecasting of inflation, growth and other important macroeconomics indicators; Analytical studies involving statistical/econometric models in the operational areas of interest to the Reserve Bank; planning, designing and organizing sample surveys; maintaining technology-driven centralized reporting system and Data warehouse for information management /dissemination; and Development of methodology for the measurement and estimation of variables and improvement of the database of various sectors of the economy. Application of Data Science/Artificial Intelligence/Machine Learning techniques to derive insights from large volume data.

### (ii) Scheme of Selection

Selection will be through Online/ Written Examination (WE) and Interview. There are 3 papers for the Examination. Paper-I Objective Type (on Statistics) to be held on **September 14, 2024** and Paper-II & III will be held on **October 26, 2024** (date to be confirmed in Admit Cards).

Name of Paper	Duration	Maximum Marks
Paper-I : Objective Type (on Statistics)	120 minutes	100
Paper-II : Descriptive Type (on Statistics) (Question paper displayed on computer, answers to be written on paper)	180 minutes	100
Paper-III : English – Descriptive (To be typed with help of keyboard)	90 minutes	100
<b>Total</b>		<b>300</b>

Other detailed information regarding the examination will be given in an Information Handout, which will be made available to the candidates for download along with the Admit Card for examination from the RBI website.

Candidates have to secure minimum marks as may be prescribed by the Board.

Candidates, who secure minimum aggregate marks in Paper-I, as prescribed, will be shortlisted for Paper-II and Paper-III of the examination based on the aggregate marks obtained in Paper-I. The minimum aggregate cut-off marks for being shortlisted for Paper-II and Paper-III of the examination will be decided by the Board in relation to the number of vacancies. Roll Number of the candidates shortlisted for Paper-II and Paper-III examination will be published on the RBI website, tentatively within a week after Paper-I examination.



### **(iii) Paper – II and Paper-III - Online/Written Examination**

The Paper-II and Paper-III Examination will be conducted on **October 26, 2024** only for the candidates who are shortlisted on the basis of results of Paper-I. The Paper-II and Paper-III examination will be in shifts. Candidates are required to appear for all shifts. Separate Admit Cards will be issued for each shift. The timetable for Paper-II and Paper-III will be intimated to the candidates concerned along with Admit Card for Paper-II and Paper-III.

(iv) Question papers for 'WE' will be set in Hindi and in English (except Paper-III on English). Answers for Paper-II may be written either in Hindi or English. Paper-III will have to be answered in English only. Candidates may opt for Interview in Hindi or English.

v) The number of candidates to be called for the Interview will be decided by the Board.

vi) Final selection will be on the basis of performance in the 'Online / WE' (Paper-I, II and III) and Interview taken together. Interview will be of 75 marks. Candidate may opt for Interview either in Hindi or English.

vii) Candidate shall be required to undergo Personality Assessment conducted by the Bank before appearing for the Interview. No marks will be allotted for the same and it will not form part of the final selection criteria.

### **Syllabi**

Standard of papers would be that of Master's Degree examination of any Central University in India.

#### **Paper-I**

Questions would cover Probability: Definition of Probability, Standard distribution, Large and small sample theory, Analysis of Variance, Estimation, Testing of Hypotheses, Multivariate analysis and Stochastic Processes.

#### **Paper-II**

Questions would cover (i) Probability and Sampling, (ii) Linear Models and Economic Statistics, (iii) Statistical Inference: Estimation, Testing of hypothesis and Non-parametric Test, (iv) Stochastic Processes, (v) Multivariate analysis, (vi) Econometrics and time series, (vii) Statistical computing; and (viii) Data Science, Artificial Intelligence and Machine Learning Techniques.

### **Detailed Syllabus**

#### **1. Theory of Probability and Probability Distributions**

Classical and axiomatic approach of probability and its properties, Bayes Theorem and its application, strong and weak laws of large numbers, characteristic functions, central limit theorem, probability inequalities.

Standard probability distributions – Binomial, Poison, Geometric, Negative binomial, Uniform, Normal, exponential, Logistic, Log-normal, Beta, Gamma, Weibull, Bivariate normal etc.

Exact Sampling distributions - Chi-square, student's t, F and Z distributions and their applications. Asymptotic sampling distributions and large sample tests, association and analysis of contingency tables.

#### **Sampling Theory:**

Standard sampling methods such simple random sampling, Stratified random sampling, Systematic sampling, Cluster sampling, Two stage sampling, Probability proportional to size etc. Ratio estimation, Regression estimation, non-sampling errors and problem of non-response, and Correspondence and categorical data analysis.



## 2. Linear Models and Economic Statistics

Simple linear regression - assumptions, estimation, and inference diagnostic checks; polynomial regression, transformations on Y or X (Box-Cox, square root, log etc.), method of weighted least squares, inverse regression. Multiple regression - Standard Gauss Markov setup, least squares estimation and related properties, regression analysis with correlated observations. Simultaneous estimation of linear parametric functions, Testing of hypotheses; Confidence intervals and regions; Multicollinearity and ridge regression, LASSO.

Definition and construction of index numbers, Standard index numbers; Conversion of chain base index to fixed base and vice-versa; base shifting, splicing and deflating of index numbers; Measurement of economic inequality: Gini's coefficient, Lorenz curves etc.

## 3. Statistical Inference: Estimation, Testing of Hypothesis and Non-Parametric Test

### 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.

### Methods of Estimation

Method of moments, method of maximum likelihood estimation, method of least square, method of minimum Chi-square, basic idea of Bayes estimators.

### Principles of Test of Significance

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 theory of testing of hypothesis. Likelihood ratio tests, Tests of goodness of fit. Bartlett's test for homogeneity of variances.

### Non-Parametric Test

The Kolmogorov-Smirnov test, Sign test, Wilcoxon Signed-rank test, Wilcoxon Rank-Sum test, Mann Whitney U-test, Kruskal-Wallis one way ANOVA test, Friedman's test, Kendall's Tau coefficient, Spearman's coefficient of rank correlation.

## 4. Stochastic Processes

### Poisson Processes

Arrival, interarrival and conditional arrival distributions. Non-homogeneous Processes. Law of Rare Events and Poisson Process. Compound Poisson Processes.

### Markov Chains

Transition probability matrix, Chapman- Kolmogorov equations, Regular chains and Stationary distributions, Periodicity, Limit theorems. Patterns for recurrent events. Brownian Motion - Limit of Random Walk, its defining characteristics and peculiarities; Martingales.

## 5. Multivariate Analysis

Multivariate normal distribution and its properties and characterization; Wishart matrix, its distribution and properties, Hotelling's T<sup>2</sup> statistic, its distribution and properties, and its applications in tests on mean vector, Mahalanobis' D<sup>2</sup> statistics; Canonical correlation analysis, Principal components analysis, Factor analysis and cluster analysis.

## 6. Econometrics and Time Series

General linear model and its extensions, ordinary least squares and generalized least squares estimation and prediction, heteroscedastic disturbances, pure and mixed estimation. Auto correlation, its consequences and related tests; Theil BLUS procedure, estimation and prediction; issue of multi-collinearity, its implications and tools for handling it; Ridge regression.



Linear regression and stochastic regression, instrumental variable regression, autoregressive linear regression, distributed lag models, estimation of lags by OLS method. Simultaneous linear equations model and its generalization, identification problem, restrictions on structural parameters, rank and order conditions; different estimation methods for simultaneous equations model, prediction and simultaneous confidence intervals.

Exploratory analysis of time series; Concepts of weak and strong stationarity; AR, MA and ARMA processes and their properties; model identification based on ACF and PACF; model estimation and diagnostic tests; Box-Jenkins models; ARCH/GARCH models.

### **Inference with Non-Stationary Models**

ARIMA model, determination of the order of integration, trend stationarity and difference stationary processes, tests of non-stationarity.

## **7. Statistical Computing**

Simulation techniques for various probability models, and resampling methods jack-knife, bootstrap and cross-validation; techniques for robust linear regression, nonlinear and generalized linear regression problem, tree-structured regression and classification; Analysis of incomplete data – EM algorithm, single and multiple imputation; Markov Chain Monte Carlo and annealing techniques, Gibbs sampling, Metropolis-Hastings algorithm; Neural Networks, Association Rules and learning algorithms.

## **8. Data Science, Artificial Intelligence and Machine Learning Techniques**

Introduction to supervised and unsupervised pattern classification; unsupervised and reinforcement learning, basics of optimization, model accuracy measures.

### **Supervised Algorithms**

Linear Regression, Logistic Regression, Penalized Regression, Naïve Bayes, Nearest Neighbour, Decision Tree, Support Vector Machine, Kernel density estimation and kernel discriminant analysis; Classification under a regression framework, neural network, kernel regression and tree and random forests.

### **Unsupervised Classification**

Hierarchical and non-hierarchical methods: k-means, k-medoids and linkage methods, Cluster validation indices: Dunn index, Gap statistics.

Bagging (Random Forest) and Boosting (Adaptive Boosting, Gradient Boosting) techniques; Recurrent Neural Network (RNN); Convolutional Neural Network; Natural Language Processing.

## **Paper-III**

English: The paper on English shall be framed in a manner to assess the writing skills including expression and understanding of the topic.

### **Suggested Reading Material:**

#### **For Paper-I and Paper-II**

##### **▪ Theory of Probability and Probability Distributions**

- Rohatgi, V. K. and Saleh, A.K. Md. E. (2005). An Introduction to Probability and Statistics
- Goon, A.M., Gupta, M.K. and Dasgupta. B. (1985). An Outline of Statistical Theory Vol- I & II
- Sukhatme, P.V., Sukhatme, B.V., Sukhatme, S. and Asok, C. (1984). Sampling Theory of Surveys with Applications
- S. C. Gupta, V. K. Kapoor (2000). Fundamentals of Mathematical Statistics
- W.G. Cochran (1977). Sampling Techniques



▪ **Linear Models and Economic Statistics**

- P.G. Hoel, S.C. Port and C.J. Stone (1971). Introduction to Statistical Theory
- A.M. Mood, F.A. Graybill and D.C. Boes (1974). Introduction to Theory of Statistics
- R. G. D. Allen (1975). Index Numbers in Theory and Practice

▪ **Statistical Inference**

- Kale, B.K. (1999). A First Course on Parametric Inference
- Rao, C.R. (1973). Linear Statistical Inference and Its Applications
- Bartoszynski, R. and Bugaj, M.N. (2007). Probability and Statistical Inference
- Gibbons, J.D. and Chakraborti, S. (1992). Nonparametric Statistical Inference

▪ **Stochastic Processes**

- Bhat, B.R. (2000). Stochastic Models- Analysis and Applications
- Prabhu, N.U. (2007). Stochastic Processes: Basic Theory and its Applications
- J. Medhi (2009). Stochastic Process

▪ **Multivariate Analysis**

- Anderson, T.W. (2003). An Introduction to Multivariate Statistical Analysis
- Arnold, Steven F. (1981). The Theory of Linear Models and Multivariate Analysis
- Giri, N.C. (1977). Multivariate Statistical Inference, Academic Press
- Alvin C. Rencher (2012). Methods of Multivariate Analysis

▪ **Econometrics and Time Series**

- Johnston, J. (1984). Econometric Methods
- James H. Stock and Mark W. Watson (2019). Introduction to Econometrics
- J.D. Hamilton (1994). Time Series Analysis
- William H. Greene (2018). Econometric Analysis

▪ **Statistical Computing and Data Science, Artificial Intelligence and Machine Learning Techniques**

- Sheldon M. Ross (2012). Simulation
- Trevor Hastie, Robert Tibshirani, Jerome Friedman (2009). The Elements of Statistical Learning, Data Mining, Inference, and Prediction, Second Edition
- Charu C. Aggarwal (2018). Neural Networks and Deep Learning
- Roger D. Peng: Advanced Statistical Computing
- William J. Kennedy, Jr. and James E. Gentle: Statistical Computing

**C. Manner of conduct of examinations for Grade 'B' (DR)-DEPR /DSIM**

**DEPR :**

(i) The examination will be conducted on two days i.e. Phase-I (Paper-I & II) (Online Examination) on **September 14, 2024** and Phase-II (Paper-I & II) (Online / Written Examination) will be held separately on **October 26, 2024** (date to be confirmed in Admit Cards).

(ii) Phase-I : Paper-I - Objective Type (on Economics) will be conducted online and comprise multiple choice questions. Paper-II - Descriptive Type (on English) to be typed with help of keyboard.



(iii) Phase-II : Paper-I & II will be a Descriptive Type (on Economics) pen / paper based examination where the questions will be displayed on computer screen, answers to be written on paper.

**DSIM :**

(i) The examination will be conducted on two days i.e. Paper-I on **September 14, 2024** and Paper-II & III will be held separately on **October 26, 2024** (date to be confirmed in Admit Cards).

(ii) Paper - I (Objective type on Statistics) will be conducted online and comprise multiple choice questions.

(iii) Paper - II (on Statistics) will be a Descriptive Type pen/paper based examination where the questions will be displayed on computer screen, answers to be written on paper.

(iv) Paper –III (English) will be of Descriptive Type where the candidates will be expected to type out answers on a computer.

**The Board reserves the right to modify the exam dates and time entirely at its discretion.**