DEPARTMENT OF STATISTICS

B. Sc. (H) Statistics

Category I

DISCIPLINE SPECIFIC CORE COURSE-20: BAYESIAN INFERENCE

CREDIT DISTRIBUTION, ELIGIBILITY, AND PRE-REQUISITES OF THE COURSE

Course title and code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lectures	tutorials	practicals		
Bayesian Inference	**4**	**3**	**0**	**1**	Class XII pass with Mathematics	

Learning Objectives:

The learning objectives of this course is

- To introduce students to the Bayesian approach to statistics.
- To make students understand the basic difference between the commonly-taught Frequentist approach and the Bayesian Paradigm.
- To demonstrate the benefits of using a Bayesian approach and obtaining results that are more interpretable.

Learning Outcomes:

After completion of this course, students should have developed a clear understanding of:

- Bayes theorem for random variables
- Prior and posterior distributions
- Conjugate prior
- Non-informative priors
- Bayesian point estimation
- Bayesian Credible intervals
- Bayes factor

SYLLABUS OF DSC-20

Theory

UNIT I **(5 Hours)**

Bayes Theorem for Random Variables

Concept of inverse probability; Bayes theorem for random variables; Concept of likelihood function, prior distribution and posterior distribution.

UNIT II **(12 Hours)**

Conjugate Prior and Non-Informative Priors

Thumb rule for constructing a conjugate prior; Conjugate families for samples from various standard distributions; Uniform prior; Jeffreys' non-informative priors; Normal approximations to posterior distribution.

UNIT III **(15 Hours)**

Bayes Estimation and Credible Interval

Elements of Bayes Decision Theory; Loss Functions such as Squared error loss function, Bilinear loss function; Bayes risk; Normal and Extensive form of analysis; Duality between loss and prior; Generalised maximum likelihood estimate; Bayesian credible intervals; Difference between Bayesian credible intervals and classical confidence intervals; Application in linear regression model.

UNIT IV **(13 hours)**

Hypothesis Testing

Prior and posterior odds; Bayes factor for simple versus simple hypothesis; Bayes factor for composite versus composite hypothesis; Lindley's procedure for test of significance.

PRACTICAL / LAB WORK – 30 Hours

List of Practicals:

1. Plotting of Prior and posterior distributions for Binomial distribution case.
2. Plotting of Prior and posterior distributions for Poisson distribution case.
3. Bayes Estimation using Normal distribution and Squared error loss function.
4. Bayes Estimation using Binomial distribution and Absolute error loss function.
5. Construction of credible intervals and their comparison with corresponding classical confidence interval for Normal distribution case.
6. Construction of credible intervals and their comparison with corresponding classical confidence interval for Binomial distribution case.
7. Normal Approximation to Posterior Distribution.
8. Construction of HPD credible interval for Normal case.

Practical work to be conducted using electronic spreadsheet / EXCEL/ Statistical Software Package/ SPSS/ calculators.

ESSENTIAL READINGS

- Bansal, A.K. (2007). Bayesian Parametric Inference, Narosa Publishing House.
- Barnett, V. (1982). Comparative Statistical Inference, J. Wiley, New York.
- Berger, J.O. (1985). Statistical Decision Theory and Bayesian analysis, Second Edition, Springer-Verlag, New York.

SUGGESTED READINGS:

- Box, G.E.P. and Tiao, G.C. (1973). Bayesian Inference in Statistical Analysis, Addison-Wesley.
- Lee, P. M. (1997). Bayesian Statistics: An Introduction, Arnold Press.
- O'Hagan, A. and Forster, J. (2004). Kendall's Advanced theory of Statistics, Volume 2B, Bayesian Inference, Oxford University Press, New York.

- Robert, C.P. (2001). The Bayesian Choice: A Decision Theoretic Foundations to Computational Implementation, Second Edition, Springer-Verlag, New York.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch University of Delhi, from time to time.

B.Sc. (P)/B.A(P) with Statistics as Major

Category II

DISCIPLINE SPECIFIC CORE COURSE –14: ELEMENTS OF ECONOMETRICS

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Elements of Econometrics	4	3	0	1	Class XII pass with Mathematics	Nil

Learning Objectives

The learning objectives include:

- Interpretation and critical evaluation of the outcomes of empirical analysis.
- To judge the validity of the economic theories
- To carry out evaluation of economic theories in numerical terms
- To extract useful information about important economic policy issues from the available data.
- The course is designed to provide the students with the basic quantitative techniques needed to undertake applied research projects.

Learning Outcomes:

After completing this course, students should have developed a clear understanding of:

- The fundamental concepts of econometrics.
- Specification of the model.
- Simple Linear Regression.
- Multiple Linear Regression.
- Multicollinearity.
- Heteroscedasticity.
- Autocorrelation.

SYLLABUS OF DSC-14

Theory

UNIT I **(15 hours)**

Introduction

Nature and Scope of Econometrics: Objective behind building econometric models, nature of econometrics, model building, role of econometrics, interpretation of regression, nature and sources of data for econometric analysis, different measurement scales of variables

UNIT II **(15 hours)**

Regression Models

Simple and Multiple Linear Regression Model: Estimation of model by method of ordinary least squares(OLS), properties of estimators, goodness of fit, tests of hypotheses, confidence intervals, coefficient of determination, Gauss-Markov theorem and forecasting.

UNIT III **(5 hours)**

Autocorrelation

Autocorrelation: Concept, consequences of autocorrelated disturbances, detection and solution of autocorrelation.

UNIT IV **(10 hours)**

Multicollinearity and Heteroscedasticity

Violations of Classical Assumptions: Multicollinearity- Concept, Consequences, Detection and Remedies. Heteroscedasticity and serial correlation– Concept and Consequences.

PRACTICAL/LAB WORK – (30 hours)

List of Practical:

1. Problems based on estimation of simple linear model.
2. Testing of parameters of simple linear model.
3. Multiple Regression.
4. Problems concerning specification errors.
5. Problems related to consequences of Multicollinearity.
6. Diagnostics of Multicollinearity.
7. Problems related to consequences Heteroscedasticity.
8. Diagnostics of Heteroscedasticity.
9. Estimation of problems of General linear model under Heteroscedastic distance terms.
10. Problems related to selection of best regression model.

Practical work to be conducted using electronic spreadsheet / EXCEL/ Statistical Software Package/ SPSS/ calculators.

ESSENTIAL READINGS:

- Gujarati, D. and Guneshker, S. (2007). Basic Econometrics, 4th Ed., McGraw Hill Companies.
- Johnston, J. (1972). Econometric Methods, 2nd Ed., McGraw Hill International.

SUGGESTIVE READINGS:

- Koutsoyiannis, A. (2004). Theory of Econometrics, 2 Ed., Palgrave Macmillan Limited.

- Maddala, G.S. and Lahiri, K. (2009). Introduction to Econometrics, 4 Ed., John Wiley & Sons.
- Greene, W. H. (2002) Econometric Analysis.5th Edition, Prentice Hall.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch University of Delhi, from time to time.

B.Sc. (P)/B.A(P) with Statistics as Non- Major

Category III

DISCIPLINE SPECIFIC CORE COURSE –8: ELEMENTS OF ECONOMETRICS

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Elements of Econometrics	4	3	0	1	Class XII pass with Mathematics	Nil

Learning Objectives

The learning objectives include:

- Interpretation and critical evaluation of the outcomes of empirical analysis.
- To judge the validity of the economic theories
- To carry out evaluation of economic theories in numerical terms
- To extract useful information about important economic policy issues from the available data.
- The course is designed to provide the students with the basic quantitative techniques needed to undertake applied research projects.

Learning Outcomes:

After completing this course, students should have developed a clear understanding of:

- The fundamental concepts of econometrics.
- Specification of the model.
- Simple Linear Regression.
- Multiple Linear Regression.
- Multicollinearity.
- Heteroscedasticity.
- Autocorrelation.

SYLLABUS OF DSC-8

Theory

UNIT I **(15 hours)**

Introduction

Nature and Scope of Econometrics: Objective behind building econometric models, nature of econometrics, model building, role of econometrics, interpretation of regression, nature and sources of data for econometric analysis, different measurement scales of variables

UNIT II **(15 hours)**

Regression Models

Simple and Multiple Linear Regression Model: Estimation of model by method of ordinary least squares(OLS), properties of estimators, goodness of fit, tests of hypotheses, confidence intervals, coefficient of determination, Gauss-Markov theorem and forecasting.

UNIT III **(5 hours)**

Autocorrelation

Autocorrelation: Concept, consequences of autocorrelated disturbances, detection and solution of autocorrelation.

UNIT IV **(10 hours)**

Multicollinearity and Heteroscedasticity

Violations of Classical Assumptions: Multicollinearity- Concept, Consequences, Detection and Remedies. Heteroscedasticity and serial correlation– Concept and Consequences.

PRACTICAL/LAB WORK – (30 hours)

List of Practical:

11. Problems based on estimation of simple linear model.
12. Testing of parameters of simple linear model.
13. Multiple Regression.
14. Problems concerning specification errors.
15. Problems related to consequences of Multicollinearity.
16. Diagnostics of Multicollinearity.
17. Problems related to consequences Heteroscedasticity.
18. Diagnostics of Heteroscedasticity.
19. Estimation of problems of General linear model under Heteroscedastic distance terms.
20. Problems related to selection of best regression model.

Practical work to be conducted using electronic spreadsheet / EXCEL/ Statistical Software Package/ SPSS/ calculators.

ESSENTIAL READINGS:

- Gujarati, D. and Guneshker, S. (2007). Basic Econometrics, 4th Ed., McGraw Hill Companies.
- Johnston, J. (1972). Econometric Methods, 2nd Ed., McGraw Hill International.

SUGGESTIVE READINGS:

- Koutsoyiannis, A. (2004). Theory of Econometrics, 2 Ed., Palgrave Macmillan Limited.
- Maddala, G.S. and Lahiri, K. (2009). Introduction to Econometrics, 4 Ed., John Wiley & Sons.
- Greene, W. H. (2002) Econometric Analysis.5th Edition, Prentice Hall.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch University of Delhi, from time to time.

Discipline Specific Elective for B. Sc. (H) Statistics

Category-V

DISCIPLINE SPECIFIC ELECTIVE COURSE – 6A: NONPARAMETRIC TESTING

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Nonparametric Testing	4	3	0	1	Class XII pass with Mathematics	Hypothesis testing

Learning Objectives

The learning objectives include:

- Usefulness of Nonparametric/distribution free tests their strength and weaknesses
- Quantile and Empirical distributions and their utility
- Test for randomness, location and scales under nonparametric setup
- Test association of bivariate samples

Learning Outcomes

After completing this course, students should have developed a clear understanding of:

- Make distinction between Parametric and Nonparametric test and measurement scales.
- Appreciate the role of quantile and empirical distribution function and associated tests.
- Identify suitable nonparametric test for both location and scale and able to apply one/two tests including Kolmogorov- Smirnov one sample and two sample tests, sign test, Wilcoxon signed rank test, run test. Median test, Kruskal-Wallis one-way analysis of variance by ranks, Friedman two way analysis of variance by ranks.
- Test association of bivariate samples using Kendall tau and Spearman's rank correlation.

SYLLABUS OF DSE-6A

Theory

UNIT I **(15 hours)**

Introduction

Nonparametric Tests: Non-parametric tests-their advantages and disadvantages, comparison with parametric tests. Measurement scale-nominal, ordinal, interval and ratio. The quantile function, the empirical distribution function, Glivenko Cantelli Theorem (without proof), Kolmogorov Goodness of fit test, confidence interval for a population quantile, hypothesis testing for a population quantile.

UNIT II **(15 hours)**

One sample and two sample tests

One-Sample, two-sample problem and Paired-Sample Procedures: the sign test and confidence interval for the median, rank-order statistics, treatment of ties in rank tests, Wilcoxon signed-rank test, confidence interval, Wald-Wolfowitz runs test, Kolmogorov-Smirnov one and two-sample test, median test and the Mann-Whitney U test.

UNIT III **(15 hours)**

K sample tests

Linear Rank Tests for the Location and Scale Problem: Definition of linear rank statistics, Wilcoxon rank-sum test; Tests of the Equality of k Independent Samples: The Kruskal-Wallis one-way ANOVA test and multiple comparisons.; Measures of Association for Bivariate Samples: definition of measures of association in a bivariate population, Kendall's Tau coefficient, Spearman's coefficient of rank correlation.

PRACTICAL/LABWORK(30 hours):

List of Practical:

1. Obtaining quantile and Empirical Distribution
2. Test for randomness
3. Sign test
4. Wilcoxon Signed rank test
5. Wald-Wolfowitz runs test,
6. Kolmogorov-Smirnov one and two-sample test,
7. median test and the Mann-Whitney U test.
8. Wilcoxon rank-sum test
9. The Kruskal-Wallis one-way ANOVA test
10. Test based on Kendall's Tau coefficient.
11. Spearman's coefficient of rank correlation

Practical work to be conducted using electronic spreadsheet / EXCEL/ Statistical Software Package/ SPSS/ calculators.

ESSENTIAL READINGS:

- Gibbons, J. D., and Chakraborti, S. (2020): Nonparametric statistical inference. CRC press.
- Siegel, S. (1956). Nonparametric statistics for the behavioral sciences. McGraw-Hill.

SUGGESTIVE READINGS:

- Kloke, J., and McKean, J. W. (2014) : Nonparametric statistical methods using R. CRC Press.
- Hollander, M., Wolfe, D. A., and Chicken, E. (2013): Nonparametric statistical methods (Vol. 751). John Wiley & Sons.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE COURSE – 6B: RELIABILITY THEORY AND LIFE TESTING

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Statistics	4	3	0	1	Class XII pass with Mathematics	Nil

Learning Objectives

The learning objectives include:

- To understand the reliability and their application area.
- To develop the thinking of students so that they can use the concepts of reliability in real life scenario.
- To determine if the performance of components, equipment, and systems, either under closely controlled and known stress conditions in a testing laboratory or under field use conditions.
- To determine the growth in the mean life and/or the reliability of units during their research, engineering and development phase.

Learning Outcomes:

After completing this course, students should have developed a clear understanding of:

- Concept of Reliability and life testing.
- Various estimation procedures of reliability function(s).
- Comparison of various estimates of reliability through simulation study using different software.
- Real data fitting in reliability modelling

SYLLABUS OF DSE-6B

THEORY

UNIT I **(12 hours)**

Reliability and reliability measures

Definition of components and systems, coherent systems, Reliability, Maintainability and Availability; Lifetime distributions, failure rates, MTTF, Bathtub failure rate, reliability of

coherent systems in terms of paths and cuts, modular decomposition, reliability importance of components; Parametric families of some common lifetime distributions and their properties (Exponential, Weibull and Gamma).

UNIT II **(10 hours)**

Reliability estimation

Various methods of reliability estimation (Classical and Bayesian);Exponential, Weibull and Gamma lifetime distributions, Reliability estimation under complete, truncated and censored samples, estimates based on components of ordered statistics.

UNIT III **(10 hours)**

Stress-Strength and multicomponent reliability

Stress-Strength reliability: concepts and its estimation for exponential, Weibull and gammadistributions, k-out-of-n (exponential and gamma). Mixture distribution, convolutions and competing risks: introduction, mixture of exponentials, mixture of Weibull, competing risk.Bayesian Approximation and Reliability: Lindley's expansion, reliability estimation (Normal and Weibull)

UNIT IV **(13 hours)**

Reliability systems and life testing

Reliability of series/parallel systems: introduction, series systems with identical components. Reliability bounds (classical and Bayesian approaches), parallel systems.Different types of redundancy and use of redundancy in reliability improvement. Problems of life testing.Notions of Ageing: IFR, IFRA, NBU, DMRL, NBUE and HNBUE classes, their duals and relationship between them.

PRACTICAL/LAB WORK – (30 hours)
List of Practical:

1. Calculation of reliability function and its estimates
2. Calculation of hazard rate, MTBF for various systems.
3. Calculation of stress-strength reliability and its estimates.
4. Various reliability and hazard rate plots.
5. Validation of reliability estimates through simulation study.
6. Behavior of reliability estimates corresponding to sample size.
7. Behavior of hazard rates corresponding to different values of parameter(s).
8. Effect of different sample sizes on reliability estimates.
9. Comparison of various methods of estimation of reliability through simulation study.
10. Other relevant problems.

Practical work to be conducted using electronic spreadsheet / EXCEL/ Statistical Software Package/ SPSS/ calculators.

ESSENTIAL READINGS:

- Balagurusamy (2017): Reliability Engineering; Wiley
- Sinha, S.K. (1986): Reliability and Life testing; Wiley Eastern.

SUGGESTIVE READINGS:

- Barlow, R.E. and Proschan F. (1985): Statistical Theory of Reliability and Life Testing; Holt, Rinehart and Winston.
- Lawless, J.F. (2003): Statistical Models and Methods of Life Time Data; John Wiley.

- Bain L.J. and Max Engelhardt (1991): Statistical Analysis of Reliability and Life Testing Models; Marcel Dekker.
- Nelson, W (2003): Applied Life Data Analysis; John Wiley.
- Rand M and Hoyland A (2004): System reliability theory, Models, Statistical methods and itsapplications;Wiley.
- Zacks, S(1992): Introdcution to Reliability Analysis, Springer Verlag

Note: Examination scheme and mode shall be as prescribed by the Examination Branch University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE COURSE-6C: GENERALIZED LINEAR MODELS

CREDIT DISTRIBUTION, ELIGIBILITY, AND PRE-REQUISITES OF THE COURSE

Course title & code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lectures	tutorials	practical		
Generalized Linear Models	4	3	0	1	Class XII pass with Mathematics	

Learning Objectives:

learning objectives include:

- Provide the ability to learn and use linear and non-linear models for normal data
- Developing ability to learn generalized linear models for normal and non-normal responses.

Learning Outcomes:

After completion of this course, students should have developed a clear understanding of:

- Use linear and Non-linear models, apply data transformations, and appreciate the need and uses of generalized linear models.
- Use logistic and Poisson regression models.
- Understand deviance, analysis of deviance, Lack-of-Fit tests in Logistic and Poisson regression, and the concept of overdispersion.
- Use Log linear models for contingency tables, and likelihood ratio tests for various hypotheses including independence, marginal and conditional independence, and partial association.
- Understand graphical and non-graphical models.
- Use the concepts of Generalized Linear Models in real life problems.

SYLLABUS OF DSE-6C

UNIT I **(11 Hours)**

Nonlinear Regression Models
Review of linear regression models, Nonlinear regression models, Origins of Nonlinear Models, Transforming to a Linear Model, Estimation of parameters and Statistical Inferences in nonlinear regression.

UNIT II **(12 Hours)**
Logistic regression models
Logistic regression models, Estimation of parameters, Statistical Inferences on model parameters, Confidence Intervals, Lack-of-Fit tests, and Diagnostic checking in Logistic regression.

UNIT III **(12 Hours)**
Poisson Regression Models
Poisson regression models, Estimation of parameters in Poisson regression, Applications in Poisson regressions. Overdispersion in Logistic and Poisson regression models. Link function.

UNIT IV **(10 Hours)**
Log-Linear Models
Log-linear models for contingency tables: interpretation of parameters, Estimation of parameters, likelihood ratio tests for various hypotheses, Graphical and decomposable models.

PRACTICAL/LABWORK -30 Hours

List of Practicals

1. Fitting of non-linear regression model.
2. Fitting of logistic regression model.
3. Tests of hypotheses about parameters.
4. Analysis of deviance.
5. Lack-of-Fit tests in Logistic regression.
6. Fitting of Poisson regression model.
7. Log-linear models for contingency tables.
8. Tests for independence,
9. Tests for marginal and conditional independence,
10. Tests for partial association.

Practical work to be conducted using electronic spreadsheet / EXCEL/ Statistical Software Package/ SPSS/ calculators.

ESSENTIAL READINGS

- Dobson, A.J. and Barnett, A.G. (2018): Introduction to Generalized Linear Models, 4th ed., Chapman and Hall/CRC. London.
- Myers, R.H., Montgomery, D.C., Vining, G.G. and Robinson, T.J. (2010): Generalized Linear Models with Applications in Engineering and the Sciences, 2nd ed., John Wiley & Sons.

SUGGESTED READINGS:

- McCullagh, P. and Nelder, J.A. (1989): Generalized Linear Models, 2nd ed., Chapman and Hall.
- Montgomery, D. C., Peck, E. A. and Vining, G. G. (2012): Introduction to Linear Regression Analysis, 5th Ed., John Wiley and Sons.

DISCIPLINE SPECIFIC ELECTIVE COURSE – 6D: STATISTICAL COMPUTING AND BASIC DATA MINING

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Statistical Computing and Basic Data Mining	4	3	0	1	Class XII pass with Mathematics	Possess skill in MATLAB / OCTAVE / R / Python / C

Learning Objectives

learning objectives include:

- Understand the theoretical foundations and practical aspects of statistical computing and data mining.
- Develop skills in the use of statistical computing and data mining software to solve problems and analyze data. The programming implementations will be completed using MATLAB/OCTAVE/R/Python/C.

Learning Outcomes:

After completion of this course, students should have developed a clear understanding of:

- Apply knowledge of statistical computing and data mining techniques to solve problems and analyze data.
- Communicate effectively about statistical computing and data mining concepts and techniques both orally and in writing.
- Develop ability for programming implementation using MATLAB/OCTAVE/R/Python/C.

SYLLABUS OF DSE-6D

Theory

UNIT I **(15 hours)**

Simulation techniques

Random number generation: Review; Simulating multivariate distributions; Simulating stochastic processes. Variance reduction methods.

UNIT II **(12 hours)**

Markov Chain Monte Carlo methods

Markov Chain Monte Carlo methods: The Metropolis–Hastings Algorithm; Gibbs sampling.

UNIT III **(18 hours)**

Data Mining and its applications

Introduction to Data Mining and its Applications. Data Pre-processing Techniques: Data Cleaning, Data Integration, Data Transformation, and Data Reduction. Exploratory Data Analysis. Classification Techniques: Decision Trees, Naive Bayes, k-Nearest Neighbors (k-NN). Clustering Techniques: K-Means, Hierarchical Clustering. Association rule mining. Evaluation of Data Mining Models.

PRACTICAL/LAB WORK – (30 hours)

List of Practical:

1. Practical based on random number generation: univariate and multivariate distributions.
2. Practical on simulating stochastic processes; variance reduction.
3. Simple practical problems on MCMC.
4. Practical based on Data pre-processing, transformation, reduction.
5. Practical based on classification and clustering.

Practical work to be conducted using electronic spreadsheet / EXCEL/ Statistical Software Package/ SPSS/ calculators.

ESSENTIAL READINGS

- Rubinstein, R.Y. (2017). Simulation and the Monte Carlo Methods, Wiley.
- Voss, J. (2014). *An introduction to statistical computing: a simulation-based approach,*Wiley series in computational statistics.
- Tan, P. N., Steinbach, M., & Kumar, V. (2016). Introduction to data mining. Pearson Education India.
- Han, J., Kamber, M., & Pei, J. (2012). Data mining concepts and techniques third edition. *University of Illinois at Urbana-Champaign Micheline Kamber Jian Pei Simon Fraser University*.
- Witten, I. H., Frank, E., Hall, M. A., & Pal, C. J. (2017). *Data Mining:* Practical machine learning tools and techniques, Elsevier Inc.

SUGGESTIVE READINGS:

- Vetterling, William T., Saul A. Teukolsky, William H. Press, and Brian P. Flannery. *Numerical recipes in C: the art of scientific computing*. Cambridge university press, 1999.
- Christian, P. R., & George, C. (1999). Monte Carlo statistical methods. *Springer Texts in Statistics*.
- Hancock, M. F. (2012). Practical data mining. CRC Press.
- Shmueli, G., Bruce, P. C., Yahav, I., Patel, N. R., & Lichtendahl Jr, K. C. (2017). *Data mining for business analytics: concepts, techniques, and applications in R*. John Wiley & Sons.
- Shmueli, G., Bruce, P. C., Gedeck, P., & Patel, N. R. (2019). *Data mining for business analytics: concepts, techniques and applications in Python*. John Wiley & Sons.
- Hastie, T., Tibshirani, R., Friedman, J. (2008). The Elements of Statistical Learning: Data Mining, Inference and Prediction, 2nd ed., Springer.

- Murphy, K. P. (2012). Machine Learning: A Probabilistic Perspective. United States: MIT Press.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch University of Delhi, from time to time.

Discipline Specific Elective for B. Sc. (P)

DISCIPLINE SPECIFIC ELECTIVE COURSE – 6A: AN INTRODUCTION TO NON-PARAMETRIC METHODS

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
An Introduction to Non-Parametric Methods	4	3	0	1	Class XII pass with Mathematics	Knowledge of elementary Statistical Inference

Learning Objectives

learning objectives include:

- To understand the basic principles and concepts of non-parametric statistics.
- To learn the different types of non-parametric statistical tests and their applications.

Learning Outcomes:

After completion of this course, students should have developed a clear understanding of:

- Develop an understanding of the differences between parametric and non-parametric statistical tests and their advantages and disadvantages.
- Be able to apply and interpret the results of various non-parametric tests for hypothesis testing, goodness-of-fit testing, testing for randomness, and measuring the association between variables.

SYLLABUS OF DSE-6A

Theory

UNIT I **(11 hours)**

Introduction

Introduction: Definition of non-parametric statistics, Various scales of measurements – the Nominal or categorical scale, the Ordinal or ranking scale, the interval scale and the ratio

scale. The differences between parametric and non-parametric statistical tests. Advantages and disadvantages of non-parametric statistical tests.

UNIT II **(15 hours)**
One Sample Tests

One-Sample Tests: Chi-Square Goodness of Fit Test for testing whether a sample comes from a specific distribution; Kolmogorov-Smirnov Test for goodness of fit, One Sample Runs Test for Randomness to test for independence of the order of observations in the sequence. Testing the difference between the median of a sample and a hypothesized value: Sign Test, Wilcoxon Signed-Rank Test.

UNIT III **(19 hours)**
K Sample Tests

Two-Sample Tests: Whether two samples come from the same continuous distribution-Wald-Wolfowitz Runs test, Kolmogorov-Smirnov test. Test for the difference between the medians of two independent samples - Median Test, Mann-Whitney U Test. Comparison of medians of *k* independent samples - Kruskal-Wallis one-way analysis of variance by ranks. Measure of association between two variables - Spearman Rank-Order correlation coefficient and significance.

PRACTICAL/LAB WORK – (30 hours)
List of Practical:

Practicals based on
1. Chi-Square Goodness of Fit Test
2. Kolmogorov-Smirnov One Sample Test
3. One Sample Runs Test for Randomness
4. Sign Test
5. Wilcoxon Signed-Rank Test.
6. Wald-Wolfowitz Runs Test
7. Kolmogorov-Smirnov Two-Sample Test
8. Median Test
9. Wilcoxon-Mann-Whitney U Test
10. Kruskal-Wallis one-way analysis of variance by ranks
11. Spearman Rank-Order correlation coefficient

Practical work to be conducted using electronic spreadsheet / EXCEL/ Statistical Software Package/ SPSS/ calculators.

ESSENTIAL READINGS

- Gun, A. M., Gupta, M. K., & Dasgupta, B. (2013). An outline of statistical theory. World Press Pvt Limited.
- Siegel, Sidney, and N. John Jr. "Castellan. 1988. Nonparametric Statistics for the Behavioral Sciences." New York (6).
- Gibbons, J. D., & Chakraborti, S. (2014). Nonparametric statistical inference. CRC press.

SUGGESTIVE READINGS:

- Sprent, P., & Smeeton, N. C. (2016). *Applied nonparametric statistical methods*. CRC press.
- Sheskin, D. J. (2011). Handbook of parametric and nonparametric statistical procedures, CRC Press. Boca Raton, FL.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE COURSE – 6B: RELIABILITY THEORY

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Reliability Theory	4	3	0	1	Class XII pass with Mathematics	Nil

Learning Objectives

The learning objectives include:

- To describe the theoretical aspects of reliability along with their application area.
- To determine the growth in the mean life and/or the reliability of units during their research, engineering and development phase.

Learning Outcomes:

After completing this course, students should have developed a clear understanding of:

- Concept of Reliability, Maintainability and Availability.
- Various estimation procedures of reliability function(s).
- Calculate the Reliability of series and parallel systems.

SYLLABUS OF DSE-6B

Theory

UNIT I **(10 hours)**

Reliability measures

Definition of Components, systems and coherent systems. Reliability functions, hazard rate function, reverse hazard rate function, residual lifetime, inactivity time, mean residual lifetime function, mean inactivity time, reliability bounds, cut and path sets.

UNIT II **(08 hours)**

Common lifetime distributions

Common lifetime distributions and their properties (Exponential, Weibull and Gamma), scale model, proportional hazard rate model, proportional reverse hazard rate model, MTTF, Bathtub failure rate, reliability importance of components.

UNIT III **(12 hours)**

Estimation of reliability functions

Various methods of reliability estimation (Classical); of some common lifetime distributions, Reliability estimation under complete and various censored samples. Stress-Strength reliability: concepts and its estimation for exponential and Weibull, k-out-of-n (exponential) and its application.

UNIT IV **(15 hours)**

Reliability systems and ageing

Reliability of series/parallel systems: introduction, series systems with identical components. Different types of redundancy. Notions of Ageing: Different ageing classes, ageing properties of common lifetime distributions, closure properties of different ageing classes under formation of coherent structures.

PRACTICAL/LAB WORK – (30 hours)

List of Practical:

Practical based on

1. Calculation of reliability function and its estimates
2. Calculation of hazard rate for various models.
3. Calculation of stress-strength reliability.
4. Various reliability and hazard rate plots.
5. Behavior of reliability estimates corresponding to sample size.
6. Practicals on ageing.
7. Other relevant problems.

Practical work to be conducted using electronic spreadsheet / EXCEL/ Statistical Software Package/ SPSS/ calculators.

ESSENTIAL READINGS:

- Sinha, S.K. (1986): Reliability and Life testing; Wiley Eastern.

SUGGESTIVE READINGS:

- Barlow, R.E. and Proschan F. (1985): Statistical Theory of Reliability and Life Testing; Holt, Rinehart and Winston.
- Lawless, J.F. (2003): Statistical Models and Methods of Life Time Data; John Wiley.
- Bain L.J. and Max Engelhardt (1991): Statistical Analysis of Reliability and Life Testing Models; Marcel Dekker.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE COURSE – 6C: MULTIVARIATE DATA ANALYSIS

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Multivariate Data Analysis	4	3	0	1	Class XII pass with Mathematics	Nil

Learning Objectives

The learning objectives include:

- To study the concept of Bivariate Normal Distribution along with their properties.
- To study the concept of Multivariate Normal Distribution along with their properties and analysis of multivariate data.
- Concepts of regression plane, multiple and partial correlation coefficients.
- Applications of discriminant analysis, principal component analysis and factor analysis.

Learning Outcomes:

After completing this course, students should have developed a clear understanding of:

- The basic concepts associated with Multivariate Normal Distributions and their properties with special emphasis on Bivariate Normal Distribution.
- The understanding of regression plane, multiple and partial correlation coefficients.
- Analysing multivariate data using data reduction techniques like principal component analysis, factor analysis.
- Classification method namely discriminant analysis.

SYLLABUS OF DSE-6C

Theory

UNIT 1 **(16 hours)**

Bivariate Normal Distribution:

Probability density function of Bivariate Normal Distribution. Moment generating function, marginal, conditional pdf of BVN and properties of BVN. Introduction of random vector, probability mass/ density functions, distribution function, mean vector and dispersion matrix. Marginal and conditional distributions of random vector.

UNIT 2 **(16 hours)**

Multivariate Normal distribution:

Probability density function and properties of Multivariate Normal distribution. Moment generating function, marginal and conditional pdf of MVN. Sampling distribution for mean vector and variance-covariance matrix. Regression plane, multiple and partial correlation coefficient and their properties.

UNIT 3 **(13 hours)**

Data Analysis

Data Reduction Techniques: Principal component analysis and its applications, Factor analysis and its applications. Discriminant analysis and its applications.

PRACTICAL/LAB WORK – (30 hours)

List of Practical:

Practicals based on

1. Bivariate Normal Distribution and its properties.
2. Mean vector and dispersion matrix of Multivariate Normal Distribution.
3. Marginal distributions of Multivariate Normal Distribution.
4. Conditional distributions of Multivariate Normal Distribution.
5. Regression space.
6. Partial Correlation Coefficient.
7. Multiple Correlation Coefficient.
8. Principal Component Analysis.
9. Discriminant analysis.
10. Factor Analysis.

Practical work to be conducted using electronic spreadsheet / EXCEL/ Statistical Software Package/ SPSS/ calculators.

ESSENTIAL READINGS

- Anderson, T.W. (2003). *An Introduction to Multivariate Statistical Analysis*, 3rd Ed., John Wiley & Sons.
- Johnson, R.A. and Wichern, D.W. (2007). *Applied Multivariate Analysis*, 6th Ed., Prentice Hall.
- Gun, A.M., Gupta, M.K. and Dasgupta, B. (2005). *An Outline of Statistical Theory,* Volume II, World Press.
- Brian S. Everett and Graham Dunn. (2001). *Applied multivariate data analysis,* second edition, Oxford University Press.

SUGGESTED READINGS

- S.C. Gupta and V.K. Kapoor (2020). *Fundamentals of Mathematical Statistics,* 12th Ed., Sultan Chand and Sons.
- Kshirsagar, A.M. (1972). *Multivariate Analysis*, 1st Ed., Marcel Dekker.
- Muirhead, R.J. (1982). *Aspects of Multivariate Statistical Theory*, John Wiley.
- Arora, S. and Bansi, L. (1968). *New Mathematical Statistics*, 1st Ed., Vanita Printers.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE COURSE – 6D: STATISTICAL SIMULATION

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		

Statistical Simulation	4	3	0	1	Class XII pass with Mathematics	Nil

Learning Objectives

The learning objectives include:

- Concept of simulation and simulation modelling.
- Generation of Pseudo random number generators as well as from standard statisticaldistributions. Monte-Carlo simulation technique.
- Application of simulation techniques.

Learning Outcomes

After completing this course, students will possess skills concerning:

- How simulation may be used to understand the behavior of real world systems by utilizing mathematical models with an emphasis on simulation.
- How to generate random numbers by the different methods.
- Hands-on experience in using simulation software packages/structured programming languages.

SYLLABUS OF DSE- 6D

Theory

Unit I **(12 Hours)**

Introduction to simulation:

Introduction, Definitions of simulation, Need for simulation, general principles, types of simulation, Simulation models, Phases in simulation models, Event type simulation, Monte Carlo simulation technique.

Unit II **(18 Hours)**

Random numbers generation:

Methods for the generation of Random numbers, Pseudo random number generators, Mid square method for the generation of random number and its limitations, the inverse transform method; Generating the Discrete and Continuous random variables.

Unit III **(15 Hours)**

Applications of simulation:

Applications of simulation in different fields of study, simulation of Inventory problems and simulation of Queueing problems. Advantages and disadvantages of simulation, Simulation languages, Scope of simulation techniques.

Practical/Lab Work–(30 hours)

List of Practical:

1. Pseudo random number generators;
2. Generation of U(0,1).
3. Generation using the inverse transform method applied to:
   (a) Discrete distribution and
   (b) Continuous distribution.
4. Monte Carlo simulation method and applications.
5. Problems based on Queueing systems.

6. Problems based on Inventory Controls, etc.

Practical work to be conducted using electronic spreadsheet / EXCEL/ Statistical Software Package/ SPSS/ calculators.

ESSENTIAL READING:

- Sheldon M. Ross (2022) *Simulation, Sixth Edition,* Elsevier Academic press publication.
- Taha, H. A. (2010). *Operations Research. An Introduction*, 9th Ed, Pearson.
- Swarup, K. Gupta, P.K. and Mohan, M. (2019). *Operations Research, 15th Ed,* Sultan Chand & Sons.

SUGGESTED READINGS:

- Voss, J. (2013). *An introduction to statistical computing: A simulation-based approach,* 1st Ed., Wiley series in computational statistics.
- Sharma, J. K. (2017). *Operations Research: Theory and applications, 6th Edition,* Trinity Press.
- Payer T.A. (1982). *Introduction to simulation,* McGraw Hill.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch University of Delhi, from time to time.

COMMON POOL OF GENERIC ELECTIVES (GE) COURSES

OFFERED BY DEPARTMENT OF STATISTICS

CATEGORY-VI

GENERIC ELECTIVE COURSE – 8A: ORDER STATISTICS

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Order	4	3	0	1	Class XII	Nil

Statistics					pass with Mathematics	

Learning Objectives

The learning objective of this course is:

- To make the students aware of the properties and applications of order statistics.

Learning Outcomes:

After completion of this course, students should have developed a clear understanding of:

- Find joint, marginal, and conditional distributions of order statistics in the continuous and discrete cases.
- Find the distribution of sample range and other systematic statistics in case of sampling from an arbitrary continuous population and, in particular, from some specific continuous distributions such as uniform and exponential.
- Understand the Markov Chain property of order statistics in the continuous case.
- Understand the distribution-free bounds for moments of order statistics and of the range.
- Derive the recurrence relations and identities for moments of order statistics drawn from an arbitrary population (discrete or continuous), as well as from some specific distributions.
- Learn how to obtain distribution-free confidence intervals for population quantile and distribution-free tolerance intervals for population distributions based on order statistics

SYLLABUS OF GE-8a

Theory

UNIT I **(15 hours)**

Introduction

Introduction to order statistics. Basic distribution theory. Joint and marginal distributions of order statistics in the continuous case. Distribution of the range, median and other systematic statistics. Examples based on some specific continuous distributions.

UNIT II **(10 hours)**

Conditional distribution of order statistics

Conditional distributions. Order statistics as a Markov Chain. Order statistics for a discrete parent. Examples based on some specific discrete distributions.

UNIT III **(10 hours)**

Moments of order statistics

Moments of order statistics. Need of Recurrence relations and identities for moments of order statistics. Recurrence relations and identities for single and product moments of order statistics from an arbitrary distribution. Recurrence relations for single and product moments of order statistics from some specific distributions.

UNIT IV **(10 hours)**

Distribution- free intervals of order statistics

Distribution-free confidence intervals for population quantiles and distribution-free tolerance intervals. Distribution-free bounds for moments of order statistics and of the range.

PRACTICAL/LAB WORK – (30 hours)

List of Practical:

1. Problem solving using joint, marginal and conditional distributions of order statistics for some specific continuous distributions.
2. Distribution-free confidence intervals for population quantiles for various distributions.
3. Calculating Means, variances, and covariances by using exact expressions for the moment of order statistics for some specific continuous distribution.
4. Problems based on Markov Chain property of order statistics in the continuous case.
5. Distribution of sample range and other systematic statistics in sampling from differentdistributions.
6. Conditional distribution of order statistics in sampling from different distributions.
7. Calculating exact moments of order statistics by using recurrence relations for arbitrary continuous distributions.
8. Calculating exact moments of order statistics by using recurrence relations for some specific distributions.
9. Distribution-free confidence intervals for population quantiles for various distributions.

Practical work to be conducted using electronic spreadsheet / EXCEL/ Statistical Software Package/ SPSS/ calculators.

ESSENTIAL READINGS

- David, H. A. and Nagaraja, H. N. (2003). *Order Statistics*, 3rd ed., John Wiley & Sons.

SUGGESTIVE READINGS:

- Arnold, B.C., Balakrishnan, N. and Nagaraja H. N. (2008). *A First Course in OrderStatistics,* SIAM Publishers.
- Arnold, B.C. and Balakrishnan, N. (1989). *Relations, Bounds and Approximations forOrder Statistics*, Vol. 53, Springer-Verlag.
- Ahsanullah, M., Nevzorav, V.B. and Shakil, M. (2013). *An Introduction to OrderStatistics, Atlantis Studies in Probability and Statistics*, Vol. III. Atlantis Press.
- Shahbaz, M. Q., Ahsanullah, M., Shahbaz, S. H. and Al-Zahrani, B. M. (2016). *OrderedRandom variables: Theory and Applications*. Springer.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch University of Delhi, from time to time.

GENERIC ELECTIVE COURSE – 8B: STATISTICS IN FINANCE

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Statistics in Finance	4	3	0	1	Class XII pass with	Basic knowledge of Calculus ,

					Mathematics.	Probability theory and Financial markets

Learning Objectives

The learning objectives include:

- To study the Financial Statistics which deals primary and secondary financial markets and the mathematical models used by these markets?
- To study to deal with the risks in financial markets

Learning Outcomes:

After completing this course, students should have developed a clear understanding of:

- Primary financial markets and their products such as equity, bonds and cash deposits
- Secondary financial markets and their products such as futures, forwards and options (American and European)
- Applications of stochastic models to price various secondary financial markets products.
- Hedging techniques

SYLLABUS OF GE-8B

Theory

UNIT I **(12 hours)**

Theory of interest rates

Theory of interest rates- Simple and compound interest, Nominal and effective rates of interest, interest rates of varying frequencies, continuous rates, accumulation and discount factors, relationship between interest rates and discount rates, present value, future value.

Unit II **(14 hours)**

Project appraisal and investment performance

Project appraisal and investment performance- Net present value, IRR, effect of taxation, Valuation of securities- fixed asset securities, related assets, perpetuities, bonds, coupon rates, bond-pricing formula.

Unit III **(14 hours)**

Introduction to derivative pricing

An introduction to derivative pricing- arbitrage, futures and forwards, European options- Call and put, put call parity, volatility, Black-Scholes option pricing formula, binomial model of option pricing. Hedging- delta, gamma and theta.

PRACTICAL/LAB WORK – (30 hours)

List of Practical:

Practical based on

1. Relationship between various interest and discount rates
2. Calculation of present values and future values of cashflows
3. To compute NPV and to obtain IRR of the investments.
4. To compute bond price and yields
5. To verify “no arbitrage” principle.
6. To price future / forward contracts
7. To price options using Black – Scholes formula.
8. Pricing of options using discrete time models.
9. Call-put parity for options.

10. Application of Greeks to hedge investment portfolios.

Practical work to be conducted using electronic spreadsheet / EXCEL/ Statistical Software Package/ SPSS/ calculators.

ESSENTIAL READINGS

- David, G. L. (2015). *Investment Science*, Oxford University Press(South Asian edition)
- John C. Hull and SankarshanBasu (10th edition) Options, Future and other derivatives, PearsonIndian edition

SUGGESTIVE READINGS:

- Franke, J., Hardle, W.K. and Hafner, C.M. (2011). *Statistics of Financial Markets: An Introduction*, 3rd Ed., Springer Publications.
- Garrett S. J. (2013) *An introduction to the mathematics of Finance: A deterministic approach*, 2nd edition, Elsevier
- Ambrose Lo (2018): Derivative Pricing: A problem based primer, Chapman & Hall

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GENERIC ELECTIVE COURSE – 8C: INTRODUCTION TO RELIABILITY THEORY

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Introduction to Reliability Theory	4	3	0	1	Class XII pass with Mathematics	Nil

Learning Objectives

The learning objectives include:

- To describe the theoretical aspects of reliability along with their application area.
- To determine the growth in the mean life and/or the reliability of units during their research, engineering and development phase.

Learning Outcomes:

After completing this course, students should have developed a clear understanding of:

- Concept of Reliability, Maintainability and Availability.
- Various estimation procedures of reliability function(s).

- Calculate the Reliability of series and parallel systems.

SYLLABUS OF DSE-6B

Theory

UNIT I **(10 hours)**

Reliability measures

Definition of Components, systems and coherent systems. Reliability functions, hazard rate function, reverse hazard rate function, residual lifetime, inactivity time, mean residual lifetime function, mean inactivity time, reliability bounds, cut and path sets.

UNIT II **(08 hours)**

Common lifetime distributions

Common lifetime distributions and their properties (Exponential, Weibull and Gamma), scale model, proportional hazard rate model, proportional reverse hazard rate model, MTTF, Bathtub failure rate, reliability importance of components.

UNIT III **(12 hours)**

Estimation of reliability functions

Various methods of reliability estimation (Classical); of some common lifetime distributions, Reliability estimation under complete and various censored samples. Stress-Strength reliability: concepts and its estimation for exponential and Weibull, k-out-of-n (exponential) and its application.

UNIT IV **(15 hours)**

Reliability systems and ageing

Reliability of series/parallel systems: introduction, series systems with identical components. Different types of redundancy. Notions of Ageing: Different ageing classes, ageing properties of common lifetime distributions, closure properties of different ageing classes under formation of coherent structures.

PRACTICAL/LAB WORK – (30 hours)

List of Practical:

Practical based on

1. Calculation of reliability function and its estimates
2. Calculation of hazard rate for various models.
3. Calculation of stress-strength reliability.
4. Various reliability and hazard rate plots.
5. Behavior of reliability estimates corresponding to sample size.
6. Practicals on ageing.
7. Other relevant problems.

Practical work to be conducted using electronic spreadsheet / EXCEL/ Statistical Software Package/ SPSS/ calculators.

ESSENTIAL READINGS:

- Sinha, S.K. (1986): Reliability and Life testing; Wiley Eastern.

SUGGESTIVE READINGS:

- Barlow, R.E. and Proschan F. (1985): Statistical Theory of Reliability and Life Testing; Holt, Rinehart and Winston.
- Lawless, J.F. (2003): Statistical Models and Methods of Life Time Data; John Wiley.
- Bain L.J. and Max Engelhardt (1991): Statistical Analysis of Reliability and Life Testing Models; Marcel Dekker.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch University of Delhi, from time to time.