SEMESTER: 1
COURSE CODE: ST 211
COURSE TITLE: ANALYTICAL TOOLS FOR STATISTICS – I

Course outcomes

On completion of the course, the students should be able to:

CO1. Describe classes of open and closed sets of R.

CO2. Describe the concept of compactness

CO3. Describe Metric space - Metric in R^n.

CO4. Use the concept of Cauchy sequence, completeness, compactness and connectedness to solve the problems

CO5. Explain the concept of Riemann- integral and Describe the properties of Riemann- integral.

CO6. Apply integral calculus in problem solving

CO7. Compute Partial derivatives of functions of several variables

CO8. Compute maxima, minima of functions

CO9. Compute conditional maxima and conditional minima

CO10. Visualize complex numbers as points of R^2

CO11. Understand the significance of differentiability and analyticity of complex functions leading to the Cauchy–Riemann equations.

CO12. Evaluation of contour integrals using Cauchy's theorem and Cauchy integral formula

CO13. Learn Taylor and Laurent series expansions of analytic functions, classify the nature of singularity, poles and residues

CO14. Apply Cauchy Residue theorem in evaluating integrals

Sl. No:	Outcomes On completion of each module, students should be able to:	Taxonomy Level
MODULE: I	MO1. Describe classes of open and closed set MO2. Apply the concept of compactness MO3. Describe Metric space - Metric in R^n. MO4. Use the concept of Cauchy sequence, completeness, compactness and connectedness to solve the problems	Understand Understand Understand Apply
MODULE II.	MO1. Explain the concept of Riemann- integral MO2. Solve integration problems MO3. Apply integral calculus in solving statistical problems M04: Compute Partial derivatives of functions of several Variables M05: Compute maxima, minima of functions M06: Compute conditional maxima and conditional minima MO7: Apply partial derivatives, maxima and minima in statistics	Understand Evaluate Apply Evaluate Evaluate Evaluate Apply
MODULE III	MO1.Understand the concept of Complex numbers MO2. Significance of differentiability and analyticity of complex functions MO3. Evaluate integrals using Cauchy's theorem MO4. Evaluate integrals using Cauchy integral formula MO5. Apply Liouville's theorem	Understand Understand Evaluate Evaluate Apply
MODULE IV	MO1. Learn Taylor and Laurent series expansions of analytic functions	Understand

	MO2. classify the nature of singularity, poles and residues MO3. Understand the basic concepts of contour integration MO4 Apply Cauchy Residue theorem in evaluating integrals	Evaluate Understand Apply

Course content

Module I

Euclidean space R^n, open balls, open sets, closed sets, adherent points. Bolzano – Weierstrass theorem, Cantor intersection theorem, compactness in R^n, Heine-Borel theorem, Metric space (definition and examples). Compact subsets of a metric space, convergent sequence, Cauchy sequence, complete metric space

Limit of real valued functions, continuous functions, continuity and inverse images of open and closed sets, Connected sets, uniform continuity and monotone functions (definition examples and applications only). Functions of bounded variation, properties, total variation and additive property, continuous functions of bounded variation.

Sequences of functions, uniform convergence, Cauchy's conditions.

Chapter 3 , Chapter 4[Sections 4.1 – 4.5, 4.8, 4.9, 4.12, 4.13, 4.16, 4.19, 4.20, 4.23] , Chapter 6 [Sections 6.1- 6.8] and chapter 9[Sections 9.1–9.5] of Apostol T. M

Module II

Definition and existence of Riemann integral, Riemann-Stieltjes integral, its reduction to Riemann integral, properties of Riemann-Stieltjes integrals (viz. linearity, product, quotient and modulus of integrals). Riemann's Condition, Fundamental theorem of integral calculus, mean value theorems,

Functions of several variables, partial derivatives, maximum and minimum of functions, conditional maxima and minima, Lagranges multiplier method.

Chapter 7 [Sections 7.1 – 7.5, 7.7, 7.11, 7.13, 7.14, 7.18, 7.19, 7.20] of Apostol T. M and Chapter 9 [Sections 1 – 4] of Malik, S.C., Arora, S

Chapter 15 [Section 11] and Chapter 16 [Section 3] of Malik, S.C., Arora, S

Module II

Complex numbers and complex plane, functions of complex variables, analytic functions, Cauchy-Riemann equations (concepts and examples only). Cauchy's integral theorem, Cauchy's integral formula, Liouville's theorem, maximum modulus principle.

Chapter 1, Chapter 2[Sections 1,2,3] and Chapter 3[Sections 1-7] of Levinson,N., Redheffer ,M,R

Module IV

The zeros of analytic function, singularities and their types, residues, poles, Cauchy's residue theorem (statement and application only), contour integration (basic theory) and evaluation of integrals of the form:

$$\int_0^{2\pi} f(\sin\theta,\cos\theta)d\theta,\ \int_{-\infty}^{\infty} f(x)e^{imx}dx,\ \int_{-\infty}^{\infty} f(x)dx.$$

Chapter 3 [Sections 8-10], Chapter 4 [Sections 1-3] of Levinson,N., Redheffer ,M,R , and Chapter 5 [Section 3] of Ahlfors, L.V.

Texts:

1. Apostol T. M. (1974): *Mathematical Analysis*, Narosa Publishing House, New Delhi.
2. Malik, S.C., Arora, S. (2012): *Mathematical Analysis,* New Age International, New Delhi.
3. Levinson,N.,Redheffer ,M,R.(2015).*Complex Vaiables*.McGraw Hill Education(India) Limited.
4. Ahlfors, L.V.(2016). *Complex Analysis* .McGraw Hill Education(India) Limited.3rd Edition.

References:

1. Goldberg, R.R. (1970): *Methods of Real Analysis*, Oxford and IBH Publishing Company (P) Ltd, New Delhi.
2. Somasundaram, D, Chaudhary, B . (1999): First *Course in Mathematical Analysis*, Narosa Publishing House, New Delhi.
3. Lang, S.(1998). *Complex Analysis*. Springer , New York.

4. Ponnusamy ,S(2015). *Foundations of Complex Analysis* . Narosa Publishing House, New Delhi

COURSE CODE : ST 212
COURSE TITLE : ANALYTICAL TOOLS FOR STATISTICS – II

COURSE OUTCOMES

On completion of the course, students should be able to:

CO1. Have a clear understanding of vector space, subspaces, independence of vectors, basis, dimension and Gram Schmidt orthogonalization

CO2. Understand different types of matrices, concept of determinants, rank of a matrix, nullity and partitioned matrices with the help of examples.

CO3. Define Characteristic roots and vectors and their properties, determination of characteristic roots- power method and Jacobi method, spectral decomposition of matrices, Cayley-Hamilton theorem, algebraic and geometric multiplicity

CO 4. Achieve ideas on quadratic forms and reduction of quadratic forms and gets ability for solving problems in these areas.

CO5. Understand the concept of generalized inverse, Moore-Penrose g-inverse and derives its properties.

CO6. Understand different methods of solving a system of linear equations

MODULE OUTCOME

SL. NO	**Outcomes** On completion of each module, students should be able to:	**Taxonomy Level**
Module I	M01. Articulate and exemplify the concepts of vector space, subspace, independence of vectors, basis and dimension, inner product, norm	Understand
	M02. Explain the concept of inner product, norm	
	M03. Describe Gram Schmidt orthogonalization, orthogonal transformation.	Understand Understand

Module II	M01. Describe different types of matrices- Triangular, Idempotent, nilpotent, nonnegative, Unitary, Hermitian and skew Hermitian matrices M02. Concept of determinants and its properties M03. Explain the rank and nullity of a matrix, rank nullity theorem.	Understand Apply understand
Module III	M01. Determine the Eigen values and Eigen vectors of the given matrix M02. Application of Cayley Hamilton theorem M03. Obtain the diagonal form and triangular form of a given matrix. M04. Write down the spectral decomposition M05. Understanding Algebraic and geometric multiplicity of characteristic roots	Understand Apply Understand Understand Understand
Module IV	M01. Find the nature of the quadratic form. M02. Articulate the concept of generalized inverse. M03. Obtain the g-inverse and Moore- Penrose g-inverse of the given matrix. M04. Solving a system of linear equations - inversion, elimination, iterative	Analyze Understand Apply Apply

Course content

Module I

Linear vector space, subspace, independence of vectors, basis and dimension, inner product, norm, orthonormal basis, orthogonal subspaces, Gram Schmidt orthogonalization, orthogonal transformation.

Module II

Matrices, Different types of matrices- Triangular, Idempotent, nilpotent, nonnegative, Unitary, Hermitian and skew Hermitian matrices. Determinants and their properties. Rank of a matrix, null space, nullity, partitioned matrices, Kronecker product, linear

transformations, matrix representation of linear transformations, similarity of transformation.

Module III

Characteristic roots and vectors of matrices and their properties, determination of characteristic roots- power method and Jacobi method, spectral decomposition of matrices, Cayley- Hamilton theorem, algebraic and geometric multiplicity of characteristic roots.

Module IV

Quadratic forms- definition, classification and reduction of quadratic forms, real, symmetric and orthogonal reduction, simultaneous reduction, scalar valued functions of vectors and their derivatives with respect to a vector/matrix, Jacobian transformation.

Methods of computation of inverse of a non singular matrix, generalized inverse, reflexive inverse, solutions of matrix equations, determination of Moore- Penrose g-inverse, solution of a system of linear equations-methods of solution (inversion, elimination, iterative).

Text Books:

1. Biswas, S. (2012). Textbook of Matrix Algebra, Third edition, PHI Learning Pvt Ltd, New Delhi.
2. Sundarapandian, V. (2008). Numerical Linear Algebra, PHI Learning Pvt. Ltd,New Delhi.

Reference Texts:

1. Banerjee, S and Roy, A (2014). Linear Algebra and Matrix Analysis for Statistics, CRC Press, New York
2. Healy, M. J. R. (1986). Matrices for Statistics, Oxford Science Publications.
3. Lay, D. C. (2006). Linear Algebra and its Applications, Pearson Education.
4. Lipschutz, S. and Lipson, M. (2005). Linear Algebra. Tata McGraw- Hill Publishing Co. Ltd. New Delhi.
5. Monahan J.F. (2001). Numerical Methods of Statistics, Cambridge University Press.
6. Rao, C.R. (1973). Linear Statistical Inference and its Applications, Wiley Eastern

COURSE CODE: ST 213
COURSE TITLE: PROBABILITY THEORY I

Course Outcomes

On completion of the course, students should be able to:

CO1. Explain Sequence of sets and its convergence.

CO2. Describe various types of measures and explain its properties.

CO3. Explain Lebesgue and Lebesgue-Stieljes measures and its properties.

CO4. Explain measurable functions and its convergence

CO5: Explain probability measure and probability space.

CO6: Explain conditional probability and Baye's theorem.

CO7. Identify various types of random variables and explain its properties

CO8. Decompose distribution function.

Module Outcomes

Sl.No	**Outcomes** On completion of each module, students should be able to:	**Taxonomy Level**
Module I	M01. Explain and exemplify the concepts of sequence of events	Understand
	M02. Construction of the various types of fields.	Understand
	M03. State and explain various measures associated with a set function.	Remember
	M04. Explain the concepts of measurable functions.	Remember
	M05. Explain sequence of measurable functions and its convergence.	Create
Module II	M01. Integral of simple functions and measurable functions'	Apply
	M02. Evaluation of Lebesgue integral and Lebesgue- Stieltjes integral.	Apply
	M03.Describe Lebesgue decomposition theorem and Radon- Nykodym theorem	Understand
Module III	M01. Construct counter examples for proving/illustrating certain results associated with probability measure	Evaluate
	M02. Evaluate the conditional probability and verify its properties	Apply
	M03. Articulate the Bayes theorem and apply it to	

	calculate apriori probabilities	Evaluate
Module IV	M01. Describe random variables and find the functions for various random variables M02.Explain distribution function and its properties. M03. Describe the decomposition of distribution function	Apply Understand Evaluate

Course Content

Module I

Sequence of sets, limit supremum, limit infimum and limit of sequence of sets, Monotone sequence of sets. Class of sets- Semi ring, ring, sigma ring (definition and examples only), field and sigma field. Borel sigma field and monotone class. Definition of minimal sigma field, generated sigma field and induced sigma field. Set functions, additive set functions and sigma additive set functions. Measure and its properties. Measure space, finite measure, sigma finite measure, complete measure, counting measure and signed measure (definition and examples only).) Outer measure, Lebesgue measure, Lebesgue –Stieltjes measure, Caratheodory extension theorem (statement only). Measurable functions and properties (viz. linearity, product, maxima, minima, limit sup, limit inf,and modulus of measurable functions). Simple functions. Sequence of measurable functions. Point-wise convergence, almost everywhere convergence, uniform convergence, convergence in measure, convergence in p^{th} mean (concept only).

Module II

Integral of non- negative simple function, integral of non-negative measurable functions and integral of measurable functions. Lebesgue integral and its properties. Monotone convergence theorem, Fatou's theorem, Lebesgue dominated convergence theorem. Lebesgue –Stieltjes integral and its reduction to Riemann-Stieltjes integral and Riemann integral. Absolute continuity and singularity of measures (definition only). Statement and applications of Lebesgue decomposition theorem and Radon-Nykodym theorem

Module III

Sample space and events, probability measure, probability space. Limit of sequence of events, monotone and continuity properties of probability measure. Independence of

sequence of events, conditional probability and Bayes theorem. Borel- Cantelli lemma, Borel zero-one law and Kolmogorov 0-1 law.

Module IV

Random Variables, discrete and continuous-type random variables, induced probability measure and induced probability space, probability distribution and distribution function, properties of distribution function., mixture of distribution functions (concept only). Decomposition of distribution function-Jordan decomposition theorem. Functions of a random variable, random vectors, distribution function of random vector (concept only). Independence of sequence of random variables.

Text books:

1. Jain, ,P.K. and Gupta, V.P.(2000). Lebesgue Measure and Integration, New Age International (P) Ltd., NewDelhi(For Unit 2).
2. Kingman, J.F.C. and Taylor, S.J. (1977). A text book of Introduction to Measure Theory and Probability, 3rdEdn., Cambridge University Press, London (For Unit 1, Unit 2 and Unit 3).
3. Laha, R.G. and Rohatgi, V.K. (1979).Probability Theory, John Wiley, New York(For Unit 4 and Unit 5).
4. Rohatgi, V.K. and Saleh, Ehsanes (2014). An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern Ltd.(For Unit 4 and Unit 5)
5. Roussas, G.G.(2014). An Introduction to Measure-Theoretic Probability, Academic Press, USA.

References:

1. Malik, S.C. and Arora, S.(2011) Mathematical Analysis, 4th Edn New Age international (P) Ltd, New Delhi.
2. Bhat, B.R.(1991). Modern Probability Theory, 2ndEdn., Wiley Eastern Ltd., New Delhi.
3. De Barra, G. (2000). Measure Theory and Integration, New Age International (P) Ltd., NewDelhi.
4. Feller W. (1968) Introduction to Probability Theory and Its Applications Vol. 1 and 2, John Wiley, New York.
5. Loeve, M (1968) Probability Theory Allied East-West Press.
6. Mukhopadhyay, P. (2011). An Introduction to the Theory of Probability, World Scientific Publishing Company.

COURSE CODE : ST 214
COURSE TITLE : SAMPLING TECHNIQUES

COURSE OUTCOMES

On completion of the course, students should be able to:

CO1. Understand the principles underlying sampling as a means of making inferences about a population.

CO2. Collect data from a smaller part of a large group so that the students can able to learn something about the larger group.

CO3. Understand the difference between randomization theory and model based analysis.

CO4. understand the concepts of bias and sampling variability and strategies for reducing these.

CO5. Understand the sampling schemes like SRS, Stratified sampling, Systematic sampling, Cluster sampling, Multi stage sampling, sampling with varying probabilities of selection etc.

CO6. Have an appreciation of the practical issues arising in sampling studies.

MODULE OUTCOMES

Sl. No:	**Outcomes** On completion of each module, students should be able to:	**Taxonomy level**
Module I	Explain population, sample, sampling and non-sampling errors, sampling frame, probability and non-probability sampling, sampling design, sampling strategy. M02.Discuss simple random sampling with and without replacement. M03. Articulate the estimation of population mean, total and proportion and hence the estimation of the standard error. M04. Explain determination of sample size and confidence interval	Understand Analysis Evaluate Apply

	M01. Explain PPS sampling and articulate to selection procedures using PPS with and without replacement M02. Find methods to estimate population mean, total and variance with respect to PPS sampling M03. Apply various selection procedures for selecting samples using PPS	Evaluate Analysis Remembe r
Module II	M01. Explain the purpose of stratification M02. Explain stratified random sampling M03. Discuss various allocation procedures M04. Explain systematic sampling M05.estimation of the population mean and variance of the estimator under systematic sampling M06. Describe the comparison of simple random sample, systematic sample and stratified sample for a population with linear trend.	Apply Understand Analysis Understand Analysis Evaluate
Module III	M01. Explain PPS sampling and articulate to selection procedures using PPS with and without replacement M02. Find methods to estimate population mean, total and variance with respect to PPS sampling M03. Distinguish between ordered and unordered sampling method M04. Des Raj's ordered estimator, Murthy's unordered estimator, Horvitz-Thompson estimator, Yates- Grundy form of estimated variance, Zen-Midzuno scheme of sampling , πps sampling	Understan d Evaluate Understan d Evaluate

Module IV	M01. Distinguish between ratio and regression estimators M02. Explain various properties of ratio and regression estimators M03. Explain cluster sampling. M04. Estimation of population mean and variance of the estimator and efficiency of cluster sampling. M05. Explain Two stage sampling M06. Estimation of population mean and variance M07. Comparison of two-stage with one stage	Understand Evaluate Understand Apply Understand Evaluate Evaluate

COURSE CONTENT

Module I

Concept of population and sample, sampling and non-sampling errors, sampling frame, probability and non-probability sampling, concept of sampling design, sampling strategy, simple random sampling with and without replacement, procedures for selection of simple random sample, Estimation of population mean, population total, population proportion, and the variance of these estimators. Estimation of their standard errors. Confidence limits for population mean and for proportion. Estimation of sample size.

Module II

Stratified sampling, procedure of sample selection, estimation of population mean and variance of the estimator, choice of the sample size in different strata (optimum

allocation, Neyman allocation and proportional allocation), variance of the estimator of population mean under these allocations, comparison of these variances, comparison of stratified sampling with SRS.

Systematic sampling- sample selection procedure, estimation of the population mean and variance of the estimator, comparison of systematic sampling with SRSWOR, comparison of systematic sampling with stratified sampling, comparison of systematic sampling with SRSWOR and stratified random sampling for population with linear trend, circular systematic sampling- sample selection procedure.

Module III

Sampling with varying probabilities: PPS sampling with replacement, method to select PPSWR sample, estimation of population mean and variance of the estimator, PPS sampling without replacement, Des Raj's ordered estimator, mean of the estimator for the case of two draws and general case, Murthy's unordered estimator(Definition only), Horvitz-Thompson estimator of population mean and variance of the estimator, Yates- Grundy form of estimated variance, Zen-Midzuno scheme of sampling (concept only), πps sampling (definition only)

Module IV

Ratio method of estimation - Ratio estimator, bias and MSE of the ratio estimator, first order approximation to the bias of ratio estimator, approximate variance of ratio estimator.

Regression method of estimation – Difference estimator, the regression estimator, bias and MSE of the regression estimator, comparison of regression estimator with ratio estimator, approximate variance of the regression estimator

Cluster sampling- cluster sampling with clusters are of equal size, estimation of population mean and variance of the estimator, efficiency of cluster sampling. Two stage sampling-Two stage sampling with equal first stage units, estimation of the population mean and the variance of the estimator. Comparison of two-stage with one stage sampling. Multistage sampling (concept only).

Text Books

1. Bensal A (2017). Survey Sampling, Narosa Publishing House Pvt. Ltd.
2. Cochran, W. G. (1977). Sampling Techniques, Third edition, Wiley Eastern Ltd.
3. Mukhopadhyay, M. (2009). Theory and Methods of Survey Sampling, Second Edition, PHI Learning Pvt. Ltd.

References

1. Gupta A K and Kabe D G (2011), Theory of Sample Surveys, World Scientific.
2. Murthy, M. N. (1967). Sampling Theory and Methods, Statistical Publishing Society, Calcutta.
3. Sampath, S. (2001). Sampling Theory and Methods, Second edition, Narosa Publishing Company, New Delhi.
4. Singh, D. and Chaudhary, F.S. (1986). Theory and Analysis of Sample Survey Designs, Wiley Eastern Ltd.
5. Sukhatme, P.V. and Sukhatme, B.V. (1970). Sampling Theory of Surveys with Applications, second edn, Asia Publishing House, Bombay.

COURSE CODE: ST 215

COURSE TITLE: INTRODUCTION TO R AND PYTHON

Course Outcomes

After completion of this course the students will be able to:

C01. Write programs for statistical applications using R and Python.

C02. Use R and Python graphical functions/packages to create plots.

C03. Learn basic data handling methods using R and Python.

CO4. Crete user defined functions in R and Python.

Module Outcomes

Sl.No.	Outcomes On Completion of each module, Students should be able to:	Taxonomy level
MODULE I.	MO1.Download and install R and R packages MO2. Apply R syntax and R objects MO3.Apply built in functions in R	Remember and Apply Understand and Apply Understand and Apply

	MO4.Reshape and manipulate Data MO5. Write own functions in R	Understand and Apply Understand and create
MODULE II	MO1.Apply Graphical functions in R MO2.Write programs to create graphs/plots	Understand and Apply Apply and Create
MODULE III	MO1. Installing and running python MO2. Basic python commands and operations MO3. Learn control structures, iteration and data types	Remember and Apply Understand and apply Learn and apply
MODULE IV	MO1. Creating functions in Python MO2. Learning Data Visualization in Python MO3. Creation of diagrams and graphs	Learn Learn and apply Understand and Apply

Course Content

MODULE I

Installing R, R user interface, Expressions, objects, symbols, functions, special values (NA, Inf and –Inf, NaN, NULL), Constants, Numeric vectors, Character vectors, Symbols, Order of operations, Assignments, Conditional statements, Loops, indexing by Integer vector, indexing by Logical vector, indexing by Name. **R Objects**:- Object types, vectors, lists, matrices, arrays, missing values, factors, data frames.

Functions - The function keyword, Arguments, Return values, Functions as arguments, Anonymous functions, properties of functions, calling basic functions, math functions, vector and matrix operations, statistical functions, Reading Data into R- Reading CSVs, Excel Data, Manipulating Data- Apply family of functions Data Reshaping- cbind, rbind, joins, basic string operations.

MODULE II

R-Graphics: - An overview of R graphics, Scatterplots, Bar charts, Histogram, Pie charts, Plotting time series, Box plots, Lattice Graphics, Stem and leaf plots, Q-Q plots, Graphical parameters, Basic graphic functions, Drawing- mathematical functions, Logarithmic functions, Trigonometric functions, polynomial functions, dot chart and violin plot examples,.

MODULE III

Installing Python, Basics of Python Programming, Running Python Scripts, Using the Terminal Command Prompt, IDEs for python, Variables, Assignment, Keywords, Input-Output, Indentation. Types, Operators and Expressions: Types - Integers, Strings, Booleans; Operators- Arithmetic Operators, Comparison (Relational) Operators, Assignment Operators, Logical Operators, Bitwise Operators, Membership Operators, Identity Operators, Expressions and order of evaluations Control Flow- if, if-elif-else, for, while, break, continue, pass, Exception handling. Data Structures: Lists - Operations, Slicing, Methods; Tuples, Sets, Dictionaries, Built-in methods of lists, sets and dictionaries, Mutable and Immutable Objects.

MODULE IV

Functions: Defining Functions, Calling Functions, Passing Arguments, Recursion, Keyword Arguments, Default Arguments, Variable-length arguments, Anonymous Functions, Fruitful Functions (Function Returning Values), Scope of the Variables in a Function - Global and Local Variables. Basic plot functions in Matplotlib library: Line Plot, Bar Plot, Pie Chart, Box Plot, Histogram Plot, Scatter Plot.

TEXTBOOKS

1. Adler, J. (2010). *R in a nutshell: A desktop quick reference*. " O'Reilly Media, Inc.".
2. Chun, W. (2006) Core python programming. Prentice Hall Professional.
3. Embarak, O. (2018). Data Analysis and Visualization Using Python: Analyze Data to Create Visualizations for BI Systems. Apress.
4. Lambert, K. A. (2011). Fundamentals of Python: First Programs. Cengage Learning.
5. Wickham, H. & Grolemund, G. (2018). R for Data Science. O'Reilly: New York. Available for free at http://r4ds.had.co.nz

REFERENCES

1. Braun, W. J., & Murdoch, D. J. (2016). *A first course in statistical programming with R*. Cambridge University Press.

2. Everitt, B.S. and Hothorn T. (2010) A Handbook of Statistical Analysis Using R, Second
Edition, CRC Press.

3. Michael J. Crawley (2013) The R book, Second Edition, John Wiley & Sons Ltd.
4. Rubinstein, R.Y. (1981) Simulation and Monte Carlo Methods, Wiley.

5. Thereja, R. (2019). Python Programming Using Problem Solving Approach. Oxford University Press
6. Jackson, C. (2018). Learn Programming in Python with Cody Jackson, Packt Publishing
7. Balagurusamy, E. (2017). Introduction to Computing & Problem Solving using Python, McGraw Hill Education (India) Private Limited