M.Sc. Statistics

Course Title	**:**	**Probability Distributions**	**For 2nd Sem. (PG)**
Course Code	**:**	**STA551C**	
Credit hrs.	**:**	**5**	

Course Objective: The main objective is to introduce standard discrete and continuous distributions along with some generalized distributions and order statistics.

Course Outcomes: After completion of this course student will able to

1. Recognize basic discrete and continuous probability distributions and their properties.
2. Identify distributions of functions of random variables.
3. Understand the concept of Compound, truncated, mixture and sampling distributions.
4. Understand concept of order statistics and its applications
5. Have an idea of some generalized distributions.
6. Use various distributions for variety of real life situations.

Unit I

Discrete distributions: binomial, Poisson, multinomial, Geometric, hypergeometric, negative binomial, Logarithmic series distribution; properties and applications.

Unit II: Continuous Distributions: uniform, normal, exponential, gamma, Weibull, Pareto, beta, Burr, lognormal, Laplace, Cauchy distributions; properties and applications.

Unit III: Functions of random variables and their distributions using Jacobian of transformation and other tools. Concept of a sampling distribution. Sampling distributions of t, $\chi 2$ and F (both central and non-central), their properties and applications.

Unit IV Compound, truncated and mixture distributions. Convolutions of two distributions. Order statistics: their distributions and properties. Joint, marginal and conditional distribution of order statistics. The distribution of range and median. Extreme values and their asymptotic distribution (statement only) with applications.

Unit V Generalized Poisson, Generalized Negative Binomial, Generalized Geometric and Generalized Logarithmic Series Distributions, Generalized Power Series Distributions, Generalized exponential distributions, Bivariate normal and bivariate exponential distributions Logistic, Log-logistic. Rayleigh; properties and applications.

References:

- Rohatgi V.K & A.K. MD. Ehsanes Saleh (2001): An Introduction to Probability Theory and Statistics, 2nd. John Wiley and Sons.

- Rohatgi,V.K.(1990) : An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern Ltd.
- Johnson, N.L. and Kotz, S. (1969): Distributions in Statistics; Discrete distributions. John Wiley and Sons, New York.
- Hogg, R.V. and Craig ,A.T.(1989) : Introduction to Mathematical Statistics, Macmillan Publishing Company
- Johnson, N.L., Kotz, S. and Balakrishnan, N (1994): Continuous Univariate Distributions - 1, 2nd Edition John Wiley and Sons, New York.
- Johnson, N.L., Kotz, S. and Balakrishnan, N (1995): Continuous Univariate Distributions - 2, 2nd Edition , John Wiley and Sons, New York.
- Johnson, N.L., Kemp, A.W. and Kotz, S. (2005): Univariate Discrete Distributions , 3nd Edition , John Wiley and Sons, New York.
- Wackerly D.D; Mendenhall III, William and Scheaffer, R.L.: Mathematical Statistics with applicable Duxbury, 2002.
- Consul, P.C. and Famoye, F. (2006): Lagrangian Probability Distributions.

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Course Title	**:**	**Stochastic Models**	**For 2nd Sem. (PG)**
Course Code	**:**	**STA552C**	
Credit hrs.	**:**	**4**	

Course objective: The main objective of this course is to apprise the students about the existence of several stochastic processes in real life situations and to equip them with the techniques to study their statistical behavior as a sequence of dependent random variables.

Course Outcomes:

1. Describe the techniques of stochastic processes.
2. Apply the concepts and results of stochastic process in the real-life scenario, including competing risks, branching process, Renewal process, Wiener process etc.

Unit I: Definition and classification of a stochastic process. Finite and countable Markov chains with stationary transition probabilities, classification of states, communicating classes, Irreducibility, Stationary distribution and its interpretation, random walk and gambler's ruin problems. Computing n-step transition probability matrix. Absorption probability and mean time to absorption.

Unit II: Markov processes, Kolmogorov forward and backward equations, Poisson process, compound Poisson process, Cramér-Lundberg model, Markov pure jump processes, birth-death processes. Yule process. Renewal processes, renewal function. Elementary renewal theorem and its applications. Sickness and marriage models in terms of Markov processes.

Unit III: Maximum likelihood estimation of transition probabilities. MLEs of transition intensities, Testing the order of a Markov chain. Simulation of a Markov chain and MCMC method.

Unit IV: Galton -Watson branching processes. Generating functions and their properties. Offspring mean and probability of extinction. Introduction to Brownian motion process and its basic properties. Forward and backward equations, Applications to insurance problems.

References:

- Ross, S. (2005) Introduction to Probability Models,6/e, Academic Press.
- Bhat, B.R. (2000). Stochastic Models: Analysis and Applications, 2/e, New Age International, India.
- Medhi, Jyotiprasad (1994): Stochastic Processes, Wiley Eastern Limited, 2/e.
- Adke, S.R. and Manjunath S.M. (1985). Finite Markov Processes. Wiley Eastern (New Age Publishing)
- Taylor and Karlin (1984). An Introduction to Stochastic Modeling, Academic Press.

- Feller, W. (1972) An Introduction to Probability Theory and its Applications,Vol. 3/e Wiley Eastern Ltd.
- Karlin, S & Taylor, H. M. (1969) A First Course in Stochastic Processes 2/e. Academic Press
- Hoel, P. G. Port, S.C. & Stone, C. J. (1972) Introduction to Stochastic Processes Houghton Mifflin
- Kulkarni, Vidyadhar (1995): Modeling and Analysis of Stochastic systems, G. Thomson Science and Professional.

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Course Title	**:**	**Regression Theory & Linear Models**	**For 2nd Sem. (PG)**
Course Code	**:**	**STA553C**	**Credits : 5**
Credit hrs.	**:**	**4**	

Objective: The main purpose is to provide the theoretical foundations for the Linear Estimation Theory and Regression Analysis.

Course Outcomes:

Upon successful completion of this course, the student will be able to:

1. Employ a multiple linear regression model for real life data sets.
2. Perform statistical tests and construct statistical intervals in a multiple linear regression set up.
3. Validate regression model using different diagnostic procedures.
4. Estimate regression parameters in the presence of multicollinearity.
5. Opt appropriate link function for building regression model.

Unit I: Correlation Analysis - conceptual frame work. Methods of studying correlation-Scatter diagram, Karl Pearson's correlation coefficient, Spearman's rank correlation coefficient and concurrent deviation methods. Probable error (ungrouped data), coefficient of determination.

Unit II:. Simple regression model with one independent variable (X), assumptions, estimation of parameters using least squares theory, standard error of estimator, testing of hypothesis about parameters, coefficient of determination and its use to measure the goodness of fit of a linear regression model, prediction of response with confidence limits.

Unit III: Diagnostic checks for suitability and validity of a linear regression model, graphical techniques, tests for normality, un-correlatedness, lack of fit. Multiple regression model, standard Guass-Markov setup, least squares estimation

Unit IV: Fundamental concepts of Generalized Linear Model (GLM), exponential family of distributions, link functions such as Poisson, binomial, normal, exponential and Gamma, logistic regression

Unit V: Concepts of deviancy, estimation of parameters of a GLM, suitability of a model by using analysis of deviancy and by examining the significance of parameters, Pearson and deviancy residuals, statistical tests for acceptability of a fitted model; Pearson's chi square test and likelihood ratio test.

References:

1. Montgomery, Douglas C.; Peck, Elizabeth A.; Vining, G. Geoffrey: (2003); Introduction to Linear Regression Analysis.
2. McCullagh, P &Nelder, J. A. (1989) Generalized Linear Models (Chapman & Hall).

3. Draper, N. R. & Smith, H(1998) Applied Regression Analysis, 3rd Ed. (JohnWiley).
4. Ratkowsky, D.A. (1983) Nonlinear Regression Modelling (Marcel Dekker).
5. Hosmer, D.W. &Lemeshow, S. (1989) Applied Logistic Regression (John Wiley).
6. Seber, G.E.F. and Wild, C.J. (1989) Nonlinear Regression (Wiley)
7. Neter, J., Wasserman, W., Kutner,M.H. (1985) Applied Linear Statistical Models. (Richard D. Irwin).
8. Phillip Boland (2007). Statistical and Probabilistic Methods in Actuarial Science

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Course Title	**:**	Statistical Package	**For 2nd Sem. (PG)**
Course Code	**:**	STA591C	
Credit hrs.	**:**	3	

Objective: To learn the R and SPSS software for data analysis.

Course Outcomes:
After the completion of paper student will able to:

1. Use R as a calculator and as a helping tool for the analysis.
2. Apply R and SPSS software for effective data visualization.
3. Perform simulation using R Software.

Unit I: Introduction to R – R as a calculator, R data structures, help functions in R, assignment operator, vectors, operations on vectors. Setting working directories, importing different data formats (.csv, .xlsx, .sav) into R, sub-setting and writing output. Handling matrices, data frames and lists in R. Introduction to creating functions, calling functions, plots and graphics in R.

Unit II: Descriptive statistics in R, various summary statistics commands, correlation and regression. Apply family of functions in R- apply(), lapply(), sapply() and tapply(). Random data generation in R. Creating frequency tables, proportion tables and crosstabs for categorical variables.

Unit III: Introduction to SPSS-Variable view and data view. Working with data files, SPSS windows, menus, dialogue boxes. Preparing the data file: Creating data file and entering data, defining the variables, entering data, modifying data file and import file. Descriptive statistics: Categorical variables, continuous variables, checking normality, outliers checking. Running correlation, simple linear regression and multiple linear regression analysis. Conducting one sample and two independent sample t test, paired sample t test, one way analysis of variance in SPSS. Graphics and plots in SPSS.

Text Books and Reference Books:

1. Jones, O., Maillardet. R. and Robinson, A. (2014). Introduction to Scientific Programming and Simulation Using R. Chapman & Hall/CRC, The R Series.

2. Matloff, N. (2016). The art of R programming: A tour of statistical software design. No Starch Press

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Course Title : Practical **Semester-2nd**
Course Code : STA590C
Credit hrs. : 2

Objective:
The main objective is to enhance the practical knowledge of the students in the courses of Regression theory and Probability theory.

Course Outcomes:

1. Learning to perform different regression techniques using R.
2. Learning to perform fitting of probability models on real life data.

Practical's based on STA551C, STA553C and STA591C