M.Sc. Statistics

Course Title	**:**	**Probability and Statistics**	**Semester-2nd**
Course Code	**:**	**STA551C**	
Credit hrs.	**:**	**5**	

Course Objective: The main objective of this course is to provide students with the foundations of probabilistic models used in varied applications in engineering and other applied sciences like disease modeling, climate prediction and computer networks etc.

Unit I Discrete distributions: binomial, Poisson, multinomial, Geometric, hypergeometric, negative binomial, properties and applications.

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

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 The concept of estimation, estimator and estimate, unbiasedness and consistency. Families of distributions, sufficiency, factorization theorem, minimal sufficiency, completeness and bounded completeness. Location, scale, Pitman and exponential families. Statement of the theorem on complete sufficient statistic in k-parameter exponential family.

References:

- Bhat, B.R. (1999):Modern Probability Theory, 2/e., New Age International, New Delhi.
- Rao B. L. S. Prakasa (2009): A First course in Probability and Statistics. World Scientific
- Meyer, P.A. (1976). An Introduction to Probability and Its Applications. PHI
- John E Freund (2004): Mathematical Statistics with applications. 7/e, Upper saddle River, NJ: Prentice Hall. ISBN: 0131246461.
- Rohatgi V.K & A.K. MD. Ehsanes Saleh (2001): An Introduction to Probability Theory and Mathematical Statistics, 2nd. John Wiley and Sons.
- Wackerly D.D; Mendenhall III, William and Scheaffer, R.L.: Mathematical Statistics with applicable Duxbury, 2002.
- Hogg, R.V. and Craig, A.T.(1978): Introduction to Mathematical Statistics, 5/e, Pearsons Education.
- Dudewicz, E. J. and Mishra, S. N.(1988): Modern Mathematical Statistics, Wiley & Sons.
- Feller, W.(1968): Introduction to Probability and its Applications, Vol.1, Wiley Eastern.
- Gutt Alle (2010). Probability: A Graduate Course, Springer.

M.Sc. Statistics (Actuarial)

Course Title	**:**	**Stochastic Models**	**Semester-2nd**
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.

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.

M.Sc. Statistics (Actuarial)

Course Title	**:**	**Regression Theory and Linear Models**	**Semester-2nd**
Course Code	**:**	**STA553C**	
Credit hrs.	**:**	**5**	

Course Objective: The students will get familiar with the need of modeling random responses using independent predictors through linear and logistic (for binary responses) models in real life situations. Least square estimation of parameters of these models will be discussed along with their statistical significance.

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:

- Montgomery, Douglas C.; Peck, Elizabeth A.; Vining, G. Geoffrey: (2003); Introduction to Linear Regression Analysis.
- McCullagh, P & Nelder, J. A. (1989) Generalized Linear Models (Chapman & Hall).
- Draper, N. R. & Smith, H(1998) Applied Regression Analysis, 3rd Ed. (JohnWiley).
- Ratkowsky, D.A. (1983) Nonlinear Regression Modelling (Marcel Dekker).
- Hosmer, D.W. & Lemeshow, S. (1989) Applied Logistic Regression (John Wiley).
- Seber, G.E.F. and Wild, C.J. (1989) Nonlinear Regression (Wiley)
- Neter, J., Wasserman, W., Kutner,M.H. (1985) Applied Linear Statistical Models. (Richard D. Irwin).
- Montgomery, Douglas C.; Peck, Elizabeth A.; Vining, G. Geoffrey: (2003); Introduction to Linear Regression Analysis.
- Phillip Boland (2007). Statistical and Probabilistic Methods in Actuarial Science

M.Sc. Statistics (Actuarial)

Course Title	**:**	**Practical**	**Semester-2nd**
Course Code	**:**	**STA590C**	
Credit hrs.	**:**	**3**	

Course Objective: This course aims to provide a practical introduction to the R programming language and SPSS. By the end of the course, the user will be able to use R and SPSS for effective data analysis. The students will be able to handle practical issues in statistical computing which includes programming in R, reading data into R and SPSS, accessing R packages, writing R functions, debugging, organizing, commenting R code and visualizing data and conducting univariate/ multivariate statistical analysis using R and SPSS.

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.