M.Sc. Statistics
Program Syllabi

Note: Students have to choose elective subjects either STA605E and MTH601E or STA603E and STA604E.

Course Title	**:**	**Statistical Inference**	**Semester-3rd**
Course Code	**:**	**STA601C**	
Credit hrs.	**:**	**5**	

Course Objective:

This course aims to provide a basic and advanced understanding of many of the important foundational concepts in statistical inference. The student will get a strong mathematical and conceptual foundation in the methods of parametric estimation and their properties. The student will be comfortable in solving the statistical inference problems arising from various practical fields.

Unit I Rao-Blackwell and Lehmann-Scheffe theorems, Fisher information function. Cramer-Rao inequality. Uniformly Minimum Variance Unbiased (UMVU) Estimation. Fisher information matrix, illustration with one and two parameters. Method of Maximum Likelihood and Method of Minimum Chi-Square and Method of Moments. Confidence intervals.

Unit II Testing of hypotheses, null and alternative, simple and composite. Type I and Type II errors, Test function, size and power function. Concept of p-value. Review of standard one and two-sample significance tests. Most powerful tests, Neyman-Pearson lemma, MLR property, UMP tests.

Unit III Likelihood Ratio (LR) Test. Construction of LR tests for normal mean and variance, one and two sample problems. Asymptotic distribution of LR test statistic. Application to an r x c contingency table, Wald test and Rao's score test. Nonparametric tests: Mann-Whitney-Wilcoxon test, Wilcoxon signed-rank test, Sign test, test for quantile, Chi-square test of goodness of fit. Kolmogorov-Smirnov test. Wald-Wolfowitz run test. Test for randomness.

Unit IV Bayes paradigm. Prior and posterior distributions. Predictive distributions. Conjugate and non-informative priors. Construction of Bayes estimators relative to squared error, weighted squared error, absolute error and LINEX loss functions. Bayesian credible intervals. Minimax estimation.

References:

- Casella G, Berger R. L. (2001). Statistical Inference, 2/e, Cengage Learning Pvt. Ltd.
- Kale B.K. (2005). A First Course on Parametric Inference, (2nd Narosa Publishing House).
- Rohatgi V.K.and Ehsanes Saleh A.K.MD. (2003). An Introduction to Probability Theory and Mathematical Statistics, 2/e, Wiley Eastern.
- Dudewicz, E.J.and Mishra, S.N. (1988). Modern Mathematical Statistics, Wiley Sons
- Lehmann E.L . (1986). Theory of Point Estimation, (Student Edition).
- Lehmann, E.L. (1986). Testing Statistical Hypotheses, (Student Edition)
- Rao,C.R. (2002). Linear Statistical Inference and its Applications, 2/e, Wiley.
- J.K.Ghosh, D.Delampady and T. Samanta. (2006). Introduction to Bayesian Inference, Theory & Methods, Springer
- Berger, J. O. (1985): Statistical Decision: Theory and Bayesian Analysis, 2/e, Springer-Verlag.

M.Sc. Statistics (Actuarial)

Course Title	**:**	**Survival Analysis**	**Semester-3rd**
Course Code	**:**	**STA602C**	
Credit hrs.	**:**	**4**	

Course Objective: The course aims to focus on the basic concepts of survival (time-to-event) data analysis. Understanding and learning different types of censoring, estimating and interpreting survival characteristics, comparing survival rates in different groups, assessing the relationship of risk factors and survival times using the parametric and non-parametric models. Developing analytic skills through the analysis of data sets taken from the fields of medicine and public health.

Unit I: Survival function, hazard rate, cumulative hazard function, and mean residual life. Parametric models for study of event time data: Exponential, Weibull, extreme value, gamma, Pareto, logistic, log-logistic, normal, log–normal and mixture models -their survival characteristics. Longitudinal studies. Censoring mechanisms- type I, type II and left right and interval censoring. Likelihood function under censoring. Fitting parametric models to survival data with right censoring. Large sample tests with censored data. The E–M algorithm.

Unit II: Actuarial and Kaplan–Meier estimators. Treatment of ties. Self consistency property and asymptotic properties of K–M estimator (statement). Pointwise confidence interval for S(t). Nelson-Aalen estimator of cumulative hazard function and estimation of S(t) based on it. Two–sample methods. Comparison of survival functions: Log rank and Tarone-Ware tests. Competing risks model; Kaplan-Meier estimator of survival function, Nelson-Aalen estimator.

Unit III: Explanatory variables- factors and variates. Cox proportional hazards model. The partial likelihood and estimation of regression coefficients and their standard errors. Breslow's estimator of the baseline hazard function; estimation of cumulative hazard rate and S(t). Statement of asymptotic properties of the estimator. Confidence interval for regression coefficients. Wald, Rao and likelihood tests for β. Accelerated life model. Model selection criteria and comparison of nested models (-2logL and AIC). Using information on prognostic variables in a competing risks model.

Unit IV: Parametric regression-Weibull and Gompertz models. Residuals and model checking under Cox and parametric models. Comparing two survival curves. Hazard plots, Survival plots. Comparing alternative models, AIC criterion. Comparing observed and fitted survival models. Testing proportional hazards hypothesis in the Weibull model of cumulative incidence function.

References:

- Klien, J.P. and Moeschberger, M.L. (2003). Survival Analysis: Techniques for censored and Trun-cated Data. 2/e. Springer
- Kalbfleisch, J.D. and Prentice, R. L (2002), The Statistical Analysis of Failure Time Data, 2nd edition, J. Wiley, New York.
- Miller, J (1980), Survival Analysis, J. Wiley, New York.
- Elandt-Johnson, Regina C; Johnson, Norman L.(1999). Survival models and data analysis. Classics Library ed. – John Wiley & Sons.
- Macdonald A S, An Actuarial Survey of Statistical Models for Decrement and Transition Data, British Actuarial Journal 2 (1996), (Research paper)
- Klein, J.P (2003): Survival Analysis, Springer Verlag.

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Course Title	**:**	**Multivariate Analysis**	**Semester-3rd**
Course Code	**:**	**STA603C**	
Credit hrs.	**:**	**4**	

Course Objective: The course aims to provide knowledge within multivariate statistics: theory, calculation technique and applications. The course will also provide some deeper studies of the inference theory in multivariate analysis. The student will also get the understanding of the extensions of univariate techniques to multivariate frameworks and learn to apply dimension reduction techniques used in the data analysis.

UNIT-I: Introduction to Matrix Algebra, Multivariate Normal Distribution Theory: Marginal and conditional distribution, Joint distribution, Linear function of correlated normal variate. Characteristics function of multivariate normal distribution, Maximum likelihood estimation of the mean vector and co-variance matrix and their independence. Distribution of sample mean vector.

UNIT-II: Quadratic form and its distribution. Multiple linear equations, Multiple correlation, partial correlation in multiple setup. Partial and multiple correlation coefficients, their maximum likelihood estimators (MLE). Canonical Correlation and Canonical variables: Definition, uses, estimation and statistical inference. Distribution of characteristic roots and vectors: The distribution of canonical Correlation.

UNIT-III: Wishart matrix and its distribution. Some important properties of the Wishart distribution. Characteristic function of Wishart distribution, Hotelling's T^2statistic as a generalization of square of Student's statistic. Derivation of the generalized T^2 statistics and its distribution. Some important properties of T^2 statistics and its uses. Distance between two populations, Mahalnobis D^2 statistic and its relation with Hotelling's T^2 statistic.

UNIT-IV: Discrimination procedure for discrimination between two multivariate normal populations, Sample discriminant function, tests associated with discriminate function, Principal Component: Definition of principal components, uses, estimation and computation, Statistical inference on principal components. Factor Analysis: Definition of factor analysis and uses, linear factor models, estimation of factor loading, Factor rotation, estimation of factor scores.

TEXT BOOKS:

1. Alvin C. Rencher: Methods of Multivariate Analysis, 2nd Ed. John Wiely
2. Kshirsagar A. M. : Multivariate Analysis. Maral-Dekker.
3. Johnosn, R.A. and Wichern. D.W.:Applied multivariate Analysis. 5thAd.Prentice –Hall.
4. Anderson T. W.: An introduction to Multivariate statistical Analysis2nd Ed. John Wiely.
5. Morrison D.F.: Multivariate Statistical Methods McGraw-Hill.
6. Giri, N. C. (2014). Multivariate Statistical Inference. Academic Press.

M.Sc. Statistics (Actuarial)

Course Title	**:**	**Design of Experiments**	**Semester-3rd**
Course Code	**:**	**STA605E**	
Credit hrs.	**:**	**4**	

Course Objective: The aim of the course is to give knowledge in statistical experimental design in regards to designing and conducting experiments and analysis of data generated from experiments. Experiments that are given special focus in the course include single factor experiments, randomized blocks, Latin squares, factorial experiments (e.g. 2k factorial experiments), and analysis of variance. Different applications of experimental design and analysis of variance are given much focus in the course. The course provides a basis for further advanced studies and research studies in Statistics.

UNIT-I: Planning of experiment: Nomenclature, Introduction to basic designs and their analysis, Principles of Experimental design. Completely Randomized Design (CRD), Randomized Block Design (RBD), Latin Square Design (LSD), Missing plot techniques in RBD with one and two missing observations, Analysis of LSD with one missing observation.

UNIT-II: Introduction to Incomplete block design intra block analysis (estimability), estimates of estimable linear parametric function; Balanced Incomplete Block Design. Intra block analysis, recovery of inter block information;

UNIT-III: Analysis of covariance. Practical situations where analysis of covariance is applicable. Model for analysis of covariance in CRD and RBD. Estimation of parameters. Preparation of analysis of covariance (ANOCOVA) table, test for $\beta = 0$, test for equality of treatment effects (computational technique only). Numerical illustrations.

UNIT IV: General description of factorial experiments, factorial effects, analysis of factorial experiment (2^n,3^n), main and interaction effects, advantages and disadvantages, total and partial confounding, split plot experiment.

References:

1. Goon, Gupta, Dasgupta: Fundamental of Statistics, Vol. I and II, The World Press Pvt. Ltd. Kolkata.
2. Montgomery, D.C.: Design and Analysis of Experiments, Wiley Eastern Ltd., New Delhi.
3. Cochran, W.G. and Cox, G.M.: Experimental Design, John Wiley and Sons, Inc., New York.
4. Gupta, S.C. and Kapoor, V.K. : Fundamentals of Applied Statistics, S. Chand & Sons, New Delhi.
5. Das, M.N. and Giri, N.C. : Design and Analysis of Experiments, Wiley Eastern Ltd., New Delhi.
6. Joshi, D. D.: Linear estimation and design of experiment.
7. Dey, Alok: Theory of block designs, Wiley Eastern.
8. Angela Dean Daniel Voss (1999): Design and Analysis of Experiments, Springer.

M.Sc. Statistics (Actuarial)

Course Title : Real Analysis **Semester-3rd**
Course Code : MTH601E
Credit hrs. : 4

Course Objective: Introduces students the computational and algebraic techniques in real analysis with applications in day today applied fields.

Unit I: Real numbers, ordered sets; bounded sets**,** supremum and infimum, **o**rdered fields; completeness of the set of real numbers, Archimedean property, sequences and series, convergence Bolzano-Weistrass Theorem; Heine Borel Theorem

Unit II: Continuity, uniform continuity; differentiability, Mean Value Theorem, sequences and series of functions, uniform convergence, Riemann sums, Riemann Integral, Improper integral

Unit III: Algebra of complex numbers, the complex plane, power series, polynomials, transcendental functions, analytic functions, Cauchy-Riemann Equations,

Unit IV: Contour integrals, Cauchy's theorem and Cauchy's integral formula, Liouville's Theorem, Maximum Modulus Principle, Schwarz Lemma, `Taylor and Laurent series, calculus of residues

Text Books:

- Mathematical Analysis by Tom Apostol
- Principles of Mathematical Analysis by Walter Rudin
- An Introduction to Real Analysis by Bartle and Sherbert (Wiley & Sons).
- A Course in Real Analysis by Shanti Narayan
- Real Analysis by Terence Tao, Hindustan Book Agency (TRIM Series)
- Complex Analysis by Lars V. Ahlfors
- Functions of a Complex Variable by John B. Conway

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Course Title	**:**	**Financial Mathematics**	**Semester-3rd**
Course Code	**:**	STA603E	
Credit hrs.	**:**	**4**	

Course Objective: Introduces students the basic grounding in financial mathematics like simple interest, compound interest and their applications to calculate, accumulate value, present value, cash flows and loan calculation.

Unit I: Accumulation Function, Simple interest, compound interest, Generalized Cash- flow model, discounting. Nominal interest rates or discount rates in terms of different time periods. Force of interest.

Unit II: Definition of compound interest functions including annuities certain, Level payment annuities, Level payment perpetuities, Repayment mode, Non-level payment annuities and perpetuities: Geometric, Increasing and Decreasing, Continuous payment Cash flows.

Unit III: Inflations, arbitrage and hedging, the investment and risk characteristics of the different types of asset available for investment purposes. Variable interest rates, Investment and risk characteristics of various types of assets such as bonds, shares and other types of equity finance, options and derivatives.

Unit IV: Forwards and futures, hedging using futures, different types of futures, standardization, marking to market.

References:

- Hull, J. C., (2003): Derivatives Options & Futures, Pearson Education.
- Donald D.W.A. (1984): Compound Interest & Annuities Certain. Published for the Institute of Actuaries and the Faculty of Actuaries, London.
- Mark Suresh Joshi,(2009): The Concept and Practice of Mathematical Finance, Cambridge University Press.
- Dixit S. P., Modi C.S. and Joshi R.V. (2000): Mathematical Basis of Life Assurance, Insurance Institute of India, Bombay.
- Kellison, Stephen G(1991): The Theory of Interest, Homewood, IL: Richard D. Irwin, 2/e
- Luenberger (1976). Investment Science (Indian Edition), Oxford University Press

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Course Title	**:**	**Financial Reporting**	**Semester-3rd**
Course Code	**:**	STA604E	
Credit hrs.	**:**	**4**	

Course Objective: Introduces students the basic grounding in financial reporting like investment and asset management. It will also introduce students to corporate finance and capital project appraisal.

Unit-I: Investment and Asset management. Principles of finance, stakeholders in an organization, role and effects of capital markets, agency theory. Finances of joint stock, companies, types of companies, short, medium and long term financing of companies.

Unit-II. Principles of personal and corporate taxation, principles of double taxation relief. Financial instrument: stocks, loan, debentures, bonds and shares. Types of shares and share issues. Capital structure, its effect of valuation of a company. Distribution of profits: dividend policies.

Unit III: Depreciation and its purpose, straight line basis, reducing balance method, generating accounts, the trial balance, goodwill on consolidation

Unit-III: Company's cost of capital, interaction with investment project, Evaluation of projects and risky investments. Annual reports and accounts, Construction of accounts, types of accounts. Construction of balance sheets. Various accounting ratios.

Unit-IV: Subsidiary and associated companies. Interpretation of accounts of a company or a group of companies. Assessment of capital investment projects.

References:

- Chandra Prasana (2008).Financial Management, Theories and Practices
- Brealey, R.A., Meyers S.C. and Allen F. (2001). Principles of corporate Finance, 9th Edition, Mcgraw Hill Professional.
- Financial statement analysis in Europe. (1999): Samuels, J M; Brayshaw, R E; Craner, J M. - Chapman & Hall.
- Fundamentals of financial management.(2000): Brigham, Eugene F; Houston, Joel F., 9/e, Har-court Brace,
- How to read the financial pages (2003): Brett, M., 2/e, Random House Business Books, 430 pages.
- Interpreting Company Reports and Accounts. (2002): Holmes, Geoffrey; Sugden, Alan;Gee, Paul. - 8/e - Pearson Education
- Panday I. M (1978).Financial management