Syllabus
M.Sc. Statistics

Students with **B.Sc. Statistics** or studied at least one paper of Statistics at graduation level of **B.Sc. or B.Com. with advance statistics** are applicable for this course.

Semester - 1							
Paper no.	**Title of Paper**	**No. of Hrs. Per Week**	**Weightage For Internal Examination**	**Weightage For Semester end Examination**	**Total Marks**	**Duration of Semester end Exam in Hrs.**	**Course Credits**
MAS-101	Basics of Statistical Methods	4	30	70	100	3	4
MAS-102	Statistical Computing and Numerical Methods	4	30	70	100	3	4
MAS-103	Statistical Inference and Non – Parametric Test	4	30	70	100	3	4
MAS-104	Probability and Distribution Theory	4	30	70	100	3	4
MAS-105	Mathematical Statistics	4	30	70	100	3	4
MAS-106	Practical	12	-	100	100	5	4
Total		32	150	450	600	20	24

Semester - 2							
Paper no.	**Title of Paper**	**No. of Hrs. Per Week**	**Weightage For Internal Examination**	**Weightage For Semester end Examination**	**Total Marks**	**Duration of Semester end Exam in Hrs.**	**Course Credits**
MAS-201	Data Mining And Predictive Analysis	4	30	70	100	3	4
MAS-202	Planning and Analysis of Industrial Experiments	4	30	70	100	3	4
MAS-203	Statistical Modeling	4	30	70	100	3	4
MAS-204	Sampling Techniques	4	30	70	100	3	4
MAS-205	Base SAS Programming	4	30	70	100	3	4
MAS-206	Practical	12	-	100	100	5	4
Total		32	150	450	600	20	24

Semester - 3							
Paper no.	**Title of Paper**	**No. of Hrs. Per Week**	**Weightage For Internal Examination**	**Weightage For Semester end Examination**	**Total Marks**	**Duration of Semester end Exam in Hrs.**	**Course Credits**
MAS-301	Reliability and Survival Analysis	4	30	70	100	3	4
MAS-302	Analysis of Clinical Data	4	30	70	100	3	4
MAS-303	Optimizing Techniques	4	30	70	100	3	4
MAS-304	Stochastic Process	4	30	70	100	3	4
MAS-305	Applied Econometrics	4	30	70	100	3	4
MAS-306	Practical	12	-	100	100	5	4
Total		32	150	450	600	20	24

Semester – 4							
Paper no.	**Title of Paper**	**No. of Hrs. Per Week**	**Weightage For Internal Examination**	**Weightage For Semester end Examination**	**Total Marks**	**Duration of Semester end Exam in Hrs.**	**Course Credits**
MAS-401	Industrial Statistics	4	30	70	100	3	4
MAS-402	Applied Multivariate Analysis	4	30	70	100	3	4
MAS-403	Actuarial Statistics	4	30	70	100	3	4
MAS-404	Project & Viva	20	-	300	300	-	12
Total		32	150	450	600	20	24

SEMESTER -1

MAS – 101: BASICS OF STATISTICAL METHODS

1. Exploratory data analysis and Descriptive Statistics: Random Variables, Types of Variable and Data Types, Graphical Displays of Sample Data, Histograms, Box plot, Scatter plot, Bar chart, Measures of Centre Tendency, Measures of Dispersion, Moments, Skewness and Kurtosis.
2. Theory of Probability: Basic Ideas, Definitions and Properties. Conditional Probability and Independent Events, Bays Formula. Application of probability in Diagnostic: Sensitivity, Specificity, Predictive Power, ROC curves. Application of probability in Epidemiology: Odds Ratios, Relative Risk.
3. Classical Probability Distributions:
   Discrete Distributions: Bernoulli, Binomial, Poisson, Negative Binomial, Geometric, Hypergeometric, Multinomial Distribution.
   Continuous Distributions: Normal, Uniform, Gamma, Beta distribution of first kind, Beta distribution of second kind, Exponential, Weibul, Logistic, Cauchy, Central Limit Theorem.
4. Sampling Distributions: Chi-Square Distribution, t-distribution, F- distribution, and Z-distribution.
5. Statistical Inference and Hypothesis Testing: One sample tests, two sample tests, several sample tests. Applications: Case-Control Studies, Test of Association and Test of Homogeneity, Odds Ratios, Mantel-Haenszel Estimate.
6. Correlation and Regression: Karl Pearson's Coefficient of Correlation, Spearman's rank correlation coefficient, Linear Regression.
7. SPSS: Introduction to SPSS, Statistical analysis using SPSS

References

1. S. C. Gupta and V. K. Kapoor: Fundamentals of Mathematical Statistics.
2. Rohatgi, V. K. (1984). An introduction to probability theory and mathematical Statistics. New age International Publication.
3. B. L. Agarwal: Basic Statistics.
4. Kiran Pandya, Smruti Bulsari and Sanjay Sinha : SPSS in Simple Steps

MAS – 102: STATISTICAL COMPUTING AND NUMERICAL METHODS

1. Concept of random number generator, congruential method of generating uniform Variate. Concept of simulation: Generation of Binomial, Poisson, Geometric, Negative Binomial & Multinomial variate. Proofs of related results.
2. Generation of continuous random variables covering Exponential, Normal, Gamma, Chi-square, Bivariate exponential, Bivariate Normal distributions, and mixture of distributions.
3. Excel Introduction to MSEXCEL and exercises on using EXCEL for Statistical analysis covering frequency distribution, histograms, t-test, and test for Independence in 2x2 contingency tables.
4. R – Language. : Introduction to R, elementary programming, application to data analysis.
5. Solution to a nonlinear equation: Bisection method, Newton-Raphson method.
6. Iterative methods: Jacobi, Gauss-Seidel methods with convergence analysis.
7. Numerical Integration: integration by interpolation, adaptive quadratures and Gauss Methods.

References

1. Morgan B. J. T.(1984): Elements of Simulation. Chapman and Hall.
2. Kennedy William J.,Jr. James E. Gentle. (1980): Statistical Computing Marcel Dekker, Inc. New York and Basel.
3. Christion P. Robert, George Casella (1999): Monte Carlo Statistical Methods, Springer-Verlag, New York, Inc.
4. Luc Devroye (1986): Non- Uniform Random Variate Generation; Springer-Verlag New York Berlin-Heidelberg Tokyo.
5. Rubinstein, R. Y. (1998): Modern Simulation and Modeling (Wiley Series in Probability and Statistics).
6. K.E. Atkinson (1989): An Introduction to Numerical Analysis, Wiley, 1989.
7. K. Eriksson, D. Estep P. Hansbo and C. Johnson (1996): Computational Differential Equations, Cambridge Univ. Press, Cambridge.
8. G.H. Golub and J.M. Ortega (1992): Scientific Computing and Differential Equations: An Introduction to Numerical Methods, Academic Press.
9. J. Stoer and R. Bulirsch (1993): Introduction to Numerical Analysis, 2nd ed., Texts in Applied Mathematics, Vol. 12, Springer Verlag, New York.

MAS – 103: STATISTICAL INFERENCE AND NON PARAMETRIC TESTS

1. Viewed on unbiasedness, efficiency, consistency and sufficiency. Neyman Factorization theorem, minimal sufficient statistics.
2. Method of estimations: maximum likelihood method, method of moments, minimum Chi square method. Minimum variance unbiased estimators, Rao-Blackwell theorem. Completeness, Lehman – Scheffe's necessary and sufficient condition for MBUE, Cramer – Rao lower bound approach and Bhattacharya's system of lower bounds for a single parameter.
3. Rank test, locally most powerful rank test, linear rank statistics and their distributional properties under null hypothesis.
4. Statistical decision problem: Non randomized and randomized decision rules. Loss function, expected loss, risk function. Concept of admissibility, Bayes rule, admissibility of Bayes rules.
5. Minimax rules, least favorable distributions, complete class and minimal complete class. Decision problem for finite parameter space. Convex loss function. Bayes minimax estimators, illustrations.
6. Test of hypothesis: simple and composite hypothesis, two types of errors, critical regions, randomized tests, power function, and most powerful and most powerful tests. Neyman Pearson lemma, generalized Neyman Pearson lemma.
7. Unbiased tests: uniformly most powerful unbiased test, similar test, relation between UMP unbiased test and a UMP similar test, application to one parameter exponential family. Tests with Neyman structure. Inference on scale and location parameters: estimation and tests.
8. One sample location problem, sign test, signed rank test, two sample Kolmogorov – Smirnov tests. Two sample location and scale problems. Wilcoxon – mann – Whitney tests. Krusal – Wallis k sample tests.

Reference:

1. Kale, B.K. (1999). A first course on parametric inference. Narosa
2. Rohatgi, V. K. (1984). An introduction to probability theory and mathematical statistics. New age International Publication.
3. Rao, C. R. (1973). Linear Statsitical Inference and its applications, 2nd edition. John wiley and sons.
4. Furguson, T.S. (1967). Mathematical Statistics, Academic Press.
5. Zacks, S. (1989). Theory of Statistical Inference. John Wiley and sons.
6. Gibbons, J. D. (1985). Non parametric Statistical Inference, 2nd edition, Marcel Dekker.
7. Hajek, J. and Sidak, Z. (1967). Theory of rank tests. Academic press.
8. Fraser, D.A.S. (1957). Non parametric methods in Statistics. John wiley and sons

MAS – 104: PROBABILITY AND DISTRIBUTION THEORY

1. Introduction of Probability, Probability Spaces, random variables, expectations and moments, Minkowski inequality, Schwartz inequality, Jensen inequality, Markov inequality, Holder's inequality and Tchebyshev's inequality.
2. Law of large numbers: Weak law of large numbers, Strong law of large numbers for i. i. d. sequence, strong law of large numbers, Kolmogorov's strong law of large numbers. Borel 0-1 law, Bore l- Cantelli lemma, Kolmogorov 0 – 1 law.
3. Convergence in Probability, in distribution and in mean. Central limit theorem for a sequence of independent random variables under Lindberg's condition, Liapounov's CLT (only statement).
4. Brief review of basic distribution theory. Joint, Marginal and Conditional probability mass function (pmf) and probability density function (pdf) , Discrete and continuous distributions.
5. Function of random variables and their distributions using Jacobin of transformation and their tools, probability distribution of a random variables, properties of distribution functions, Characteristics functions and its properties, Inversion theorem, uniqueness theorem and Convolutions.
6. Power series distribution: its mean, variance, mgf, cgf, and recurrence relations. Various discrete distributions as its particular cases.
7. Sampling distributions: Non central chi square, t and f – distributions and their properties. Distributions of quadratic form under normality.
8. Order statistics: their distribution and properties, joint and marginal distributions of order statistics. Extreme values and their asymptotic distributions (Statement only) and its applications.

References:

1. Asb Robert. (1972). Real analysis and probability, Academic Press.
2. Billingsley, P. (1986). Probability and Measure Wiley .
3. Kingman J.F.C. and Taylo S. J. (1966). Introducton to measure and probability. Cambridge University Press).
4. Rohatgi, V. K. (1984). An introduction to probability theory and mathematical statistics. New age International Publication.
5. Rao, C. R. (1973). Linear Statsitical Inference and its applications, 2nd edition. John wiley and sons.
6. Johnson, S. and Kotz (1972). Distributions in Statistics. Vol I, II, III. Houghton and Maffin publication.
7. Cramer, H. (1946). Mathematical methods of Statistics. Princeton.

MAS – 105: MATHEMATICAL STATISTICS

1. Set of real numbers, countable and uncountable sets, countability of rationals and uncountability of the interval (0,1) Supremum and Infimum of bounded sets, limit point of a set, open, closed, dense and compact sets. Bolzano-Weierstrass and Heine-Borel Theorems (Statements only). Applications of these theorems.
2. Sequence of real numbers, convergence, divergence. Cauchy sequence. Convergence of bounded monotone sequence. Limit inferior and limit superior of the sequences.
3. Series of numbers, tests for convergence (without proof) test for absolute convergence, convergence of sequences of non-negative terms.
4. Vector space, subspace, linear dependence and independence, basis, dimension of a vector space, example of vector spaces.
5. Null space, Special types of matrices: elementary operations, rank of a matrix. Orthonormal basis and orthogonal projection of a vector. Gram-Schmidt orthogonalisation, Kroneckar product. Idempotent matrices, inverse of a matrix, their Simple properties, Partitioned Matrices, Orthogonal matrices.
6. Characteristic roots of a matrix, algebraic and geometric multiplicities, characteristic vectors and their orthogonal property. Caley-Hamilton Theorem and applications.

References:

1. Malik S. C. & Arora S.(1991) : Mathematical Analysis- Wiley Eastern Limited IInd edition.
2. Goldberg R. R. (1964): Methods of Real Analysis- Blaisdell Publishing company, New York, U.S.A.
3. Bartle G. R. (1976): Element of Real Analysis- Wiley 2nd edition.
4. Bartle G.R. & Sherbert D. R. (2000): Introduction to Real Analysis- John Wiley & Son Inc.
5. Royden (1988): Principles of Real Analysis - Macmillian.
6. Widder (1989): Advanced Calculus - Dover Publication.
7. Apostol (1985): Mathematical Analysis - Narosa Publishing House, T.M.
8. Rao A. R. & Bhimashankaram P. (1992) : Linear Algebra. Tata Mc-Graw Hill, New Delhi
9. Hadely G (1987): Linear Algebra - Narosa Publishing House.
10. Rao C. R. (1973): Linear Statistical Inference and Its Applications, Second Edition Wiley Eastern.
11. Searl S. B.(1982) : Matrix Algebra Useful for Statistics – Wiley.
12. Graybill , F.A (1961) : An introduction to linear Statistical models Vol-I- McGraw-Hill Book company Inc.

MAS-106 Practical

MAS-106 (a) Practical Based on MAS-101 & MAS-103

MAS-106(b) Practical Based on MAS-102

SEMESTER -2

MAS-201: DATA MINING AND PREDICTIVE ANALYTICS

1. An introduction to data mining and predictive analytics, data pre-processing, exploratory data analysis, dimension-reduction methods.
2. Statistical analysis: Univariate statistical analysis, Multivariate Statistics, preparing to model the data, simple linear regression, multiple regression and model building.
3. Classification: k-nearest neighbor algorithm, decision trees, neural networks, logistic regression, naive Bayes and Bayesian networks, model evaluation techniques, cost-benefit analysis using data-driven costs, graphical evaluation of classification models.
4. Clustering: hierarchical and k-means clustering, birch clustering, measuring cluster goodness.
5. Imputation of missing data.
6. case study: business understanding, data preparation and eda, clustering and principal components analysis, modeling and evaluation for performance and interpretability

References:

1. Daniel T. Larose, Chantal D. Larose (2015): Data Mining and Predictive Analytics, 2nd Edition.
2. Bruce Ratner (2011): Statistical and Machine-Learning Data Mining: Techniques for Better Predictive Modeling and Analysis of Big Data, Second Edition.
3. Bertrand Clarke, Ernest Fokoue, Hao Helen Zhang (2009): Principles and Theory for Data Mining and Machine Learning.
4. Trevor Hastie, Robert Tibshirani, Jerome Friedman (2009): The Elements of Statistical Learning: Data Mining, Inference, and Prediction, Second Edition.
5. Vijay Kotu(2015):Predictive Analytics and Data Mining.

MAS - 202: PLANNING AND ANALYSIS OF INDUSTRIAL EXPERIMENTS

1. A review of basic concepts of designs of experiment.
2. Factorial Experiments: Concepts of main effects, interaction, Analysis of Full 2^n and 3^n factorial designs, Analysis of single replicate of 2^n and 3- design.
3. Confounding: Total and partial confounding, construction and analysis of 2^n and 3^n confounded design.
4. Fractional replication for symmetric factorials, concept of aliasing, resolution and minimum aberration, construction of 2^{n-k} design, analysis of 2^{n-k} replicated and single replicate design.
5. Response surface experiments: linear and quadratic model, stationary point, central composition design.
6. Taguchi methods: Concept of loss function, S/N ratio. Linear graphs, inner and outer arrays, ANOVA.
7. Random effects model for one-way classification.

References:

1. Jeff Wu C.F., Hamada M. (2000): Experiments: Planning, Analysis and parameter design optimization, John Wiley & Sons.
2. Phadke M.S. (1989): Quality Engineering using Robust Design, Prentice-Hall.
3. Montgomery D.C. (2001): Design and Analysis of Experiments 5th edition, Wiley New York.

MAS - 203 STATISTICAL MODELING

1. Standard Gauss – Markov models: Estimability of parameters, Best linear unbiased estimator (BLUE), method of least square and Gauss – Markov theorem, Variance and Covariance of BLUE.
2. Fixed, Random and Mixed effect models, Analysis of variance of one way and two way classifications. Orthogonal and Non orthogonal data. Analysis of variance of Orthogonal and Non orthogonal data.
3. Introducing of one way random effects linear models and estimation of Variance components.
4. Maximum likelihood, MINQUE and restricted maximum likelihood estimators of variance components, best linear unbiased predicators(BLUP).
5. Bi-variate and multiple linear regression, polynomial regression, use of orthogonal polynomial. Linear and non-linear regression models.

References:

1. Cook, R.D. and Weisberg's (1982). Residual and influence in Regression. Chapman and Hall.
2. Draper, N.R. and Smith, H.(1998). Applied regression analysis, Third Ed. John Wiley.
3. Grust, R.F. and Mason, R.L.(1980). Regression analysis and its applications-A data oriented approach, Marcel and Dekkar.
4. Rao, C.R.(1973). Linear Statistical Inference and its application, new age international publication.
5. Rao, C.R. and Kleffe, J.(1988). Estimation of variance component and applications, North Holland.
6. Weisberg, S.(1985). Applied linear regression, Wiley, John
7. Searle, S.R. , Caselle, G. and Mccullocb, C.E. (1992). Variance components, Wiley John.
8. Seber, G. A. and Wild, G.J. (1989). Nonlinear regression, Wiley John.

MAS - 204: SAMPLING TECHNIQUES

1. Concept of population and sample, Need for Sampling, census & sample surveys, basic concepts in sampling and designing of large-scale surveys design, sampling scheme and sampling strategy. Basic methods of sample selection: SRSWR, SRSWOR.
2. Stratification, Allocation and estimation problems. Construction of Strata: deep stratification, method of collapsed strata.
3. Systematic sampling: The sample mean and its variance, comparison of systematic with random sampling, comparison of systematic sampling with stratified sampling, comparison of systematic with simple and stratified random sampling for certain specified population. Estimation of variance, Two stage sample: Equal first stage units, Two stage sample: Unequal first stage units; systematic sampling of second stage units.
4. PPSWR methods: Cumulative total method, Lahiri's method related estimation Problems and PPSWOR methods and related estimation of a finite population mean (Horwitz- Thompson and Des Raj estimators for a general sample size and Murthy's estimator for a sample of size 2), Midzuno sampling.
5. Use of supplementary information for estimation: ratio and regression estimators and Their properties. Unbiased and almost unbiased ratio type estimators, Double sampling.
6. Cluster sampling. Two – stage sampling with equal number of second stage units.

7. Non - sampling errors: Response and non- response errors. Hansen – Horwitz and Demig's techniques.

References:

1. Sukhatme P. V., Sukhatme S. & Ashok C : Sampling Theory of Surveys and Applications – Piyush publications
2. Des Raj and Chandhok. P. (1998): Sample Survey Theory - Narosa publication.
3. William G. Cochran. (1977): Sampling Techniques- IIIrd edition –John and Wiley sons Inc.
4. Parimal Mukhopadhyay (1998): Theory and Methods of Survey Sampling –Prentice Hall of India private limited.
5. Murthy M.N. (1977): Sampling Theory of Methods - Statistical Publishing Society, Calcutta.

MAS - 205 Base SAS Programming

1. Introd uction to SAS programs, running SAS Programs, diagnosing and correcting syntax errors. Producing List Reports using PRINT procedure; sequencing and grouping observations, using special WHERE statement operators; customizing report appearance – formatting data values, creating HTML reports. Programming with the DATA step – reading SAS data sets and creating variables, executing statement conditionally, dropping and keeping variables. Assigning and Changing variable attributes, Combining merging and SAS Data Sets Producing Summary Reports using REPORT procedure.
2. Using SAS Enterprise Guide: naming a project, working with existing code, diagnosing and correcting errors, creating SAS programs, accessing data sources with the LIBNAME statement, understanding Output Delivery System (ODS). Using Graphics in SAS Enterprise Guide. Controlling Input and Output – controlling when a record loads, reading hierarchical raw data files; outputting multiple observation, selecting variables and observations, writing to multiple SAS data sets, writing to external files. Processing Data iteratively using DO loop, SAS array processing.
3. Using SQL with SAS: Understanding the purpose, design, uses, and terminology of SQL; Basic Queries, using SQL procedure, summarizing data with column and row functions, grouping data, performing analyses on groups of data, subquerying, and remerging, ordering data, customizing query output. Combining Tables – querying multiple tables using joins, using union, intersect, and other set operators to combine tables. Creating and Modifying Tables and Views, using views to simplify queries and access changing data, creating and using indexes; maintaining tables, views, and indexes.
4. Introduction to the Macro Facility – purpose of the macro facility, program flow. Macro Variables and macro functions; defining and calling macros, macro parameters.
5. Data Step and SQL Interfaces – creating macro variables in the DATA step, indirect references to macro variable, retrieving macro variable in the DATA step, creating macro variables in SQL.

Reference:

1. Cody R, Smith J. 'Applied Statistics & the SAS Programming Language'. Prentice hall 1997. 4th Edition.
2. N. Jyoti Bass, K. Madhavi Lata. "Base SAS Programming".

3. Geoff Der, Brian Everitt – 2007 Basic Statistics Using SAS Enterprise Guide: A Primer
4. Sandra D. Schlotzhauer – 2015 Elementary Statistics Using SAS
5. James B. Davis, Statistics Using SAS, SAS Institute.
6. Larry Hatcher – 2003, Step by Step Basic Statistics Using SAS: Student Guide
7. Bruce R. Lewis, Richard K. Ford – 1987, Basic Statistics Using SAS
8. Lora D. Delwiche, Susan J. Slaughter – 2012, The Little SAS Book: A Primer, Fifth Edition

MAS - 206 PRACTICAL

MAS-206 (a) Practical based on MAS-202

MAS-206 (b) Practical based on MAS-205

SEMESTER-3

MAS - 301 REALIBILITY AND SURVIVAL ANALYSIS

1. Structure function, dual of a structure, cuts and paths, Modular decomposition, Bounds on system reliability. Associated random variables. Reliability concepts and measures, components & systems, coherent systems, reliability of coherent systems.
2. Life time distributions, survival functions, hazard rate, cumulative hazard function, residual life time, survival function of residual life time, mean residual life time, one one correspondence of these functions. Computation of these function for Common life time distributions: exponential Weibull, Gamma, Makeham, Pareto, Rayleigh, log-normal etc: computation of survival and failure rate function proportional hazard models and proportional hazard model.
3. Notions of aging: IFR, IFRA, DMRL, NBU, NBUE classes and their duals, aging properties of common life time distributions, closure Properties under formation of coherent structures, convolutions and mixtures of these classes.
4. Concept of censoring, various types of censoring, Estimation and Testing of parameters of exponential distribution under various types of censoring.
5. Estimation of survival function: Actuarial Estimator, Kaplan Meir product limit estimator, properties: self-consistency and MLE.
6. Tests for exponentiality against alternatives IFRA, NBU and NBUE.
7. Two-sample problem: Gehen test, Log rank test, Mantel Haenszel test.
8. Semi parametric regression for failure rate – Cox's proportional hazards model. Related estimation and test procedures.

References:

1. Barlow R.E. and Proschan F. (1975): Statistical Theory of Relibilty & Life Testing, Holt, Reinhart and Winston.
2. Lawless J.F.(1982) : Statistical Models & Methods of Life Time Data, John Wiley.
3. Miller R.C. (1981) : Survival Analysis. John Wiley
4. Bain L.J (1978) : Statistical Analysis of Reliability & Life testing , Models, Marcel Dekker.
5. Martz H.F. and Waller R.A (1982): Bayesian Reliability Analysis, John Wiley.
6. Nelson W. (1982): Applied Life Data Analysis, Jhon Wiley and Sons Inc.
7. Deshpande, Purohit: Life time data: statistical models and methods, World Scientific, 2005.

MAS – 302 ANALYSIS OF CLINICAL DATA

1. Introduction to clinical trials and other types of clinical research, bias and random error in clinical studies, overview of Phase I-IV trials, multi-center trials; randomized, controlled clinical trials; concept of blinding/masking in clinical trials.
2. Design of Phase 1-3 clinical trials: parallel vs. cross-over designs, cross-sectional vs. longitudinal designs, review of factorial designs, objectives and endpoints of clinical trials, formulation of appropriate hypotheses (equivalence, non-inferiority, etc.); sample size calculation; design for bioequivalence/ bioavailability trials, sequential stopping in clinical trials.
3. Analysis of Phase 1-3 trials: Use of generalized linear models; analysis of categorical outcomes, Bayesian and non-parametric methods; analysis of survival data from clinical trials
4. Epidemiological studies: case-control and cohort designs; odds ratio and relative risk; logistic and multiple regression models.

References:

1. S.C. Chow and J.P. Liu (1998): Design and Analysis of Clinical Trials - Concepts & Methodologies, John Wiley & Sons, NY.
2. S.C. Chow and J.P. Liu (2000): Design and Analysis of Bioavailability & Bioequivalence Studies, Marcel Dekker.
3. W.W. Daniel, Biostatistics (2002): A Foundation for Analysis in the Health Sciences (6th ed.), John Wiley, NewYork.
4. J.L. Fleiss (1986): The Design and Analysis of Clinical Experiments, John Wiley & Sons.
5. D.W. Hosmer and S. Lemeshow (1989): Applied Logistic Regression, John Wiley and Sons, NY.
6. E. Vittinghoff, D.V. Glidden, S.C. Shiboski and C.E. McCulloch (2005): Regression Methods in Biostatistics, Springer Verlag.
7. J.G. Ibrahim, M-H Chen and D. Sinha (2001): Bayesian survival analysis, Springer, NY.

MAS - 303: OPTIMIZATION TECHNIQUES

1. Linear programming problem (LPP): Theorems related to the development of Simplex algorithm, Proof of the theorems related to a basic feasible solution (b.f.s); Reduction of a feasible solution to a basic feasible solution, Improvement of a basic feasible solution, Existence of unbounded solution, Optimality conditions. For other related theorems, statements only.
2. Artificial variable technique; two phase and Big M method, the case of redundancy. Revised simplex method.
3. Concept of Duality, theorems related to duality, complementary slackness property and development of dual simplex algorithm.
4. Sensitivity Analysis: Changes in the cost vector, requirement vector and non basic activity vector; addition of new variables and addition of new constraints.
5. Theory of games: two person zero sum games, minimax and maximin principles, Saddle point, mixed strategies; rules of dominance, solution of 2 x 2 game by algebraic method, 13 Graphical method, Reduction of the game problem as LPP, Minimax and maximin theorem (without proof).

6. Integer Linear Programming Problem (ILPP): The concept of cutting plane, Gomory's method of cutting plane for all ILPP and mixed ILLP, Branch and Bound method.
7. Quadratic programming: Kuhn-Tucker conditions of optimality, methods due to Beale, Wofle.

References:

1. Hadley G.(1969): Linear Programming ,Addison Wesley
2. Taha H. A. (1971): Operation Research An Introduction- Macmillan N.Y.
3. Kanti Swaroop & Gupta M. M. (1985): Operations Research, Sultan Chand & Co.
4. J. K. Sharma (2003): Operation Research theory and Applications, IInd Edition Macmillan India ltd.

MAS - 304: STOCHASTIC PROCESSES.

1. Definition of stochastic process, classification of stochastic processes according to state space and time domain. Finite dimensional distributions. Examples of various stochastic processes.
2. Definition of Markov chain. Examples of Markov chains, Formulation of Markov chain models initial distribution transition probability matrix, Chapman-Kolmogorov equation calculation of n-step transition probabilities.
3. Classification of states, irreducible Markov chain, period of the state, random walk & gambler's ruin problem. First Entrance Theorem, First passage time distribution.
4. Long-run distributions of Markov chain, relation with mean recurrence time, stationary distribution.
5. Discrete state space continuous time Markov chain. Poisson process & related results. Birth and death processes and associated cases. M/M/1, M/M/S queuing models and related properties.
6. Renewal and delayed renewal processes, related theorems, key renewal theorem (without proof) and its application.
7. Galton-Watson Binaymi Branching process. Probability of ultimate extinction. Distribution of population size, and association results.
8. Simulation of Markov Chain, Poisson process and branching process. (Algorithms)

References

1. Medhi J. (1982): Stochastic Process, Wiley Eastern.
2. Parzen E. (1962): Stochastic Process, Holden-Pay.
3. Karlin & Taylor: A First Course in Stochastic Process, Vol. -1, Academic Press.
4. Cinlar E.: Introduction to Stochastic Process, Prentice Hall.
5. Srinivas and Mehta (1976): Stochastic Processes, TATA McGraw -Hill, Publishing Conpany limited New Delhi.

MAS - 305 APPLIED ECONOMETRICS

1. Nature of econometrics: the general model (GLM) and its existence. Ordinary least square (OLS) estimation and prediction. Use of dummy variables. Generalized least square (GLS) estimation and prediction. Heteroscedastic disturbance.
2. Auto correlation, its consequences and tests. Their BLUE procedure. Estimation and prediction. Multi co linearity problem, its implication and tools for handling the problem. Ridge regression.
3. Linear regression and stochastic regression. Instrumental variable equation, error in variables. Auto regressive linear regression. Distributed Lag models.

4. Simultaneous linear equations model. Examples Identification problem. Restriction on structural parameter rank and order condition.
5. Estimation on simultaneously equation model, 2 SLS estimators, limited information estimator, 3 SLS estimation, full information maximum likelihood method. Monte Carlo studies and simulation.

Reference:

1. Apte, P.G. (1990). Text book of econometrics. Tata McGraw hill.
2. Gujarathi, D. (1979). Basic Econometrics, Tata McGraw hill.
3. Klein, L.R. (1962). An introduction to Econometrics, prentice hall of India.
4. Thiel, H. (1982). Introduction to the theory and practice of Econometrics, John Wiley.
5. Johnston, J. (1984). Econometric methods, 3rd edition, Tata McGraw hill.

MAS - 306 PRACTICAL

MAS-306 (a) Practical based on MAS-301 & MAS-302

MAS-306 (b) Practical based on MAS-305

SEMESTER-4

MAS - 401: INDUSTRIAL STATISTICS

1. Basic concept of quality control, process control and product control, seven SPC tools Flowchart. Histogram, Check sheet. Ishikawa diagram, Pareto chart, Defect concentration diagram, control chart. Deming's PDCA cycle for continuous improvements and its applications.
2. Control charts for measurements and attributes *x*, R, S, p, np. Charts with subgrouping, CUSUM chart, tabular form and V-mask use of these charts for process control. Moving average and exponentially weighted moving average charts.
3. Process capability Cp, Cpk and Cpm . Determining process capability with *x* chart. Estimation of process capability.
4. Sampling Inspection plans: for attribute inspection: Single, double & sequential sampling plans and their properties. Dodge & Roming characterization by OC curve and ARL-Inspection by variables for one or two sided specifications.
5. Multivariate control charts for measurements data. Hotelling T2 control charts.
6. Introduction to Six-Sigma Methodology. DMAIC cycle & case studies.
7. Simulation of X -bar and R control charts, estimation of ARL and process capability indices.

References:

1. Guenther W.C (1981): Sampling Inspection in Statistical Quality Control Charter Grifits.
2. Montgomery D.C. (1996): Introduction to Statistical Quality Control, John Wiley & Sons Inc.
3. Kotz S. (1993): Process capability indices. Chapman and Hall.
4. Abraham Bovas (1998) Quality Improvement through statistical methods. Birkhauser.

MAS - 402: APPLIED MULTIVARIATE ANALYSIS

1. Multivariate normal distribution, two definitions and their equivalence, singular and nonsingular normal distribution, characteristic function, moments, marginal and conditional distributions.
2. Maximum likelihood estimators of the parameters of the multivariate normal distribution and their sampling distributions.
3. Wishart matrix and its distribution of properties of Wishart distribution, distribution of generalized variance.
4. Hotelling's T2 Statistic and its distribution. Applications of T2 statistics and its relationship with Mahalanobis' D2 statistic. Confidence region for the mean vector.
5. Discrimination and classification. Fisher's discriminant function and likelihood ratio procedure, minimum ECM rule, Rao's U statistics and its use in tests associated with discriminant function, classification with three populations.
6. Principal components. Dimension reductions, Canonical Correlation and canonical variables.
7. Introduction to factor analysis, Cluster analysis, Heirarchical and non-Heirarchical clustering. Single, complete, average linkage method and K-means clustering.

Reference:

1. Kshirsagar A. M.(1972): Multivariate Analysis. Marcel-Dekker.
2. Johnosn, R.A. and Wichern . D.W (2002): Applied multivariate Analysis. 5th Ad. Prentice Hall.
3. Anderson T. W. (1984): An introduction to Multivariate statistical Analysis 2nd Ed. John Wiley.
4. Morrison D.F. (1976): Multivariate Statistical Methods McGraw-Hill.

MAS - 403 ACTURIAL STATISTICS

1. Basic concepts and Life Tables: Utility theory, insurance and utility theory, models for individual claims and their sums, survival function, curtate future lifetime, force of mortality. Life table and its relation with survival function, examples, assumptions for fractional ages, some analytical laws of mortality, select and ultimate tables. Multiple life functions, joint life and last survivor status, insurance and annuity benefits through multiple life functions evaluation for special mortality laws.
2. Probability Models: Multiple decrement models, deterministic and random survivorship groups, associated single decrement tables, central rates of multiple decrement, net single premiums and their numerical evaluations.
3. Distribution of aggregate claims, compound Poisson distribution and its applications. Distribution of aggregate claims, compound Poisson distribution and its applications.
4. Principles of compound interest: Nominal and effective rates of interest and discount, force of interest and discount, compound interest, accumulation factor, continuous compounding.
5. Life insurance: Insurance payable at the moment's of death and at the end of the year of death-level benefit insurance, endowment insurance, differed insurance and varying benefit insurance, recursions, commutation functions.
6. Life annuities: Single payment, continuous life annuities, discrete life annuities, life annuities with monthly payments, commutation functions, varying annuities, recursions, complete annuities-immediate and apportion able annuities-due.
7. Net premiums: Continuous and discrete premiums, true monthly payment premiums, apportion able premiums, commutation functions, and accumulation type benefits.

Payment premiums, apportion able premiums, commutation functions accumulation type benefits.

8. Net premium reserves: Continuous and discrete net premium reserve, reserves on a semi continuous basis, reserves based on true monthly premiums, reserves on an apportion able or discounted continuous basis, reserves at fractional durations, allocations of loss to policy years, recursive formulas and differential equations for reserves, commutation functions.

References:

1. Actuarial Mathematics', Society of Actuaries, Itasca, IIIinois, U. S. A. Second Edition (1997)
2. Spurgeon E. T. (1972): Life Contingencies, Cambridge University Press.
3. Neill, A.: Life Contingencies, Heinemann

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