Swami Ramanand Teerth Marathwada University, Nanded
School of Mathematical Sciences

Two Year M. A. / M. Sc. Degree Program in Statistics

Revised Syllabi of M. A. / M. Sc. in Statistics

(Choice Based Credit System)

(To be implemented in the Department of Statistics, Swami Ramanand Teerth Marathwada University, Nanded)

(With effect from Academic Year 2015-2016)

Structure of the course: M.A./M.Sc. (Statistics)-Third Semester (CBCS Pattern)

SEMESTER-III								
Sr. No.	**Course**	**Course Title**	**Theory/ Practical Paper**	**No. of Credits**	**Marks@ 25/Credit**	**Internal Component (50%)**	**Semester End Component (50%)**	**Grand Total**
STT 11	Core XI	Industrial Statistics	**L/T**	**4**	**100**	**50**	**50**	**100**
STT 12	Core XII	Operations Research-I	**L/T**	**4**	**100**	**50**	**50**	**100**
STT 13	Core XIII	Design of Experiments	**L/T**	**4**	**100**	**50**	**50**	**100**
STT 14	Core XIV	Testing of hypotheses	**L/T**	**4**	**100**	**50**	**50**	**100**
STT 15 (A)/(B)	Elective Group I	Time Series Analysis/ Decision Theory	**L/T**	**4**	**100**	**50**	**50**	**100**
STP 05	Core Practical III	Practical-V (based on STT 11, STT 12 and STT 14)	**P**	**2**	**50**	**--**	**50**	**50**
STP 06	Core Practical IV	Practical-VI (based on STT 13 and Elective) STT 15(A) OR STT 15(B))	**P**	**2**	**50**	**--**	**50**	**50**
		Total						**600**

List of Core/ Elective Subjects to be offered

Core Subjects

1. Industrial Statistics
2. Operations Research-I
3. Design of Experiments
4. Testing of hypotheses
5. Practical-V (based on STT 11, STT 12 and STT 14)
6. Practical-VI (based on STT 13 and Elective STT 15(A) OR STT 15(B))

Elective Subjects (Only Four)

Elective Group I (Any one for Third Semester)

1. Time Series Analysis
2. Decision Theory

NOTE:

1) Third semester will have five theory papers and assessment for each theory paper will be of 100 Marks (50External Exam+ 50 Internal Exam[02 tests each of 15 Marks+10 Marks for assignment+ 10 Marks for Class Performance)).
2) Core practical V and VI carry 50 marks each.
3) (i)Project carrying 100 marks which is to be given at the beginning of sem-III and evaluated at the end of sem-IV.
   (ii) Project batch is of minimum 02 and maximum 04 students.
4) In STT-12 paper i.e. Operations Research-II -TORA software and Solver tool pack will be used for practical purpose.
5) One credit is of 25 marks.

Structure of the course: M.A. / M.Sc. (Statistics)-Third Semester (CBCS Pattern)

SEMESTER-III	
Paper No.	Name of the paper
STT 11	Industrial Statistics
STT 12	Operations Research-I
STT 13	Design and Analysis of Experiment
STT 14	Testing of hypotheses
STT 15 (A)/ (B)	Time Series Analysis/ Decision Theory
STP 05	Practical-V (based on STT 11, STT 12 and STT 14)
STP 06	Practical-VI(based on STT 13 and STT 15)

STT 11 INDUSTRIAL STATISTICS

(Maximum no. of periods = 60)

Unit I: Basic concepts of process monitoring and control. Review of control charts for attributes and variable data. O. C. and ARL of control charts. Cusum & V-masks charts. **(12L+3T)**

Unit II: Concepts of AQL ,LTPD, AOQL average amount of inspection and ASN functions. Acceptance sampling plans for attributes inspection, single, double and sequential sampling plans and their properties. Continuous sampling plans of Dodge type and their properties. **(12L+3T)**

Unit III: Capability indices Cp, C_{pk} and C_{pm}, estimation, confidence intervals and tests of hypothesis relating to capability indices for normally distributed characteristics. **(12L+3T)**

Unit IV: The weighted control charts: Exponential Weighted Moving Average chart. Multivariate SPC: Multivariate quality control problem, description of Multivariate data, The Hotelling T^2 control chart, Multivariate EWMA control chart, regression adjustment, Latent structure methods. Quality Systems: ISO 9000 standards, QS 9000 standards, concept of six sigma. Total Quality management. Taguchi Design. **(12L+3T)**

REFERENCES:

(1) Montgomery D.C. (1996) Introduction to Statistical Quality Control, Wiley.
(2) Wetherill G.B. (1977) Sampling Inspection & Quality Control, Halsted Press.
(3) Logothetis N. (1992) Managing Total Quality, Prentice Hall of India.
(4) Oakland J.S. (1989) Total Quality Management; Butterworth- Heinemann.
(5) Mittog H.J. and Rinne H. (1993) Statistical Methods of Quality Assurance.
(6) Guenther W.C (1981) Sampling Inspection in Statistical Quality Control Charter Grifits.
(7) Kotz S. (1993) Process capability indices, Chapman and Hall.
(8) Abraham Bovas (1998) Quality Improvement through statistical methods
(9) Birkhauser.
(10) Barlow R.E. And Proschan F. (1985) Statistical Theory of methods reliability and Life Testing ,Holt Rinehart and Winston.
(11) Lawless J.F. (1982) Statistical Models and methods of life Time Data, John Wiley.
(12) Bain L.J. And Engelhard (1991) Statistical Analysis of Reliability and Life Testing models Marcel Dekker.
(13) Nelson W. (1982) Applied Life Data Analysis, John Wiley.
(14) Zacks S. (1992) Introduction to reliability analysis Probability Models and statistical Methods, Springer-verlag.
(15) Mahajan M. (2004) Statistical Quality Control.

STT 12 OPERATIONS RESEARCH-I

(Maximum Number of Periods: 60)

UNIT I: Operations research & its scope, Necessity of operations research in industry, Introductions to Linear programming problems, General linear programming problems , Mathematical Formulation of L.P.P., Basic solution, Important theorems, solution of linear programming problem, Graphical method for solution, convex set , some important theorems, Revised simplex method, dual simplex method. **(12L+3T)**

UNIT II: Theory of Simplex methods: Introduction, slack and surplus variables, some definitions and notations, Fundamental theorems of linear programming, BSF from F.S., Improved B.S.F. Unbounded solution, optimality of solutions. **(12L+3T)**

UNIT III: computational procedure of simplex method for the solution of a maximization L.P.P., artificial variable technique, duality and sensitivity analysis. **(12L+3T)**

UNIT IV: Introduction, competitive game, finite and infinite game, two person zero sum game, rectangular game , solution of game, saddle point, solution of a rectangular game with saddle point. PERT-CPM, product planning control with PERT-CPM. **(12L+3T)**

REFERENCES:

1) R. K. Gupta "Linear Programming",Krishna Prakashan Mandir.
2) F.S.Hillier and G.J.Liebermann,(1995) Introduction to Operations Research (6th Ed.) Mc Graw Hill.
3) Kantiswaroop, P.K.Gupta and Manmohan, Operations Research, Sultan Chand & Sons, New Delhi.
4) G.Hadley, Linear Programming, Narosa publishing House, 1995.
5) G.Hadley, Nonlinear and Dynamic Programming, Addison-Wesley, Reading Mass.
6) H.A.Taha, Operations Research - An Introduction, Macmillan Publishing Company, Inc, New York.
7) S.S.Rao, Optimization Theory and Applications, Wiley Eastern Ltd., New Delhi.
8) P. K. Gupta and D. S. Hira, Operations Research – A Introduction. S. Chand & company Ltd, New Delhi.
9) N. S. Kambo, Mathematical Programming Techniques. Affiliated East-West Press Pvt. Ltd, New Delhi.

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STT 13 DESIGN OF ANALYSIS AND EXPERIMENTS

(Maximum no. of periods = 60)

UNIT I: General Linear Model: Definition, assumption, concept of estimability, Least square estimation, Best Linear Unbiased Estimator (BLUE). Error space, Gauss- Markov theorem, Estimation of error Variances. **(12L+3T)**

UNIT II: Basic designs–CRD, RBD, LSD and their analyses, Missing plot techniques in RBD and LSD. Tests for comparing pairs of treatment means: Tukey's test, Fishers LSD test, Duncan's Multiple Range Test (DMRT), Newman- Keul's test, Dunnet test. ANCOVA: One way and Two way classification. Definition and analysis of split plot design, split-split plot design and Strip plot design. **(12L+3T)**

Unit III: General factorial experiments, factorial effects, study of 2^2, 2^3 , 2^4 and 2^k factorial experiments. Study of 3^2, 3^3 designs : Contrasts for linear and quadratic effects, statistical analysis of 3^k design. **(12L+3T)**

Unit IV: Fractional factorial experiments. Resolution III, IV and V of a design aberration of a design. Confounding in factorial experiments, complete and partial confounding, concept of generalized interaction. Elementary parametric relations and analysis of BIBD. Definitions and parametric relations of PBIBD. Definition and analysis of Quasi-Latin square designs, Youden square design. Cross-over designs. **(12L+3T)**

REFERENCES:

(1) Alok Dey (1986) Theory of Block Designs, Wiley Eastern.
(2) Das, M.N. and Giri, N. (1979) Design and Analysis of Experiments, Wiley.
(3) Joshi, D. D. (1987) Linear Estimation and Design of Experiments, John Wiley.
(4) Montgomery, D.C. (2005) Design & Analysis of Experiments, Wiley.
(5)Chakrabarti M. C. (1962) Mathematics of Design and Analysis of Experiments, Asia Pub. Hs.
(6) Cochran W.G. & Cox D.R.(1957) Experimental Designs, 2nd Ed., JohnWiley.
(7) Dean A. M. & Voss D. (1999) Design and Analysis of Experiments, Springer.
(8) Dey A. & Mukerjee R. (1999) Fractional Factorial Plans, John Wiley.
(9) Dey A. (1986) Theory of Block Designs, Wiley Eastern.
(10)John J.A. & Quenouille M.H. (1977) Experiments: Design and Analysis, Charles & Griffin.
(11) Kempthorne, O. (1976) Design and Analysis of Experiments, John Wiley.

(12) Khuri A.I. & Cornell J.A. (1996) Response Surface Designs and Analysis. 2nd Ed.,Marcel Dekker.
(13) Raghavarao D. (1971) Construction and Combinatorial Problems in Design of Experiments, John Wiley.

STT 14 TESTING OF HYPOTHESES

(Maximum no of periods: 60)

UNIT I: Problem of testing of hypothesis: Simple and Composite hypotheses. Randomized and non-randomized tests. Most powerful test, Neyman-Pearson Lemma and its applications. Determination of minimum sample size to achieve the desired strengths. **(12L+3T)**

UNIT II:Composite hypotheses: Monotone likelihood ratio (MLR) property, power function of a test, existence of UMP tests for one-sided alternatives. UMP tests for two sided alternatives, their existence and non-existence. Examples. **(12L+3T)**

UNIT III: Generalized Neyman Pearson Lemma: Unbiased test, UMPU tests and their existence in the case of exponential families. (statements of the theorems only), Similar tests, test with Neyman structure. **(12L+3T)**

UNIT IV: Problem of confidence intervals, relation with testing of hypotheses problem, UMA and UMAU confidence intervals, shortest length confidence intervals. Likelihood ratio test, Application to standard distributions. Goodness of fit test based on Chi-square distribution, application to contingency tables. **(12L+3T)**

Reference Books:

1. Kale B.K. (1999): A first Course on Parametric Inference-Narosa
2. Rohatgi V.K.(1988): Introduction to Probability and Mathematical Statistics, Wiley Eastern Ltd. New Delhi. Student Edition.
3. Dudewicz E.J. & Mishra S.N.(1988): Modern Mathematical Statistics, Wiley Series
4. Lehman E.L. (1987): Theory of Testing of Hypotheses. Student Edition.
5. Ferguson T.S. (1967): Mathematical Statistics*:* A decision Theoretical Approach. Academic Press.
6. Zacks S.(1971): Theory of Statistics Inference- John Wiley and Sons, New York.

STT 15 TIME SERIES ANALYSIS/ DECISION THEORY

(A) TIME SERIES ANALYSIS

(Maximum no. of periods = 60)

UNIT I: Time-series as discrete parameter stochastic process. Auto covariance and autocorrelation functions and their properties. **(12L+3T)**

UNIT II: Exploratory Time Series Analysis: Tests for trend and seasonally, Exponential and Moving average smoothing. Holt winters smoothing. Forecasting based on smoothing, adaptive smoothing. **(12L+3T)**

UNIT III: Stationary processes: (i) moving average (MA), (ii) Auto Regressive(AR), (iii) ARMA and (iv) AR integrated MA (ARIMA) models, Box-Jenkins models. Discussion,(without proof) of estimation of mean, auto covariance and auto correlation functions under large sample theory. **(12L+3T)**

UNIT IV: Choice of AR and MA periods, Estimation of ARIMA models parameters. Forecasting, Residual analysis and diagnostic checking.Spectral analysis of weakly stationary process, Periodogram and Correlogram analysis. Spectral Decomposition of weakly AR process and representations as one sided MA process- necessary and sufficient conditions. **(12L+3T)**

REFERENCES:

1) Anderson, T. W (1971) The Statistical Analysis of Time Series, Wiley, N.Y.
2) Box, G.E.P. and Jenkins, G.M. (1976) Time Series Analysis-Forecasting and Control, Hodlen-day, San Francisco.
3) Kendall, Sir Maurice and Ord. J. K. (1990) Time Series, 3rd Ed., Edward Arnold.
4) Montgomery, D. C. and Johnson, L. A. (1977) Forecasting and Time SeriesAnalysis, McGraw Hill.
5) Brockwell P.J. and Davis R.A. (1991) Time Series: Theory and Methods, 2nd Ed., Springer-Verlag.
6) Fuller W.A. (1976) Introduction to Statistical time series, John Wiley N.Y.
7) Priestley M.B. (1981) Spectral analysis and time Series Griffin London.
8) Kendall M.G. And Stuart A. (1996) The advanced theory of Statistics, Vol. 3, Charles Griffin London.
9) Bloomfield P (1976) Fourier analysis of Time series – an introduction, Wiley.
10) Granger C.W. J and Hatanks (1964) Spectral analysis of economic Time Series, Princeton University Press N.J.

11) Koopmens C.R. (1973) The Spectral analysis of time series, Academic presses.
12) Nelson C.R. (1973) Applied Time Series for managerial forecasting, Holden –day.
13) Findley D.F.(1981) Applied Time Series analysis, Academic Press.
14) Wethirll G.B. (1986) Regression analysis with applications, Chapman Hall.

(B) DECISION THEORY

(Maximum no. of periods = 60)

Unit I: Decision problem, loss function, risk function, randomized and non-randomized decision rule. Decision principles (Conditional Bayes, Frequentist). Testing and estimation problem as decision problems. Optimal decision rule. **(12L+3T)**

Unit II: Concept of admissibility and completeness, Bayes rules, minimax decision rule. Admissibility of Bayes rules. Existence of Bayes decision rule. **(12L+3T)**

Unit III: Definition of non-parametric test, advantages and disadvantages of nonparametric tests. Single sample problems. (i) Test of randomness (ii) Tests of goodness of fit: Empirical distribution function. Kolmogorov-Smirnov test, comparison of Chi-squareand KS test. (iii) Problem of location: Sign test, Wilcoxon's signed rank test, Wilcoxon paired sample signed rank test. **(12L+3T)**

Unit IV: Two Sample Problems: Different types of alternative, sign test, Wilcoxon two sample rank sum test, Wald-Wolfiwitz run test, Mann-Whitney-Wilcoxon test, median test. K-S two sample test. One sample U statistic, Kernel and symmetric Kernel, variance of U statistic, two sample U statistics, linear rank statistics and their distribution properties under null hypothesis. **(12L+3T)**

REFERENCES:

1) Ferguson T. S. (1967) Mathematical Statistics, Academic Press, New York.
2) Fraser, D.A.J. (1957) Non-parametric methods in Statistics, John Wiley.
3) Gibben J.D.(1992) Non Parametric Statistical inference, Marcel Dekker, Inc., New York.
4) Goon A.M., Gupta M.K., Dasgupta : An Outline of Statistical Inference. The World Press Pvt. Ltd.
5) Berger, J.O. (1980) Statistical Decision Theory: Foundations, Concepts and Methods, Springer-Verlag.
6) Berger, J.O. (1985) Statistical Design Theory and Bayesian Analysis, 2nd ed., Springer-Verlag.
7) Gupta S. S. and Huang, D. (1981) Multiple Statistical Decision Theory, Springer-Verlag, New York.

Structure of the course: M.A. / M.Sc. (Statistics)-Fourth Semester (CBCS Pattern)

SEMESTER-IV								
Sr. No.	**Course**	**Course Title**	**Theory/ Practical Paper**	**No. of Credits**	**Marks@ 25/Credit**	**Internal Component (50%)**	**Semester End Component (50%)**	**Grand Total**
STT 16	Core XV	Asymptotic Inference	**L/T**	**4**	**100**	**50**	**50**	**100**
STT 17	Core XVI	Operations Research-II	**L/T**	**4**	**100**	**50**	**50**	**100**
STT 18	Core XVII	Actuarial Statistics	**L/T**	**4**	**100**	**50**	**50**	**100**
STT 19	Core XVIII	Reliability and Survival Analysis	**L/T**	**4**	**100**	**50**	**50**	**100**
STT 20 (A)/(B)	Elective Group II	Data Mining Techniques/ Directional Data Analysis	**L/T**	**4**	**100**	**50**	**50**	**100**
STP 07	Core Practical III	Practical-VII (based on STT 16, STT 17 and STT 20)	**L/T**	**2**	**50**	**--**	**50**	**50**
STP 08	Core Practical IV	Practical-VIII (based on STT 18 , STT 19)	**P**	**2**	**50**	**--**	**50**	**50**
STM 02	Core Project	Project (carrying 100 marks)	**P**	**2**	**100**	**--**	**100**	**100**
		Total						**700**

List of Core/ Elective Subjects to be offered

Core Subjects

7. Asymptotic Inference
8. Operations Research-II
9. Actuarial Statistics
10. Reliability and Survival Analysis
11. Practical-VII (based on STT 16, STT 17 and Elective STT 20(A) OR STT 20(B))
12. Practical-VIII (based on STT 18 , STT 19)
13. Project (carrying 100 marks)

Elective Group II (Any one for Fourth Semester)

1. Data Mining Techniques
2. Directional Data Analysis

NOTE:

1) (i)Project carrying 100 marks which is to be given at the beginning of Semester-III and evaluated at the end of Semester-IV.

(ii) Project batch is of minimum 02 and maximum 04 students.

2) Fourth semester will have five Theory papers and assessment for each theory paper will be of 100 Marks [50 External Exam+ 50 Internal Exam (02 tests each of 15 Marks+20 Marks for assignment]

3) Semester-IV is of 700 marks each.

4) One credit is of 25 marks.

5) In STT-17 paper i.e. Operations Research-II -TORA software and Solver tool pack will be used for practical purpose.

M.Sc. (STATISTICS) FOURTH SEMESTER (CBCS)

W.E.F. from Academic year 2015-16

SEMESTER-I	
Paper No.	**Name of the paper**
STT 16	Asymptotic Inference
STT 17	Operations Research-II
STT 18	Actuarial Statistics
STT 19	Reliability and Survival Analysis
STT 20(A)/(B)	Data Mining Techniques/ Directional Data Analysis
STP 01	Practical-VII (based on STT 16, STT 17 and STT 20)
STP 02	Practical-VIII (based on STT 18 , STT 19)
STM-02	Project

STT 16 ASYMPTOTIC INFERENCE

(Maximum no of periods: 60)

UNIT I: Consistency and asymptotic normality (CAN) of real and vector parameters. Invariance of consistency under continuous transformation.Invariance of CAN estimators under differentiable transformations, generation of CAN estimators using central limit theorem. **(12L+3T)**

UNIT II: Method of moments, method of maximum likelihood, Special cases such as exponential class of densities and multinomial distribution, Cramer-Huzurbazar theorem, method of scoring. **(12L+3T)**

UNIT III: Tests based on MLEs. Likelihood ratio tests, asymptotic distribution of log likelihood ratio, Wald Test, Score Test, locally most powerful tests, Bartlett's test for homogeneity of variances. **(12L+3T)**

UNIT IV: Applications to categorical data analysis, three dimensional contingency tables, Pearson's chi-square test and LR test. Asymptotic comparison of tests. Asymptotic Relative Efficiency (Pitman's), asymptotic normality of posterior distributions. **(12L+3T)**

REFERENCES:

1) Kale B.K. (2005) A First Course on Parametric Inference, Second Edition, Narosa.
2) Cramer, H.(1974) Mathematical Methods in Statistics, Princeton Univ. Press.
3) Rao, C. R.(1995) Linear Statistical Inference and its Applications, Wiley Eastern Ltd.
4) Silvey, S. D.(1975) Statistical Inference, Chapman- Hall.
5) Wilks, S.S.(1962) Mathematical Statistics, John Wiley.
6) Ferguson, T.S. (1996) A Course in Large Sample Theory, Chapman and Hall.

STT 17 OPERATIONS RESEARCH-II

(Maximum no of periods: 60)

UNIT I: Integer Linear Programming Problem (ILPP): The concept of cutting plane, Gomory's method of cutting plane for all ILPP and mixed ILPP, Branch and Bound method. **(12L+3T)**

UNIT II: The Recursive equation approach and characteristic of Dynamic programming, Dynamic programming algorithm, Deterministic processes, Non-sequential discrete optimization-allocation problems. **(12L+3T)**

UNIT III: Inventory models: Inventory problems and their analytical structure.EOQ, deterministic models of inventory control. Inventory (S,s) policy periodic review models with stochastic demand. Probabilistic re-order point, lot size inventory system. **(12L+3T)**

UNIT IV: Basic characteristics of queuing system, different performance measures, steady state solution of Markovian queuing models: M/M/1, M/M/1 with limited waiting space M/M/C, M/M/C with limited waiting space. Imbedded Markov chain method to obtain steady state solution of M/G/1, G/M/1 and M/D/C, Network models. Quadratic programming: Kuhn-Tucker conditions of optimality, methods due to Beale, Wolfe.
(12L+3T)

REFERENCES:

1) R. K. Gupta "Linear Programming",Krishna Prakashan Mandir.
2) F.S.Hillier and G.J.Liebermann,(1995) Introduction to Operations Research (6th Ed.) Mc Graw Hill.
3) Kantiswaroop, P.K.Gupta and Manmohan, Operations Research, Sultan Chand & Sons, New Delhi.
4) G.Hadley, Linear Programming, Narosa publishing House, 1995.
5) G.Hadley, Nonlinear and Dynamic Programming, Addison-Wesley, Reading Mass.
6) H.A.Taha, Operations Research - An Introduction, Macmillan Publishing Company, Inc, New York.
7) S.S.Rao, Optimization Theory and Applications, Wiley Eastern Ltd., New Delhi.
8) P. K. Gupta and D. S. Hira, Operations Research – A Introduction. S. Chand & company Ltd, New Delhi.
9) N. S. Kambo, Mathematical Programming Techniques. Affiliated East-West Press Pvt. Ltd, New Delhi.

STT 18 ACTUARIAL STATISTICS

(Maximum no of periods: 60)

UNIT I: 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. **(12L+3T)**

UNIT II: Principles of compound interest: Nominal and effective rates of interest and discount, force of interest and discount, compound interest, accumulation factor, continuous compounding. **(12L+3T)**

UNIT III: Life insurance: Insurance payable at the moment's of death and at the end of the year of death-level benefit insurance, endowment insurance, deferred insurance and varying benefit insurance. **(12L+3T)**

UNIT IV: Life annuities: Continuous life annuities, discrete life annuities, life annuities with monthly payments.Net premiums: Continuous and discrete premiums, true monthly payment Premiums and some practical considerations. Net premium reserves: Continuous and discrete net premium reserve, reserves on a semi continuous basis, reserves based on true monthly premiums. **(12L+3T)**

REFERENCES:

1) N. L. Bowers, H. U. Gerber, J. C. Hickman, D. A. Jones and C. J. Nesbitt, (1986) Actuarial Mathematics', Society of Actuaries, Itasca, IIIinois, U. S. A. Second Edition (1997)

2) Deshmukh S.R. (2009) An Introduction to Actuarial Statistics Using R , Uni. Press.

ADDITIONAL REFERENCES:

1) Spurgeon E. T. (1972) Life Contingencies, Cambridge University Press.

2) Neill, A. (1977) Life Contingencies, Heinemann.

STT 19 SURVIVAL ANALYSIS

(Maximum no of periods: 60)

UNIT I: Elements of Reliability, definition and relationship between survival function, hazard function, distribution with DFR and IFR, series and parallel systems. Life testing experiments, stress–strength reliability and its estimation. **(12L+3T)**

.**UNIT II:** Basic concepts of Time, Order and Random Censoring. Life distributions - Exponential Gamma, Weibull, Lognormal, Pareto, Linear Failure rate. Parametric inference Point estimation, Confidence Intervals, Scores, tests based on LR, MLE Life tables, Failure rate, mean residual life and their elementary properties. Ageing classes - IFR, IFRA, NBU, NBUE, HNBUE and their duals, Bathtub Failure rate. **(12L+3T)**

UNIT III: Ageing classes - IFR, IFRA, NBU, NBUE, HNBUE and their duals, Bathtub Failure rate. Estimation of survival function - Actuarial Estimator, Kaplan – Meier Estimator, Estimation under the assumption of IFR/DFR. **(12L+3T)**

UNIT IV: Tests of exponentiality against non-parametric classes - Total time on test, Deshpande test. Two sample problem - Gehan Test, Log rank test. Mantel - Haenszel Test, Tarone -Ware tests. Semi-parametric regression for failure rate - Cox's proportional hazards model with one and several covariates. **(12L+3T)**

REFERENCES:

1) Cox, D.R. and Oakes, D. (1984) Analysis of Survival Data, Chapman and Hall, New York.
2) Gross A.J. and Clark, V. A. (1975) Survival Distributions: Reliability Applications in the Biomedical Sciences, John Wiley and Sons.
3) Elandt - Johnson, R.E. Johnson N.L. (1980) Survival models and Data Analysis, John Wiley.
4) Miller, R.G. (1981) Survival Analysis, Wiley.
5) Zacks, S. Reliability.

STT 20(A) DATA MINING TECHNIQUES

(Maximum no of periods: 60)

UNIT I: Basic data mining tasks, Introduction to databases, including simple relational databases, data warehouses and introduction to online analytical data processing. Association rules and prediction, data attributes, applications to electronic commerce. **(12L+3T)**

UNIT II: Unsupervised learning from univariate and multivariate data, Dimension reduction and feature selection. **(12L+3T)**

UNIT III: Supervised learning from moderate to high dimensional input spaces, artificial neural networks and extensions of regression models, regression trees. **(12L+3T)**

UNIT IV: Review of classification methods from multivariate analysis, classification and decision trees. Clustering methods from both statistical and data mining viewpoints, vector quantization. **(12L+3T)**

REFERENCES:

1) Berson, A. and Smith, S.J. (1997) Data Warehousing, Data Mining, and OLAP, McGraw-Hill.
2) Breiman, L., Friedman, J.H., Olshen, R.A. and Stone, C.J. (1984) Classification and Regression Trees, Wadsworth and Brooks/Cole.
3) Han,J. and Kamber.M. (2000) Data Mining; Concepts and Techniques, Morgan Kaufmann.
4) Mitchell, T.M. (1997) Machine Learning, McGraw-Hill.
5) Ripley, B.D. (1996) Pattern Recognition and Neural Networks, Cambridge University Press.

STT 20(B) DIRECTIONAL DATA ANALYSIS

(Maximum no of periods: 60)

UNIT I: Graphical representation of data, Frequency distribution, Measures of location, circular variance and concentration, Correction for mean grouping, Measures of skewness and kurtosis. **(12L+3T)**

UNIT II: Circular models, distribution theory, independence, convolution, moments, distributions of an arc, mixtures, lattice distributions, wrapped normal, Cauchy, Poisson distributions, Von Mises, Fisher distribution characteristics functions, Polar distributions, isotropic random walk on the circle. **(12L+3T)**

UNIT III: Point estimation, Cramer Rao type bound, sufficiency, Methods of estimation. Testing hypothesis from parametric models. Neyman-Pearson and likelihood ratio principles. **(12L+3T)**

UNIT IV: Non-parametric methods: Tests for randomness, goodness of fit, Rayleigh's test. Durand and Greenwood's test, Range test, Kuper's test Watson's test, Uniform score tests, Runs test, Rank sum test, Test for dispersion. **(12L+3T)**

REFERENCES:

1) Mardia K.V. (1972): Statistics of Directional data, Academic Press.
2) Batschelet E. (1981): Circular Statistics in Biology, Academic Press.
3) Watson G. S. (1983): Statistics on Spheres, Wiley.