SHIVAJI UNIVERSITY, KOLHAPUR.

B
Accredited By NAAC
(2009)

Revised Syllabus For

M.Sc –II Statistics (College level) Sem III & IV

Syllabus to be implemented from June 2012 onwards

MCST-301 RELIABILITY THEORY

Unit-1: a) Structure function, dual of a structure, cuts and paths, bounds on system reliability. Associated random variables, reliability concepts and measures, coherent systems, reliability of coherent systems.

b) Notions of aging: IFR, IFRA, DMRL, NBU, NBUE classes and their duals. Closure properties under formation of coherent structures, convolutions and mixtures of these classes.

(11)

Unit-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, aging properties of these life time distributions proportional hazard models.

(12)

Unit-3 : Stochastic ordering : usual stochastic ordering , hazarad rate ordering, reverse hazard rate ordering, dispersive ordering, mean residual life ordering and their implications.

(11)

Unit-4: a) Univariate shock models and life distributions arising from shock models, bivariate exponential distribution, bivariate shock models.

b) Availability, interval reliability, availability of a system with a single spare and a repair facility.

(11)

References :

1) Barlow R.E. and Proschan F. (1975): Statistcal Theory of relibilty & Life testing , Holt, Reinhart and Winston.
2) Lawless J.F.(1982) : Statistical Models & Methods of Life Tome 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 Ral*ability Analysis* , *John Wiley.*

MCST 302 : ELEMENTARY STOCHASTIC PROCESSES.

Unit-1: a) Definition of stochastic process, classification of stochastic processes according to state space and time domain. Finite dimensional distributions. Examples of various stochastic processes.

b) 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. (11)

Unit-2: a) Classification of states, irreducible Markov chain, period of the state, random walk & gambler's ruin problem. First Entrance Theorem, First passage time distribution.

b) Long-run distributions of Markov chain, relation with mean recurrence time, stationary distribution. (11)

Unit-3: a) 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.

b) Renewal and delayed renewal processes, related theorems, key renewal theorem (without proof) and its application. (12)

Unit-4 a) Galton-Watson-Binaymi Branching process. probability of ultimate extinction. Distribution of population size, and association results.

b) Simulation of Markov Chain, Poisson process and branching process. (Algorithms) (11)

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.

MCST 303 : PLANNING AND ANALYSIS OF INDUSTRIAL EXPERIMENTS

Unit-1: a) A review of basic concepts of designs of experiment.

b) Factorial Experiments : Concepts of main effects, interaction, Analysis of Full 2^n and 3^2 factorial designs, Analysis of single replicate of 2^n and 3^2 design.

(11)

Unit-2: a) Confounding : Total and partial confounding, construction and analysis of 2^n and 3^2 confounded design.

b) 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. (12)

Unit-3: Response surface experiments : linear and quadratic model, stationary point, central composite design. (11)

Unit-4: a) Taguchi methods: Concept of loss function, S/N ratio. Linear graphs, inner and outer arrays, ANOVA.

b) Random effects model for one-way classification. (11)

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 5^{th} edition, Wiley New York.

MCST-304- REGRESSION ANALYSIS

Unit-1: **a)**. Multiple regression model, Least squares estimate (LSE), Properties of LSE

b) Hypothesis testing, confidence and prediction intervals. General linear hypothesis testing.

(11)

Unit-2: Multiple correlation and adjusted multiple correlation coefficient, Null distribution of sample correlation and multiple correlation coefficient. Partial correlation coefficient and its relation with multiple correlation coefficient. Tests for significance of simple, multiple and partial correlation coefficients. Variable Selection Procedures: Mallows Cp, forward, backward selection methods.

(11)

Unit-3: a) Residuals and residual diagnostics. Transformation of Variables: Box-Cox power transformation.

b) Dummy variables and their use in regression analysis.

(11)

Unit-4: a) Multicollinearity: Consequences, detection and remedies. Autocorrelation: Consequences. Durbin-Watson test, Estimation of parameters in presence of auto-correlation.

b) Introduction to Nonlinear regression models.

(12)

References

1. Draper N.R. and Smith,H. (1998): Applied Regression Analysis.3rd ed Wiley
2. Wiesberg, S.(1985): Applied Linear Regression, Wiley.
3. Kutner, Neter, Nachtsheim and Wasserman (2003): Applied Linear Regression Models, 4th Edition, McGraw-Hill
4. Montgomery, D.C., Peck, E.A.,and Vining, G.(2001): Introduction to Linear Regression Analysis, 3rd Ed .Wiley
5. Cook, R.D. and Wiesberg, S.(1982): Residuals and Influence in Regression. Chapman and Hall.

MCST 321: ASYMPTOTIC INFERENCE

Unit 1. Consistency of estimators joint and marginal consistency, Weak and strong consistency, Invariance under continuous transformation , Asymptotic relative efficiency, error probabilities and their rates of convergence. (11)

Unit 2. Asymptotic Normality, CAN estimators; invariance of CAN property under non-vanishing differentiable transformation. Methods of obtaining consistent and CAN estimators; Super-efficient estimators. (11)

Unit 3 a) BAN estimators : Cramer regularity conditions and asymptotic properties of the MLE (Cramer-Huzurbazar results with proofs)

b) CAN and BAN estimation for multiparameter exponential family. (11)

Unit 4 a) Variance stabilizing transformations; their existence; their applications in obtaining large sample tests and estimators.

b). Asymptotic Distribution of likelihood ratio test statistics, Wald test, Rao's Score test, Pearson Chi-square test for goodness of fit, Barttletts test for homogenity of variances.

(12)

References:

1) Kale B.K. (1999) A first course on parametric inference, Narosa Pub.
2) Zacks S. (1971) : Theory of statistical inference, wiley & sons inc.
3) Rohatgi V.K.& Saleh A. K. Md. E.(2001) : Introduction to Probability Theory and Mathematical Statistics- John Wiley and sons Inc.

MCST 322: DEMOGRAPHY

Unit 1. Demography and its interdisciplinary nature, sources of demographic data, Coverage and Content errors. The use of balancing equation, Chandrasekaran and Deming formula to check completeness of registration data. Use of Whipple's Myers's and UN Indices. (11)

Unit 2. Measures of Mortality : Various measures of mortality, infant mortality rate, cause specific death rates and standardized death rates . Measures of Fertility: Period and cohort fertility measures, use of birth order statistics, child-women ratio, Brass P/F ratio to estimate current level of fertility, Measures of reproduction and replacement. Sheps and Perrin stochastic human reproductive process

(11)

Unit 3 Life Tables : Types of life tables, inter-relationships between life table functions, construction of life tables using Reed- Meerel and Greville's Method. Probability distribution of life table functions and their optimum properties. Population estimation and Projection : Mathematical , Statistical and Demographic Methods, Component method.

(12)

Unit 4 Stable and Quasi – stable population: Derivation of Lotka's stable population model and properties, Intrinsic growth rate and derivation, age structure and birth rate of a stable population, mean length of generation, momentum of population growth, Quasi-stable population under changing fertility and mortality situations . (11)

References:

1) Shryoch,Henry S,Jacob S,Siegel and Associates (1964)-Methods and materials of demography (condensed edition) Academic press,London.

2) Barclay,George W.(1968) Techniques of population analysis,John Wiley and sons,New York.

3) Keyfitz N.(1968) Introduction to Mathematics of Population.Addision-Wesley Publishing Co,Reading , Messachusetts.

4) Chiang C.L.(1968) Introduction to stochastic processes in Biostatistics,John Wiley and sons, New York.

5) R.Ramkumar (1986) Technical Demography,Wiley Eastern,New Delhi.

6) Sudhendu Biswas (1988) , Stochastic processes in Demography and Applications,Wiley Eastern, New Delhi

MCST 324 : Actuarial Statistics

Unit-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. (11)

Unit-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.

Distribution of aggregate claims, compound Poisson distribution and its applications. Distribution of aggregate claims, compound Poisson distribution and its applications. (11)

Unit-3: Principles of compound interest: Nominal and effective rates of interest and discount, force of interest and discount, compound interest, accumulation factor, continuous compounding.

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.

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.

(11)

Unit-4: a) 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.

b) 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.

(12)

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.
   Neill, A. Life Contingencies, Heinemann
3. Deshamukh, S.R. (2009) Acturial Statistics: An Introduction using R, University Press, India.

MCST 316- PRACTICAL –III

1. Realization from a Markov Chain.
2. Classification of t.p.m and computation of n-step probability matrix.
3. Classification of State: Computations of absorption probabilities.
4. Stationary distribution and recurrence times.
5. Realization from discrete state space Markov Processes and related estimation.
6. Computation of reliabilities of K-out in system of independent components.
7. Availability and interval reliability.
8. Autocorrelation and multicolinearity.
9. Variable selection methods.
10. Analysis of full replicated unconfounded 2^n and 3^2 factorial experiments.
11. Analysis of Single replicate 2^n factorial experiment.
12. Analysis of confounded 2^n factorial experiments: total and partial confounding.
13. Analysis of confound 3^2 factional experiments.
14. Analysis of fractional factorial 2^{n-k} experiment.
15. Analysis of response surface 1^{st} and 2^{nd} order experiments.
16. Analysis of one way classification random effects data.

17–18 Practical on the optional paper.

MCST 401: OPTIMIZATION TECHNIQUES

Unit-1: a) 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 f.s. to a b.f.s., Improvement of a b.f.s., Existence of unbounded solution, Optimality conditions. For other related theorems (statements only).

b)Artificial variable technique; two phase and Big M method, the case of redundancy. Revised simplex method.

(12)

Unit-2: a)Concept of Duality, theorems related to duality, complementary slackness property and development of dual simplex algorithm.

b)Sensitivity Analysis: Changes in the cost vector, requirement vector and non basic activity vector; addition of new variables and addition of new constraints.

(11)

Unit-3: 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, Graphical method, Reduction of the game problem as LPP, Minimax and maximin theorem . (11)

Unit-4: a)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.

(6)

b)Quadratic programming: Kuhn-Tucker conditions of optimality, methods due to Beale, Wolfe.

(12)

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.*

MCST 402 : DISCRETE DATA ANALYSIS

Unit1:.Log linear model for two and three dimensional contingency tables : Interpretation of parameters, comparison with ANOVA and regression. ML estimation of parameters, likelihood ratio tests for various hypotheses including independence . marginal and conditional independence, partial association, models with quantitative levels (12)

Unit2:. Generalized linear models: concept of generalized linear model, Link function, ML estimation, large sample tests about parameters, goodness of fit, analysis of deviance, introduction to Poisson regression. (11)

Unit3:. Logistic regression : logit model for dichotomous data with single and multiple explanatory variables, ML estimation, large sample tests about parameters,, variable selection, extension to polytomous data. (11)

Uni4:Non-parametric regression and Interpolating and smoothing splines for simple regression. Use of cross-validation applications to logistic and Poisson regression. (11)

References :

1) Yvonne M. Bishop, Stephen E. Fienberg, Paul W. Holland Discrete. (1975): Multivariate Analysis: Theory and Practice

2) Hosmer D.W. and Lemeshow S. (2000) : applied Logistic regression, 2nd ED. Wiley New York.

3) Agesti A. (1990) : Categorical Data Analysis. Wiley , New York.

4) R.Christensen (1997) Log-Linear Models And Logistic Regression. 2nd Ed. Springer. New York.

5) Montgomery.D.C. Peack,E.A. and Vining G (2001) Introduction to Linear Regression Analysis John Wiely.

MCST- 403 : INDUSTRIAL STATISTICS

Unit1: 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.

(11)

Unit2: a) Control charts for measurements and attributes $\bar{x}$. R. S, p, np. charts with sub-grouping, CUSUM chart, tabular form and V-mask use of these charts for process control. Moving average and exponentially weighted moving average charts.

b) Process capability C_p, C_{pk} and C_{pm} . Determining process capability with $\bar{x}$ chart. Estimation of process capability.

(12)

Unit3: 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.

(11)

Unit4:a). Multivariate control charts for measurements data. Hotelling T^2 control charts.

b)Introduction to Six-Sigma Methodology. DMAIC cycle & case studies.

c)Simulation of X -bar and R control charts, estimation of ARL and process capability indices.

(11)

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.

MCST 404 : TIME SERIES ANALYSIS

Unit1: a) Time-series as discrete parameter stochastic process. Auto covariance and auto correlation functions and their properties.

b) Exploratory Time Series Analysis: Tests for trend and seasonally, Exponential and Moving average smoothing. Holt Winters smoothing. Forecasting based on smoothing, adaptive smoothing.

(12)

Unit2: Stationary processes: a) moving average (MA), b) Auto Regressive (AR), c) ARMA and (d) 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.

(11)

Unit3: Choice of AR and MA periods, Estimation of ARIMA models parameters. Forecasting, Residual analysis and diagnostic checking.

(11)

Unit4: Spectral analysis of weakly stationary process, Periodogram and Correlogram analysis. Introduction to ARCH and GARCH models.

(11)

References

1. Anderson, T. W (1971) : The Statistical Analysis of Time Series, Wiley, N.Y.
2. Brockwell, P.J. and Davis, R. A. Time-Series : Theory and Methods
3. (Second Edition), Springer-Verlag.
4. Box, G.E.P. and Jenkins, G.M. (1976) : Time Series Analysis-Forecasting and control, Hodlen-day, San Franciscor.
5. Kendall, Sir Maurice and Ord. J. K. (1990) : Time Series (Third Edition) Edward Arnold.
6. Montgomery, D. C. and Johnson, L. A. (1977) : Forecasting and Time Series Analysis, McGraw Hill.

MCST 421 SURVIVAL ANALYSIS

Unit-1: a) Estimation and testing for: Exponential, Gamma, Weibull, Lognormal, Pareto, and Linear failure rate distribution, for complete data.

b)Concept of censoring, various types of censoring, Estimation and Testing of parameters of exponential distribution under various types of censoring.

(11)

Unit-2: Estimation of survival function: Actuarial Estimator, Kaplan Meir product limit estimator, properties: self-consistency and MLE.

(11)

Unit-3: Tests for exponentiality against alternatives IFRA, NBU and NBUE.

(11)

Unit-4: a) Two-sample problem: Gehen test, Log rank test, Mantel Haenszel test.

b) Semi parametric regression for failure rate – Cox's proportional hazards model. Related estimation and test procedures. (12)

References:

1. 1. Barlow R. E. & Proschann F. (1965) Mathematical Theory of Reliability, John Wiley & Sons, Inc.
2. 2. Lawless J. F.(1982): Statistical Models and Methods of Failure Time Data, John Wiley.
3. Miller R. G.(1981): Survival Analysis, John Wiley and Sons.
4. Bain L. O.(1978): Statistical Analysis of Reliability and Life Testing Models, Marcel Dekker, Inc, N.Y.
5. Nelson W. (1982): Applied Life Data Analysis, Jhon Wiley and Sons Inc.

MCST 423 : DATA MINING

Unit1: a). Review of classification methods from multivariate analysis. Classification and decision trees, regression trees.

b). Convexity and optimization : Convexity, conjugate functions, unconstrained and constrained optimization, KKT conditions.

(11)

Unit2: a). Unsupervised learning from univariate and multivariate data; dimension reduction and feature selection ,supervised learning from moderate to high dimensional input spaces;

b) Artificial Neural Networks(ANN): Introduction to ANN, types of activation function, McCulloch-Pitts ANN model, single layer network, multilayer feed forward network model, training methods, ANN & regression.

(12)

Unit3:. Support vector machine : Introduction to support vector machine, loss functions, soft margin ,optimization hyper-plane, support vector classification, support vector regression, linear programming for support vector classification and regression. (11)

Unit4: a) Association rules and prediction ; A priori Algorithm data attributes, applications to electronic commerce.

b) Implementation of various data-mining algorithm using R- Software

(11)

References

1. Berson and Smith S.J. (1997) : Data warehousing, Data Mining, and OLAP, McGraw-Hill.
2. B reiman J.H Friedman, R.A. Olshen and stone C.J. (1984) : Classification and Regression Trees, Wadsworth and Brooks / Cole.
3. Han and Kamber (2000) : data Mining ; Concepts and Techniques. Morgan Gaufmann.
4. Mitchell T.M. (1997) : Machine Learning , McGraw-Hill.
5. Ripley B.D. (1996) : Pattern Recognition and Neural Networks. Cambridge University Press.
6. Vapnik V.N. the nature of Statistical learning theory Springer.
7. Cristianini N. and Shawe-Tayler J.An Introduction to support vector machines.
8. Data set source : http://www.ICS.uci.edu/~ mlearn/MLReposity.html
9. Elements of Statistical Learning
10. Mehrica K Mohan C and Ranka (1997) Elements of Artificial neural networks. Penram international
11. Hastie T,Tibshirani R,Friedmant J, (2009): The elements of statistical learning Springer.

MCST 424 : BIOSTATISTICS

Unit1: Study designs in epidemiology. Measures of disease occurrence and association, variation and bias. Identifying non-casual association and confounding.

(12)

Unit2: Defining and assessing heterogeneity of effects, interaction. Sensitivity and specificity of diagnostic test, Cohort study designs, statistical power and sample size computations.

(11)

Unit3:. Cross-control study designs, matched case –control studies. Survival data: Proportional hazards model, multivariate survival data.

(11)

Unit4: Causal Inference, longitudinal data. Communicating results of epidemiological studies, ethical issues in epidemiology.

(11)

References

1. Selvin : Statistical analysis of epidemiological data.
2. Diggle,Liang and Zeger : Analysis of Longitudinal data.
3. Piantadosi: Clinical trials.
4. Mitchell T.M. (1997) : Machine Learning , McGraw-Hill.
5. Clayton and Hills: Statistical methods in Epidemiology

MCST 416- PRACTICAL –IV

1. Solution to LPP using graphical methods and simplex method.
2. Revised Simplex method and Dual Simplex Method.
3. Game Theory.
4. Quadratic programming
5. Integer programming.
6. Logistic regression.
7. Log-linear model.
8. Control Charts
9. Process Capability indices
10. Seven SPC Tools.
11. Estimation of trend and Seasonality
12. Exponential , moving average and Holt Winter smoothing.
13. Analysis of some real time series data.

14-15 Based on optional paper.

Marking Scheme for Practical – 416: (80+20)

1) There will be a practical examination having 50 marks.
2) The question paper will consists of 8 questions each of 10 marks out of which any five have to be attempted.
3) Project work will be evaluated for 30 marks on the basis of project report and oral presentation (20+10 marks).
4) There Shall be 10 marks for day to day journal and internal test will be for 10 Marks.