

PONDICHERRY UNIVERSITY

DEPARTMENT OF STATISTICS



**SYLLABUS FOR M.Sc - STATISTICS
(CBCS – Five Year Integrated)
Effective from the Academic Year 2011-2012**

PONDICHERY UNIVERSITY
CHOICE BASED CREDIT SYSTEM
SYLLABUS FOR THE M.Sc. INTEGRATED STATISTICS COURSE
Effective from the Academic Year 2011 – 2012

SEMESTER	COURSE CODE	TITLE OF THE COURSE	NATURE OF THE COURSE	NO. OF CREDITS
I	STAT 111	Basic Statistics	Hard Core	3
II	STAT 121	Basic Probability Theory	Hard Core	3
III	STAT 231	Probability Distributions	Hard Core	3
	STAT 232	Sampling Theory	Hard Core	3
IV	STAT 241	Basic Estimation Theory	Hard Core	3
	STAT 242	Practical – I	Hard Core	2
V	STAT 351	Elements of Testing Statistical Hypotheses	Hard Core	3
	STAT 352	Statistical Quality Control and Operations Research	Hard Core	3
	STAT 353	Practical – II	Hard Core	2
VI	STAT 361	Principles of Experimental Design	Hard Core	3
	STAT 362	Applied Statistics	Hard Core	3
	STAT 363	Practical – III	Hard Core	2
VII	STAT 411	Mathematical Methods for Statistics	Hard Core	4
	STAT 412	Probability Theory	Hard Core	4
	STAT 413	Sampling Theory	Hard Core	4
	STAT 414	Distribution Theory	Hard Core	4
	STAT 415	Statistical Laboratory – I (Based on STAT 413)	Hard Core	3
VIII	STAT 421	Theory of Estimation	Hard Core	4
	STAT 422	Statistical Quality Control and Operations Research	Hard Core	4
	STAT 423	Stochastic Processes	Hard Core	4
		Soft Core	Soft Core	3
	STAT 424	Statistical Laboratory - II (Based on STAT 421, 422)	Hard Core	3
IX	STAT 531	Multivariate Statistical Analysis	Hard Core	4
	STAT 532	Testing of Statistical Hypotheses	Hard Core	4
	STAT 533	Linear Models and Regression Analysis	Hard Core	4
		Soft Core	Soft Core	3
	STAT 534	Statistical Laboratory – III (Based on STAT 531, 532, 533)	Hard Core	3
X	STAT 541	Design and Analysis of Experiments	Hard Core	4
		Soft Core	Soft Core	3
		Soft Core	Soft Core	3
	STAT 542	Statistical Laboratory – IV (Based on STAT 541)	Hard Core	3
	STAT 543	Project and Viva-Voce	Hard Core	4

Soft Core Papers

	Semester VIII		Semester IX
STAT 425	Statistical Data Mining Methods	STAT 535	Reliability Theory
STAT 426	Econometrics	STAT 536	Biostatistics
STAT 427	Demographic Techniques	STAT 537	Actuarial Statistics
STAT 428	Bayesian Inference	STAT 538	Total Quality Management
	Semester X		
STAT 544	Survival Analysis		
STAT 545	Advanced Operations Research		
STAT 546	Programming in C++		
STAT 547	Time Series Analysis		
STAT 548	Statistical Genetics		

Unit I

Definition of statistics – Scope and limitations of statistics – Primary and Secondary data-Collection and presentation of data – summarizing data – frequency distribution – Measures of location – mean – median – mode – (Simple problems) Percentiles.

Unit II

Measures of variability – Range – Quartile deviation – Standard deviation – coefficient of variation – Moments about the origin and mean – Skewness, Kurtosis and their measures.

Unit III

Measures of association between attributes - coefficient of association and contingency; Measures of relation between two variables – correlation and regression – Curve fitting by least squares.

Unit IV

Partial and Multiple correlation coefficients (three variables only) – Rank correlation – Simple problems.

Unit V

Present official statistical system in India relating to population, agriculture, Industrial production, trade and prices; Methods of collecting official statistics, their reliability and limitations; Principal publications containing such statistics; Official agencies responsible for their collection and their functions.

Books for Study

1. Hooda.R.P.(2003): Statistics for Business and Economics , 3/e, Mac Millan .
2. Medhi.J. (1992): Statistical Methods an Introductory Text , Wiley Eastern Ltd.
3. Srivastava S.C. and Sangya Srivastava (2003): Fundamentals of Statistics, 1/e, Anmol Publications, New Delhi
4. Ken Black(2010): Business Statistics: Contemporary Decision Making, 6/e, John Wiley & Sons.

Books for Reference

1. Agarwal.B.L(1996): Basic statistics , 3/e, New Age International (P) Ltd.
2. Anderson.R, Sweeney.J and Williams.A (2002): Statistics for Business and Economics, 8/e, Thomson.
3. Guide to current Indian Official statistics – Central Statistical Organisation, Govt. of India.
4. Gupta.S.C. and Kapoor.V.K. (2000): Fundamentals of Mathematical Statistics , 10/e, Sultan Chand and sons.
5. Nabendu Pal and Sahadeb Sarkar (2005): Statistics concepts and Applications, Prentice-Hall of India Private Ltd., New Delhi.
6. Sheldon M.Ross (2006) : Introductory Statistics , 2/e, Elsevier Publications.
7. Murray R. Spiegel and Larry J. Stephens (2005): Schaum's Outline of Theory and Problems of Statistics, 3/e, Tata Mc Graw Hill Publishing Company Ltd, New Delhi.

Unit I

Events - Sample Space - Mathematical and Statistical definitions of Probability - Axiomatic definition of Probability –Addition & multiplication theorems - conditional probability – Bayes' Theorem - Simple problems.

Unit II

Random variable - Discrete and Continuous Random variables - Distribution function and its properties - Expectation - Moment Generating function - Probability Generating function

Unit III

Chebychev's inequality - Cauchy - Schwartz inequality - characteristic function, its properties and uses.

Unit IV

Concept of Bivariate distributions - conditional and marginal distributions -Notion of Independence of Random variables - Conditional Expectation - Simple problems

Unit V

Weak Law of Large numbers (WLLN) - Bernoulli's Theorem, convergence in probability and distributions - Central Limit theorem for iid case

Books for Study

1. Hogg, R.V. , Mc Kean J W and Craig, A.T.(2005): Introduction to Mathematical Statistics, 6/e Pearson Edition
2. Bansilal, Sanjay Arora and Sudha Arora (2006): Introducing Probability and Statistics, 2/e, Satya Prakashan Publications, New Delhi

Books for Reference

1. Bhat, B.R., Srivenkataramana, T and Rao Madhava, K.S. (1997): Statistics: A Beginner's Text, Vol. II New Age International (P) Ltd.
2. Goon, A.M., Gupta, M.K. and Das Gupta,B. (2001): Fundamentals of Statistics, Vol. II, World Press, Calcutta.
3. Gupta,S.C. and Kapoor, V.K. (2000): Fundamentals of Mathematical Statistics, 10/e, Sultan Chand and sons.
4. Hoel, P.G. (1971): Introduction to Mathematical Statistics, Asia Publishing house.
5. Meyer, P.L. (1970): Introductory Probability and statistical Applications, Addison Wesley.
6. Mood, A.M., Graybill, F.A and Boes, D.C.(1974): Introduction to the Theory of Statistics, McGraw Hill.
7. Pitman, Jim (1993): Probability, Narosa Publishing House.

Unit I

Discrete Distributions: Bernoulli, Binomial - Poisson - Geometric - Multinomial distributions and their characteristics.

Unit II

Continuous Distributions: Uniform - exponential - Normal - Gamma - Beta distributions and their characteristics.

Unit III

Cauchy distribution - Laplace distribution - Bivariate Normal distribution - Conditional and marginal distributions

Unit IV

Sampling distributions - standard error - Sampling distributions t, F and chi-square distributions - Interrelationship among t, F and chi-square distributions and their characteristics

Unit V

Concept of Order statistics - Distribution of the Order Statistics including that of maximum and minimum - Distribution of the sample Range and median

Books for Study

1. Gupta, S.C. and Kapoor, V.K.(2000): Fundamentals of Mathematical Statistics, 10/e, Sultan Chand and Sons
2. Hogg, R.V. , Mc Kean J W and Craig, A.T.(2005): Introduction to Mathematical Statistics, 6/e Pearson Edition
3. Irwin Miller and Marlyees Miller (2002): John E Freund's Mathematical Statistics, 6/e, PHI
4. Bansilal, Sanjay Arora and Sudha Arora (2006): Introducing Probability and Statistics, 2/e, Satya Prakashan Publications, New Delhi

Books for Reference

1. Anderson,R., Sweeney,J and Williams,A.(2002): Statistics for Business and Economics, 8/e , Thomson.
2. Johnson, S. and Kotz (1972): Distributions in Statistics, Vol. I , Vol. II, Houghton and Mifflin.
3. Rao, C.R.(1973): Linear Statistical Inference and its applications 2/e, Wiley eastern.
4. Richard, A. Johnson (2002): Probability and Statistics for Engineers, 6/e, PHI, New Delhi.
5. Rohatgi, V.K. and Saleh (2002): An Introduction to Probability Theory and Mathematical Statistics, John Wiley.
6. William Mendenhall and Robert J. Beewer (1991): Introduction to Probability and Statistics, 8/e, PWS-Kent Publishing Company.

Unit I

Concept of sampling - Need for sampling - population and sample - sampling unit and sample frame - Types of Population - Basic properties of population - sample survey and census - Principal steps in a Sample survey - Notion of sampling error.

Unit II

Simple Random Sampling with and without replacement - Estimation of Population mean and proportion and their variances- Determination of sample size.

Unit III

Stratified sampling - Principles of stratification - Estimation of population mean and its variance - Allocation techniques - Estimation of gain due to stratification

Unit IV

Systematic sampling - Estimation of population mean and its sampling variance - Circular systematic sampling - comparison of systematic, simple random and stratified random sampling - cluster sampling with equal sized clusters - estimation of population mean and variance.

Unit V

Large scale sample surveys - Sources of Non sampling errors and methods of controlling them - NSS and CSO and their functions.

Books for Study

1. Singh D and Choudhary F.S. (1986): Theory and Analysis of Sample Survey and Designs, New Age International.

Books for Reference

1. Cochran, W.G. (1977): Sampling Techniques, 3/e, Wiley.
2. Desraj (2000): Sample survey theory, Narosa Publishing House.
3. Murthy M.N. (1967): Sampling theory and methods, Statistical Publishing society, Calcutta.
4. Sukhatme etal (1984): Sampling theory of surveys with applications, Iowa State University Press and IARS.
5. Sampath (2000): Sampling Theory and Methods, Narosa Publishing house.

Unit I

Basic problem of statistical Inference; Point estimation; Properties of estimators; Unbiasedness and consistency; conditions for consistency; sufficiency; factorisation theorem (without proof) - Applications.

Unit II

Efficiency; minimum variance unbiased estimators and their properties ; Cramer-Rao Inequality, Rao - Blackwell Theorem and their applications.

Unit III

Methods of Estimation: Methods of moments, least square and minimum chi-square methods; Statement of their properties and applications.

Unit IV

Method of maximum likelihood and its applications; properties of maximum likelihood estimators, asymptotic properties (without proof). Bayes' Estimators: Notions of Prior and Posterior distributions, improper and conjugate prior and Bayes' Estimators.

Unit V

Confidence intervals: Basic Notions; Confidence Intervals for the mean, proportion and variance (for the case of one and two populations) and correlation coefficients- Large sample Confidence Intervals

Books for Study

1. Hogg, R.V. , Mc Kean J W and Craig, A.T.(2005): Introduction to Mathematical Statistics, 6/e Pearson Edition
2. Ken Black(2010): Business Statistics: Contemporary Decision Making, 6/e, John Wiley & Sons.
3. Bansilal, Sanjay Arora and Sudha Arora (2006): Introducing Probability and Statistics, 2/e, Satya Prakashan Publications, New Delhi

Books for Reference

1. Larson(1982): Introduction to Probability Theory and Statistical Inference, 3/e, John Wiley.
2. Rohatgi,V.K. and Saleh, A.K.(2002): An Introduction to Probability and Statistics , 2/e, John Wiley.
3. Gupta, S.C. and V.K. Kapoor (2000): Fundamental Mathematical Statistics, Sultan Chand and Co.
4. Mood,A.M., Graybill, A.M. and Boes, D.C. (1974): Introduction to theory of Statistics , Mc Graw Hill.
5. Goon, A.M., Gupta, M.K.and Das Gupta,B. (2001): An Outline of statistical theory , Vol. II , 6/e, World Press, Calcutta.
6. Miller.I and Miller.M (2002): John E. Freunds Mathematical statistics, Pearson Education.

I. BASIC STATISTICS

1. Diagrammatic Representation – Bar Chart, Pie Diagram
2. Construction of Frequency Tables and their graphical representations
3. Measures of Central Tendency, Dispersion, Moments, Skewness and Kurtosis
4. Fitting of straight line, second degree parabola and exponential curves
5. Simple correlation, regression, rank correlation
6. Partial and multiple correlation
7. Measures of association

II. SAMPLING THEORY

1. Use of random numbers and Simple random sampling
2. Stratified random sampling – Proportional allocation and Optimum allocation
3. Systematic sampling
4. Cluster sampling (equal size)

III. ESTIMATION

1. Method of Maximum Likelihood
2. Method of Moments and Minimum Chi-Square
3. Bayesian Estimation
4. Confidence Intervals

STAT 351 -ELEMENTS OF TESTING STATISTICAL HYPOTHESES

CREDITS: 3

Unit I

Neyman -Pearson formulation of the Hypothesis testing problem; concept of hypotheses - Types of errors and power - most powerful tests - Neyman-Pearson Fundamental Lemma and its applications - Notion of Uniformly most powerful tests

Unit II

Likelihood Ratio tests: Description and property of LR tests - Application to standard distributions - Large sample properties

Unit III

Standard tests of significance relating to mean, proportion and variance (for one and two populations), tests for correlation coefficients - Large sample tests

Unit IV

Non Parametric Tests: Sign test, Signed rank test, Median test , Mann-Whitney test, Goodness of fit test; Chi-square and Kolmogorov –Smirnov test (Description, properties and applications only)

Unit V

Linear Models: Estimation of parameters - Gauss –Markov theorem - Tests of significance for the parameters in the model

Books for Study

1. Rohatgi, V.K. and Saleh, A.K.(2002): An Introduction to Probability and Statistics , 2/e, John Wiley.
2. Hogg, R.V. , Mc Kean J W and Craig, A.T.(2005): Introduction to Mathematical Statistics, 6/e Pearson Edition
3. Manoj Kumar Srivastava and Namita Srivastava (2009): Statistical Inference – Testing of Hypotheses, Prentice Hall of India
4. Bansilal, Sanjay Arora and Sudha Arora (2006): Introducing Probability and Statistics, 2/e, Satya Prakashan Publications, New Delhi

Books for Reference

1. Larson(1982): Introduction to Probability Theory and Statistical Inference, 3/e, John Wiley.
2. Gupta, S.C. and V.K. Kapoor (2000): Fundamentals of Mathematical Statistics, Sultan Chand and Co.
3. Mood, A.M., Graybill, A.M. and Boes, D.C.(1974): Introduction to Theory of Statistics , Mc Graw Hill.
4. Goon, A.M., Gupta, M.K. and Das Gupta, B. (2001): An Outline of Statistical Theory, Vol. II, 6/e, World Press , Calcutta.
5. Miller, I and Miller, M (2002): John E. Freund's Mathematical statistics, Pearson Education.
6. Ken Black(2010): Business Statistics: Contemporary Decision Making, 6/e, John Wiley & Sons.

STAT 352 - STATISTICAL QUALITY CONTROL AND OPERATIONS RESEARCH

CREDITS: 3

Unit I

Need for SQC in industries; Process control: Chance and assignable causes of variation; specification and tolerance limits; process capability; statistical basis for control charts, \bar{X} -R, p and c charts, their construction and analysis.

Unit II

Product control: Acceptance sampling by attributes; Producer's and Consumer's risk; Notions of AQL, LTPD and AOQL; Single and double sampling plans; OC, AOQ, ASN and ATI Curves.

Unit III

Linear Programming Problem; Graphical solution; Simplex method; Artificial variables Techniques - M-method and Two-Phase method.

Unit IV

Transportation Problem: North west corner, Least cost and Vogel's approximation methods; Assignment problem and its algorithm; Traveling Salesman Problem.

Unit V

Network analysis by CPM / PERT; Basic concepts: Constructions of the network; concepts of slack and float in network analysis; Determination of the floats and critical path.

Books for Study

1. Montgomery .D.C (1985): Introduction to Statistical quality control, 2/e, John Wiley.
2. Taha H.A. (1982) Operational Research: An Introduction, McMillan.

Books for Reference

1. Gupta.S.C. and V.K. Kapoor (2000): Fundamentals of Applied Statistics, Sultan Chand and sons.
2. Kanti Swarup.P.K, Gupta and Manmohan (1985): Operation Research, Sultan Chand and Sons.
3. J.K. Sharma (2001): Operation Research: Theory and Applications, MacMillan, India.
4. Goel and Mittal (1982): Operation Research, Pragati Pakashan, Meerut.
5. Ott, E.R. (1975): Process Quality Control; Mc Graw Hill.
6. Hillier. F.S. and Leiberman. G.J. (1962): Introduction to Operations Research, CBS Publications.

I. STATISTICAL INFERENCE

1. Large Sample Tests: Means, Variances and Proportions
2. Tests based on Chi-square statistic: Population variance, Homogeneity of correlation coefficient, Bartlett's test.
3. Test based on t statistic: Single mean, Difference of means, Paired t test, Correlation coefficient, Regression coefficient.
4. Tests based on F statistic: Equality of two population variances
5. Non-parametric tests – Sign test, Wilcoxon test, Mann-Whitney U test, Median test, Run test, Chi-square goodness of fit test and Kolmogorov –Smirnov one sample test

II. STATISTICAL QUALITY CONTROL

1. \bar{X} and R chart
2. p chart and np chart
3. Control chart for number of defects
4. Single Sampling Plan – OC, ATI, AOQ curves
5. Double Sampling Plan - OC, ATI, AOQ curves

Unit I

Basic Principles for designing statistical experiments: Randomisation, Replication and local control techniques; determination of experimental units and notion of experimental error. Analysis of variance with one-way and two-way classifications; Models and Methods of analysis.

Unit II

Completely randomized and randomized block designs - Models and estimates of parameters and their standard error - Analysis of data arising from such designs, Analysis when one or two observations are missing.

Unit III

Latin Square Design – Model – Estimation of parameters – Method of analysis – Missing Plot technique in LSD - Analysis of covariance - One-way classification only

Unit IV

Multiple Comparison tests: LSD , Student-Newman–Keuls test , Duncan’s Multiple range test, Tukey’s test - Transformations to stabilize the variance .

Unit V

Factorial Experiments: 2^2 , 2^3 and 3^2 designs; estimation of main effects and interactions and their standard errors - Principles of confounding

Books for Study

1. Das.M.N. and Giri.N.C. (1986): Design and Analysis of Experiments, Wiley eastern.
2. Gupta .S.C. and Kapoor.V.K.(2000): Fundamentals of Applied Statistics, Sultan Chand.

Books for Reference

1. Kempthorne. O. (1965): The Design and Analysis of Experiments , Wiley eastern.
2. Goon.A.M, Gupta and Dasgupta.B. (2001): An Outline of statistical theory, vol. II, 6/e World Press Calcutta.
3. Montgomery.C.D (1976): Design of Experiments, John Wiley and Sons.
4. Parimal Mukhopadhyay(2005):Applied Statistics, 2/e, Books and Allied (P) Ltd, Kolkata.

Unit I

Index Numbers; Construction of index numbers ; fixed and chain base index numbers; weighted index numbers; standard index numbers ; Tests for index numbers ; cost of living index number and its construction.

Unit II

Time Series Analysis: Time Series models - Components of a time series - Methods of trend and isolation – Moving average, Seasonal indices, Ratio to trend, Link relative methods - Cyclical fluctuations

Unit III

Sources of Demographic data: Measures of mortality – Crude and specific rates, standardized rates, Infant mortality rate, Complete life table , its construction and uses. Abridged life tables

Unit IV

Measures of fertility: CBR, ASBR, GFR and TFR, Crude, Specific and standardized rates - Measures of migration, Population growth rates; GRR and NRR.

Unit V

Educational Statistics, methods of standardization of scales and tests; Z- scores, standard scores, T- scores and percentile scores ; validity of test score and its determination; Intelligence Quotient, its measurement and uses.

Books for Study

1. Kapoor.V.K. and Gupta.S. (2000): Fundamentals of Applied Statistics,Sultan Chand and Sons.
2. Parimal Mukhopadhyay(2005):Applied Statistics, 2/e, Books and Allied (P) Ltd, Kolkata.

Books for Reference

1. Goon.A.M., Gupta.M.K. and DasGupta .B (1999) : Fundamental of Statistics , Vol. II, World Press , Calcutta.
2. Bogue.D.J.(1969) : Principles of Demography , John Wiley.
3. Misra.B.D.(1982): An Introduction to the Study of Population, South Asian Publishing.

I. DESIGN OF EXPERIMENTS

1. Completely Randomised Design
2. Randomised Block Design and R.B.D. with one or two missing values
3. Latin Square Design and L.S.D. with one missing value
4. 2^2 Design, 2^3 Design and 3^2 Design
5. Total Confounding in 2^3 experiments
6. Analysis of Covariance – CRD

II. APPLIED STATISTICS

1. Time series: Straight line trend by method of least squares, moving average method
2. Seasonal fluctuations: Method of simple averages, Ratio to trend method, Ratio to moving average method and Link relative method.
3. Index numbers: Calculation of indices using Laspeyre's, Paasche's, Marshall-Edgeworth, Bowley's and Fisher's formula.
4. Cost of Living indices.
5. Crude specific and Standardised death rates
6. Construction of life tables and abridged life tables.

Unit I

Convergence of infinite numerical sequences and series (review only) – Absolute and conditional convergence – Sequences and series of functions – Pointwise and Uniform convergence – Tests for Uniform convergence – Properties of Uniform convergence

Unit II

Riemann - Stieltjes integral: Definition and properties – Integrals with step function and monotonic functions as integrators and their properties – Mean value theorem, Taylors theorem – Evaluation of Riemann - Stieltjes integral – Fundamental theorem

Unit III

Functions of several variables : Limits and continuity – Partial derivatives and Differentiability - Properties of differentiable functions – Higher order derivatives and differentials – Taylors theorem - Maxima and Minima – Extrema under constraints

Unit IV

Vector space and sub-space – Linear independence and orthogonality – Dimension and basis of a vector space – Orthonormal basis – Gram-Schmidt orthogonalization – Matrices: Rank, inverse, trace and their properties – Characteristic roots and vectors – Orthogonal Matrices and its properties - Idempotent and partitioned matrices

Unit V

G-inverse and Moore Penrose inverse - their properties – Reduction of a matrix into diagonal, echelon, canonical and triangular forms – Quadratic forms – reductions of different types – Definite quadratic forms – Cochran's theorem

Books for Study

1. Rudin.W(1976): Principles of Mathematical Analysis, Mc Graw Hill
2. Malik .S.C. and Arora(1987): Mathematical Analysis , Wiley Eastern Ltd.,
3. Datta, K.E (1991): Matrix and Linear Algebra, Prentice-Hall of India Private Ltd.,
4. Rao, C.R (1973): Linear Statistical Inference and its Applications, Wiley Eastern Ltd.,
5. Searle, S.R (1982): Matrix Algebra useful for Statistics, John Wiley, NY.

Books for Reference

1. Apostol T.M.(1985): Mathematical Analysis, Narosa Publishing House.
2. Goldberg .R.R. (1970): Methods of Real Analysis, Oxford and IBH Publishing Co.(P) Ltd., New Delhi.
3. Shanti Narayan (1993): Mathematical Analysis, Sultan Chand and Co.
4. Gilbert and Gilbert (2005): Linear Algebra and Matrix Theory, Elsevier Publications.
5. Graybill, F.A.(1983): Matrices and applications in statistics, Wadsworth Publishing Company, Belmont, California, USA.
6. Ramachandra Rao, A.and Bhimasankaran, P.(1992): Linear Algebra , TMH.
7. Khuri A.I.(1995): Mathematical Methods for Statistics, Birkauser

Unit I

Algebra of sets - fields and sigma-fields, Inverse function – Measurable function – Probability measure on a sigma field – simple properties - Probability space - Random variables and Random vectors – Induced Probability space – Distribution functions – Decomposition of distribution functions.

Unit II

Expectation and moments – definitions and simple properties – Moment inequalities – Holder, Jensen Inequalities– Characteristic function – definition and properties – Inversion formula.

Unit III

Convergence of a sequence of r.v.s. - convergence in distribution, convergence in probability, almost sure convergence and convergence in quadratic mean - Weak and Complete convergence of distribution functions – First Helly's theorem

Unit IV

Definition of product space – Fubini's theorem (statement only) - Independence of two events – Independence of classes – Independence of random variables – properties – Borel zero –one law.

Unit V

Law of large numbers - Khintchin's weak law of large numbers, Kolmogorov strong law of large numbers (without proof) – Central Limit Theorem – Lindeberg – Levy theorem, Linderberg – Feller theorem (statement only) – Liapounov theorem – Radon Nikodym theorem and derivative (without proof) – Conditional expectation – definition and simple properties.

Books for Study

1. Bhat, B. R. (1985). Modern Probability Theory – 3rd edition, New Age International Pvt. Ltd.

Books for Reference

1. Ash, R.B. (1972): Real Analysis and Probability, Academic Press.
2. Billingsley, P. (1979): Probability and Measure, Wiley.
3. Tucker, H.G. (1967): A Graduate course in Probability, Academic Press.
4. Burill, C.W. (1972): Measure, Integration and Probability, McGraw Hill.
5. Chow, Y.S. and Teicher, H. (1979): Probability Theory, Springer.
6. Loeve, M. (1985). Probability Theory, 3rd edition, Van Nostrand.
7. Resnick S.I. (2001): A Probability Path, Birkauser.

Unit I

Preliminaries – Sampling Designs – Simple random sampling– Probability Proportional to size sampling- Inclusion Probabilities – Horvitz-Thompson estimator – Yates –Grundy form – Hansen –Hurwitz estimator – Midzuno Sampling design

Unit II

PPSWOR - Ordered estimator and unordered estimators – Systematic Sampling Schemes – Linear, Circular, Balanced and Modified systematic sampling methods – Stratified Sampling – Allocation problems.

Unit III

Ratio estimates and their properties for Simple Random and Stratified Random sampling – Ratio estimator and Multivariate Ratio estimator - Regression Estimators – Regression estimates with pre assigned “b” – sample estimate of variance – Bias – Regression estimators in Stratified Sampling - Multivariate Regression Estimator.

Unit IV

Cluster Sampling: Equal cluster sampling – Estimators of mean and variance, optimum cluster size, Unequal cluster sampling – Estimators of mean and variance, varying probability cluster sampling - Two stage sampling – variance of the estimated mean – Double Sampling for stratification and Ratio estimation

Unit V

Randomized response methods - Sources of errors in Surveys - Mathematical model for the effects of call-backs and the errors of measurement – Official Statistical Systems in India – Role of NSSO and CSO and their activities – Organization of Large Scale Sample Surveys.

Books for Study

1. Cochran, W.G(1977): Sampling Techniques, Wiley Eastern Ltd., (Chapter 6 for Unit I, Chapter 7 for Unit II and Chapter 13 for Unit V)
2. Singh, D and Choudhary, F.S(1986): Theory and Analysis of Sample Survey Designs, Wiley Eastern Ltd., (Chapter 5 for Unit III and Chapter 8 for Unit IV)
3. Sukhatme et al (1984): Sampling Theory of Surveys with Applications, Iowa State University Press and IARS

Books for Reference

1. Desraj and Chandok (1998): Sampling Theory, Narosa Publications, New Delhi
2. Kish, L(1995) : Survey Sampling, John Wiley and Sons.
3. Murthy, M.N (1979): Sampling Theory and Methods, Statistical Publishing Society, Calcutta.
4. Sharon L Lohr (1999): Sampling : Design and Analysis, Duxbary Press
5. Sampath S(2000): Sampling Theory and Methods, Narosa Publishing House.
6. Sarjinder Singh (2004): Advanced Sampling - Theory with Applications, Kluwer Publications
7. Parimal Mukhopadhyay(2008): Theory and Methods of Survey Sampling, Books and Allied (P) Ltd, Kolkata.

Unit I

Brief review of distribution theory, distribution of functions of random variables - Laplace, Cauchy, Inverse Gaussian, lognormal, logarithmic series and power series distributions - Multinomial distribution

Unit II

Bivariate Binomial – Bivariate Poisson – Bivariate Normal- Bivariate Exponential of Marshall and Olkin - Compound, truncated and mixture of distributions, Concept of convolution

Unit III

Multivariate normal distribution and its properties – marginal and conditional distributions – characteristic function - Sampling distributions: Non-central chi-square, t and F distributions and their properties

Unit IV

Distributions of quadratic forms under normality-independence of quadratic forms and linear form- Cochran's theorem - Order statistics, their distributions and properties- Joint and marginal distributions of order statistics - Distribution of range and mid range - Extreme values and their asymptotic distributions (concepts only)

Unit V

Empirical distribution function and its properties, Kolmogorov Smirnov distributions, life time distributions - exponential and Weibull distributions - Mills ratio, distributions classified by hazard rate.

Books for Study

1. M. Mood, F.A.Graybill and D.C.Boes(2001) : Introduction to the Theory of Statistics, Tata McGraw-Hill, New Delhi.
2. Johnson, N.L,Kotz.S and Balakrishnan N(1994): Continuous Univariate Distributions, Vol.1 &2, Wiley Series in Probability and Statistics.
3. Johnson, N.L , Kemp A.W. & Kotz.S (1994): Univariate Discrete Distributions, Wiley Series in Probability and Statistics
4. David H. A. and Nagaraja H.N.(2003): Order Statistics, 3/e, John Wiley & Sons.

Books for Reference

1. Bhattacharya and Johnson(1977): Statistical Concepts and Methods, John Wiley.
2. Pitman J. (1993): Probability Distributions, Narosa Publishing House.
3. Rao C. R.,(1998): Linear Statistical Inference and its Applications, Wiley Eastern Ltd, New Delhi.
4. Dudewicz, E.J and Mishra, S.N(1980): Mathematical Statistics, John Wiley, NY.
5. Kocherlakota S and Kocherlakota K(1992), Bivariate Discrete distributions, M. Dekker.
6. Balakrishnan N and Lai C.D.(2009): Continuous Bivariate Distributions, Springer.
7. Parimal Mukhopadhyay(2006):Mathematical Statistics, 3/e, Books and Allied (P) Ltd, Kolkata.

I Sampling Theory (20 marks) (Calculator based)

1. Simple random sampling methods of drawing sample – Estimation of the population total and variance estimation.
2. PPSWR – Hurwitz Thompson estimator - Des Raj ordered estimator – Murthy's unordered estimator – Midzuno scheme.
3. Linear and circular systematic sampling.
4. Stratified sampling – SRS, PPSWR, PPSWOR
5. Cluster sampling – of equal sizes.
6. Ratio, Regression and Difference estimation.

II. Computations based on SYSTAT software (40 marks)

1. Random number generation. (i) Binomial, (ii) Poisson, (iii) Normal
2. Fitting of distributions – Binomial, Poisson and Normal
3. Computation of simple and multiple correlation coefficients
4. Statistical Tests
 - (i) Z test and Confidence Interval
 - (ii) One sample t-test and Confidence Interval
 - (iii) Two sample t-test and Confidence Interval
 - (iv) Chi-square test for independence of attributes
 - (v) Tests for homogeneity of proportions, variances and correlation coefficients
5. Non – Parametric Tests
 - (i) Run test
 - (ii) Sign test
 - (iii) Wilcoxon one sample test
 - (iv) Mann – Whitney U test
6. Design of Experiments
 - (i) One-way ANOVA
 - (ii) Two-way ANOVA

Unit I

Parametric point estimation – properties of estimators – Consistency and its different forms
Sufficient condition for consistency- Unbiasedness – sufficient statistics – Factorization theorem
- Distributions admitting sufficient statistic – Exponential and Pitman families procedure for
finding minimal sufficient statistic.

Unit II

The information measure – Cramer - Rao (CR) inequality - Chapman - Robbins (KCR)
inequality - Bhattacharya inequality - minimum variance bound estimator- Invariant
(equivariant) estimators (concepts only)

Unit III

Uniformly minimum variance unbiased estimators (UMVUE)- condition for the existence of
UMVUE- Completeness and Bounded completeness- Relation between complete statistic and
minimal sufficient statistic- Rao - Blackwell Theorem- Lehmann – Scheffe’s theorem.

Unit IV

Methods of estimation – method of moments and its properties - method of maximum likelihood
and its properties-Large sample properties of MLE - Method of minimum chi- square and its
properties – Methods of least squares – Optimum properties of least square estimates in linear
model.

Unit V

Interval estimation – Pivotal method of construction - shortest confidence intervals and their
construction (minimum average width) - Construction of shortest confidence intervals in large
samples.

Notion of Bayes estimation – Concepts of prior, posterior and conjugate priors. Simple
problems involving quadratic error loss function - Elementary notions of minimax estimation -
Simple illustrations – Bayesian confidence intervals.

Books for Study

1. Rohatgi, V.K(1986): Statistical Inference, Wiley Eastern Ltd,.
2. Kale .B.K. (1999): A First course on parametric inference , Narosa Publishing House.
3. Zacks,S (1981): Parametric Statistical Inference, John Wiley, NY.

Books for Reference

1. Goon, A.M, Gupta,M.K, and Das Gupta, B.C(1980) : An outline of Statistical Theory, Vol. II,The World Press, Calcutta.
2. Lehmann, E.L and Casella G(1998) :Theory of Point Estimation, 2/e, Wiley Eastern Ltd.
3. Mood, A.M., Graybill, F.A and Boers, D.C(1974) : Introduction to Theory of Statistics, Mc Graw-Hill Book Company.
4. Rao, C.R(1998): Linear Statistical Inference and its Applications, Wiley Eastern Ltd,.
5. Casella, G and Berger, R.L(2002):Statistical Inference, Duxubury Process, Belmont, USA.
6. Parimal Mukhopadhyay(2006):Mathematical Statistics, 3/e, Books and Allied (P) Ltd, Kolkata.

STAT 422 – STATISTICAL QUALITY CONTROL AND OPERATIONS RESEARCH

CREDITS: 4

Unit I

Quality improvement: Meaning of quality and quality improvement – Different types of Quality costs and their management

Control charts: Review of \bar{X} , R, p, c, d charts - Modified control charts for mean – CUSUM chart – technique of V-mask – Weighted Moving average charts – Slogging control charts and group control charts

Unit II

Process Capability analysis: Meaning, Estimation technique for capability of a process – Capability Indices: C_p , capability ratio and C_{pk} index – Estimation of natural tolerance limit of a process

Acceptance Sampling plans for attributes: Single, double, multiple and continuous sampling plans for attributes (Dodge type)

Unit III

Acceptance Sampling plans for variables: one sided and two sided specification – Standardized plans (ANSI/ANSQ Z1.9) and MIL-STD-414

Taguchi's Loss function – Signal to Noise ratio – 5S concepts, Kaizen

Unit IV

Review of LPP – Simplex and revised simplex methods - Duality in LPP – Dual Simplex method – Some important theorems on duality - Sensitivity Analysis – Variation in cost vector 'c' – Variation in the requirement vector 'b' – Addition and deletion of single variable – Addition and deletion of single constraint

Unit V

Replacement problem – Replacement of policy when value of money changes/does not change with time – Replacement of equipment that fails suddenly – Group replacement – Simulation – Introduction and Scope – Monto-carlo Simulation – Random Number Generation – Role of Computers in Simulation

Books for Study

1. Douglas C. Montgomery (2009): Introduction to Statistical Quality Control, 6/e, John Wiley and Sons, New York.
2. Hamdy A. Taha (2006) : Operations Research – An Introduction, 8/e, Prentice Hall of India Private Ltd, New Delhi.

Books for Reference

1. Mahajan,M(1998): Statistical Quality Control, Dhanpat Rai & Co Private Ltd., New Delhi.
2. Gupta,H.D (1984): Quality assurance through ISO 9000, South Asia Publication, New Delhi
3. Smith, G.M(1991): Statistical Process Control and Quality Improvement, 3/e, Printice Hall, New York.
4. Tapan K Pakchi – Taguchi Methods Explained, Wiley Eastern Publications
5. Sinha S M (2006): Mathematical Programming : Theory and Methods, Elsevier Publications.
6. Mittage, H.J and Rinne, H(1993): Statistical Methods of Quality Assurance, Chapmann Hall, London, UK
7. Kombo N.S.(1997): Mathematical Programming Techniques, Affiliated East-West Press
8. Kapoor V.K.(2008): Operations Research, 8/e, Sultan Chand & Sons
9. Hillier F S and Libermann G J(2002): Introduction to Operations Research, 7/e, McGraw Hill

Unit I

Stochastic processes and their classification – Markov chain– Examples (Random walk, Gambler's ruin problem)- classification of states of a Markov chain-Recurrence-Basic limit theorem of Markov chains-Absorption probabilities and criteria for recurrence.

Unit II

Markov chains continuous in time – General pure birth processes and Poisson process, birth and death processes, finite state continuous time Markov chains.

Unit III

Branching processes discrete in time – Generating functions relations – Mean and variance – Extinction probabilities – Concept of Age dependent Branching process

Unit IV

Renewal processes – Definition and examples – key renewal theorem – Study of residual life time process –

Unit V

Stationary process – weakly and strongly stationary process – Moving average and Autoregressive processes and their covariance functions - Brownian Motion process – Joint probabilities for Brownian motion process – Brownian motion as a limit of random walk

Books for Study

1. Karlin, S and Taylor H.M (1975): A First Course in Stochastic Processes, Academic Press, New York.
2. Medhi,J (2009): Stochastic Processes, 3/e, New age International.
3. Sidney I. Resnick(1992):Adventures in Stochastic Processes, Birkhauser, Boston.

Books for Reference

1. Bhattacharya and Waymire, E.C. (1992): Stochastic Process with Applications John Wiley and sons.
2. Jones,P.W and Smith,P(2001): Stochastic Processes: An Introduction, Arnold Press.
3. Cinlar, E(1975): Introduction to Stochastic Processes, Prentice-Hall Inc., New Jersey.
4. Cox, D.R and Miller, H.D(1983) : Theory of Stochastic Processes – Chapman and Hall, HallLondon,Third Edition
5. Prabu N.U. (1965): Stochastic Processes Macmillan.
6. Ross S.M (1983): Stochastic Process, Wiley.

I. Estimation (20 marks) (Calculator based)

1. MLE and Standard error of ML estimators.
2. MLE through the method of successive approximation.
3. MLE for truncated distribution.
4. Method of Moments
5. Method of Minimum Chi-square
6. Method of Least square
7. Interval estimation: Confidence interval for mean, difference of means, variance and ratio of variances.

II. Statistical Quality Control (20 marks) (Calculator based)

Control charts:

- i. CUSUM chart
- ii. Modified Control chart
- iii. Moving Average Control chart
- iv. Exponentially Weighted Moving Average chart
- v. Sloping Control Chart

Acceptance sampling:

- i. Single sampling plans and double sampling plans (for attributes)
- ii. Variable Sampling plans (Single and double specifications)
- iii. Standard plans

III. Computations Based on SPSS software (20 marks)

1. Basics – Import and Export of data files, Recoding, computing new variables – Descriptive statistics.
2. Selection of cases, splitting and merging of files.
3. Computation of simple, multiple, partial and rank correlation coefficients.
4. Computation of simple regression.
5. Fitting of curves – Linear, parabola, cubic and exponential.
6. Testing of Hypothesis – t, F, Chi square and one way ANOVA.

Unit I

Maximum likelihood estimation of the parameters of Multivariate Normal and their sampling distributions – Inference concerning the mean vector when covariance matrix is known - Total, Partial, Multiple correlation in the Multivariate setup – MLEs of Total, Partial and Multiple correlation coefficients and their sampling distributions in the null case

Unit II

Hotelling T^2 distribution and its applications - derivation of generalized T^2 statistic and its distribution - Uses of T^2 statistic - optimum properties of T^2 statistic - Mahalanobis D^2 statistic and its distribution - relation between T^2 and D^2 – Test based on T^2 statistic

Unit III

Generalized variance - Wishart distribution (statement only) – Properties of Wishart distribution - Test for covariance matrix – Test for equality of covariance matrices – Test for independence of sets of variables

Unit IV

Classification problems - Classification into one of two populations (known and unknown dispersion matrix) - Classification into one of several populations – Linear discriminant function – Multivariate analysis of variance (MANOVA) – One- Way classification .

Unit V

Principal components - Definition- Maximum likelihood estimates of the principal components and their variances – Extraction of Principal components and their variances. Factor analysis - Mathematical model- Estimation of Factor Loadings – Canonical correlation – Estimation of canonical correlation and variates – Concept of factor rotation – Varimax criterion

Books for Study

1. Anderson, T.W(2003) : An Introduction to Multivariate Statistical Analysis, Wiley Eastern Ltd.
2. Johnson, Richard A and. Wichern D.W (2007): Applied Multivariate Statistical Analysis, 6/e, Prentice-Hall of India Private Ltd., New Delhi.

Books for Reference

1. Giri, N.C(1977): Multivariate Statistical Inference, Academic Press, NY
2. Morrison, F (1985): Multivariate Statistical Methods, Mc Graw Hill Book Company.
3. Rao, C.R (1998): Linear Statistical Inference and its Applications, Wiley Eastern Ltd.,
4. Jolliffe I.T. (2002): Principal Component Analysis, 2/e, Springer.
5. Alvin C. Rencher (2002): Methods of Multivariate Analysis, 2/e, Wiley Interscience
6. Kshirsagar A.M. (1972): Multivariate Analysis, M.Dekker.
7. Srivastava M.S. and Khatri C.G.(1979):Introduction to Multivariate Analysis, Elsevier

Unit I

Randomized and non-randomized tests, Neyman – Pearson fundamental lemma, Most powerful tests, Uniformly most powerful test, Uniformly most powerful test for distributions with monotone likelihood ratio, Generalization of fundamental lemma and its applications

Unit II

Unbiasedness for hypothesis testing, Uniformly most powerful unbiased tests, Unbiased tests for one parameter exponential family, Similar test and complete sufficient statistics, Similar tests with Neyman structure, Uniformly most powerful unbiased tests, Locally most powerful tests.

Unit III

Invariant tests, maximal invariants, Uniformly most powerful invariant tests, Consistent tests, Likelihood ratio test, its properties and its asymptotic distribution, Applications of the LR method.

Unit IV

Non-parametric tests: Goodness of fit test : Chi-square and Kolmogorov Smirnov test - Test for randomness, Wilcoxon Signed rank test – Two sample problem: Kolmogorov-Smirnov test, Wald-Wolfowitz run test, Mann-Whitney U test, Median test -k- sample problem: Extension of Median test, Kruskal Wallis test, Friedman test – Notion of ARE.

Unit V

Sequential methods: Sequential unbiased estimation – Application to Normal distribution - Sequential test - Basic Structure of Sequential tests – Sequential Probability Ratio Test (SPRT) and its applications – Determination of the boundary constants – Operating Characteristic and expected sample size of SPRT - Optimum properties of SPRT.

Books for Study

1. Lehmann, E.L and Joseph P. Romano(2005): Testing Statistical Hypotheses, 3/e, Springer.
2. Rohatgi, V.K (1986): An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern Ltd., New Delhi.
3. Kale .B.K. (1999):A First course on Parametric Inference , Narosa Publishing House.
4. Gibbons .J.D. (1985) : Non Parametric Statistical Inference , 2/e , Marckel Decker.

Books for Reference

1. Rao, C.R (1998): Linear Statistical Inference and its Application, John Wiley, Second Edition.
2. Casella, G & Berger, R.L (1990):Statistical Inference , Duxubury Press, Belmont. USA
3. Wald, A(1949): Sequential Analysis, John Wiley, NY
4. Ghosh,B.K(1970): Sequential Tests of Statistical Hypotheses, Addison Wesley.
5. Parimal Mukhopadhyay(2006):Mathematical Statistics, 3/e, Books and Allied (P) Ltd, Kolkata.
6. Manoj Kumar Srivastava and Namita Srivastava (2009): Statistical Inference – Testing of Hypotheses, Prentice Hall of India

Unit I

Full rank linear model – least square estimators of the parameters and their properties – Gauss-Markov theorem - Model in centered form – Estimators under normality assumption and their properties – Coefficient of determination – Generalized least squares – misspecification of the error structure and the model.

Unit II

Test for overall regression and for a subset of the parameters – test in terms of R^2 – General Linear Hypothesis testing – special cases – confidence region for the parameters and the mean – prediction intervals – likelihood ratio tests for the parameters – study of the residual outliers and influential observations

Unit III

Selection of input variables and model selection – Methods of obtaining the best fit - Stepwise regression, Forward selection and backward elimination – Multicollinearity – Collinearity diagnostics – Causes, Consequences and Remedy

Unit IV

Introduction to general non-linear regression – Least squares in non-linear case – Estimating the parameters of a non-linear system – Reparametrisation of the model – Non-linear growth models – Concept of non-parametric regression

Unit V

Robust regression – Linear absolute deviation regression – M estimators – Robust regression with rank residuals – Resampling procedures for regression models – methods and its properties (without proof) - Jackknife techniques and least squares approach based on M-estimators.

Books for Study

1. Draper, N and Smith, H(1981) : Applied Regression Analysis , Second Edition.
2. Alvin C. Rencher (2000): Linear Models in Statistics, John Wiley & Sons, New York (Chapters 7,8 & 9 for Unit I & II)
3. Elizabeth C. Peck, Douglas C. Montgomery, G. Geoffrey Vinning (2006): Introduction to Linear Regression Analysis, 3/e, John Wiley & Sons.

Books for Reference

1. Chatterjee, S and Price, B (1971): Regression Analysis by Example, John Wiley.
2. Gunst, R.F and Mason, R.L (1980): Regression Analysis and Applications – A Data Oriented Approach, Marcel Dekker.
3. Guttman, I (1982): Linear Models - An Introduction , John Wiley.
4. Kshirsagar, A.M (1972): Course in Linear Models, Marcel Dekker.
5. Wetherill, G.B (1986): Regression Analysis.
6. Searle, S.R.(1971): Linear Models, John Wiley.
7. Thomas P.Ryan(2006): Modern Regression Methods, John Wiley and Sons,Inc.
8. Seber G.A.F and Wild C.J. (2003): Nonlinear Regression, John Wiley & Sons

(Based on STAT 531, STAT 532 and STAT 533)**I Multivariate analysis (20 marks) (Calculator based)**

1. Maximum likelihood estimators – Mean vector and dispersion matrix, Test for Mean Vectors (Σ known and unknown)
2. Test for covariance matrix
3. Discriminant analysis
4. Principal Component Analysis
5. Canonical correlation and canonical variables

II Testing of hypothesis (10 marks) (Calculator based)

1. Construction of randomized and nonrandomized MP, UMP and UMPU tests of hypotheses and drawing the power curves.
2. Construction of SPRT and its OC and ASN curves.
3. Non parametric tests:
Kolmogorov Smirnov test, Mann-Whitney U test, Median test for k-sample problem, Kruskal Wallis test and Friedman's test

III Linear Models and Regression Analysis (10 marks) (Calculator based)

1. Fitting of Multiple linear regression model
2. Residual Analysis for model adequacy, detection of outliers and influential observations
3. Tests of General Linear Hypotheses

IV Advanced Statistical Analysis using SPSS software (20 marks)

1. Computation of Multiple linear regression.
2. Computation of Hotelling T^2 statistic.
3. Discriminant Analysis and MANOVA.
4. Non Parametric tests: Kruskal – Wallis, Friedman, Kolmogorov – Smirnov, McNemer, Median tests.
5. Factor Analysis.

Unit I

Notion of design matrix- general analysis of design models (Inter and Intra Block analysis) – C Matrix and its properties – EMS and its uses, Algorithm for calculating EMS - Two way elimination of heterogeneity – Orthogonality – Connectedness and resolvability

Unit II

Principles of scientific experimentation – Pen and Plot techniques - Basic Design: CRD, RBD and LSD, Analysis of RBD (with one observation per cell, More than one but equal number of observations per cell) – Derivation of one and two missing values: Iterative and non-iterative methods – Loss of Efficiency due to missing values- Multiple comparison test: LSD, SNK, DMR, Tukey tests.

Unit III

Factorial experiments: 2ⁿ and 3ⁿ experiments and their analysis – Complete and Partial Confounding - Fractional Replication in Factorial Experiments – Split plot and strip plot design and their analysis .

Unit IV

BIBD - Types of BIBD - Simple construction methods - Concept of connectedness and balancing – Intra Block analysis of BIBD – Recovery of InterBlock information – Partially Balanced Incomplete Block Design with two associate classes – intra block analysis only.

Unit V

Youden square and lattice design and their analysis – Analysis of Covariance with one concomitant variable – Analysis for CRD and RBD only –Response Surface Designs – Method of Steepest Ascent- Taguchi Orthogonal Array Experiments

Books for Study

1. Das, M.N. and Giri, N.C(1979): Design and Analysis of Experiments, Wiley Eastern Ltd, (Relevant Chapters for Units II, III, IV and V)
2. Douglas C. Montgomery (2009) : Design and Analysis of Experiments, 7/e, John Wiley and Sons, (Chapter 16 for Parts of Unit IV and Unit V)
3. Graybill, F.A(1961) : An Introduction to Linear Statistical Models, Mc Graw Hill Book Company,(Chapter 5 & Parts of Chapter 6 for Unit I)
4. Tapan K Bakchi(1993) – Taguchi Methods Explained, Prentice Hall of India

Books for Reference

1. John, P.W.M (1971) : Statistical Design and Analysis of Experiments, Mc Graw Hill Book Company.
2. Kempthorne, O(1966): The Design and Analysis of Experiments, John Wiley and Sons.
3. Ragahavarao, D(1971): Constructions and Combinatorial Problems in Design of Experiments, John Wiley and Sons.
4. Searle, S.R(1987) : Linear Models, John Wiley and Sons.
5. Cochran .W.G. and Cox .G.M. (1995) : Experimental designs, 4/e, Wiley .
6. Cobb G.W.(1998): Introduction to Design and Analysis of Experiments.
7. Parimal Mukhopadhyay(2005):Applied Statistics, 2/e, Books and Allied (P) Ltd, Kolkata.

I. Design of Experiments (30 marks) (Calculator based)

1. Multiple Comparison tests
2. 2^4 , 3^2 , 3^3 factorial experiment
3. Complete and partial confounding in 2^4 , 3^2 , 3^3 factorial experiments
4. Fractional factorial
5. Split plot design and Strip plot design
6. Missing data analysis
7. BIBD
8. PBIBD with two associate classes
9. Youden Square Design
10. Analysis of Covariance – CRD and RBD

II. Computations based on R programming language (30 marks)

1. Creating objects, vectors, sequence, lists, arrays and matrices and performing basic operations.
2. Generating random numbers from Uniform, Binomial, Poisson, Normal, Multivariate Normal and Exponential distributions and fitting of the distributions.
3. Creating data frames – reading from a text file – using data editor to create a data frame.
4. Computation of descriptive statistics, correlation and regression coefficients.
5. One and two sample t tests, one way and two way ANOVA.

STAT 543 – PROJECT AND VIVA-VOCE**CREDITS: 4**

1. A project work is compulsory and shall be offered in semester IV. It will have 4 credits.
2. A project work may be taken individually or by a group of two students.
3. Project work shall be supervised by a faculty member assigned by the Head of the Department in the beginning of the semester.
4. The project work should be selected in such a way that there is enough scope to apply and demonstrate the statistical techniques learnt in the course.
5. At the end of the semester, before the last working day, a report on the work done should be submitted (two copies). If a team of two students jointly do a project work then they must submit individual reports separately (not copy of the same report).
6. The project report shall clearly state the selected problem, the statistical methodologies employed for data collection and analysis and the conclusions arrived at. Details of previous studies in the area and related references should also be given.
7. The project work will be assessed for a maximum of 100 marks. Each student will give a seminar before the end of the semester on their project work which will be evaluated internally for a maximum of 30 marks. There will be viva-voce examination for a maximum of 10 marks by an internal and an external examiner. The project report will be valued by the same external and internal examiner for a maximum of 60 marks.

SOFT CORE PAPERS

SEMESTER VIII

STAT 425 - STATISTICAL DATA MINING METHODS

CREDITS: 3

Unit I

Introduction to data mining – data types – Measures of similarity and dissimilarity – Data mining tools – supervised and unsupervised learning – Introduction to Cluster Analysis – Types of clustering – Agglomerative Hierarchical clustering algorithm – Issues – strength and weaknesses.

Unit II

Basic k-means algorithm – Issues – Bisecting k-means – fuzzy clustering – fuzzy c means algorithm - cluster evaluation – unsupervised and supervised measures - Introduction to classification – Decision Trees – Building a decision tree – Tree induction algorithm – Splitting of nodes based on information gain and Gini index – model over fitting – Evaluating the performance of a classifier

Unit III

Nearest Neighbor classifiers – kNN algorithm – Naïve Bayesian classifier – Binary logistic regression – odds ratio – Interpreting logistic regression coefficients – Multiple logistic regression

Unit IV

Association rules mining – Basics – Apriori algorithm – Pruning and candidate generation – Rule mining.

Unit V

Case studies based on k means clustering, fuzzy c means clustering, kNN classification, Binary logistic regression using R programming language or Excel Miner.

Books for study

1. Tan, T., Steinbach, M. and Kumar, V. (2006): Introduction to Data Mining, Pearson Education. (relevant portions of Chapters 1, 2, 4, 5 and 8).
2. Gupta, G.K. (2008): Introduction to Data Mining with case studies, Prentice – Hall of India Pvt. Ltd. (relevant portions of Chapter 2)
3. Daniel T. Larose (2006): Data Mining: Methods and Models, John Wiley and sons. (relevant portions of Chapter 4).

Books for reference

1. Han, J. and Kamber, M. (2006): Data Mining: Concepts and Techniques, 2nd Edition, Morgan Kaufmann Publishers.
2. Paolo Gludici (2003): Applied Data Mining: Statistical Methods for Business and Industry, John Wiley and sons.
3. Rajan Chattamvelli (2009): Data Mining Methods, Narosa Publishing House, New Delhi.

Unit I

Nature and Scope of Econometrics. The General Linear Model (GLM) and its extensions. Ordinary Least Squares (OLS)-estimation and prediction. Use of dummy variables and seasonal adjustment. Generalized Least Squares (GLS) estimation and prediction. Heteroscedastic disturbances- pure and mixed estimation. Grouping of observations and of equations.

Unit II

Auto correlation, its consequences and tests. Theil BLUS procedure, Estimation and prediction. Multicollinearity problem, its consequences, detection, implications and tools for handling the problem. Ridge regression.

Unit III

Linear regression with stochastic regressors. Instrumental variable estimation. Errors in variables. Autoregressive linear regression. Distributed lag models. Use of principal components, canonical correlations and discriminant analyses in econometrics.

Unit IV

Simultaneous linear equations model. Identification problem. Restrictions on structural parameters - rank and order conditions. Restrictions on variances and covariances. Estimation in simultaneous equations model.

Unit V

2 SLS Estimators. Limited information estimators, k-class estimators. 3 SLS estimation. Full information maximum likelihood method. Prediction and simultaneous confidence intervals. Monte Carlo studies and simulation.

Books for Study

1. Gujarati, DN (2003): Basic Econometrics, McGraw Hill.
2. Johnston, J. (1984): Econometric methods, Third edition, McGraw Hill.
3. Nachane. DM (2006): Econometrics: Theoretical Foundations and Empirical Perspective, Oxford University Press.

Books for Reference

1. Cramer, J.S. (1971): Empirical Econometrics, North Holland.
2. Intrulligator, MD (1980): Econometric models - Techniques and applications, Prentice Hall of India.
3. Klein, L.R. (1962): An introduction to Econometrics, Prentice Hall of India.
4. Koutsoyiannis, A (1979): Theory of Econometrics, Macmillan Press.
5. Malinvaud, E (1966): Statistical methods of Econometrics, North Holland.
6. Theil, H. (1982): Introduction to the theory and practice of Econometrics, John Wiley.
7. Walters, A (1970): An introduction to Econometrics, McMillan & Co.
8. Wetherill, G.B. (1986): Regression analysis with applications, Chapman Hall.
9. Apte, PG (1990): Text book of Econometrics. Tata McGraw Hill.

STAT 427 - DEMOGRAPHIC TECHNIQUES

CREDITS: 3

Unit I

Sources of demographic Statistics, Basic demographic measures: Ratios, Proportions and percentages, Population Pyramids, Sex ratio Crude rates, Labour force participation rates, Density of population, Probability of dying.

Unit II

Life tables: Construction of a life table, Graphs of l_x , q_x , d_x , Functions L_x , T_x , and E_x . Abridged life tables Mortality: Rates and Ratios, Infant mortality, Maternal mortality, Expected number of deaths, Direct and Indirect Standardization, Compound analysis, Morbidity.

Unit III

Fertility: Measures of Fertility, Reproductively formulae, Rates of natural increase, Fertility Schedules, Differential fertility, Stable Populations, Calculation of the age distribution of a stable population, Model Stable Populations.

Unit IV

Population estimates, Population Projections: Component method, Mortality basis for projections, Fertility basis for projections, Migration basis for projections,

Unit V

Ageing of the population, Estimation of demographic measures from incomplete data.

Books for Study

1. Pollard, A. H. Yusuf, F. and Pollard, G.N. (1990). Demographic Techniques, Pergamon Press, Chapters 1-8, 12.

Reference Books

1. Keyfitz, N. (1977) Applied Mathematical Demography A Willey-Interscience Publication.
2. Keyfitz, N. (1968) Introduction to the Mathematics of Population Reading, Mass: Addison-Wesley.
3. Keyfitz, N. and Caswell, H. (2005) Applied Mathematical Demography, Third edition, Springer.

Unit I

Subjective Interpretation of probability in terms of fair odds. Evaluation of (i) Subjective probability of an event using a subjectively unbiased coin (ii) Subjective prior distribution of a parameter - Bayes theorem and computation of the posterior distribution.

Unit II

Natural Conjugate family of priors for a model. Hyper parameters of a prior from conjugate family. Conjugate families for (i) exponential family models. (ii) models admitting sufficient statistics of fixed dimension. Enlarging the natural conjugate family by (i) enlarging hyper parameter space (ii) mixtures from conjugate family, choosing an appropriate member of conjugate prior family. Non informative, improper and invariant priors. Jeffrey's invariant prior.

Unit III

Bayesian point estimation: as a prediction problem from posterior distribution. Bayes estimators for (i) absolute error loss (ii) squared error loss (iii) 0 -1 loss. Generalization to convex loss functions. Evaluation of the estimate in terms of the posterior risk.- Bayesian interval estimation : Credible intervals. Highest posterior density regions - Interpretation of the confidence coefficient of an interval

Unit IV

Bayesian Testing of Hypothesis: Specification of the appropriate form of the prior distribution for a Bayesian testing of hypothesis problem - Prior odds, Posterior odds, Bayes factor for various types of testing hypothesis problems depending upon whether the null hypothesis and the alternative hypothesis are simple or composite. Specification of the Bayes tests in the above cases. Discussion of Lindley's paradox for testing a point hypothesis for normal mean against the two sided alternative hypothesis.

Unit V

Bayesian prediction problem - Large sample approximations for the posterior distribution - Bayesian calculations for non conjugate priors: (i) Importance sampling, (ii) Obtaining a large sample of parameter values from the posterior distribution using Acceptance – Rejection methods, Markov Chain Monte Carlo methods and other computer simulation methods.

Books for Study

1. Berger, J.O.(1985): Statistical Decision Theory and Bayesian Analysis, 2/eSpringer Verlag.
2. Robert C.P. and Casella, G.(2004): Monte Carlo Statistical Methods, 2/e, Springer Verlag.
3. Leonard T. and Hsu, J.S.J. (1999): Bayesian Methods: An Analysis for Statisticians and Interdisciplinary Researchers, Cambridge University Press.
4. Bansal A.K.(2007): Bayesian Parametric Inference, Narosa Publications
5. Lee, P(1997): Bayesian Statistics: An Introduction, 2/e, Oxford University Press

Books for Reference

1. DeGroot M.H.(2004): Optimal Statistical Decisions, Wiley-InterScience.
2. Bernardo. J.M. and Smith, A.F.M.(1994): Bayesian Theory, John Wiley and Sons.
3. Robert, C.P.(2001): The Bayesian Choice : A decision Theoretic Motivation, 2/e, Springer.
4. Gemerman, D. Markov Chain Monte Carlo(1997): Stochastic Simulation for Bayesian Inference. Chapman Hall.
5. Box, G.P. and Tiao, G.C.(1973): Bayesian Inference in Statistical Analysis, Addison – Wesley.

**SOFT CORE PAPERS
SEMESTER IX**

STAT 535 – RELIABILITY THEORY

CREDITS: 3

Unit I

Introduction to Reliability and its needs; Structural properties of coherent system: components and systems, coherent structures, representation of coherent systems in terms of paths and cuts, relevant & irrelevant structure; Modules of coherent systems; Reliability of a coherent systems; Reliability importance of components; Bounds on System Reliability.

Unit II

Life Distributions: Concept of distribution function, hazard function, Reliability function, MTTF, Bathtub failure rate; loss of memory property of Exponential distribution; parametric families of some common life distributions – exponential, Weibull and Gamma and its characterization; Reliability estimation of parameters in these models.

Unit III

Notions of Ageing; Classes of life distributions and their duals: IFR, IFRA, NBU, DMRL, NBUE, HNBUE (Duals: DFR, DFRA, NWU, IMRL, NWUE, HNWUE) ; preservation of life distribution classes for reliability operation: Formation of coherent systems, convolutions and mixtures.

Unit IV

Univariate stock models and life distributions arising out of them: cumulative damage model, shock models leading to univariate IFR, Successive shock model; bivariate shock models; common bivariate exponential distributions due to shock and their properties.

Unit V

Reliability growth models; probability plotting techniques; Hollander –Proschan and Deshpande tests for exponentiality – Basic ideas of accelerated life testing.

Books for Study

1. Barlow R.E. and Proschan F. (1985) Statistical Theory of Reliability and Life Testing; Rinehart and Winston.
2. Lawless J.F. (2003): Statistical Models and Methods of Life Time Data; John Wiley.

Books for Reference

1. Bain L.J. and Max Engelhardt (1991): Statistical Analysis of Reliability and Life Testing Models; Marcel Dekker.
2. Nelson, W (1982): Applied Life Data analysis; John Wiley.
3. Zacks S(1992): Introduction to Reliability Analysis, Springer Verlag.
4. Marshall A.W. and Olkin I(2007):Life Distributions, Springer

Unit I

Statistical Methods in Clinical Trials: Introduction to clinical trial and its phases I, II, III and IV, statistical designs-fixed sample trials: simple randomized design, stratified randomized crossover design; Sequential design - open and close sequential design. Randomization-Dynamic randomization, Permuted block randomization; Blinding-Single, double and triple.

Unit II

Biological Assays: Introduction, parallel-line assay, slope- ratio assays and quantal- response assay. Dose-response relationships-qualitative and quantitative response, dose response relation-estimation of median effective dose.

Unit III

Data editing and transformations: Transformation in general, logarithmic, square root and power transformations; transformations for proportions – angular, probit and logit transformations. Outlying observations – box plot, M- estimators. Test for normality - p-p plot and q-q plot and Kolmogorov-Smirnov test.

Unit IV

Categorical Data Analysis: Categorical response data, logistic regression-odds ratio, Wald's statistic, logistic regression and its diagnostics, poisson regression and its applications.

Unit V

One way ANOVA and Multiple comparisons- Tukey, Bonferroni, Scheffe's, Dunnett's test and Duncan Multiple range test. Confidence Interval for multiple comparisons, , Non Parametric ANOVA and multiple comparison - contrasts, Multiple Comparisons among medians and variances

Books for Study

1. Elisa T.Lee & John Wenyu Wang (2003), Statistical methods for Survival Data analysis, 3rd Edition, John Wiley
2. Jerrold Zar (1999), 4th Edition, Biostatistical analysis , Pearson Edition
3. Alan Agresti (2002), 2nd Edition, Categorical Data analysis, John Wiley
4. Armitage, P, Berry G and Mathews J.N.S (2002), Statistical Methods in Medical Research, 4/e, Blackwell Scientific Publications

Books for Reference

1. Hosmer and Lemeshow (2000), 2nd Edition, "Applied Logistic Regression", Wiley Series (Unit – IV)
2. Fred C Pampel, (2000), Logistic Regression- A primer, Sage Publications
3. Sylvia Wasserthial and Smoller, (2004), Biostatistics and Epidemiology – A Primer for Health and Biomedical professionals, 3rd Edition, Springer
4. Rastogi, (2006), Fundamentals of Biostatistics, ANE Books, India
5. EricVittinghoff, StephenC.Shiboski, DavidV.Glidden, CharlesE.McCulloch, (2005), Regression Methods in Biostatistics, Springer

Unit I

Basic deterministic model: Cash flows, discount function, interest and discount rates, balances and reserves, internal rate of return, The life table: Basic definitions, probabilities, construction of life tables, life expectancy, Life annuities: Introduction, calculating annuity premium, interest and survivorship discount function, guaranteed payments, deferred annuities.

Unit II

Life insurance: Introduction, calculation of life insurance premiums, types of life insurance, combined benefits, insurances viewed as annuities, Insurance and annuity reserves: The general pattern reserves, recursion, detailed analysis of an insurance, bases for reserves, non forfeiture values, policies involving a return of the reserve, premium difference and paid-up formula.

Unit III

Fractional durations: Life annuities paid monthly, immediate annuities, fractional period premium and reserves, reserves at fractional durations, Continuous payments: Continuous annuities, force of discount, force of mortality, Insurance payable at the moment of death, premiums and reserves. The general insurance – annuity identity, Select mortality: Select an ultimate tables, Changed in formulas.

Unit IV

Multiple life contracts: Joint life status, joint annuities and insurances, last survivor annuities and insurances, moment of death insurances. The general two life annuity and insurance contracts, contingent insurances

Unit – V

Multiple decrement theory: Basic model, insurances, Determination of the models from the forces of decrement. Stochastic approach to insurance and annuities; Stochastic approach to insurance and annuity benefits, deferred contracts, Stochastic approach to reserves and premiums, variance formula.

Books for Study

1. Promislow, S.D(2006) Fundamentals of Actuarial Mathematics, John Willey, Chapters 2- 11 &14.

Books for Reference

1. Neill, A. (1977) Life contingencies, Heinemann, London.
2. Newton L. Bowers, Jr, Hans U. Gerber, James C. Hickmann, Donald A. Jones and Cecil J. Nesbitt (1997) Actuarial Mathematics, The Society of Actuaries.
3. King, G. Institute of Actuaries Text Book. Part 11, Second edition, Charles and Edwin Layton, London.
4. Donald D.W.A. (1970) Compound Interest and Annuities, Heinemann, London.
5. Jordan, C.W. Jr. (1967) Life Contingencies, Second edition, Chicago Society of Actuaries.
6. Hooker, P.F. and Longley Cook, L.W. (1953) Life and other Contingencies, Volume I and Volume II (1957) Cambridge University Press.
7. Spurgeon, E.T. (1972), Life Contingencies, Third edition, Cambridge University Press.

Unit I

Need for TQM, evolution of quality, Definition of quality, TQM philosophy – Contributions of Deming, Juran, Crosby, Taguchi and Ishikawa.

Unit II

Vision, Mission, Quality policy and objective, Planning and Organization for quality, Quality policy Deployment, Quality function deployment, Analysis of Quality Costs.

Unit III

Customer focus, Leadership and Top management commitment, Employee involvement – Empowerment and Team work, Supplier Quality Management, Continuous process improvement, Training, performance Measurement and customer satisfaction.

Unit IV

PDSA, The Seven QC Tools of Quality, New Seven management tools, Concept of six sigma, FMEA, Bench Marking, JIT, POKA YOKE, 5S, KAIZEN, Quality circles.

Unit V

Need for ISO 9000 Systems, clauses, Documentation, Implementation, Introduction to QS 9000 , Implementation of QMS, Case Studies.

Books for Study

1. Dale H. Besterfield (2002): “Total Quality Management”, Pearson Education Asia
2. Oakland J.S. (1989): “Total Quality Management”, Butterworth-Heinemann Ltd., Oxford

Books for Reference

1. Narayana V. and Sreenivasan, N.S. (1996): “Quality Management – Concepts and Tasks”, New Age International.
2. Zeiri (1991): “Total Quality Management for Engineers”, Wood Head Publishers.
3. Juran J.M and Frank M. Gryna Jr. (1982): “Quality Planning and Analysis”, TMH, India.
4. Brain Rethery (1993): ISO 9000, Productivity and Quality Publishing Pvt.Ltd.
5. D.Mills (1993): Quality Auditing, Chapman and Hall.

**SOFT CORE PAPERS
SEMESTER X**

STAT 544- SURVIVAL ANALYSIS

CREDITS: 3

Unit I

Concepts of time, Order and random Censoring, likelihood in these cases. Life distributions – Exponential, Gamma, Weibull, Lognormal, Pareto, Linear Failure rate. Parametric inference (Point estimation, Scores, MLE)

Unit II

Life tables, failure rate, mean residual life and their elementary properties. Ageing classes – and their properties , Bathtub Failure rate.

Unit III

Estimation of survival function – Actuarial Estimator, Kaplan- Meier Estimator, Estimation under the assumption of IFR / DFR . Tests of exponentiality against non- parametric classes – Total time on test, Deshpande test.

Unit IV

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 convariates. Rank test for the regression coefficients.

Unit V

Competing risks model, parametric and non- parametric inference for this model. Multiple decrement life table.

Books for Study

1. Miller, R.G. (1981) : Survival analysis (John Wiley).
2. Cox, D.R. and Oakes, D. (1984) : Analysis of Survival Data, Chapman and Hall, New York.
3. Elisa T.Lee, John Wenyu Wang and Timothy Wenyu Patt (2003): Statistical Methods for Survival Data Analysis, 3/e, WileyInterScience

Books for Reference

1. Gross, A.J. and Clark, V.A. (1975) : Survival distribution : Reliability applications in the Biomedical Sciences, John Wiley and Sons.
2. Elandt –Johnson, R.E. Johnson N.L.(1999): Survival Models and Data Analysis, John Wiley and sons.
3. Kalbfleisch J.D. and Prentice R.L.(2003), The Statistical Analysis of Failure Time Data, John Wiley.
4. Klein P. John and Moeschberger(2003): Survival Analysis: Techniques for Censored and Truncated Data, 2/e, Springer.
5. Lawless J.F. (2002): Statistical Models and Methods for Life Time Data, 2/e, John Wiley & Sons.

Unit I

Parameter Programming – Parameterization of the Cost Vector ‘c’ -Parameterization of requirement vector ‘b’ – All integer programming problem- Gomory’s cutting plane algorithm – Mixed integer programming problem – Branch and Bound technique.

Unit II

Inventory models with one or two price breaks - Multi item deterministic problem – Constraints on storage and investment – Probabilistic Inventory models – Periodic Review systems – Fixed order quantity system

Unit III

Non-linear programming problem – Kuhn Tucker conditions – Quadratic programming problem (QPP) - Wolfe’s and Beale’s algorithms for solving QPP – Geometric programming

Unit IV

Dynamic programming problem (DPP) - Bellman’s principle of optimality - General formulation - computation methods and application of DP - Solving LPP through DP approach - Convex programming

Unit V

Queuing theory – Basic characteristics of queuing models – Arrival and service distribution – steady state solution of M/M/1 and M/M/C models with associated distribution of queue length and waiting time - M/G/1 queue-steady results using embedded Markov chain Methods - Pollaczek Khinchin formula.

Books for Study

1. Hamdy A. Taha (2006): Operations Research – An Introduction, 8/e, Prentice Hall of India Private Ltd, New Delhi, 5/e.
2. Sinha S M (2006): Mathematical Programming: Theory and Methods, Elsevier Publications.
3. Gross and Harris(1982): Fundamentals of Queuing Theory, John Wiley .

Books for Reference

1. Sharma .S.D(1999): Operation Research , Kedar Nath Ram Nath & Co., Meerut.
2. Kanti Swarup, P.K. Gupta and Man Mohan(2004): Operations Research, Sultan Chand and Sons, New Delhi.
3. Hillier F.S. and Libermann G.J(2002).: Introduction to Operations Research, 7/e, McGraw Hill.

Unit I

Constants- Variables - Declaration of variables - Type conversions - Relational operators - Decision making, branching and looping - Functions - Simple functions - Passing arguments to functions - Returning values from functions - Reference arguments - Overloaded functions - Inline functions.

Unit II

Defining classes - Creating objects - Constructors - Accessing class members - Member functions - Overloaded constructors - Static class data - Arrays and strings.

Unit III

Operator overloading - Overloading unary and binary operators- Data conversion - Derived class- Class hierarchies - Public and private inheritance - Multiple inheritance.

Unit IV

Pointers in addresses - Arrays, functions and strings - Memory management - New and delete functions – Friend functions - Pointer to objects

Unit V

Files and streams - the fstream class – Exception handling – Class templates

Books for Study

1. Robert Lafore(1997): Object Oriented Programming in Turbo C++, Galgotia Publishers Private Ltd.
2. Balagurusamy, E.(2002): Object –Oriented Programming with C++, 2/C Tata Mc Graw Hill Publishing Company Ltd., New Delhi.

Reference books

1. Arumugam S, Thangapandi Isaac A, and Somasundaram A,(2005): Numerical Methods, Scitech Publications (India) Pvt. Ltd., Second Edition Chennai.
2. Bjarne .Stroustrup (2000) : The C++ Programming language , 3 rd , edition , Addison Wesley.
3. John Hubbard(2000):Programming with C++, 2/e, Schaum Series
4. Sastry, S.S(1990): Introductory Methods of Numerical Analysis, Prentice Hall of India Private Ltd, New Delhi.

STAT 547 - TIME SERIES ANALYSIS

CREDITS: 3

Unit I

Stochastic Time Series models – Classification of Stochastic Processes – The family of finite dimensional distribution function - Stationary models and their autocorrelation properties – Estimation of autocorrelation and partial auto correlation and their standard error
Deseasonalising and detrending an observed time series – Exponential and Moving average smoothing

Unit II

General linear stationary models – stationarity and invertability – Autoregressive and moving average processes and their autocorrelation functions – mixed autoregressive moving average processes

Unit III

Model estimation – Likelihood and sum of squares functions – Nonlinear estimation – estimation for special processes AR, MA, mixed processes – separation of linear and nonlinear components in estimation – estimation using Bayes' theorem

Unit IV

Forecasting: MMSE forecasts and their properties – Forecasts and their updating – Forecast of functions and forecast of weights – examples

Unit V

ARIMA models – Box Jenkins methodology for fitting ARIMA models

Books for Study

1. Box G E P, Jenkins G M and Reinsel G C (2004): Time Series Analysis – Forecasting and Control, Pearson Education.
2. Brockwell P J and Davis R A (2002): Introduction to Time Series and Forecasting, Springer.
3. Kendall, Sir Maurice and Ord J K (1990): Time Series, Edward Arnold.

Books for Reference

1. Bovas Abraham and Johannes Ledolter(2005): Statistical Methods for Forecasting, 2/e, John Wiley & Sons.
2. Chatfield C (1996): The Analysis of Time Series: Theory and Practice, fifth edition, Chapman and Hall.
3. Montgomery D C and Johnson L A (1977): Forecasting and Time Series analysis, McGraw Hill.
4. Nachane D.M.(2006): Econometrics: Theoretical Foundations and Empirical Perspective, Oxford University Press

STAT 548 STATISTICAL GENETICS

CREDITS: 3

Unit I

Introduction, Mendel's Laws, Linkage and Crossing over, Linkage Maps, Statistical Analysis for Segregation and Linkage: Single Factor Segregation, Two factor segregation, Detection of Linkage, Estimation of Linkage.

Unit II

Random mating: Hardy-Weinberg law of equilibrium. Single Locus, Sex-linked genes, Autopolyploids, Forces affecting gene frequency, Fisher's fundamental theorem, inbreeding: Mutation and migration different approaches, concepts and definition, path Coefficients, Stochastic Process of gene-frequency change, Diffusion approach, Transition matrix approach.

Unit III

Genetic components of variance: Relationship between phenotype and genotype, Different approaches, Genetic components of covariance between Traits; Linkage effects, Sex-linked genes, Maternal effect, Epistatic interaction, Genotype X Environment interaction.

Unit IV

Heritability, Estimation of Heritability, Precision of Heritability estimates, Repeatability, Estimates of Genetic correlation, Generalized Heritability

Unit V

Relation between phenotypic selection and genotypic selection, Intensity of selection correlated, Response to selection. Selection for improving several characters.

Books for Study

1. Narain, P. (1990). Statistical Genetics, Wiley, Chapters 1-5, 7,8,10,14.

Books for Reference

1. Liu, B.H. (1998). Statistical Genomics, CRC Press, New York.
2. Falconer, D.S. (1970). Introduction to Genetics, Oliver L& Boyd.