

Statistics

Objectives of the Course

This course is designed to provide the science student an intense foundational introduction to the fundamental concepts in Statistics. The course continues the introduction to the student started in Statistics to many branches of Sciences and concentrates on pertinent and concrete examples and applications. After completing the course the student should be able to work basic problem and word problems in probability, and statistics.

It is imperative to know the importance and scope of the discipline, to inculcate interest in statistics to impart knowledge of science as the basic objective of Education, to develop a scientific attitude to make students open minded, to develop an ability to work on their own and to make them fit for the society, to expose themselves to the diversity amongst life forms, to develop skill in practical analysis along with collection and interpretation of statistical materials and data, to develop an ability for the application of the acquired knowledge in the fields of statistics so as to make our country self reliant and self sufficient and to make them able to appreciate and apply ethical principles to statistical research and studies. The science/ mathematics/ engineering/ business student should have mastered and demonstrated the following quantitative skills after completing Statistics

B. Sc. STATISTICS

Offered By:

Department of Mathematics

Faculty of Science

JECRC University, Jaipur

Semester-wise Distribution of Courses and Credits

Semester –I		
Course Code	Title	Credits
BST001A	Descriptive Statistics-I	3
BST002A	Probability Theory I	3
Total		6
Semester –II		
BST003A	Descriptive Statistics-II	3
BST004A	Probability distributions and Numerical Analysis	3
Total		6
Semester –III		
BST005A	Sampling Distributions	3
BST006A	Applied Statistics-I	3
Total		6
Semester –IV		
BST007A	Survey Sampling	3
BST008A	Applied Statistics-II	3
Total		6
Semester -V		
BST009A	Testing of Hypothesis	3
BST010A	Operational Research	3
BST011A	Elective (Any one) i) Computer Programming in C ii) Real Analysis iii) Stochastic	3

	Processes	
Total		9
Semester -VI		
BST012A	Linear Models	3
BST013A	Design of Experiments	3
BST014A	Elective (Any one) i) Econometrics ii) Bio-Statistics iii) Project based on any topic of statistics	3
Total		9

Grand Total-42

Semester -I

Descriptive Statistics (S101)

Unit - I

Introduction to Statistics

Meaning of Statistics as a Science. Importance of Statistics.

Scope of Statistics: In the field of Industry, Biological sciences, Medical sciences, Economics, Social Sciences, Management sciences, Agriculture, Insurance, Information technology, Education and Psychology.

Statistical organizations in India and their functions: CSO, ISI, NSS, IIPS (Devnar, Mumbai), Bureau of Economics and statistics. Review / Revision of Presentation of Data.

Unit - II

Organization of data :Qualitative and Quantitative classification, discrete and continuous classification, Geographical and Chronological classification.

Construction of frequency tables, frequency distribution for continuous and discrete data, cumulative frequency distributions (inclusive and exclusive methods).

Graphical presentation of data: Histogram, Frequency Polygon, Frequency curve and Ogives

Unit – III

Measures of Central Tendency : Concept of central tendency of statistical data, Statistical averages, characteristics of a good statistical average. Arithmetic Mean (A.M.): Definition, effect of change of origin and scale.

Mode and Median: Definition, formulae (for ungrouped and grouped data), merits and demerits. Empirical relation between mean, median and mode (without proof) merits and demerits. Measure of Dispersion- Definition, different measures of Dispersion, merits and demerits. Coefficient of variation.

Unit – IV

Moments:

Raw moments (m'_r) for ungrouped and grouped data.

Central moments (m_r) for ungrouped and grouped data, Effect of change of origin and scale. Relations between central moments and raw moments, upto 4-th order (without proof).

Unit – V

Skewness and Kurtosis : Concept of skewness of frequency distribution, positive skewness, negative skewness, symmetric frequency distribution. Bowley's coefficient of skewness : Bowley's coefficient of skewness lies between -1 to 1 (with proof), interpretation using Box plot. Karl Pearson's coefficient of skewness. Measures of skewness based on moments (β_1, γ_1).

Concepts of kurtosis, leptokurtic, mesokurtic and platykurtic frequency distributions. Measures of kurtosis based on moments (β_2, γ_2).

Books suggested:

1. Goon A.M., Gupta M.K., Dasgupta B. Fundamentals of Statistics, Volume I, The World Press Private Limited, Calcutta. Fifth edition.
2. Kothari, C.R.: Research Methodology, Methods and Techniques , Wiley Eastern Limited. First Edition.
3. Shah R.J.:Descriptive Statistics, Seth Puplications. Eighth edition.
4. Spiegel, M.R.: Theory and Problems of Statistics, Schaum's Publishing Series. Tata McGraw-Hill. First edition.
5. Welling, Khandeparkar, Pawar, Naralkar : Descriptive Statistics : Manan Prakashan
6. S.P. Gupta : Statistical Methods, Sultan Chand & Sons. First edition.
7. Richard. I. Levin, David .S. Rubin: Statistics for Management . Fifth edition
8. Prem . S. Mann (2007) . Introductory Statistics (6th edition) John Wiley & Sons.
9. Allan Bluman (2009) Introductory Statistics. A step by step approach (7th edition). McGraw-Hill

Probability Theory I (S102)

Unit – I

Random experiment, trial, sample point and sample space, events, operations of events, concepts of equally likely, mutually exclusive and exhaustive events.

Unit – II

Definition of probability : Classical, relative frequency and axiomatic approaches. Discrete probability space, properties of probability under set theoretic approach. Independence of events, Conditional probability, total and compound probability theorems, Bayes theorem and its applications.

Unit – III

Random variables – discrete and continuous, probability mass function (pmf) and probability density function (pdf), Cumulative distribution function (cdf). Joint distribution of two random variables, marginal and conditional distributions.

Unit – IV

Expectation of a random variable and its simple properties. Addition and Multiplication theorems of Expectations. Variance and covariance and their properties.

Unit – V

Moments, moment generating function (m.g.f.) & their properties, continuity theorem for m.g.f. (without proof). Chebyshev's inequality. Cumulant generating functions.

Books suggested:

1. Parzen, E.S. : Modern Probability Theory and its Applications.
2. Meyer, P. : Introductory Probability and Statistical Applications.
3. Stirzeker David (1994) : Elementary Probability, Cambridge University Press.
4. Mood A.M., Graybill F.A. and Boes D.C. (1974) : Introduction to the theory of Statistics, McGraw Hill.
5. Mukhopadhyay, P : Mathematical Statistics, new central book agency.
6. S.P. Gupta : Statistical Methods, Sultan Chand & Sons. First edition.

Statistical Lab-I(S103)

List of Practicals:

1. Collection of Data from Secondary source (including Internet sites) / Primary source
2. Tabulation of data (Quantitative and Categorical)
3. Classification of data.
4. Graphs and Diagrams
5. Measures of Central Tendency.
6. Index Numbers.
7. Measures of Dispersion.
8. Skewness and Kurtosis.
9. Problems on Bivariate Probability distributions

Semester -II

Descriptive Statistics-II (S201)

Unit – I

Theory of Attributes:Class, class frequencies, order of class frequencies, Ultimate class frequency, Consistency of data (up to order 3). Independence of attributes, contingency table, Association of attributes, Measures of association.

Unit – II

Curve Fitting:Scatter Diagram, Concept of curve fitting and Principles of Least Squares. Fitting of straight line, Parabola, Power Curves and Exponential Curves.

Unit – III

Correlation and Regression:Correlation, Scatter Diagram, Karl Pearson's Coefficient of Correlation and its properties. Spearman's Rank Correlation Coefficient. Regression-Fitting of Regression Lines, Regression Coefficients with properties.

Unit – IV

Time Series: Introduction, decomposition of a time series, different components with illustrations. additive and multiplicative models. Different methods of determining trend and seasonal fluctuations, their merits and demerits. Measurement of trend-Graphical Method, Method of Semi-averages .

Unit – IV

Time Series: Measurement of trend-Method of fitting curves (straight line, polynomials, growth curves-modified exponential curve, Gompertz curve and logistic curve). Method of Moving Averages. Measurement of seasonal variation- Method of Simple Averages, Ratio to Trend Method

Books suggested:

1. Goon, A.M., Gupta, M.K. and Dasgupta, B. (1991): Fundamentals of Statistics, Volume II, The World Press Pvt Ltd, Calcutta
2. Gupta, S.C. and Kapoor, V.K.: Fundamentals of Mathematical Statistics, S Chand & Company, New Delhi
3. Mood Alexander M., Graybill Frankline and Boes Duane C.: Introduction to Theory of Statistics, Mc Graw Hill & Company Third Edition .
4. Spiegel M.R., (1967): Theory and Problem of Statistics, Schaum's Publishing Series.
3. Gupta, O.P.:Mathematical Statistics, Kedarnath Publication, Meerut
5. Goon, A.M., Gupta, M.K. and Dasgupta, B. (1991): An Outline of Statistics Volume II, The World Press Pvt Ltd, Calcutta

Probability distributions and Numerical Analysis(S202)

Unit – I

Univariate distributions: Binomial, Poisson, Hypergeometric, Geometric and Negative Binomial. Normal and Poisson distributions as limiting case of binomial distribution.

Unit – II

Uniform (discrete & continuous), Normal, Exponential, Gamma, Beta distributions. Cauchy, Laplace, Pareto, Weibull, Log normal Distributions.

Unit – III

Calculus of finite differences, operators, separation of symbols, examples and problems. Interpolation formulas with remainder term. Newton's forward and backward formulae.

Unit – IV

Central difference formulae, Newton's divided difference formulae for interpolation. Lagrange's interpolation formulae. Numerical differentiation using Newton's forward and backward formulae.

Unit – V

Numerical Integration: General quadrature formula for equidistant ordinates. Application of trapezoidal, Simpson's $1/3^{\text{rd}}$ and $3/8^{\text{th}}$ rules. Weddle's rule.

REFERENCES

1. Parzen, E.S. : Modern Probability Theory and Its Applications.
2. Meyer, P.: Introductory Probability and Statistical Applications.
3. Freeman : Finite Differences.
4. Scarborough: Numerical Analysis.
5. S.S. Sastry : Introductory Methods of Numerical Analysis; Prentice Hall of India Pvt. Limited.
6. Jain, M.K., Iyengar, SRK and Jain R.K.: Numerical Methods For Scientific And Engineering Computations; NEW AGE International (P) Limited.
7. Saxena, H.C : Calculus of Finite Differences (S. Chand & Co.).
8. Gupta, S.C. and Kapoor, V.K.: Fundamentals of Mathematical Statistics, S Chand & Company, New Delhi

Statistical Lab-II(S203)

List of Practicals:

1. Fitting of Binomial and Poisson distribution.
2. Fitting of the following curves by the method of least squares:
 - a) Straight Line
 - b) Parabola
 - c) Exponential Curve
 - d) Power Curve
3. Computation of Correlation Coefficient and rank correlation.
4. Fitting of Regression lines.
5. Estimation of one or two missing values.
6. Interpolation for equal intervals by: Newton-Gregory formula (forward & backward).
7. Interpolation for equal intervals: Lagrange's formula.
8. Interpolation by Newton's divided difference formula for unequal intervals.
9. Interpolation by Lagrange's formula for unequal intervals.
10. Approximate integration (Trapezoidal rule, Simpson's one-third rule, Simpson's three-eighth rule), Weddle's rule.
11. Testing of Independence of Attributes.
12. Yule's Coefficient of Association of Attributes.

Semester -III

Sampling Distributions(S301)

Basic Concepts

Concept of statistic and sampling distribution. Sampling Distribution of sum of Binomial, Poisson and mean of Normal Distribution. Standard Error: Meaning and role. The Central Limit Theorem for identically independently distributed (i.i.d) random variable.

Chi-square Distribution

Definition, Derivation, Moments, Moment Generating Function, Cumulant Generating Function. Limiting and Additive property of Chi-square variates. Distribution of ratio of chi-square variates

Applications of Chi-square

Chi-square test for testing normal population variance, Test for goodness of fit, Contingency table and Test for independence of attributes, Yates correction for 2x2 contingency table conditions of Chi-square.

t-Distribution

Definition of Student's-t and Fisher's-t statistics and derivation of their distributions. Limiting property of t-distribution. Applications: Testing of single mean, Difference of two means, paired t-test and sample correlation coefficient.

F-Distribution

Definition of Snedecor's F-distribution and its derivation. Applications- Testing of equality of two variance. Fisher's transformation and its uses. Relationship between 't' and 'F' statistics and between 'F' and chi-square statistics.

References:

1. Goon, A.M., Gupta, M.K. and Dasgupta, B. (1991): Fundamentals of Statistics, Volume II, The World Press Pvt Ltd, Calcutta
2. Gupta, S.C. and Kapoor, V.K.: Fundamentals of Mathematical Statistics, S Chand & Company, New Delhi
3. Mood Alexander M., Graybill Frankline and Boes Duane C.: Introduction to Theory of Statistics, Mc Graw Hill & Company Third Edition
4. Spiegel M.R., (1967): Theory and Problem of Statistics, Schaum's Publishing Series.
5. Gupta, O.P.: Mathematical Statistics, Kedarnath Publication, Meerut
6. Goon, A.M., Gupta, M.K. and Dasgupta, B. (1991): An Outline of Statistics Volume II, The World Press Pvt Ltd, Calcutta

Applied Statistics-I(S302)

Index Numbers:

Definition, construction of index numbers by different methods, Problems faced in their construction, criterion of a good index number-Test Theory-unit, time reversal, factor reversal and circular tests. Errors in the construction of index

numbers. Chain and Fixed base index numbers. Base Shifting, Splicing and Deflating of index numbers. Cost of Living Index numbers- construction and uses.

Wholesale Price Index and Index of Industrial Production.

Demand Analysis:

Demand function, price and income elasticity of demand, nature of commodities, laws of supply and demand, Income distributions, Pareto – curves of concentration.

Utility and Production Functions: utility function, constrained utility maximisation, indifference curves, derivation of demand curve, production function, homogeneous production functions, Isoquant and Isocost curves, Elasticity of substitution, C.E.S. functions, Multiple production by monopolist, discriminating monopolistic form, multiplant form.

Application of integration in Economics:

Given Elasticity of any function then how to find function, consumer surplus, producer surplus, learning curves, finding consumption function from M.P.C, finding profit function from M.R and M.C.

Mathematical Finance:

Compound Interest, Discount and present value, Different types of annuities.

SUGGESTED READINGS:

1. Allen, R.G.D. (1975): Index Numbers in Theory and Practice. Macmillan.
2. Allen, R.G.D. (1995): Mathematical Analysis for Economist. Macmillan.
3. Ayer, Frank. (1983): Theory and Problems of Mathematics of Finance (Schaum's Outline Series),
Mc Graw Hill Book Company, Singapore
4. Croxton, F.E., Cowden, D.J. and Klein, S. (1982): Applied General Statistics, 3rd Edn. Prentice Hall
of India (P) Ltd.
5. Gupta, S.C. and Kapoor, V.K. (2008): Fundamentals of Applied Statistics, 4th Edn., (Reprint),
Sultan Chand and Sons.
6. Soni, R.S. (1996): Business Mathematics with Application in Business and Economics. Pitamber Publishing Co.

STATISTICS LAB-III(S303):

List of Practicals:

1. Test of Significance:
a) Chi-square test for variance, goodness of fit and independence of Attributes.

- b) t-test for mean and difference of means (paired and unpaired cases and for correlation coefficient).
 - c) F-test for equality of population variances.
2. 2) Economic Statistics:
 - a) Laspeyres, Paasche's and Fisher's Index Numbers.
 - b) Fixed base and chain base index number.
 - c) Cost of Living Index Numbers
 3. Measurement of Trend by method of:
 - a) Moving Averages.
 - b) Curve fitting by least squares.
 4. Measurement of seasonal fluctuations:
 - a) Ratio to Trend
 - b) Ratio to Moving Averages.
 - c) Link Relative Method.

Semester -IV

Survey Sampling(S401)

Sample Surveys: Concepts of Population and sample. Complete enumeration vs sampling. Need for sampling. Principal and organisational aspects in the conduct of a sample survey.

Probability sampling design. Properties of a good estimator. Sampling errors. Basic sampling methods: Simple random sampling with or without replacement for the estimation of mean, total, proportion and ratio. T1 and T2 classes of Linear estimators and minimum variance.

Determination of sample size. Probability proportional to size sampling (with replacement).

Stratified random sampling: Different allocations. Post-stratification, Method of collapsed strata. Ratio method of estimation, optimality of ratio estimator. Difference and Regression methods of estimation, optimality of regression estimator. Linear and circular systematic sampling, performance of systematic sampling in populations with linear trend. Cluster sampling with equal size of clusters. Two stage sampling (Sub-sampling) with equal first stage units. Non sampling errors. Sources, Hansen and Hurwitz technique .

SUGGESTED READINGS:

1. Cochran, W.G. (1977): Sampling Techniques. John Wiley and Sons, N.Y.

2. Murthy, M.N. (1967): Sampling Theory and Methods. Statistical Publishing Society, Kolkata.
3. Raj, D. and Chandhoke, P. (1998): Sample Survey Theory. Narosa Publishing house.
4. Singh, D. and Chaudhary, F.S. (1995): Theory and Analysis of Sample Survey Designs. New Age International (P) Ltd.
5. Sukhatme, P.V., Sukhatme, B.V., Sukhatme, S. and Asok, C. (1984): Sampling Theory of Surveys with Applications. Iowa State University Press, Iowa, USA.

Applied Statistics-II(S402)

Statistical Quality Control (S.Q.C.):

Its concept, application and importance. Process and Product Controls, causes of variations in quality -control limits and their justification. Theory of control charts for variables and attributes: \bar{x} , R, s, p, np, c and u-charts. Natural Tolerance Limits. Specification Control Limits and Modified Control Limits.

Sampling Inspection Plans-

Acceptance-Rejection and Acceptance-Rectification plans, concepts, Acceptance Quality level (AQL), Lot Tolerance Percent Defective (LTPD), Process Average Fraction Defective, Producer's Risk, Consumer's Risk, Average Outgoing Quality (AOQ), Average Outgoing Quality Limit (AOQL), Operating Characteristic (OC) curve, Average Sample Number (ASN) Curve and Average Amount of Total Inspection (ATI) Curve.

Single Sampling Plan-

Probability of Acceptance using hypergeometric distribution and its approximation to Poisson and binomial distributions, its OC, AOQ, ASN and ATI functions. Determination of n and c using different approaches.

SUGGESTED READINGS:

1. Croxton, F.E., Cowden, D.J. and Klein, S. (1982): Applied General Statistics, 3rd Edn. Prentice Hall of India (P) Ltd.
2. Duncan, A.J. and Erwin, R.D. (1974): Quality Control and Industrial Statistics, 4th Edn. Taraporewala and Sons.

3. Elhance, D. N. and Elhance, V. (1996): Fundamentals of Statistics. D.K. Publishers.
4. Goon A.M., Gupta M.K. and Dasgupta B. (2005): Fundamentals of Statistics, Vol. II, 8th Edn. World Press, Kolkata.
5. Grant, E.L. (1999): Statistical Quality Control. Tata McGraw-Hill.
6. Gupta, S.C. and Kapoor, V.K. (2008): Fundamentals of Applied Statistics, 4th Edn., (Reprint), Sultan Chand and Sons.
7. Montgomery, D.C. (2007): Introduction to Statistical Quality Control. Wiley India.
8. Mukhopadhyay, P. (1999): Applied Statistics. Books and Allied (P) Ltd.

STATISTICS LAB-IV(S403):

List of Practicals:

1. Sample Surveys: To draw a simple random sample (SRS) with & without replacement to obtain an estimate of the population mean along with estimate of their variances. To compare the efficiency of SRSWOR with respect to SRSWR.
2. To draw all the possible samples by **SRS** – technique and to show that expected value of the sample mean equals the population mean and to show the expected value of sample mean square is population mean square.
3. Stratified Sampling:
 - i) Estimate the sample sizes by proportional allocation and Neyman's Optimum Allocation.
 - ii) Estimate the mean of the population under the above scheme.
 - iii) Calculation of the sampling variance.
 - iv) Computation of relative efficiencies of the allocation scheme among themselves as well as with SRS.
4. Systematic Sampling and its comparison with SRS and Stratified Sampling.
5. Cluster Sampling
6. Control Charts:
 - a) \bar{X} , R chart.
 - b) p and np - chart for equal & unequal sample sizes.
 - c) c-chart.

Semester -V

Testing of Hypothesis (S501)

Estimation: Parametric space, sample space, point estimation.

Requirements of good estimator: Consistency, unbiasedness, efficiency, sufficiency and completeness. Minimum variance unbiased (MVU) estimators. Cramer-Rao inequality. Minimum Variance Bound (MVB) estimators, Rao-Blackwell theorem, Lehmann-Scheffe theorem.

Statistical Hypothesis and test of significance I

Definition, Simple and Composite hypotheses. Null and Alternative Hypotheses, two Types of errors in sampling, critical region, level of significance critical and p-values, procedure and testing of hypothesis.

Statistical Hypothesis II

Statistical test: one tailed and two tailed test, Power and size of the test, and critical region Neyman Pearson Lemma and its application for finding BCR. BCR in case of Binomial, Poisson.

BCR in case of Normal and Exponential Populations. Definition of order statistics, distributions of range and median (when n is odd)

Sequential analysis

Elementary of Wald's sequential testing, sequential probability ratio test with essential and optimum properties (without proof).

Non Parametric Tests

Definition merits and limitations, Sign test for univariate and bivariate distributions, Run test and Median test for small and large samples.

References:

1. Goon, A.M., Gupta, M.K. and Dasgupta, B. Das (1991): An Outline of
a. Statistics, Volume II, The World Press Pvt Ltd, Calcutta Gupta,
S.C. and Kapoor, V.K.:
2. Fundamentals of Mathematical Statistics, S Chand & Company, New
Delhi.

3. Mood Alexander M., Graybill Frankline and Boes Duane C.: Introduction to Theory of Statistics, Mc Graw Hill & Company Third Edition
4. Rohatgi, V.K.(1967): An Introduction to Probability Theory and Statistics, John Wiley And Sons.
5. Casella,G. and Berger, Roger L.: Statistical Inference, Duxbury Thompson Learning , Second Edition.
6. Snedecor, G.W. and Cochran, W.G. (1967): Statistical Methods, Iowa
7. State University Press.
8. Gibbons, J. Dickinson and Chakraborty, S.: Nonparametric Statistical Inference, CRC, Fourth Edition.

Operational Research (S502)

Introduction to OR:

Phases of OR, model building and various types of OR Problems, Linear Programming: Models, graphical solution, simplex method and M-technique. Concept of duality, dual simplex method, post-optimality analysis.

The transportation problems:

North-West corner rule, Least cost method, Vogel's approximation method and MODI's method to find the optimal solution. The assignment problem. Networking problems. Individual replacement model.

Game Theory:

Rectangular games; methods of solution: dominance method, modified dominance, Graphical solution and algebraic technique solution by L.P. Method.

Simulations:

Simulation models, event-type simulation, generation of random phenomena, steps in simulation, application of simulation techniques.

References:

1. Gass, S.I. (1985): Linear Programming: Methods and Applications. Boyd Fraser Publishing Co., Danvers.
2. Hadley, G. (2002): Linear Programming (Reprint). Narosa Publishing House.
3. Hillier, F.S. and Lieberman, G. J. (2001): Introduction to Operational Research, 7th Edn. Irwin.
4. Kantiswarup, Gupta, P.K. and Manmohan (2008): Operations Research, 13th Edn. Sultan Chand and Sons.

5. Sharma, S.D. (2009): Operations Research-Theory, Methods and Applications, 16th Revised Edn., Kedar Nath Ram Nath.
6. Taha, H.A. (2007): Operations Research: An Introduction, 8th Edn. Prentice Hall of India.

Elective (S503)
Computer programming in C

History and features of C language. Components of C language, Structure of a C Program. Data type: Basic data types, Enumerated data types, Derived data types. Variable Declaration : Local, Global, Parametric Variables, Assignment of variables. Numeric, Character, real and string constants. Arithmetic, Relation and logical operators. Assignment operators. Increment and Decrement operators, conditional operators.

Type modifiers and expressions, Writing and interpreting expressions, using expressions in statements. Basic input/output.

Control Statements, conditional statements, if. .. else, Nesting of if else, else if ladder, switch statements. Loops in C : for, while, do ... while loops. break, continue, exit(), goto and label declarations.

One dimensional, two dimensional and multidimensional arrays.

Functions, classification of functions, functions definition and declaration, accessing a function, return statement. Operations using string functions. Parameter passing in functions, recursion in Functions.

Storage classes: Automatic variables, External variables, static variables, register variables, Scope and lifetime of variables. Pointers; Pointer Notation: and * operators. Pointer declaration and Initialization, Accessing a variable through pointer, pointer expressions, pointer arithmetic. Pointers and Arrays: Pointers and one dimensional arrays, dynamic memory allocation. Function returning pointers (single variable and onedimensional arrays).

Files in C: Defining and opening a file, closing a file, input-output operation on file. Creating a file, reading a file.

Preprocessors: Introduction to preprocessors, #define and #include.

References:

1. Balagurusamy, E. (2008): Programming in ANSI C, 4th Edn. Tata McGraw Hill.
2. Forouzan, B.A. and Gilberg, R.F. (2007): Computer Science – A Structured Programming

3. Approach Using C. (Third Edn.). Thompson Course Technology.
4. Gottfried, B.S. (1996): Schaum's Outline of Programming with C, 2nd Edn. McGraw Hill.
5. Kanetakar, Y. (2008): Let us C. BPB Publications.

Real Analysis

Real Analysis: Representation of real numbers as points on the line and the set of real numbers as complete ordered field. Bounded and unbounded sets, neighborhoods and limit points, supremum and infimum, derived sets, open and closed sets, sequences and their convergence, limits of some special sequences such as and Cauchy's general principle of convergence, Cauchy's first theorem on limits, monotonic sequences, limit superior and limit inferior of a bounded sequence.

Infinite series, positive termed series and their convergence, Comparison test, D'Alembert's ratio test, Cauchy's nth root test, Raabe's test. Gauss test and Maclaurin's integral test. Leibnitz's test for the convergence of alternating series, Absolute convergence and Conditional convergence of series.

Continuous functions, algebra of continuous functions, continuous functions and boundedness.

Differentiability, Rolle's theorem, Mean Value theorems. Taylor's theorem with Lagrange's and Cauchy's form of remainder. Taylor's and Maclaurin's series expansions of $\sin x$, $\cos x$, $\log(1+x)$. Indeterminate form, L'Hospital's rule.

References:

1. Apostol, T.M. (1985): Mathematical Analysis, Narosa Publishing House, New Delhi.
2. Bartle, R. G. and Sherbert, D. R. (2002): Introduction to Real Analysis (3rd Edition), John Wiley and Sons (Asia) Pte. Ltd., Singapore.
3. Ghorpade, Sudhir R. and Limaye, Balmohan V. (2006): A Course in Calculus and Real Analysis,
4. Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint.
5. Ross, K. A. (2004): Elementary analysis: the theory of calculus, Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint.
6. Rudin, W. (1976): Principles of Mathematical Analysis, Tata McGraw-Hill.
7. Singhal, M.K. and Singhal, A.R. (1992): A First course in Real Analysis. R. Chand & Co.

Stochastic Processes

Definition, classification and illustrative examples of stochastic processes, Mean value function and covariance Kernel, Probability generating function, Bivariate probability generating function, Convolution and compound distribution, recurrent events, random walk model, absorbing and reflecting barriers, first passage probabilities and Gambler's ruin problem, Discrete branching process, extinction probabilities

Markov chain-definition and examples, Chapman Kolmogorov's equations and m-step transition probabilities, classification of states, closures and closed sets. Poisson process and its applications- Pure Birth Process, Pure Death Process, Birth and Death process

Introduction to queuing theory, M/M/1 Queue with infinite waiting space. Yule Furry Process and Linear growth process.

References:

1. Bhat, B.R. (2000): Stochastic Models-Analysis and Applications. New Age International Publishers.
2. Feller, W. (1993): An Introduction to Probability Theory and its Applications, Vol. I, 9th Wiley Eastern (Reprint).
3. Karlin, S. and Taylor, H.M. (1975): A First Course in Stochastic Processes, 2nd Edn. Academic Press.
4. Medhi, J. (2008): Stochastic Processes, 2nd Edn. (Reprint). New Age International.
5. . Ross, S. M. (1996): Stochastic Processes, 2nd Edn. John Wiley and Sons.
6. Taha, H.A. (2007): Operations Research: An Introduction, 8th Edn. Prentice Hall of India.

Semester - VI

Linear Models(S601)

General Linear models, estimability and BLUE, method of least squares, Gauss-Markoff theorem, estimation of error variance, distribution of quadratic forms for standard normal variates, tests of linear hypothesis.

Analysis of variance: One-way and two-way classified data with m (≥ 1) observations per cell for fixed effects models. Analysis of Covariance: One-way and two-way classified data with one concomitant variable.

Straight Line relationship between two variables, precision of the estimated regression. Examination of the regression equation. Lack of fit and pure error. Fitting a straight line in matrix form. variance and covariance of b_0 and b_1 from the matrix calculation. Variance of \bar{Y} using the matrix development.

Orthogonal columns in the X-matrix. partial F-Test and Sequential F-Tests. Selection of best regression equations by step wise procedure. Bias in regression estimates. Residuals, Polynomial models. orthogonal polynomials.

References:

1. Bapat, R.B. (1999): Linear Algebra and Linear Models, 2nd Edn. Hindustan Book Agency.
2. Draper, N.R. and Smith, H. (1998): Applied Regression Analysis, 2nd Edn. John Wiley & Sons.
3. Montgomery, D.C. (2001): Design and Analysis of Experiments, 2nd Edn. John Wiley & Sons.
4. Montgomery, D.C., Peck, E.A. and Vining, G.G. (2006): Introduction to Linear Regression Analysis, 4th Edn. John Wiley & Sons.
5. Rencher, A.C. and Schaalje, G.B. (2008): Linear Models in Statistics, 2nd Edn. John Wiley & Sons.
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Design of Experiments(S602)

Experimental designs: Role, historical perspective, terminology, experimental error, basic principles, uniformity trials, fertility contour maps, choice of size and shape of plots and blocks.

Basic designs: Completely Randomized Design (CRD), Randomized Block Design (RBD), Latin Square Design (LSD) – layout, model and statistical analysis, relative efficiency, analysis with missing observations.

Incomplete Block Designs: Balanced Incomplete Block Design (BIBD) – parameters, relationships among its parameters, incidence matrix and its properties, Symmetric BIBD, Resolvable BIBD, Affine Resolvable BIBD, Intra Block analysis, complimentary BIBD, Residual BIBD, Dual BIBD, Derived BIBD.

Factorial experiments: advantages, notations and concepts, 2^2 , $2^3 \dots 2^n$ and 3^2 factorial experiments, design and analysis, Total and Partial confounding for 2^n ($n \leq 5$), 3^2 and 3^3 . Factorial experiments in a single replicate.

Fractional factorial experiments: Construction of one-half and one-quarter fractions of 2^n ($n \leq 5$) factorial experiments, Alias structure, Resolution of a design.

References:

1. Cochran, W.G. and Cox, G.M. (1959): Experimental Design. Asis Publishing House.

2. Das, M.N. and Giri, N.C. (1986): Design and Analysis of Experiments. Wiley Eastern Ltd.
3. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2005): Fundamentals of Statistics. Vol. II, 8th Edn. World Press, Kolkata.
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Elective (S603)

Econometrics

Objectives behind econometric models, General Linear Model: assumptions, least-squares estimation. BLUE, analysis of variance, tests of significance, confidence intervals for the parameters,

Prediction, Estimation under linear restrictions. Multicollinearity, concept, detection of multicollinearity, consequences and solutions of multicollinearity. Generalized least squares estimation, Aitken estimators, Heteroscedastic disturbances, efficiency of Aitken estimator with OLS estimator under heteroscedasticity.

Autocorrelation: concept, consequences of autocorrelated disturbances, detection of autocorrelation, their estimation and testing, estimation using Durbin-Watson statistic.

Forecasting: exponential smoothing for linear trend model.

References:

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4. Koutsoyiannis, A. (1984): Theory of Econometrics: An Introductory Exposition of Econometric Methods, 2nd Edn. Macmillan.
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Bio-Statistics

Functions of survival time, survival distributions and their applications viz. exponential, gamma, Weibull, Rayleigh, lognormal, death density function for a distribution having bath-tub shape hazard function.

Type I, Type II and progressive or random censoring with biological examples. Estimation of mean survival time and variance of the estimator for type I and type II censored data with numerical examples.

Non-parametric methods for estimating survival function and variance of the estimator viz. Actuarial and Kaplan-Meier methods.

Competing risk theory, Indices for measurement of probability of death under competing risks and their inter-relations. Estimation of probabilities of death under competing risks by maximum likelihood and modified minimum Chi-square methods.

Theory of independent and dependent risks. Bivariate normal dependent risk model. Conditional death density functions.

Stochastic epidemic models: Simple and general epidemic models (by use of random variable technique). Duration of an epidemic.

Planning and design of clinical trials, Phase I, II and III trials. Blindings single, double and triple. Consideration in planning a clinical trial.

References:

1. Biswas, S. (2004): Applied Stochastic Processes: A Biostatistical and Population Oriented Approach, 2nd Central Edn. New Central Book Agency.
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