

MANONMANIAM SUNDARANAR UNIVERSITY. TIRUNELVELI

DIRECTORATE OF DISTANCE AND CONTINUING EDUCATION

B.Sc. STATISTICS

(Effective from the Academic Year 2016-2017 onwards)

Eligibility for Admission:

Candidates who have passed the higher secondary examination conducted by Government of Tamil Nadu or the equivalent examinations conducted by competing body with Statistics / Mathematics / Business Mathematics / Computer Science / Physics / Chemistry / Economics / Commerce as one of the subjects or other equivalent examinations are eligible for admission to the first year of the B.Sc., (Statistics) degree course.

Duration of the Course:

The duration of the course is three years. Examinations will be conducted at the end of each year in respective subjects.

Medium of Instructions and Examinations:

The medium of instructions and examinations for the subjects of Part I and Part II shall be in the languages concerned. For the subjects of Part III, the medium of instructions and examinations shall be in English.

Lateral Entry:

Candidates who have passed B.Sc., degree with Mathematics / Computer Science / Physics / Information Technology as the main subject and Statistics as an allied subject and BCA are eligible for admission to the second year of the B.Sc.,(Statistics) degree course. Candidates who have passed PG Diploma Course in Statistical Methods and their Applications are also eligible for admission to second year of the B.Sc., (Statistics) degree course.

Examination

The regulations for examination, passing minimum in each subject and classification of successful candidates are at par with the regulations for other undergraduate science courses offered by the University through DD&CE.

SCHEME OF EXAMINATION

Part	Title of the Subject		Credits
I Year			
I	1.1	Language	5
II	1.2	English	5
III	1.3	Real Analysis and Matrices	6
III	1.4	Descriptive Statistics	6
III	1.5	Probability Theory	6
III	1.6	Mathematics	4
		Total	32
II Year			
I	2.1	Language	5
II	2.2	English	5
III	2.3	Statistical Distributions	6
III	2.4	Sampling Techniques	6
III	2.5	Programming with C and R	4
III	2.6	Statistical Practical – I	6
		Total	32
III Year			
I	3.1	Statistical Inference	6
II	3.2	Design of Experiments	6
III	3.3	Statistical Quality Control	6
III	3.4	Operations Research	6
IV	3.5	Time Series and Official Statistics	6
IV	3.6	Statistical Practical - II	6
		Total	36

Note 2: Statistical Practical – I is based on the courses: 1.3 Matrices
 1.4 Descriptive Statistics
 2.3 Statistical Distributions
 2.4 Sampling Techniques

Statistical Practical – II is based on the courses: 3.1 Statistical Inference
 3.2 Design of Experiments
 3.3 Statistical Quality Control
 3.4 Operations Research
 3.5 Time Series and Official Statistics

Candidates admitted to this course shall do the practical exercises in Statistical Practical – I & II using non-programmable scientific calculators.

I YEAR - 1.3 REAL ANALYSIS AND MATRICES

Unit - I

Sets - Countability, Open and Closed sets of real numbers. Sequences – Convergent and Divergent sequences, Bounded and Monotone sequences, Cauchy sequences. Series of real numbers - Convergence and divergence-series with nonnegative terms - comparison test - D'Alembert's ratio test - Cauchy's root test. - conditional and absolute convergence.

Unit - II

Differentiation - Limit of a function of a single variable, Continuity properties of a continuous function in a closed interval, Derivatives, Rolle's Theorem, Mean value theorem, Taylor's theorem.

Unit - III

Integration - Concept of Riemann Integral, Sufficient condition for Riemann integrability, Darboux theorem, Fundamental theorem, First mean value theorem – Improper Riemann integrals. Beta and Gamma Integrals.

Unit - IV

Matrices - Operations on Matrices – Symmetric and Skew-symmetric Matrices – Conjugate of a Matrix – Determinant of a Matrix – Inverse of a Matrix. Solving system of linear equations. Elementary transformations, Elementary matrices, Row and Column ranks – rank of a matrix. Reduction to Normal form, Equivalent matrices.

Unit - V

Characteristic roots and vectors, Cayley- Hamilton theorem, Minimal equation of a matrix. Quadratic Form – Matrix of a quadratic form – rank, signature and classification of quadratic forms – Sylvester's of Inertia.

REFERENCE BOOKS::

1. Arora, S. (1988) Real Analysis, Satya Prakashan Mandir, New Delhi.
2. Shanthi Narayan. (2003) Elements of Real Analysis, S. Chand & Co, New Delhi
3. Somasundaram, D. and Choudhary, B. (2002) A First Course in Mathematical Analysis, Narosa, Chennai
4. Rudin, W. (2000) Principles of Mathematical Analysis, McGraw Hill, New York.
5. Malik, S.C. and Arora, S. (2009) Mathematical Analysis, New Age Science, New Delhi.
6. Vasishtha, A. R. (2014) Matrices, Krishna Prakashan, Meerut.
7. Shanthi Narayan and Mittal, P. K. (2000) A Text Book of Matrices, S. Chand & Co, New Delhi
8. Gentle, J. E. (2007) Matrix Algebra Theory, Computations and Applications in Statistics, Springer, New York.
9. Richard Bronson (2011) Matrix Operations, Schaum's Outline Series, McGraw Hill, New York.
10. Searle, S. R. (2006) Matrix Algebra useful for Statistics, Wiley Interscience, New York.

1.4 DESCRIPTIVE STATISTICS

Unit - I

Origin, scope, limitations and misuses of Statistics – Collection - Classification- Tabulation of data. Frequency Distributions – Nominal, ordinal, Interval and ratio. Diagrammatic presentation of data: one dimensional and two-dimensional diagrams – graphic representation: line diagram, frequency polygon, frequency curve, histogram and Ogive curves.

Unit - II

Measures of central tendency: mean, median, mode, geometric mean and harmonic mean. Partition values: Quartiles, Deciles and Percentiles. Measures of Dispersion: Mean deviation, Quartile deviation and Standard deviation – Coefficient of variation.

Unit - III

Moments - measures of Skewness - Pearson's and Bowley's Coefficients of skewness, Coefficient of Skewness based on moments – co-efficient of Kurtosis.

Unit - IV

Curve fitting: principle of least squares, fitting of the curves of the form $y = a+bx$, $y = a+bx+cx^2$ and Exponential and Growth curves.

Unit - V

Linear correlation - scatter diagram, Pearson's coefficient of correlation, computation of co-efficient of correlation from a bivariate frequency distribution, Rank correlation, Coefficient of concurrent deviation- Regression equations - properties of regression coefficients.

REFERENCE BOOKS::

1. Anderson, T.W. and Sclove, S.L. (1978) Introduction to Statistical Analysis of data, Houghton Mifflin, Boston.
2. Bhat, B.R., Srivenkataramna, T. and Madhava Rao, K.S. (1996) Statistics A Beginner's Text, Vol. I, New Age International, New Delhi.
3. Croxton, F.E. and Cowden, D.J. (1969) Applied General Statistics, Prentice Hall, New Delhi.
4. Goon, A.M., M.K. Gupta and B. Das Gupta (2002) Fundamentals of Statistics- Vol. I., World Press Ltd, Kolkata.
5. Gupta, S.C. and V.K. Kapoor (2002) Fundamentals of Mathematical Statistics, Sultan Chand & Sons, New Delhi.
6. Spiegel, M.R. and Stephens, L. (2010) Statistics, Schaum's Outline Series, Mc Graw Hill, New York.

1.5 PROBABILITY THEORY

Unit - I

Probability: sample space – Events - algebraic operations on events- definition of probability - independent events – conditional probability - addition and multiplication theorems of probability – Bayes Theorem.

Unit - II

Random variables: Discrete and continuous random variables – distribution function - properties – probability mass function and probability density function – discrete and continuous probability distributions.

Unit - III

Multiple random variables: Joint, marginal and conditional distribution functions - independence of random variables – transformation of random variables (one and two dimensional - concepts only) and their distribution functions.

Unit - IV

Mathematical expectation: Expectation – properties – Cauchy - Schwartz inequality, conditional expectation and conditional variance – theorems on expectation and conditional expectation. Moment generating function, cumulant generating function, characteristic function, probability generating function and their properties. Tchebychev's inequality

Unit - V

Limit Theorems: Convergence in probability, weak law of large numbers – Bernoulli's theorem, Khintchine's theorem (statements only) – Simple form of central limit theorem i.i.d random variables.

REFERENCE BOOKS::

1. Goon, A.M., M. K. Gupta and B. Das Gupta (2002) Fundamentals of Statistics- Vol. I., World Press, Ltd, Kolkata.
2. Gupta, S.C. and V.K. Kapoor (2002) Fundamentals of Mathematical Statistics, Sultan Chand & Sons, New Delhi.
3. Bhat, B.R. (2007) Modern Probability Theory, (third edition), New Age International (P) Ltd, New Delhi.
4. Lipschutz, S. (2008) Probability Theory (Second Edition), Schaum's Outline Series, McGraw Hill, New York.
5. Mood, A.M., F.A. Graybill and D.C. Boes (1974) Introduction to Theory of Statistics McGraw Hill Book Co.,
6. Spiegel, M.R. and Ray, M. (1980) Theory and Problems of Probability and Statistics, Schaum's Outline Series, McGraw Hill, New York.

1.6 MATHEMATICS

Unit - I

Differentiation: Tangent and Normal-Direction of the tangent-Angle of intersection of curves-subtangent and subnormal - Polar coordinates - Angle between the radius vector and the tangent-Polar subtangent and polar subnormal - Length of arc in polar coordinates. Envelope - Circle, radius and centre of curvature.

Unit - II

Successive differentiation –Leibnitz's Formula. Partial differentiation – Successive partial differentiation – Implicit functions – homogeneous functions – Euler's theorem. Maxima

and Minima for one variable - Concavity, Convexity and points of inflexion - Maxima and Minima for two variables.

Unit - III

Integration- Methods of integration - Integrals of functions containing linear functions of x - Integrals of functions involving $a^2 \pm x^2$ - Integration of rational algebraic functions - $1/(ax^2+bx+c)$, $(px+q)/(ax^2+bx+c)$. Integration of irrational functions - $1/(ax^2+bx+c)^{1/2}$, $(px+q)/(ax^2+bx+c)^{1/2}$, $(px+q)\sqrt{ax^2+bx+c}$ - Integration by parts. Multiple integrals - Evaluation of double integrals - polar coordinates - Beta and Gamma functions and their properties.

Unit - IV

Differential equations: Types of first order and first degree equations. Variables separable, Homogeneous, Non-homogeneous equations and Linear equation. Equations of first order but of higher degree. Linear differential equations of second order with constant coefficients. Methods of solving homogenous linear differential equations of second order. Laplace transform and its inverse – solving ordinary differential equation with constant coefficients using Laplace transform.

Unit - V

Theory of Equations: Nature of roots, Formulation of equation whose roots are given. Relation between coefficients and roots - Transformation of equations - Reciprocal equations - Horner's method of solving equations.

REFERENCE BOOKS::

1. Narayanan, S. and Manicavachagom Pillay, T.K. (2015) Calculus Vol. I, S.Viswanathan (Printers publishers) Pvt. Ltd., Chennai.
2. Narayanan, S. and Manicavachagom Pillay, T.K. (2015) Calculus Vol. II, S.Viswanathan (Printers publishers) Pvt. Ltd., Chennai.
3. Narayanan, S. and Manicavachagom Pillay, T.K. (2014) Calculus Vol. III, S.Viswanathan (Printers publishers) Pvt. Ltd., Chennai.
4. Narayanan,S., Hanumantha Rao and T.K. Manicavachagom Pillay (2008) Ancillary Mathematics, Volume I, S. Viswanathan Pvt. Ltd, Chennai.

II YEAR - 2.3 STATISTICAL DISTRIBUTIONS

Unit - I

Distribution functions of one dimensional and two dimensional random variables – applications of Jacobian, marginal, conditional distributions - expectation.

Unit - II

Discrete distributions: One-point distribution, Bernoulli, Binomial, Poisson, Recurrence relations for probabilities, Geometric and Negative binomial distributions – Hyper geometric distribution, Multinomial distribution and discrete Uniform distribution- Moments – moment generating function, Characteristic function, Cumulant Generating function. Fitting of Binomial and Poisson distributions.

Unit - III

Continuous distributions: Uniform, Normal, Cauchy and Lognormal distributions- concepts, moments, moment generating and characteristic functions and their properties.

Unit - IV

Exponential, Gamma, Beta (first and second kinds) concepts, moments, moment generating and characteristic functions and their properties.

Unit - V

Sampling distributions: Chi-square, t and F distributions- concepts, moments, moment generating and characteristic functions and their properties.

REFERENCE BOOKS::

1. Gupta, S. C., and V. K. Kapoor (2000) Fundamentals of Mathematical Statistics, A Modern Approach (Eighth Edition). Sultan Chand & sons. New Delhi.
2. Alexander, M. Mood, Franklin A. Graybill and Duane C. Boes (1974) Introduction to the Theory of Statistics (Third Edition), Mc Graw Hill Comp Ltd. New Delhi.
3. Goon, A. M., M. K. Gupta and B. Dasgupta (2002) Fundamentals of Statistics, Vol. I, World Press Kolkata.
4. Rohatgi, V. K. and A. K. md. Ehsanes Saleh (2009) An Introduction to Probability Theory and Mathematical Statistics, 2nd Edition, Wiley Eastern Limited, New Delhi.
5. Parimal Mukopadhyay (2006) Mathematical Statistics, (Third Edition), Books and Allied Private Limited, Kolkata.
6. Edward J. Dudewicz and Satya N. Mishra (2007) Modern Mathematical Statistics, John Wiley & Sons. Inc., New York.

2.4 SAMPLING TECHNIQUES

Unit-I

Population, Census method - Need for sampling - Basic concepts of sample surveys - sampling unit - sampling frame - Principal steps involved in sample surveys - Preparation of schedules and questionnaires.

Unit-II

Sampling errors - Bias and standard errors - Mean squared error - Determination of sample size with reference to sampling errors - Non-sampling errors, Sources and types of non-sampling errors - Non-response and response errors.

Unit-III

Simple random sampling method with and without replacement (Lottery method and random number table) - estimation of population parameters - mean, variance and proportion - Simple random sampling for attributes; confidence limits - Determination of sample size.

Unit-IV

Stratified random sampling-principles of stratification - Estimation of population mean and its variance - Allocation techniques (equal allocation, proportional allocation, Neyman allocation and optimum allocation) - Estimation of gain due to stratification

Unit-V

Systematic sampling - Estimation of population mean and its variance - Comparison of simple random, stratified random and systematic sampling.

REFERENCE BOOKS::

1. William G. Cochran (1990) Sampling Techniques (Third Edition), John Wiley Sons, New York.
2. Sampath, S. (2006) Sampling Theory and Methods (Second Edition), Narosa Publishing House, New Delhi.
3. Daroga Singh and Choudary, F.S.(1986) Theory and Analysis of Sample Survey Designs, New age International publishers, New Delhi.
4. Des Raj and Promod Chandhok (1998) Sample Survey Theory, Narosa Publishing House Pvt. Ltd, New Delhi.
5. Murthy, M.N. (1977) Sampling Theory and Statistical Methods, Statistical Publishing Society, Kolkata.

2.5 PROGRAMMING with C and R

Unit - I

Introduction to Constants and Variables – Defining symbolic constant - Character set – Keywords and Identifiers – Declaration of Variables – Assigning values to variables – Declaring variable as a constant – Data Types.

Unit - II

Decision Making and Branching: Introduction – Decision making with IF statement – Simple IF statement – The ELSE IF Ladder – GOTO Statement - Decision Making and Looping : WHILE statement – Do Statement – FOR statement – Jumps in LOOPS.

Unit - III

Arrays: One-dimensional Arrays –Two-dimensional Arrays – Multi-dimensional Arrays – Dynamic Arrays - Handling of Character Strings: Declaring and Initializing String Variable – Arithmetic operations on Character – String handling functions. User Defined functions: Function calls – Function Declaration - Structures and Unions.

Unit - IV

Pointers: Understanding Pointers – Declaring Pointer Variable – Accessing a variable through its Pointer – Pointer Expression - File Management in C: Defining and Opening a File – Closing a File - Input/Output operations on Files – Random access to Files.

UNIT – V

Introduction - History of R programming - R commands – Random numbers generation – Data Types – Objects – Basic data and Computations – Data input – Data frames – Graphics – Tables. Computation of measures of central values, measures of dispersion, fitting of distributions, coefficient of correlation and fitting of regression lines using R.

REFERENCE BOOKS::

1. Balagurusamy, E. (2010) Programming in ANSI C (5th Edition), Tata McGraw-Hill Education, New Delhi.
2. Ashok, M. Kamthane (2006) Programming with ANSI and Turbo C, Dorling Kindersley (India) Pvt. Ltd., New Delhi.
3. Purohit S. G., Gore S. D. and Deshmukh S. K. (2010) Statistics using R, Narosa Narosa Publishing House Pvt. Ltd., New Delhi.
4. Ugarte, M. D., A. F. Militino, A. T. Arnholt (2008) Probability and Statistics with R, CRC Press, Taylo & Francis Group, London.
5. Peter Dalgaard (2008) Introductory Statistics with R, Springer India Private Limited, New Delhi.

2.6 STATISTICAL PRACTICAL – I

(The following exercises should be carried out using non-programmable scientific calculator)

Matrices

1. Finding determinant value of matrices of order 3×3 and 4×4 .
2. Finding inverse of matrices of order 3×3 and 4×4 .
3. Finding rank matrices of order 3×3 and 4×4 .
4. Solving system of linear equations using inverse.
5. Finding rank and signature of quadratic forms.

Descriptive Statistics

1. Construction of frequency table for univariate and bivariate data.
2. Construction of graphs: frequency polygon, frequency curve, histogram and Ogives.
3. Construction of diagrams: simple bar, compound bar, multiple bar, percentage bar diagrams.
4. Computation of mean, median and mode (ungrouped data and grouped data).
5. Computation of mean deviation, quartile deviation, standard deviation and coefficient of variation.
6. Calculating coefficients of skewness and kurtosis.
7. Fitting of linear and quadratic curves.
8. Calculation of coefficients of simple linear and rank correlation.
9. Fitting of regression equations with single regressor.

Statistical Distributions

1. Determination of the distribution function of a random variable X.
2. Find the marginal distributions of two random variables X, Y and obtain the conditional probability distribution of $X | Y$.
3. Determination of mean and variance using expectation.
4. Fitting of Binomial distribution.
5. Fitting of Poisson distribution.
6. Fitting of Normal distribution.

Sampling Techniques

1. Determination of sample size under various allocations.
2. Determination of standard errors/mean squared errors of estimates.
3. Estimation of parameters under SRSWR and SRSWOR.
4. Estimation of population mean and variance under stratified random sampling.
5. Estimation of population mean and variance under systematic sampling.

III YEAR - 3.1 STATISTICAL INFERENCE

Unit - I

Statistical Inference: meaning and purpose, parameter and statistic. Sampling distribution and standard error. Ideal estimator - consistency, unbiasedness, efficiency and sufficient statistic. Unbiased Estimator - Minimum variance unbiased estimator - Cramer-Rao Inequality and Rao-Blackwell theorem.

Unit - II

Point estimation: Moments estimator, maximum likelihood estimator and their properties. Method of Least Squares for regression models. Asymptotic properties of maximum likelihood estimators (without proof). Interval estimation for proportions, mean(s), variance(s) based on Chi-square, Student's t, F and normal distributions.

Unit - III

Statistical hypotheses- simple and composite hypotheses-null and alternative hypotheses-critical region- two kinds of errors. Randomized and non-randomized tests -most powerful test- Neyman-Pearson lemma. Likelihood ratio test- tests for mean, equality of two means (independent samples), variance and equality of variances of normal populations.

Unit - IV

Large sample tests concerning mean(s), variance(s), and proportion(s). Exact tests based on t, F and chi-square distributions concerning mean(s), variance(s), correlation coefficient(s). Chi-square Tests: Contingency table, tests for association, independence and goodness of fit.

Unit - V

Non-parametric tests – advantages and disadvantages of nonparametric tests- runs test, Kolmogorov -Smirnov test, sign test, median test, Mann-Whitney U test, and Wilcoxon's signed-rank test.

REFERENCE BOOKS::

1. Rohatgi, V. K. and A. K. md. Ehsanes Saleh (2009) An Introduction to Probability Theory and Mathematical Statistics, 2nd Edition, Wiley Eastern Limited, New Delhi.
2. Gupta, S.C., and V.K. Kapoor (1992) Fundamentals of Mathematical Statistics, A Modern Approach (Eighth Edition). Sultan Chand & sons, New Delhi.
3. Goon, A. M., M.K. Gupta, and B. Dasgupta (2005) Fundamentals of Statistics, Vol. I, (Eighth Edition), World Press, Kolkata.
4. Harold J. Larson (1982) Introduction to Probability Theory and Statistical Inference (Third Edition), John wiley & Sons. Inc., New York.
5. Robert V. Hogg, and Allen T.Craig (1978) Introduction to Mathematical Statistics (Fourth Edition), Macmillan Publishing Co., Inc., New York.
6. Parimal Mukopadhyay (2006) Mathematical Statistics (Third Edition), Books and Allied Private Limited, Kolkata.

3.2 DESIGN OF EXPERIMENTS

Unit - I

Fundamental principles of experiments – randomization, replication and local control. Size of experimental units. Analysis of variance- one-way and two-way classifications.

Unit - II

Analysis of Variance and Basic Designs: Concept of Cochran's Theorem. Completely randomized design(CRD)- Randomized block design(RBD) - Latin square design(LSD) and their analysis - Missing plot techniques in RBD and LSD.

Unit - III

Post ANOVA Tests: Multiple range test; Newman-Keul's test-Duncan's multiple range test-Tukey's test. Analysis of Covariance technique for RBD with one concomitant variable.

Unit - IV

Factorial experiments: 2^2 , 2^3 and 2^n factorial experiments. Definitions and their analyses.

Unit - V

Principles of confounding –partial and complete confounding in 2^3 – balanced incomplete block design(BIBD)– parametric relationship of BIBD.

REFERENCE BOOKS::

1. Das, M.N. and Giri,N.C. (1988) Design and Analysis of Experiments(2nd Edition). New Age International, New Delhi.
2. Douglas,C. Montgomery(2012) Design and Analysis of Experiemnts. John Wiley & sons, New York.
3. Goon A. M., Gupta, S.C. and Dasgupta, (2002)B. Fundamentals of Statistics, Vol.II, World Press, Kolkata.
4. Gupta, S. C. and V. K. Kapoor (1999) Fundamentals of Applied Statistics (Third Edition), Sultan Chand & Sons, New Delhi.
5. Dean, A and Voss (2006) Design and Analysis of Experiments. Springer India Private Limited, New Delhi.

3.3 STATISTICAL QUALITY CONTROL

Unit - I

Quality control and need for statistical quality control techniques in industries - causes of variation - process control and product control. Specifications and tolerance limits- 3σ limits, construction of Shewhart control charts - variable control charts - \bar{X} , R and σ charts.

Unit - II

Control charts for attributes: control chart for fraction defectives (p chart), number of defectives (d chart) and number of defects per unit (c chart).

Unit - III

Acceptance Sampling - Sampling inspection, producer's risk and consumer's risk-acceptable quality level (AQL), lot tolerance percent defective (LTPD), average outgoing quality level (AOQL), ATI and ASN. Rectifying inspection plans.

Unit - IV

Acceptance sampling by attributes: Single sampling plan - OC, AOQ, ATI and ASN curves - Double sampling plan and its advantages over single sampling plan, Operating procedure.

Unit - V

Acceptance sampling for variables-sampling plan based on normal distribution- known and unknown standard deviation cases. Determination of n and k for one- sided specification limits - OC curve.

REFERENCE BOOKS:

1. Montgomery, D.C. (1991) Statistical Quality Control (2nd Edition) John Wiley and Sons, New York.
2. Eugene L. Grant, and Richard S. Leavenworth (1988) Statistical Quality Control (Sixth Edition), McGrawhill Book co, New York.
3. Gupta, S. C. and V.K. Kapoor (1999) Fundamentals of Applied Statistics (Third Edition), Sultan Chand & sons, New Delhi.
4. Goon, A. M., M.K. Gupta and B. Dasgupta (1987) Fundamentals of Statistics, Vol. II. World Press, Kolkata.
5. Mahajan (1997) Statistical Quality Control, Dhanpat Rai & sons, New Delhi.
6. Juran, J.M.(1988) Quality Control Handbook, McGraw Hill, New York.

3.4 OPERATIONS RESEARCH

Unit – I: Concepts of Operations Research – Limitations - Linear Programming Problem(LPP) - mathematical formulation of normal form - graphical solution.

Unit – II: Simplex method – Big M method –Two-phase method – dual formulation.

Unit - III : Transportation problem-mathematical formulation- North-West corner rule and Vogel's rule-MODI method - Assignment problem - Hungarian method.

Unit – IV: Game theory: Maximin and Minimax criterion - saddle points- 2×2 Games without saddle point- Dominance rule based on graphical method for $(2 \times n)$ and $(m \times 2)$ games.

Unit – V: Network analysis by CPM/PERT: Constraints in Network – Construction of the Network – Time calculations – Concept of slack and float in Network Analysis – Network crashing – Finding optimum project duration and minimum project cost.

REFERENCE BOOKS::

1. Goel, B.S. and Mittal, S.K. (2000) Operations Research, PragatiPrakashan, Meerut.
2. Hillier, F.S and Lieberman, G. J. (1998) Operations Research, CBS Publishers and Distributors, New Delhi.
3. Kanti Swarup, Gupta, P.K. and Man Mohan (2008) Operations Research (3rd Edition). Sultan Chand & Co, New Delhi.
4. Kapoor, V.K. (2001), Operations Research, Sultan Chandan & Sons, New Delhi.
5. Sharma, J.K. (2001) Operations Research, Theory and applications, Macmillan, New Delhi.
6. Sharma J.K. (2002) Operations Research, Problems and solutions, Macmillan, New Delhi.
7. Taha, H.A. (2007) Operations Research – An Introduction (8th Edition) Prentice Hall of India, New Delhi.

3.5 TIME SERIES and OFFICIAL STATISTICS

Unit-I (Time Series)

Components of time series – Additive and multiplicative models - Resolving components of a time series-measuring trend: Graphic, semi-averages, moving average and least squares methods.

Unit -II (Time Series)

Seasonal variation- measuring seasonal variation: method of simple averages, ratio-to-trend method, ratio-to-moving average method and link relative method- Cyclical and Random fluctuations- variate difference method.

Unit -III (Index Numbers)

Index numbers and their definitions - construction and uses of fixed and chain based index numbers - simple and weighted index numbers - Laspeyre's, Paasche's, Fisher's, and Marshall - Edgeworth index numbers – optimum tests for index numbers - Cost of living index numbers.

Unit -IV (Demographic Methods)

Demographic data – definition, sources and surveys –registration method. Fertility measurements – crude birth rate – general, specific, total fertility rates - gross and net

reproduction rates. Mortality measurements – crude death rate – specific, standardized death rates – infant mortality rate – maternal mortality rate. Construction of Life table.

Unit -V (Official Statistics)

Present official statistics system in India – Ministry of statistics – NSSO, CSO and their functions - Registration of vital events – National Income Statistics – Agricultural Statistics – Industrial Statistics in India – Trade Statistics in India – Labour Statistics in India – Financial Statistics in India.

REFERENCE BOOKS::

1. Goon, A.M., M. K. Gupta and B. Das Gupta (2005) Fundamentals of Statistics- Vol. I, World press Ltd, Kolkata.
2. Gupta, S.C. and V.K. Kapoor (2007) Fundamentals of Applied Statistics, Sultan Chand & Sons, New Delhi.
3. Guilford, J. P. (1986) Fundamental Statistics in Psychology and Education, McGraw-Hill Book Company, New Delhi.
4. Srivastava, S. C. and S. Srivastava (2003) Fundamentals of Statistics, Anmol Publications Pvt. Ltd., New Delhi.

3.6 STATISTICAL PRACTICAL – II

(The following exercises should be carried out using non-programmable scientific calculator)

Statistical Inference

1. Computation of moment's estimator and maximum likelihood estimator.
2. Construction of confidence interval for mean and difference between means of two normal populations i) when variances are known ii) with common unknown variance.
3. Construction of confidence interval for variance and ratio of variances of two normal populations.
4. Testing the population proportion and equality of two population proportions based on large samples.
5. Testing the mean and equality of means of two normal populations i) when variances are known and ii) with common but unknown variance.
6. Testing the homogeneity of variances of two normal populations.
7. Testing the independence of two attributes.
8. Non parametric test for one sample problems – runs test, sign test, Kolmogorov – Smirnov test.
9. Non parametric test for two sample problems – median test, Mann-Whitney U test and Wilcoxon's signed – rank test.

Design of Experiments

10. Carrying out ANOVA for one way classified data.
11. Carrying our ANOVA for two way classified data.
12. Analyzing completely randomized design.
13. Analyzing randomized block design.

14. Analyzing Latin square design.
15. Analyzing 2^2 factorial design.
16. Analyzing 2^3 factorial design.

Statistical Quality Control

17. Construction of control charts for mean and range (\bar{X} and R charts)
18. Construction of control charts for standard deviation (σ chart)
19. Construction of control charts for fraction defectives (p chart)
20. Construction of control charts for number of defectives (d chart)
21. Construction of control charts for number of defects per unit (c chart)
22. Draw OC, AOQ and ATI curves for single and double sampling plans by attributes.

Operations Research

23. Solving linear programming problem applying graphical method, simplex method.
24. Finding initial basic feasible solution to transportation problem applying methods of North- West corner, row minima, column maxima, matrix minima method, Vogel's Approximation methods.
25. Solving 2 x 2 game with saddle point.
26. Solving 2 x 2 game applying dominance rules.

Time Series

27. Fitting of linear trend by applying the method of least squares and method of moving averages.
28. Determination of seasonal variations by using the method of
 - i) simple averages, ii) ratio to moving average and iii) link relatives.

Index Numbers

29. Calculation of weighted index numbers: Laspeyre's, Paasche's, Fisher's and Marshall - Edgeworth index numbers.
30. Finding cost of living index number.
31. Calculation of fixed and chain based index numbers.

Demographic Methods

32. Calculation of fertility measurements – crude birth rate – general, specific, total fertility rates - gross and net reproduction rates.
33. Calculation of mortality measurements – crude death rate – specific, standardized death rates – infant mortality rate – maternal mortality rate.
34. Construction of Life table.
