Semester –I (2012 onward)

Course No.	Title of the Course
STM-101	Mathematical Analysis
STM-102	Probability and Distribution Theory - I
STM-103	**Sample Surveys and Statistics for National Development**
STM-104	**Statistical Computing-A**
P-105	Practical based on Courses STM –102 and STM-103
P-106	Practical based on Courses STM –101 and STM-104

Semester-II(2012 onward)

Course No.	Title of the Course
STM-201	Probability and Distribution Theory - II
STM-202	Stochastic Processes
STM-203	Demography
STM-204	Linear Models and Regression Analysis
STM-205	Statistical Computing-B
P-205	Practical based on Courses STM 201 and STM-204
P-206	Practical based on Courses STM-202 and STM 203

Note: Papers STM-201, STM -202, STM -203, STM -204 and STM -205 will be of 100 marks with a break up of 20 marks for continuous assessment and 80 marks for the Semester Examination while Lab Courses P-205 and P-206 will be of 50 marks each with a break of 10 marks for continuous Assessment

Semester-III (2013 onward)

Course No.	Title of the Course
STM-301	Inference –I
STM-302	Design and Analysis of Experiments
STM-303	Operations Research – I
STM-304	Multivariate Analysis
P-305	Practical based on Courses STM-301 and STM 302
P-306	Practical based on Courses STM-303 and STM 304

Note: Each paper will be of 100 marks with a break up of 20 marks for continuous assessment and 80 marks for the Semester Examination)

Semester-IV(2013 onward)

Course No.	Title of the Course
STM-401	Inference –II
STM-402	Operations Research – II
STM-403	Industrial statistics and Reliability Theory
STM-404	Information Theory

P-405 Practical based on Courses STM-402 and STM 403

P-406 Sample Survey Project

Note: Each paper will be of 100 marks with a break up of 20 marks for continuous assessment and 80 marks for the Semester Examination)

w.e.f. 2012 onwards

Mathematical Analysis

Course No.: STM-101 **Max. Marks: 80**

UNIT-I

Algebra of Matrices, trace of a matrix, trace of AB = trace of BA, Wiellandt's Theorem as a simple consequence. Inverse of partitioned matrices, idempotent and nilpotent matrices, linear independence and dependence of row (column) vectors, orthogonal and unitary matrices, Gram-Schmidt orthogonalisation. Linear equations, solutions of homogenous and non-homogenous equations, basic linear transformation, eigen values and eigen vectors of a matrix and their determination. Quadratic forms. Necessary and sufficient condition for a quadratic form to be positive definite.

UNIT-II

Real Analysis: Finite, countable and uncountable sets, bounded and unbounded sets, Archimedean property, ordered field, completeness of R, sequence and series of functions, limit sup. and limit inf. of a bounded sequence, continuity, uniform continuity, the algebra of continuous functions, monotonic functions, types of discontinuities, infinite limits and limits at infinity. Differentiability, Rolle's Theorem, Mean Value Theorems and Uniform Convergence.

UNIT-III

Reimann Integration: Definition and existence of a Reimann integral for bounded functions, refinement of partition, behavior of the lower and upper sums under refinement of a partition. Necessary and sufficient conditions for integrability. Integrability of sum, difference, product and quotient of two integrable functions, the integral as a limit of sum. Some integrable functions. Integration and Differentiation, the Fundamental Theorem of integral calculus.

UNIT-IV

Complex Analysis: Complex numbers, Algebra of complex numbers, Analytic functions, Cayuchy-Reimann equations, line integral, Cauchy's Theorem, Cauchy's integral formula, power series, exponential, logarithm, sine and cosine functions.

TEXT BOOKS:

Apostol, T.M (1985), Mathematical Analysis, Narosa, India Ed.

Courant, R.and John, F.(1965), Introduction to Calculus and Analysis, Wiley.

S.C.Malik, Mathematical Analysis, New Age International Limited.

Miller, K.S(1975)Advanced Real Calculus, Harper, New York.

Rudin, Walter(1976). Principles of Mathematical Ananlysis, McGraw Hill.

Grabill, Walter(1976). Matrices with Applications in Statistics, 2nd Ed.Wadsworth.

Roa,C.R.(1973), Linear Statistical Inference and its Applications, 2nd Ed.John Wiley and Sons,Inc.

Searel, S.R.(1982).Matrix Algebra useful for Statistics. John Wiely and Sons,Inc.

w.e.f. 2012 onwards

PROBABILITY AND DISTRIBUTION THEORY -I

COURSE NO: STM-102 **M.M.80**

UNIT-I

Class of sets, fields, sigma fields, minimal sigma field, and Borel sigma field. Definition of probability: classical and relative frequency approach, Discrete probability space, properties of probability based on axiomatic approach, Independence of events, conditional probability, total and compound probability rules. Bayes theorem and its applications. Random variable. Cumulative distribution function of random variables and its properties, probability function of a random variable.

UNIT-II

Joint distribution function and probability function of a random variable. Expectation of a random variable and its properties, conditional expectation, covariance and correlation. Moments, measure of location and dispersion of a random variable. Moment generating function, probability-generating function, Characteristic function of a real and vector valued random variables. Inversion formula, Fourier formulas and Uniqueness theorem.

UNIT-III

Standard Univariate discrete distributions: Discrete Uniform, Bernoulli, Binomial, Poisson, Negative Binomial, Geometric, Hyper geometric and Logarithmic series distribution. Compound, truncated and mixture distributions. Its properties and applications. Marginal and conditional distributions, Distribution of functions of discrete random variables, reproductive property of standard distributions.

UNIT-IV

Univariate Continuous distributions: Uniform, Beta, Gamma, Exponential, Pareto, Weibull, Laplace, Normal, Cauchy, Logistic and Lognormal distributions. Compound, Truncated and mixture distributions, its properties and applications. Marginal and conditional distributions.

TEXT BOOKS:

Dudewicz, E.J. and Mishra, S.N. (1988): Modern Mathematical Statistics, Willy, Int'l Students edition

Rohatgi, V.K. (1994): An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern.

Rao, R.C. (1973): Linear Statistical Inference and its Applications, 2/e, Wiley Eastern.

REFERENCES:

Pitman. (1993): Probability, Narosa Publishing House.

Johnson, S.and Kotz, (1972): Distribution in Statistics, vol. I, II and III, Houghton And Miffin.

Johnson, Kotz and Kemp (1992): Univariate discrete distribution, John Wiley

Cramer, H. (1946): Mathematical Methods of Statistics, Princeton.

w.e.f. 2012 onwards

SAMPLE SURVEY & STATISTICS FOR NATIONAL DEVELOPMENT

Course No: STM-103 **M.M.80**

UNIT I

Simple Random Sampling: Concept of sampling design, expected value and sampling variance of the sample mean, expected value of the sample mean square and estimation of the variance. Determination of sample size. Simple random sampling as applied to qualitative characteristics.Stratified random Sampling: Estimation of the population mean/total and its variance, choice of sample sizes in different strata, variance under different allocations. Comparison with unstratified sampling. Estimation of the gain in precision due to stratification, construction of strata.

UNIT II

Ratio and Regression methods of Estimation: Variance of the estimates, estimation of variances, optimum property of ratio and regression estimator. Ratio and regression estimator in stratified random sampling. Some modifications of ratio and regression estimators. Comparison among regression, ratio and simple unbiased estimates. Unbiased ratio type estimates.

UNIT III

Systematic Sampling: Sample mean and its variances. Comparison of systematic with simple random and stratified sampling in the general case and also in the case of linear trend.

Cluster sampling: Estimation of mean and its variance for equal and unequal clusters. Efficiency in terms of intra-class correlation. Optimum unit of sampling. Sampling with replacement and unequal probabilities. Estimation of mean and its variance.

UNIT-IV

Double Sampling: Double Sampling for Stratification including estimation of variance. Variance of ratio and regression estimates in double sampling. Double sampling for pps estimation. Sampling on successive occasions: Sampling on two occasions, estimation of current population mean.

Two-stage sampling: (a) Equal first stage unit; estimation of population mean and its variance and estimates of variance. Comparison with one stage sampling

w.e.f. 2012 onwards

(b) Unequal first stage unit; estimation of population mean. Expected values and variance of different estimates including the case of probability proportional to size

Economic Development: Growth in per capita income and distributive justice. Indices of development, Human development indexes. Estimation of national income. Population growth in developing and developed countries. Population projection using Leslie matrix. Labour force projection measuring inequality in income, Gini coefficient, their measure. Poverty measurement.

TEXT BOOKS:

Cochran, W. G: Sampling Techniques, 3rd edition, Wiley.

Mukhopadhyay, P. (2000): Theory and Methods of Survey Sampling, Prentice Hall of

India, Private limited, New Delhi

Des Raj & Chandak(1998): Sampling Theory, Narosa.

Murthy, M. N. (1977): Sampling Theory and Methods, Statistical Publishing Society, Calcutta.

Skate teal (1984): Sampling Theory of Surveys with Applications, Iowa
State University Press, & IARS.

Singh, D and Chuddar, F. S. (1986): Theory and Analysis of Sample Survey Design,

New Age International Publisher.

CSO (1980): National Account Statistics, Source and Health.

Keyfitz, N. (1977): Applied Mathematical Demography, Springer Verlag.

Sen, A (1997): Poverty and Inequality

UNESCO: Principal for Vital Statistics System, Series M-12.

w.e.f. 2012 onwards

STATISTICAL COMPUTING-A

Course No.: STM-104 **M.M-80**

UNIT I

Programming in FORTRAN: Character codes, constants, Variable names (Real, Integer, Double Precision, Complex and logical); arithmetic, logical and relational operators, Expressions: Arithmetic, Character; Relation and Logical expressions, Rules for writing arithmetic expressions. Statements:

UNIT-II

Specification of Data, Format types, one dimensional Array Statements, Two-dimensional and multi dimensional Arrays Assignment Statement, Format Specifications. Control Statements: Do Loops, Do-Continue, IF-Blocks, Unconditional GOTO, IF (condition) GOTO Label, and Computer GOTO Statement, STOP, RETURN and END statements, COMMON Statement.

UNIT III

Built-in-Functions, User Defined Functions, Function Subprograms, Subroutine Subprograms. Writing programs for statistical calculation Addition, subtraction and multiplication of matrices,correlation, regression, t-test, chi square test, r x c contingency table. Analysis of variance (CRD, RBD, LSD)

UNIT IV

Statistical Softwares: Working with Software Package MINITAB for graphics, descriptive statistics, representation of multivariate data, simple hypothesis tests (t,χ^2 and F, analysis of variance, and linear regression and matrix processing (Basic operations, Eigen Values and inversion of Matrices etc.)

TEXT BOOKS:

1.Fortran:Fortran 77: Schaum Series

2.Matcalf M. and Reid J. (2000): Fortran-90/95 Explained, Oxford University Press.

w.e.f. 2012 onwards

PROBABILITY AND DISTRIBUTION THEORY-II

COURSE NO: STM -201 **M.M.80**

UNIT-I

Sampling distributions. Chi-square and F distributions and their properties and applications, Non-central F and Chi-square distribution. Test of significance of F and Chi-square.

UNIT-II

Sampling distributions. t distribution and its properties and applications, Non-central

t distribution. Test of significance of t.

Bivariate distributions: Bivariate normal distribution and some idea of exponential and multinomial distributions and their pdf, marginal and conditional distributions. Expectations and conditional expectations, covariance.

UNIT-III

Bivariate discrete distributions. Power series distributions and Generalized power series distribution and its properties, relations and applications.

Order Statistics: Distribution and properties. Joint and marginal distributions of order statistics. Distribution of median and range. Discrete order statistics and their joint pmf. Limiting distribution of nth order statistics. Extreme value laws and their properties. Correlation between extremes.

UNIT-IV

Convergence: Convergence of a sequence of random variables, convergence in probability, almost sure, Convergence of a sequence of pair of random variables. Convergence of moments, Helly-Bray theorem, Continuity theorem Borel Cantelli Lemma and convolution of distributions. Convergence of a series of random variables.

Chebyshev's and Kintchine's weak law of large numbers (WLLNs). Condition for the WLLNs. Strong law of large number and Kalmogrov's theorems and examples.

CLT: Introduction of CLT. Lindberg Levy , Liapunov forms and De-Movier's central limit theorems (CLT) and examples.

w.e.f. 2012 onwards

TEXT BOOKS:

Dudewicz, E.J. and Mishra, S.N. (1988): Modern Mathematical Statistics, Willy, Int'l Students edition

Rohatgi, V.K. (1994): An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern.

Rao, R.C. (1973): Linear Statistical Inference and its Applications, 2/e, Wiley Eastern

Ash, Robert. (1972): Real Analysis and Probability, Academic Process

Dudley, R.M. (1989): Real Analysis and Probability, Wads worth and Brooks /Cole

REFERENCES:

Pitman, J. (1993): Probability,Narosa Publishing House.

Johnson, S.and Kotz, (1972): Distributions in Statistics, vol. III, Houghton and I, II

And Miffin.

Johnson, Kotz and Kemp (1992): Univariate discrete distribution, John Willy

w.e.f. 2012 onwards

STOCHASTIC PROCESSES

Course No.: STM-202 **M.M.80**

UNIT I

Introduction to Stochastic Processes (SP's); Classification of Stochastic Processes according to state space and time domain. Definition of Markov Chain and examples. Countable state Markov chains (MC's), Chapman-Kolmogrov equations; Calculation of n-step transition probability and its limit.

UNIT II

Stationary distribution, Classification of states: persistent state, transient state and ergodic state, examples, limiting theorems concerning states; Simple Random Walk Model and gambler's ruin problem; expected duration of the game, Probability of ruin at the nth trail. And Probability of a draw at the rth trial, Applications from social, biological and physical sciences.

UNIT III

Markov Process with Discrete state space: Poisson processes, Poisson processes and related distributions, Birth and death process; Markov Process with Continuous state space, Brownian Motion, Wiener Process, Differential equations for a Wiener Process, Kolmogorov Equations.

UNIT IV

Introduction of Branching process: Galton-Watson branching process, properties of generating functions of branching process and distribution of population size, Calculation of moments of Branching Process and distribution of total progeny. Probability of ultimate extinction, numerical illustrations.

TEXT BOOKS:

Medhi, J. (1982): Stochastic Processes, Holden-Day.

Baily, N.T.J. (1965): The Elements of Stochastic Processes: John Wiley

Jagers P. (1974): Branching Processes with Biological Applications, Wiley.

Harris, T.E. (1963): The Theory of Branching Processes, Springer-Verlag.

Hoel, P.G., Port, S.C. and Stone, C.J (1972): Introduction to Stochastic Processes, Houghton Miffin & Co.

Karlin, S. and Taylor, H.M. (1975): A First Course in Stochastic Processes, Vol.1, And Academic Press.

Basu, A.K. (2003): Introduction to Stochastic Processes, Narosa

w.e.f. 2012 onwards

DEMOGRAPHY

COURSE NO: STM- 203 **M.M.80**

UNIT I

Introduction and Definition of vital Statistics, Coverage and content errors in demographic data use of balancing equations, Chanderasekharan-Deming formula to check completeness of registration data. Accuracy of age data on sex and age: Whipple's, Myer's and UN indices. dependency ratio.

UNIT II

Measure of fertility; relationship between CBR, GFR and TFR. Mathematical models on fertility and human reproduction process, distributions of time to first birth, inter-live birth intervals and of number of births (for both homogeneous and non-homogeneous group of women), estimation of parameters; estimation of parity progression ratios from open birth interval data.

Unit III

Mortality: concepts and rates; measures of infant mortality rate. Force of mortality. Life table and its construction: Complete and abridged. Greville's and Reed-Merrels methods. Relationship between life table functions and their estimation. Relationship between abridged life table functions.

Unit IV

Population projection: Methods for population projection. Use of Leslie matrix. Frejka's component method. Models for population growth and their fitting to population data.

Migration: concepts and rates. Uses of place of birth and duration of residence data. Estimation of measure of mobility.

TEXT BOOKS:

Bartholomew, D.J. (1982). Stochastic Models for Social Processes, John Wiley.

Benjamin, B. (1969). Demographic Analysis, George, Allen and Unwin.

Ching, C. L. (1968). Introduction to Stochastic process in Biostatistics, John Wiley.

Cox. P. R. (1970). Demography, Cambridge University Press

Keyfitz, N. (1977). Applied Mathematical Demography, Springer Verlag.

Spiegelman, M. (1969). Introduction to Demographic Analysis; Harvard University Press.

Wolfenden, H. H. (1954). Population Statistics and their Compilation; Americian Actuarial Society.

w.e.f. 2012 onwards

LINEAR MODELS & REGRESSION ANALYSIS

STM-204 **M.M.80**

UNIT-I:

Linear models; Gauss Markov set up, Model classification, Normal equations and least squares estimates, Error and estimation space, Variance and covariance of least square estimates, Estimation of error variance, estimation with correlated observations, least square estimates with restriction on parameters.

UNIT-II

Test of hypotheses for one and more than one linear parametric functions, Tests of linear hypotheses, estimable linear hypotheses, Generalized F test, Generalized t test, Multiple comparison test due to Tukey and Schaffer.

UNIT-III

Experimental Design models; Introduction, Point estimation, Re-parameterization, Variance and Covariance of estimable function, Testing of hypotheses, Regression models.

UNIT-1V

Simple linear regression fit of polynomials, Residual and their plot as tests for departure from assumption such as fitness of model, normality, and homogeneity of variances and detection of outliers

TEXT BOOKS:

Cookers. and Weisberg, S (1982). Residual and Influence in Regression. Chapman and Hall

Draper,N.R. and Smith, R.L. (1998). Applied Regression Analysis. 3rd Ed. Wiley.

Gunst, R.F. and Mason, R.L. (1980). Regression Analysis and its Applications- A Data Oriented Approach. Marcel and Decker.

Roa, C.R. (1973). Linear Statistical Inference and its Applications. Wiley Eastern.

Weisberg, S. (1985). Applied Linear Regression. Wiley

w.e.f. 2012 onwards

STATISTICAL COMPUTING-B

STM-205 **M.M.80**

Unit I

Introduction to object oriented programming, concept and designing: numerical constants and variables, integer: int, short, long, signed and unsigned, floating point: float and double. Strings: character data type, input and output of strings.

Unit II

Control statements: relation operators, compound statement, if, if else, while loop, for loop, do while loop, logical operators, switch and break statement. Array: array variable, syntax rules for arrays, multiple subscripts in arrays, for loops with arrays,

Unit III

Functions: defining and using functions. Function declaration, array in function, global, local and static variable. Pointers: pointers data type, pointers and address, pointers and arrays, pointers to functions, pointer to pointer. Writing program for statistical calculation Addition, subtraction and multiplication of matrices,correlation, regression, t-test, chi square test, r x c contingency table. Analysis of variance (CRD, RBD, LSD)

Unit IV

Statistical Softwares: Working with Software Package MINITAB for graphics, descriptive statistics, representation of multivariate data, simple hypothesis tests (t,χ^2 and F, analysis of variance, and linear regression and matrix processing (Basic operations, Eigen Values and inversion of Matrices etc.)

References

1. R. Decker and S. Hirshfield (1998). The object concept: an introduction to

computer programming using c++, PWS publishing.

2. S.B. Lipmann and J. Lajoie (1998). C++ primer. Third ED. Addison Wesley.

3. W.J. Savitch (2001). Problem solving with c++. The object of programming.

Third ED. Addison Wesley, Longman.

w.e.f. 2013onwards

INFERENCE - I

COURSE NO: STM-301 **M.M.80**

UNIT-I

Point Estimation: The general statistical decision problem, Example (Point estimation, Interval estimation etc.). Criteria of unbiasedness, consistency and efficiency. Cramer-Rao Inequality. Minimum variance unbiased (MVU) estimation, UMVU Estimation, Asymptotic relative efficiency, Invariance of consistent estimator under continuous transformation. Bhattacharya bound, Chapman Robin's Inequality.

UNIT-II

Sufficient and Complete Statistics: Sufficiency, Minimal sufficient statistic, Factorization theorem, Fisher–Neyman criterian. Characterization of distributations. Admitting Sufficient Statistics. Exponential families and Pitman families, Invariance property of sufficiency under one to one transformation of sample space. Fisher information for one and several parameter models. Rao-Blackwell theorem. Completeness and Lehman –Scheffle theorem.

UNIT-III

Methods of estimation: Method of maximum likelihood (MLE). Optimum properties of MLE. Maximum Consistent Asymptotic Normal estimators (CAN) obtained by MLE method in one parameter exponential family. Other methods of estimation: Moments, Minimum Chi –square, modified minimum Chi –square and least square estimate.

UNIT-IV

Testing of Hypothesis: Concepts of critical regions, test functions, two kinds of errors, size function, power function, level of significance, Most Powerful (MP) and Uniformly most powerful (UMP) test, in class of size tests. Neyman Pearson Lemma, MP tests for simple null against simple alternative hypothesis.

w.e.f. 2013onwards

UMP tests for simple null hypothesis against one-sided alternatives and for one-sided null against one-sided alternatives in one parameter exponential family. Extension of these results to distributions with Monotone Likelihood ratio property.

TEXT BOOKS:

Kale, B.K. (1999): A first course on Parametric Inference, Narosa Publishing House.

Rohatgi, V. (1988): An Introduction to Probability and Mathematical Statistics. Wiley Eastern Ltd. New Delhi (Student Edition)

REFERENCES:

Lehman, E.L. (1986): Theory of Point Estimation (Student Edition)

Lehman, E.L. (1986): Testing Statistical Hypothesis (Student Edition)

Rao, C.R. (1973): Linear Statistical Inference

Dudewicz, E.J. and Mishap, S.N. (1988): Modern Mathematical Statistics. Wiley Series in Prob. Math. Stat., John Wiley and Sons, New York (International Student Edition)

Ferguson, T.S. (1967): Mathematical Statistics, Academic.

Zacks,S (1971).Theory of Statistical Inference, John Wiley and Sons, New York.

w.e.f. 2013onwards

DESIGN AND ANALYSIS OF EXPERIMENTS

Course No: STM-302 **M.M.80**

UNIT-I

Introduction to basic designs and their analysis, Completely Randomized Design (CRD), Randomized Block Design (RBD), Latin Square Design (LSD), missing plot (more than one observations) techniques for RBD and LSD. Analysis of Covariance for CRD and RBD.

UNIT-II

Introduction to Incomplete block design intra block analysis (estimability), estimates of estimable linear parametric function; Balanced Incomplete Block Design. Intra block analysis, Inter block analysis, recovery of inter block information; Youden design.

UNIT-III

General factorial experiments, factorial effects; best estimates and testing the significance of factorial effects; study of 2 and 3 factorial experiments in randomized blocks; complete and partial confounding. Fractional replication for symmetric factorials. Split plot experiments.

UNIT IV

Biological assays: The structure of Bio assay. Nature of operation, relative potency, Similarity. Dose Response Curve. Fieller Theorem. Types of Bio- Assays: Direct Assays, Indirect Assays based on quantitative responses i) Parallel Line Assays, ii) Slope Ratio Assays. Quantal Response Assays: i) Dragsted-Behren Method, ii) Spearman-Karber Method.

TEXT BOOKS:

Alok dey (1986): Theory of Block Designs, Willey Eastern

Angela Dean Daniel Voss (1999): Design and Analysis of Experiments, Springer.

Das, M.N and Giri, N. (1979): Design and Analysis of Experiments, Willey Eastern

Giri, N (1986): Analysis of Variance, South Asia Publishers

John, P.W.M. (1971): Statistical Design and Analysis of Experiments,

McmillainJoshi.D.D. (1987): Linear estimation and Design of Experiments Willey Eastern

R. Rangaswamy (2005): A Text book of Agricultural Statistics. New Age International (P) Limited.

w.e.f. 2013onwards

OPERATIONS RESEARCH I

Course No.: STM-303 **M.M.80**

UNIT I:

Definition and scope of Operational research, Necessity of Operations Research in Industry; phases in Operations Research. LP problems: Simplex method and Extreme point theorems; Revised Simplex Method, Transportation and Assignment Problems with their methods of solution,

UNIT II

Duality in LPP, Symmetric and asymmetric dual problems, duality theorems, Primal-Dual Relations, Complementary Slackness Theorem and Complementary Slackness conditions, Dual Simplex Method, Sensitivity Analysis and Parametric Programming,

UNIT III

Decision Making in the face of competition, two–person, Zero sum games, Games with mixed strategies, existence of solution and uniqueness of value in zero-sum games, finding solutions in 2x2, 2xm and mxn games, Equivalence between game theory and linear programming problem.

UNIT IV

Sequencing and scheduling problems, 2 machine n-job and 3 machine n-job problems with identical machine sequence for all jobs; 2-job n-machine problem with different routings. Project management; PERT and CPM; Probability of project completion, PERT-crashing.

TEXT BOOKS :

Taha H.A. (1982) Operational Research: An introduction; Macmillan.

Philips D.T., Ravindran A. and Solberg J. Operation Research, Principles and Practice.

Kanti Swarup, P.K. and Singh,M.M.. (1985) Operation Research; Sultan Chand & Sons.

REFERENCES:

Hillier F.S. and Lieberman G.J. (1962) Introduction to Operation Research; Holden Day.

Saaty T.L. (1961) Elements of Queuing Theory with Applications; McGraw Hill.

Churchman C.W, Ackoff R.L. and Arnoff E.L. (1957) Introduction to Operations Research

R. Panneerselvam(2002): Operations Research: Prentice Hall

w.e.f. 2013onwards

MULTIVARIATE ANALYSIS

COURSE NO: STM-304 **M.M.80**

UNIT-I

Multivariate Normal Distribution Theory: Marginal and conditional distribution, Joint distribution, Linear function of correlated normal variate. Characteristics function of multivariate normal distribution, Maximum likelihood estimation of the mean vector and co-variance matrix and their independence. Distribution of sample mean vector. Large sample behavior of mean vector and co-variance matrix. Distribution of non-central chi-square, Quadratic form and its distribution.

UNIT-II

Multiple and partial correlation co-efficient and their sampling distribution. Simple regression model, regression co-efficient and distribution of sample regression co-efficient. Test of linear hypothesis about regression co-efficients and interval estimation.

Canonical Correlation and Canonical variables: Definition, uses, estimation and statistical inference. Distribution of characteristic roots and vectors: The distribution of canonical Correlation.

UNIT-III

Distribution of sample co-variance matrix and the sample generalized variance; Wishart matrix and its distribution. Some important properties of the Wishart distribution. Characteristic function of Wishart distribution.

Generalized T^2 statistics: The general T^2statistics, Derivation of the generalized T^2 statistics and its distribution. Some important properties of T^2 statistics and its uses. Two-sample problem with unequal co-variance matrices. Likelihood criterion for testing independence of set of variate and it moments. Walk's lambda criterion and its distribution. Mahalanobis D^2 statistics and its distribution.

UNIT-IV

Classification and discrimination: Classification and discrimination procedure for discrimination between two multivariate normal populations. Sample discriminant function, tests associated with discriminate function, standards of good classification, probability of misclassification and their estimation, classification into two and more than two multivariate normal population

w.e.f. 2013onwards

Principal Component: Definition of principal components, uses, estimation and computation, Statistical inference on principal components.

Factor Analysis: Definition of factor analysis and uses, linear factor models, estimation of factor loading, Factor rotation, estimation of factor scores.

TEXT BOOKS:

Anderson, T.W (1983): An Introduction to Multivariate Statistical analysis, 2nd ed., John Wiley

Johnson, R.A. and Wichen, D.W. (1992): Applied Multivariate Statistical Analysis,2nd ed. Prentice Hall.

Giri, N.C. (1977): Multivariate Statistical Inference, Academic press.

Kshirsagar, A. M (1972): Multivariate Analysis, Marcel Decker.

Morrison, D. F. (1976): Multivariate Statistical Methods, 2nd Ed, and McGraw Hill.

Sharma, S. (1996): Applied multivariate technique, Wiley

Muirhead, R. J. (1982): Aspects of multivariate statistical theory, John Wiley.

Seber, G.A.F.(1984): Multivariate observations, Wiley.

Srivastava, M.S.and Khatri, C.G. (1979): An introduction to multivariate statistics. North Holland.

Carter and Srivastava: Multivariate Analysis, North Holland.

w.e.f. 2013onwards

INFERENCE –II

COURSE NO: STM- 401 **M.M.80**

UNIT-I

Likelihood ratio tests: Large sample properties, derivation of common likelihood ratio tests, asymptotic distribution of likelihood ratio test, Consistency of tests.

Uniformly Most Powerful Unbiased Tests, similar tests with Newman structure locally best unbiased tests, type A and A1 critical regions for the exponential family. Randomized test.

UNIT-II

Interval Estimation: Determination of confidence interval based on small and large samples. Relation between confidence estimation and hypothesis testing.

Bayesian Inference: Prior and Posterior distributions, uniform prior, non- informative prior, Jeffery's invariant prior, Natural conjugate prior and improper and invariant prior. Loss function, Bayes risk. Bayesian Point estimation, Bayesian interval estimation.

UNIT-III

Sequential Analysis: Definition of Sequential Probability Ratio Test (SPRT). Fundamental relations among a, b, A and B. Determination of A and B in practice. Wald's fundamental identity and the derivation of O.C and ASN functions. Proof of the ultimate termination of SPRT for simple hypothesis. Examples based on Normal, Poisson, Binomial and Exponential conditions.

UNIT-IV

None Parametric Inference: Introduction, Advantages of none parametric methods over parametric methods. One Sample Problem: Sign Test, Wilcoxon-Signed rank test, Kolmogrove Smirnov Test, ARE, Applications of Pitman's theorem on the calculation of efficiency and ARE for Sign Test.

General Two Sample Problem: Wilcoxon-Mann- Whitney Test, Kolmogrov-Smirnov two sample test (for samples of equal size), Median test, ARE of Mann-Whitney Test. Mood Test, Ansari –Bradlay Test

w.e.f. 2013onwards

TEXT BOOKS:

Kale, B.K. (1999): A First Course on Parametric Inference, Narosa Publishing House.

Rohatgi, V. (1988): An Introduction to Probability and Mathematical Statistics. Wiley Eastern Ltd. New Delhi (Student Edition)

REFERENCES:

Lehman, E.L. (1986): Theory of Point Estimation (Student Edition)

Lehman, E.L. (1986): Testing Statistical Hypothesis (Student Edition)

Rao, C.R. (1973): Linear Statistical Inference

Dudewicz, E.J. and Mishap, S.N. (1988): Modern Mathematical Statistics. Wiley Series in Prob. Math. Stat., John Wiley and Sons, New York (International Student Edition)

Ferguson, T.S. (1967): Mathematical Statistics, Academic.

Zacks, S (1971). Theory of Statistical Inference, John Wiley and Sons, New York.

Berger, J, O.; Statistical Decision Theory and Bayesian Analysis, Springer Verlag.

Gibbons, J.D. (1985): Non-Parametric Statistical Inference. Marcel Decker.

w.e.f. 2013onwards

OPERATIONS RESEACH II

Course No.: STM-402 **M.M.80**

UNIT I

Multistage decision processes and Dynamic Programming, Integer Programming-branch and bound algorithm and Gomory's Cutting Plane algorithm. Multi Criterion and Goal Programming, Use of fractional programming.

UNIT II

Analytical structure of inventory problems; ABC Analysis: EOQ problem with and without shortages with (a) production is instantaneous (b) Finite Constant rate (c shortages permitted random models where the demand follows uniform distributing, multistage inventory subject to constraints, Dynamic programming and Inventory Control

UNIT III

Queuing models-specifications and effectiveness measures. Steady-state solutions M/M/1 and M/M/c models with associated distributions of queue-length and waiting time. M/G/1 queue. Steady-state solutions of M/Ek/1 and Ek/M/1. Machine interference problem. Transient solution of M/M/1 queue.

UNIT IV

Nonlinear programming, Formulation, Lagrange multiplier Technique, KuhnTucker necessary and sufficient conditions for optimality of an NLPP, Quadratic Programming problems, Wolfe's and Beals algorithms for solving quadratic programming problems, Separable Programming.

TEXT BOOKS:

Taha H.A. (1982) Operational Research: An introduction; Macmillan.

Hadley G.(1964) Nonlinear and Dynamic Programming; Addision Wesley.

Kabmboj ,Puri,N,C;Mathematical Programming

REFERENCE BOOKS:

Bazara and Shetty (1979) Nonlinear Programming Theory And Algorithms; John Wiley

Kanti Swarup, P.K. and Singh,M.M.. (1985) Operation Research; Sultan Chand & Sons.

Rios's (1989): Optimization Theory and Applications, Wiley Eastern

Hadley G. and Whitin T.M. (1963) Analysis of Inventory Systems; Prentice Hall.

Hillier F.S. and Lieberman G.J. (1962) Introduction to Operation Research; Holden Day.

Murthy K.G (1976) Linear and Combinatorial Programming; John Wiley.

Kleinrock L. (1975) Queuing Systems Theory Vol.1, John Wiley.

Philips D.T., Ravindran A. and Solberg J. Operation Research, Principles and Practice.

Saaty T.L.(1961) Elements of Queuing Theory with Applications; McGraw Hill.

Churchman C.W, Ackoff R.L. and Arnoff E.L. (1957) Introduction to Operations Research.

w.e.f. 2013onwards

INDUSTRIAL STATISTICS & RELIABILITY THEORY

Course No: STM-403 **M.M.80**

UNIT-I:

Meaning and scope of SQC, Stewarts control chart, Statistical basis of a control chart, control chart for variables (, R, & S) charts. Control charts for attributes (np, p & C) charts. Operating Characteristic function (OC) and Average Run length (ARL) of X-bar chart. Moving average charts.

UNIT-II:

Consumer and producer's risk, Operating Characteristic curve/function (OC). Corrective Sampling Plan (CSP), Average Sample Number (ASN), Average out-going Quality (AOQ), Graphical method of drawing AOQ, Average out-going Quality Limit (AOQL), Single Sampling Plan, Methods of finding n and c, Double Sampling Inspection Plan, evaluation and design.

UNIT-III:

Sequential Sampling Plan. Plans for Inspection by Variables for one-sided specification.Capability indices Cp, Cpk and Cpm; estimation, confidence intervals relating to capability indices for normally distributed characteristics.

UNIT-IV:

Reliability concepts, hazard rate, distribution of longevity and moments, common life distributions, exponential, Weibull, normal distributions. Properties of exponential distribution, estimation of mean length of exponential distribution samples, type I and type II censored samples with replacement. Reliability of a system with independent units connected in (a)series and (b) Parallel systems.

TEXT BOOKS:

Barlow, R.E. and Proschan, F. (1985). Statistical Theory of Reliability and Life Testing; Holt, Rinehart and Winston.

Biswas, S.(1996). Statistical Quality Control, Sampling Inspection and Reliability; New Age International Publishers.

Montgomery, D.C. (1985) Introduction to Statistical Quality Control; Wiley

Ott, E.R. (1975) Process Quality Control; McGraw hill

Phadke, M.S. (1989) Quality Engineering through Robust Design; Prentice Hall

Wetherill, G.B. (1977) Sampling Inspection and Quality Control; Halsted Press

Wetherill, G.B.and Brown, D.W Statistical Process Control, Theory and Practice; Chapman and Hall

w.e.f. 2013onwards

INFORMATION THEORY

COURSE NO: STM- 404 **M.M.80**

UNIT-I

Basic Concepts of Information Theory: Quantitative measure of information, Binary unit of information, measure of uncertainty and its properties, measure of information for two dimensional discrete and continuous finite probability scheme. Measure of mutual information. Shannon's fundamental inequalities. Redundancy, efficiency and channel capacity. Uniqueness of the entropy function, entropy maximization problem.

UNIT-II

Elements of Encoding: Purpose of encoding, separable binary codes, Shannon-Fannon encoding. Condition for noiseless coding. Fundamental theorem of discrete noiseless coding. Huffman's minimum redundancy code. Fundamental theorem of discrete encoding in presence of noise. .

UNIT-III

Entropy under Stochastic Regimes: Finite Markov Chains. Basic theorem on regular Markov chain. Entropy of a simple Markov chain. Entropy of a discrete stationary source. Discrete channels with finite memory. The extension of discrete memoryless noisy channels.

UNIT-IV

Inequalities of Information Theory: Kullback-Leibler measure of information. Mean information for discrimination and divergence and their properties. Fisher information, Information and sufficiency. Minimum discrimination information-sufficient statistics.

TEXT BOOKS:

Reza,F.M.: An Introduction to Information Theory, McGraw Hill

Mathai, A.M. and Rathie,P. N.: Basic Concepts in Information Theory and Statistics, Wiley Eastern.

Ash, R.: Information Theory, Wiley Eastern.

Kullback, S.: Information Theory and Statistics, Dover Publication.