Syllabus of M.A./M.Sc. Programme in Statistics under Choice Based Credit System (CBCS) (Semesterwise) from the Academic year 2011-12

Course Structure and Scheme of Examination for Semester I, II, III and IV.

Semester – I

Sl. No.	Paper Code No. and Title	Credits	No. of hrs/week theory/ practical	Duration of Exam in hrs. theory/practical	Internal assessment marks theory/ practical	Marks At the Exams	Total marks
1	HCT 1.1: Linear Algebra	4	4	3	20	80	100
2	HCT 1.2: Probability Theory	4	4	3	20	80	100
3	HCT 1.3: Estimtion Theory	4	4	3	20	80	100
4	SCT 1.1: Statistical Quality Control	4	4	3	20	80	100
Practicals							
1	HCP 1.1: Comp.Prog.in C Lang.with Stat.Applns-I	2	4	2	10	40	50
2	HCP 1.2: Comp.Prog.in C Lang.with Stat.Applns-II	2	4	2	10	40	50
3	HCP 1.3: Based on HCT 1.1 &HCT 1.3	2	4	2	10	40	50
4	SCP 1.1: Based on SCP 1.1	2	4	2	10	40	50

Semester - II

Sl. No.	Paper Code No. and Title	Credits	No. of hrs/week theory/ practical	Duration of Exam in hrs. theory/practical	Internal assessment marks theory/ practical	Marks At the Exams	Total marks
1	HCT 2.1: Distribution Theory	4	4	3	20	80	100
2	HCT 2.2: Testing of Hypothesis	4	4	3	20	80	100
3	SCT 2.1: Reliability Theory	4	4	3	20	80	100
4	OET 2.1: Basic Statistics	4	4	3	20	80	100
	Practicals						
1	HCP 2.1: Based on HCT 2.1	2	4	2	10	40	50
2	HCP 2.2: Based on HCT 2.2	2	4	2	10	40	50
3	SCP 2.1: Based on SCT 2.1	2	4	2	10	40	50
4	OEP 2.1: Based on OET 2.1	2	4	2	10	40	50

SEMESTER III

Sl. No.	Paper Code No. and Title	Credits	No. of hrs/week theory/ practical	Duration of Exam in hrs. theory/practical	Internal assessment marks theory/ practical	Marks At the Exams	Total marks
1	HCT 3.1: Stochastic Processes	4	4	3	20	80	100
2	HCT 3.2: Design & Analysis of Experiments	4	4	3	20	80	100
3	SCT 3.1: Demography	4	4	3	20	80	100
	SCT 3.2: Econometrics	4	4	3	20	80	100
4	OET 3.1: Statistical Methods	4	4	3	20	80	100
Practicals							
1	HCP 3.1: Based on HCT 3.1	2	4	2	10	40	50
2	HCP 3.2: Based on HCT 3.2	2	4	2	10	40	50
3	SCP 3.1/3.2: Based on SCT 3.1 / 3.2	2	4	2	10	40	50
4	OEP 3.1: Based on OEP 3.1	2	4	2	10	40	50

SEMESTER-IV

Sl. No.	Paper Code No. and Title	Credits	No. of hrs/week theory/ practical	Duration of Exam in hrs. theory/practical	Internal assessment marks theory/ practical	Marks At the Exams	Total marks
1	HCT 4.1: Sampling Theory	4	4	3	20	80	100
2	HCT 4.2: Multivariate Analysis	4	4	3	20	80	100
3	SCT 4.1 Operations Research	4	4	3	20	80	100
	SCT 4.2 Time Series Analysis	4	4	3	20	80	100
4	HCT 4.3: Major Project	6	4	3	30	120	150
Practicals							
1	HCP 4.1: Based on HCT 4.1	2	4	4	10	40	50
2	HCP 4.2: Based on HCT 4.2	2	4	4	10	40	50
3	SCP 4.1/4.2: Based on SCT 4.1/4.2	2	4	4	10	40	50

Syllabus of M.A./M.Sc. Programme in Statistics under Choice Based Credit System (CBCS) (Semesterwise) to be started from the Academic year 2011-12

SEMESTER: I

HCT 1.1: LINEAR ALGEBRA

UNIT –I

Vectors: Linear independence and dependence, necessary and sufficient condition for linear dependence, sufficient condition for linear dependence in terms of the number of vectors and components, Gramschmidt's orthogonalization process, subspace, basis and dimension and their properties, finding a basis for the subspace spanned by a given set of vectors, orthonormal basis, sum of two subspaces.

UNIT-II

Matrices: Various types, addition and multiplication, partitioned matrices, inverse of a matrix, Frame's method, generalized inverse.

UNIT-III

Rank of a matrix: Elementary operations, theorems on ranks, normal form of a matrix.

UNIT-IV

Linear equations: Homogeneous equations and their solutions, non homogenous equations, necessary and sufficient condition for consistency and solving such equations, characteristic equation of a square matrix, characteristic roots and vectors and their properties, Caley-Hamilton theorem, geometric multiplicity and algebraic multiplicity.

UNIT-V

Quadratic forms: Various types, congruent transformations, diagonal and canonical form of a quadratic form, Sylvester's law of inertia, necessary and sufficient conditions for positive definiteness.

BOOKS FOR REFERENCE

1. Gant Macher: Matrix Theory Vol. 1, Chelson Publishing Co.
2. Perlis:Theory of Matrices, Addison-Wesley.
3. Shantinarayan: A Text book of Matrices, S.Chand and Co.
4. Hadley: Linear Algebra.

HCT 1.2: PROBABILITY THEORY

UNIT-I

Events, sequences of events and their limits, field, σ -field, Boral field, functions, inverse functions, sample space, random variable, distribution function of random variable, measure, probability space. Expectation of random variable and its properties. Inequalities: Holder, Minkowiski, Basic, Markov, Jensen and Cr- Inequalities.

UNIT-II

Convergence of random variable: Convergence in probability, almost sure convergence, convergence in distributions, convergence in r-th mean. Theorens for expectation; Monotone convergence theorem, Fatuous theorem, Dominated convergence theorem.

UNIT-III

Characteristic function: Definition and simple properties, inversion formula, Buchner's theorem (statement only).

UNIT-IV

Law of large numbers: WLLN and SLLN.

UNIT-V

Central limit theorem: Lindeberg –Levy, Liapopunov's form, Lindberg-Feller (statement only).

BOOKS FOR REFERENCE

1. Bhat, B.R. (1999): Modern Probability Theory, 3/e, New International Ltd, New Delhi.
2. Rohatgi, V.K. (1976): An Introduction to Probability Theory and Mathematical Statistics; John wiley, New York.
3. Billingsley, P: Probability and Measure.
4. Chung, K.L.: Probability Theory.
5. Basu, A.K. (1999): Measure Theory and Probability. PHI.

HCT 1.3: ESTIMATION THEORY

UNIT-I

Theory of Point Estimation: Unabiasedness, consistency, sufficiency, factorization theorem (proof for the discrete case only), efficiency, real parameter exponential family, Cramer-Rao Inequality, MVB estimators, necessary and sufficient conditions for the existence of MVB estimators, uniqueness of MVB estimator, completeness & bounded completeness, Rao-Blackwell Theorem, Lehmann-Sscheffe theorem, Uniformly minimum variance unbiased estimators (UMVU), uniqueness of UMVUE. CAN and BAN estimators.

UNIT-II

Methods of estimation: Method of maximum likelihood, exact and asymptotic properties of solutions of likelihood equations, method of movements, method of minimum chi-square and method of modified minimum chi-square.

UNIT-III

Confidence set estimation: relation between testing of hypothesis and confidence set estimation, UMA and UMAU confidence sets, shortest length confidence intervals.

BOOKS FOR REFERENCE

1. Kendall M.G. and Stuart A (1961): The Advanced Theory of Statistics. Vol. 1 and 2. Charles Griffin.

2. Lehman E.L. (1984): Theory of Point Estimation. John Wiley. Eastern.

3. Rao C.R. (1973): Linear Statistical Inference and its Applications. Wiley Eastern.

4. Rohatgi V.K. (1985): An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern.

5. Zacks S. (1981): Parametric Statistical Inference. Perfumen press.

6. Kale, B.K. (1999): A First Course on Parametric Infeence. Narosa Publishers.

7. Zacks (1971): Theory of Statistical Inference. Wiley New York.

SCT 1.1: STATISTICAL QUALITY CONTROL

UNIT-I

Basic concepts of quality control, process control and process capability. Probability limits and control limits, Shewhart's control charts for X, R, S, P, NP, C and u, demerit and extreme values charts.

UNIT-II

OC and ARL of control charts, moving average charts, EWMA charts, group control charts, multivariate quality control charts, sloping control lines, use of sequential runs in constructing control limits.

UNIT-III

CUSUM charts, V-mask and its relation with SPRT. Control charts versus ANOVA and Chi square tests.

UNIT-IV

Product control: Single, double, multiple and sequential sampling plans for attributes, curtailed sampling plans. OC, AOQ, ASN and ATI functions for these plans, designing single and double

sampling plans. Continuous sampling plans, CSP-1, CSP-2, CSP-3 and multilevel sampling plans. Chain sampling plans.

UNIT-V

Sampling inspection by variables: Determination of parameters and derivation of OC function of single limit plans using normal distribution with known and unknown standard deviation.

BOOKS FOR REFERENCE

1. Duncan. A.J (1967): Quality Control and Industrial Statistics, Taraporewala Bombay.
2. Grant, E.L. (1980): Statistical Quality Control Mc-Graw Hill.
3. Montgomery D.C (1996): Introduction to Statistical Quality Control, John Wiley.
4. Burr, I-W (1976): SQC methods, Marcel-Dekker.
5. Ott.E.R. (1975): Process Quality Control, M. C-Graw Hill
6. Shilling, E.g. (1982): Acceptance Sampling in Quality Control, Marcel-Dekker
7. Weetherill G-B and Brown, D.W(1991): Statistical Process Control, Chapman and Hall, London.
8. Cowden D.J.(1957): Statistical Methods in Quality Control, Prentice Hall.
9. Rayan,T.P (1989): Statistical Methods for Quality Improvement. John Wiley.
10. Mittaga,H.j and Rinne,H(1993): Statistical Methods of Quality Assurance.

PRACTICALS

HCP 1.1: COMPUTER PROGRAMMING IN C LANGUAGE WITH STATISTICAL APPLICATIONS-I

UNIT-I

Definition, basic structure of a C program, execution of a C program, flow charts.

UNIT-II

Character set, Keywords and identifiers. Constants and their types, escape sequences, variables, data types, declaration of variables, initialization, reading data from the keyboard, defining symbolic constants.

UNIT-III

Arithmetic operators, relational operators, logical operators, assignment operators, increment and decrement operators, conditional operators, type conversion in expressions, casting a value.

UNIT-IV

Formatted input using scanf function, examples, formatted output using printf function. Examples.

UNIT-V

Decision making with if statement: simple if statement, if else statement, nesting of if else statements, the else if ladder, switch statement, conditional operator,
goto statement. Some computer programs.

BOOKS FOR REFERENCE

1) Brian W. Kernighan, Dennis M.Ritchie (1990):The C programming language, Prentice Hall.

2) Lawrence H.Miller, Alexander, E. Quilici: Programming in C. John wiley and Sons.

3) Kris Jamsa: Jamsas 1001 C/C++ TIPS, Galgotia publications Pvt., Ltd.

4) E. Balagurusamy (1992): Programming in C. Mc Graw Hill.

5) J. Jayasri: The C-language Trainer with C-Graphic and C++, Saga India Ltd.,

6) Yashawant Kanetkar (1999):Let US C, DPB publications.

HCP 1.2: COMPUTER PROGRAMMING IN C LANGUAGE WITH STATISTICAL APPLICATIONS-II

UNIT-I

While statement, do statement, for statement. Additional features of for loop, nesting of for loops, jumping out of a loop, skipping a part of a loop. Some programs.

UNIT-II

One-dimensional arrays and two-dimensional arrays, their initialization and declaration. Some programs.

UNIT-III

The form of C functions, calling a function, category of functions, functions with arrays. Some programs.

UNIT-IV

Structure definition and declaration, giving values to members, structure initialization, arrays of structures, unions.

UNIT-V

Definition, declaration and initialization of pointers, accessing a value through its pointer, pointer expressions, pointer increments and scale factor, pointers and arrays, Some programs.

BOOKS FOR REFERENCE

1) Brian W. Kernighan, Dennis M.Ritchie (1990): The C programming language, Prentice Hall.

2) Lawrnce H.Miller, Alexander, E. Quilici:Programming in C. John wiley and Sons.

3) Kris Jamsa: Jamsas 1001 C/C++ TIPS, Galgotia publications Pvt., Ltd.

4) E. Balagurusamy (1992): Programming in C. Mc Graw Hill.

5) J. Jayasri: The C-language Trainer with C-Graphic and C++, Saga India Ltd.

6) Yashawant Kanetkar (1999):Let US C, DPB publications.

HCP 1.3: Practical Based on HCT 1.1 & HCT1.3

SCP 1.1: Practical Based on SCT 1.1

SEMESTER: II

HCT 2.1 DISTRIBUTION THEORY

UNIT-I

Standard discrete distributions: Bernoulli, Binomial, Poisson, Geometric, Hyper geometric, Negative binomial, Logarithmic series, Rectangular and Multinomial distributions.

UNIT-II

Standard continuous distributions: Normal, Lognormal, Cauchy, Uniform, Exponential, Weibull, Double exponential, Gamma, Bivariate normal, Bivariate exponential distributions.

UNIT-III

Conditional, compound, truncated and mixture of distributions. Functions of random variables and their distributions.

UNIT-IV

Sampling Distributions: Central and non-central Chi-square, t and F distributions and their properties, Distribution of quadratic forms under normality.

UNIT-V

Order Statistics: Distributions of order statistics and their properties with applications.

BOOKS FOR REFERENCE

1. Dudewicz E.J. and Mishra S.N. (1988) Modern Mathematical Statistics. Wiley.
2. Johnson and Kotz (1972) Distributions in Statistics, Vol I, II and III, Houghton and Miffin.
3. Rohatgi, V.K. (1984) An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern.

4. Rao, C.R. (1973) Linear Statistical Inference and its applications, 2nd Edn. Wiley Eastern.

HCT 2.2: TESTING OF HYPOTHESES

UNIT-I

Statistical hypothesis, simple and composite hypotheses, test procedure, types of errors, level of significance, size of a test, power and power function, choice of a test procedure. Most powerful test, Nyman-Pearson 1emma (N-P 1emma).

UNIT-II

Monotone Likelihood Ratio (MLR) property, Uniformly Most Powerful (UMP) tests and their existence for families with MLR property. Unbiasedness: Uniformly Most Powerful Unbiased (UMPU) tests, UMPU tests in the case of a real parameter exponential family.

UNIT-III

Sequential tests: Wald's Sequential Probability Ratio Test (SPRT), termination property, bounds for the constants of the test, Wald's equation, Operating Characteristic (OC) and Average Sample Number (ASN) functions of SPRT.

UNIT-IV

Tests in the presence of nuisance parameters and likelihood ratio tests. Testing in the presence of nuisance parameters in a multiparameter exponential family, applications to normal distribution. Likelihood ratio tests, testing for the mean of a normal population, testing for the variance of a normal population, comparison of the means of two normal populations, comparison of variances of two normal populations, testing for the significance of correlation coefficient in a bivariate normal distribution, properties of the likelihood statistic.

UNIT-V

Non-parametric tests: Sign test, signed ranks test, median test, runs test, Mann-Whitney U test, Chisquare test of goodness of fit, Kolmogorov – Smironov test for goodness of fit.

BOOKS FOR REFERENCE

1. Conover W.J (1971): Practical Nonparametric Statistics. John Wiley.
2. Gibbons J.D (1971): Nonparametric Statistical Inference. MC Graw Hill.
3. Lehman E.L (1975): Nonparametric Statistical Methods based on Ranks. Holden Day.
4. Rundles R.H. and Wolfe D.A (1979): Introduction to the Theory of Nonparametric Statistics. John Wiley.
5. George Casella and Roger L. Berger (2003).Statistical inference, second edition,Thomson, Duxbury.

SCT 2.1 RELIABILITY THEORY

UNIT-I

Life distributions, survival functions, failure rate, Integrated hazard function, Residual life time, much residual life time.

UNIT-II

Common life distributions: Binomial negative Binomial, poison, Exponential, We bull, Gamma Pareto and Log-normal distributions. Nation of ageing, IFR, IFRA, DMRL, NBU, NBUE classes of distributions and their dual.

UNIT-III

System reliability: coherent systems, series, parallel, K-out-of-n, standby redundant-systems and their reliabilities.

UNIT-IV

Inference in reliability: Type I and type II censoring schemes, likelihood functions based on these sampling schemes for exponential distribution. Reliability estimation (complete and censored samples) for exponential distribution, testing reliability hypotheses (exponential distribution).

UNIT-V

Maintenance policies: Age replacement policy and Block replacement Policies and their characteristics. Reliability modeling: Introduction to shock models, stress-strength models, proportional hazard models.

BOOKS FOR REFERENCE

1. Barlow, R.E. and Proschan, F(1975): Statistical Theory of Reliability and Life Testing, Holt. R. Inehart and Winston, New York.
2. Sinha, S.K. and Kale, B.K. (1990): Life Testing and Reliability Estimation, Wiley Eastern.
3. Mann, N.R., Schafer, R.E. and Singpurwalla, N.(1974): Methods for Statistical Analysis of Reliability and Life Data, Wiley, New York.
4. Zacks S(1992): Introduction to Reliability Analysis, Springer Verlag, New York.
5. Cox, D.R. and Oakes, D (1984): Analysis of Survival Data ,Chapman and Hall, New York.
6. J.V. Deshpande and sudha G.Purohit (2005): Life Time Data: Statistical Models and Methods. World Scientific.
7. Bain,L.J: Statistical Analysis of Reliability and Life Testing Models.Marcel Dekker.

OET 2.1: BASIC STATISTICS

UNIT-I

Classification and tabulation of data, frequency, preparation of frequency tables, graphic representation of data.

UNIT-II

Measures of central tendency: Arithmetic mean, median, mode.

UNIT-III

Measures of dispersion: Range, mean deviation, standard deviation, coefficient of variation.

UNIT-IV

Skewness and kurtosis : Skewness, measures of skewness, Karl pearson's coefficient of skewness, moments, kurtosis.

UNIT-V

Correlation: Meaning, types of correlation, methods of studying correlation, scatter diagram method, Karl Pearson's coefficient of correlation, Regression: meaning, linear and nonlinear regression, lines of regression, coefficient of regression.

BOOKS FOR REFERENCE

1. Elhance D.W.: Statistics
2. S.C. Gupta (1993): Fundamentals of statistics, Himalaya Publishing House, Bombay.
3. Parimde Mukhopadhyay (2005): Applied Statistics, Books and flied(P) Ltd., Kolcata
4. Das M.N. (1993): Statistical Methods and concepts, Wiley Eastern Ltd.

Practicals

HCP 2.1: Based on HCT 2.1

HCP 2.2: Based on HCT 2.2

SCP 2.1: Based on SCT 2.1

OEP 2.1: Based on OET 2.1

SEMESTER: III

HCT 3.1: STOCHASTIC PROCESSES

UNIT- I

Stochastic process: Definition, classification of general stochastic processes, stationary processes. Discrete parameter Markov Chains: Definition and examples, transition probabilities, classification of states, determination of higher step transition probabilities. The basic limit theorem of Markov Chain and its application.

UNIT-II

Poison process, poison process and related distributions, pure birth process, pure death process and birth and death process.

UNIT-III

Wiener process; Definition, differential equation of Wiener process. Kolmogorov equations, first passage time distribution of Wiener process.

UNIT-IV

Renewal process; Renewal equation, Renewal theorems, Delayed and equilibrium Renewal process, Renewal reward process.

UNIT-V

Branching process: Definition, properties of generating functions of branching process, probability of extinction, moments, mean and variance of Xn. Distribution of total number of progeny, conditional limit laws (critical and subcritical processes).

BOOKS FOR REFERENCE

1. J. Medhi (1982) : Stochastic Processes; Wiley Eastern Ltd.
2. Samuel Karlin and Howard M. Taylor (1975): A First Course in Stochastic Processes; Academic Press Inc.
3. William Feller (1968): An introduction probability theory and and its applications. Vol. I; Wiley Eastern Ltd.
4. Hoel P.G. and Ports C. Stone C.J. (1972): Introduction to Stochastic Processes (Hughton-Niffin).
5. N.U. Prabhu (1975): Stochastic Process-Basic theory and its applications; New York Mcmillan.
6. U.N. Bhatt (1972): Elementary applied stochastic processes; Wiley New York.
7. Ross.S.M (1983): Stochastic process, John Wiely.

HCT 3.2: DESIGN AND ANALYSIS OF EXPERIMENTS.

UNIT-I

Gauss Markov setup, satiability of linear parametric functions, normal equations and least squares estimation. Variance and covariance of least square estimates. Best linear unbiased estimators, gauss-Markova theorems.

UNIT-II

Tests of hypothesis for one and more than one linear parametric functions. Confidence intervals and regious, ANOVA tales. Multiple comparison procedures of Tukey and Scheffe. Multiple regression models and related inference.

UNIT-III

Application of Gauss-Markow theory to the analysis of two-way and three way classification models. Two way classification with interaction, test for interaction in multiple but equal number of observations per cell. CRD, RBD, LSD. Missing plot techniques for RBD and LSD.

UNIT-IV

Incomplete block designs-BIBD and PBIBD. Balance, connectedness and orthogonality in relation to two-way designs. analysis of covariance for CRD and RBD.

UNIT-V

Factorial experiments. Analysis of 2h factorial experiments in randomized blocks confounding in 2h factorial experiments. Split-plot design. Random effects model: one way and two-way classification.

BOOKS FOR REFERENCE

1. Chakrabarthy M.C. (1971) Mathematics of Design and Analysis of Experiments. Asia publishing House.
2. Montgomery D.C(2003): Design and Analysis of Experiments, Wiley, New York.
3. Joshi, D.D. (1987): Linear Estimation and Design of Experiments. Wiley Eastern.
4. Aloke Dey (1986): Theory of Block Designs, Wiley Eastern.
5. Das, M.N. and Giri-N. (1979): Design and Analysis of Experiments, Wiley Eastern.
6. Cochran and Cox (1957): Experimental Design, John Wiley.
7. Kempthrone, O (1952): Design and Analysis of Experiments, Wiley Eastern.
8. Searle S.R. (1971): Linear models, John Wiley and Sons.
9. Pearce, S.C. (1984): Design of experiments, Wiley, New Delhi.
10. Angela Dean and Daniel Voss (1999): Design and Analysis of Experiments. Springer.

Any one of SCT 3.1 or SCT 3.2

SCT 3.1: DEMOGRAPHY

UNIT-I

Demography and its interdisciplinary nature, sources of demographic data, coverage and content, errors, use of balancing equations, Charashekharan and Deming formula to check completeness of registration data, use of Wippells, Myers and UN Indices.

UNIT-II

Fertility: Period and cohort measures, use of birth order statistics, child women ratio, Measures of reproduction and replacement. Birth intervals, Dandekar, Brass and Singh probability models of fertility.

UNIT-III

Mortality: Various measures of mortality, infant mortality rates, Cause specific death rates, standardized death rates.

UNIT-IV

Life Tables: Construction and their use, relationship between age specific death rates and life table mortality rate. Construction of life tables using Reed-Merrell's method, Goreville's method.

UNIT-V

Migration: Migration rates and ratios. Indirect measures of net-internal migration: National growth rate method, Residual method, Multi-regional matrix method. Theory of migration, push-pull factors.

UNIT-VI

Stable and Quasi-stable population: Derivation of Lotka's stable population model and its properties, intrinsic growth rate and its derivation, age structure and birth rate of stable

population, mean length of generation, momentum of population growth, Quasi-stable population under changing fertility and mortality situations.

BOOKS FOR REFERENCE

1. Shryock, Henry S, Jacob S. Siegel and Associates, The methods and materials of Demography (condensed edition). Academic Press, London.
2. Barclay, George W: Techniques of population analysis, John Wiley and Sons, Incs. New York/London, 1968.
3. Keyfitz, H: Introduction to the Mathematics of Population. Addison-Wesley Publishing Co., Resding, Mass, 1968.
4. Chaiang C.L.: Introduction to Stochastic Processes in Bio-Statistics, John Wiley & Sons, 1968.
5. Wunsch G.J. & M.G. Tarmota: Introduction to Demographic Analysis, Plenum Press, N.Y. 1978.
6. R. Ramakumar: Technical Demography, Wiley Eastern Ltd., 1986.
7. Sudhendu biswas: Stochastic Processes in Demography and Applications, 1988, Wiley Eastern.

SCT 3.2: ECONOMETRICS

UNIT-I

The nature of Econometrics, Relations between variables, Economic models, the role of Econometrics.

UNIT-II

The general linear models: Assumptions, least square estimations, multicollinearity, specification error, ridge regression estimators.

UNIT-III

Generalized least squares: The generalized least squar (Aitken) estimator, prediction, Heteroscedastic disturbances.

UNIT-IV

Auto correlation, conventional tests for autocorrelation. Instrumental variables, errors in variables.

UNIT-V

Simultaneous equation methods, identification, simultaneous equation system. Two stage least squares (2SLS) Estimators, K-Class estimators, three stage least squares, method of estimation.

BOOKS FOR REFERENCE

1. J. Johnson (1972): Econometric methods (2^{nd} edn.)
2. Goldberger A.S. (1964): Econometric theory, John Wiley.
3. Theil H. (1971): Principles of Econometrics John Wiley.
4. Bridge J.L. (1971): Applied Econometrics. North Holland Publications.
5. Kmonta J. (1971) Elements of Econometrics.

OET 3.1: STATISTICAL METHODS

UNIT-I

Measures of Dispersion: Standard deviation, coefficient of variation and their properties.

UNIT-II

Concept of probability, random experiment, sample space, events and their type, empirical definition of probability, addition law, conditional probability, Bayes' rule.

Random variables and their types, the concept of population of values of a random variable, parameters probability distribution of a random variable. The probability function, probability mass function and probability density function.

Some standard discrete probability distributions-Bernoulli, Binomial and Poisson.

Some standard continuous distributions-Normal distribution and its properties. Normal, t, F and chi-square tables.

Estimation: The concept of a random sample, statistics and estimators with examples.

UNIT-III

Statistical hypothesis and its types, critical region, test procedure and its types, types of errors, level of significance, optimum test procedure. One sample inference-testing for the mean of a normal distribution with known variance (normal test) and unknown variance (t-test), testing for the variance of a normal population.

Two-sample inference-testing for the equality of means of two independent normal populations with a common unknown variance (t-test), paired t-test, testing for the equality of variances of two independent normal populations (F-test).

Nonparametric tests-sign test, Wilcoxon signed rank test, U-test.

Tests for categorical data-two sample test for categorical data-two sample test for binomial proportions. Chi-square test of independence in contingency tables.

UNIT-IV

Correlation between two variables, examples, scatter diagram, linear correlation and its types, Karl-Pearson's product moment correlation coefficient, testing for the significance of correlation (t-test).

Regression-fitting regression lines, method of least squares.

UNIT-V

Principles of experimentation, Analysis of variance, CRD, RBD & LSD and analysis of variance in these designs.

BOOKS FOR REFERENCE

1. Bernard Roster: Fundamental of biostatistics, Third Edition, PWS Publishing Company, Boston.

2. R. Rangaswamy: A Text Book of Agricultural Statistics, New Age International Publishers Ltd., Bombay, 1995.
3. Kleinbaum, D.G., Kupper, L.L., & Moregentern, H. (1982): Epidemiological Research; Principles and Quantitative methods. Belmont, CA:Wadworth.

Practicals

HCP 3.1: Based on HCT 3.1

HCP 3.2: Based on HCT 3.2

SCP 3.1/3.2: Based on SCT 3.1/ 3.2

OEP 3.1: Based on OET 3.1

SEMESTER: IV

HCT 4.1 SAMPLING THEORY

UNIT-I

Sampling with varying probabilities of selection: PPS sampling-with and without replacement, estimation of the population total(Hansen-Hurwitz estimator), variance of the estimator and the estimator of variance, Horwitz-Thompson, Yates-Sen-Grundy estimators, Desraj's ordered estimator, Midzuno scheme of sampling, selection of a PPS sample-cumulative total method and Lahiri's method.

UNIT-II

Cluster sampling: Equal and unequal clusters, intraclass correlation coefficient and its bounds (equal clusters), efficiency of cluster sampling over SRSWOR (equal clusters) optimum cluster size (equal clusters).

UNIT-III

Two stage sampling: SRSWOR at both stages, SRSWR at the first stage and optimum allocation.

UNIT-IV

Two phase sampling: SRS at first phase and PPS at second phase, optimum allocation.

UNIT-V

Ratio method of estimation: Bias and mean square error of the estimator, simplification for SRS, estimation of bias and mean square error, almost unbiased ratio estimator (under second order approximation). Regression method of estimation: Bias and mean square error of the estimator, comparison with the ratio estimator.

BOOKS FOR REFERENCE

1. Des Raj (1976): Sampling Theory: Tata McGraw Hill.
2. Cochran W.G. (1972): Sampling Techniques: Wiley Eastern.
3. Sukhatme P.V. and Sukhatme B.V. (1977): Sampling Theory of sample surveys with applications: Asia Pub. House.
4. Murthy M.N. (1967): Sampling Theory and Methods: Statistical Pub. Society, Calcutta.
5. Daroga Singh and F.S. Choudhary (1989): Theory and Analysis of Sample Survey Designs: Wiley Eastern Ltd.
6. Hansen M.H., Herwitz W.N. and Madow W.g. (1957): Sample Survey Methods and Theory, Vol. I and Methods and Applications Vol. II; John Wiley.
7. Handrics W.A. (1956): The Mathematical Theory of Sampling; Scarecraw Press, New Brunswick.
8. Sukhatme et al. (1984): Sampling Theory of Survey with Application. Indian Society of Agrl. Statistics, New Delhi.
9. S.Sampath(2001): Sampling theory and Methods, Alpha science Internatiional Limited.

HCT 4.2: MULTIVARIATE ANALYSIS.

UNIT-I

Multivariate normal distribution, marginal and conditional distributions, characterizations in terms of linear combination of components, independence of subsectors, characteristic function.

UNIT-II

Maximum likelihood estimators of the mean vector and dispassion matrix. Distribution of the sample mean vector. Wishrt distribution and its properties. Null distribution of sample correlation coefficients. Tests for their significance.

UNIT-III

Hotel ling's T2, Null distribution of Hotel ling's T2 statistic. Application in tests on mean vector for single and several multivariate normal populations. Mahalnobis D2 statistics. Likelihood ratio test for testing the equality of covariance matrices, mean vectors and covariance metrics, independence of subsectors, sphericity of covariance matrix.

UNIT-IV

Multivariate linear regression model, estimation of parameters, testing linear hypothesis about regression co-efficient. Multivariate analysis of variance of one-way and two-way classified data.

UNIT-V

Classification and discriminate procedures for discrimination into one of two multivariate normal populations. Sample discrimination function, tests associated with discriminate function, probabilities misclassification and their estimation, classification into more than two multivariate normal populations.

UNIT-VI

Introduction to principal component analysis, Factor analysis, canonical variables and canonical correlations.

BOOKS FOR REFERENCES:

1. Anderson T.W: An Introduction to multivariate Analysis, Wiley.
2. Kshirsagar A.N.: Multivariate Analysis, Marcel Dekker.
3. Johnson, R and Wichern (2992): Applied Multivariate Statistical Analysis, PHI
4. Narayan C.Giri: Multivariate Statistical Inference, Academic press.
5. Morrison, D.F (1976): Multivariate Statistical Methods. Mcgrow Hill
6. Muirhead R.J. (1982): Aspects of Multivariate Statistical Theory, John Wiley.
7. Sharma S (1996): Applied Multivariate Techniques. John Wiley.
8. Srivastava,M.S (1979): An Introduction to Multivariate Statistics. North Holland.
9. Mardia,K.V,Kent J.T and Bibby J.M (1979): Multivariate Analysis. Academic Press.

Any one of SCT 4.1orTSCT 4.2

SCT 4.1: OPERATIONS RESEARCH

UNIT-I

Linear programming problem (lpp): Properties, simplex Algorithm, Charne's M-technique, two-phase method, primal and dual simplex algorithm.

UNIT-II

Non linear programming: GNLPP, maxima and minima of concave and convex function, saddle point problems, Kuhn-Tucker conditions, Quadratic programming: Beal's method, Wolfe's methods. Integer programming: Gomorian method.

UNIT-III

Transportation problems: existence of feasible solution: N.W. corner rule, U-V method, stepping stone algorithm. Assignment problems: Hungarian method.

UNIT-IV

Network analysis: shortest route problem, maximal flow, minimal flow, project planning with PERT and CPM.

UNIT-V

Inventory models, inventory models with space restriction, inventory models with probabilistic demand, inventory system with power demand pattern ((t_p,s) system).

BOOKS FOR REFERENCE

1. S. Hadley: Linear Programming, Addision Wesley.
2. S. Hadley: Nonlinear and Dynamic Programming, Addision Wesley.
3. E.Naddor: Inventory Systems, Wiley.
4. N.U. Prabhu: Queues and Inventories, John Wiley.
5. Sasieni,Yaspan, Friedman: Operations Research, methods and problems, Wiley.
6. H. Taha: Operations Research, Introduction, McMillan.
7. Wagner: Principles of Operations Research with applications to managerial decisions, Prentice Hall.
8. Hiller e. Gillet: Introduction to operations research:Holden Day.
9. Billey E. Gillet: Introduction to operations research: A computer oriented algorithm approach, McGraw Hill Edition.
10. Ravindran, Phillips, Solberg: Operations Research Principles and Practice, john Wiley and Sons, New York.
11. Richard Coppins: Linear Programming and Extensions, McGraw-Hill Co.
12. C.K. Mustafi: Operations Research Methods and Practice. Wiley Eastern Ltd

SCT 4.2: TIME SERIES ANALYSIS.

UNIT-I

Time-Series as discrete parameter stochastic process. Auto covariance functions and their properties.

UNIT-II

Exploratory Time Series Analysis, Tests for trend and seasonality. Exponential and Moving Average Smoothing. Forecasting based on smoothing, adaptive smoothing.

UNIT-III

Detailed study of the stationary processes: (1) moving average (MA) (2) Auto regressive (AR) (3) ARMA and ($) AR integrated MAS (ARIMA) models. Box-Jenkins models. Discussion (without proof) of estimation of mean, auto covariance and and autocorrelation functions under large sample theory. Choice of AR and MA periods. Estimation of ARIMA model parameters. Forecasting. Residual analysis and diagnostic checking.

UNIT-IV

Spectral Analysis of weakly stationary processes Periodogram and correlogram analysis. Computations based on Fourier transform. Spectral decomposition of weakly AR process and representation as a one-aided MA process-necessary and sufficient conditions. Implication in prediction problem.(60h)

BOOKS FOR REFERENCE

1. Box G.P. and Jenkins G.H. (1976): Time Series Analysis-Forecastingand control. Holden-day, San Fransisco.

2. Anderson T.W(1971): The Statistical Analysis of Time Series. Wiley, N.Y.

3. Kendall M.G. and Stuart A (1966): Advanced Theory of Statistics Vol. 3. Charies Griffin, London.

4. Montgemory, D.d. & Johnson, L.A. (1977): Forecasting and Time Series Analysis. Mc Graw Hill.

5. Kendall, Sir Maurice and Ord, J.K. (1990): Time Series (Third Edition), Edward Arnold.

6. Brockwell, P.J. and Davis, R.A. Time Series: Theory and Methods (second Edition). Springer-Verlag.

HCT 4.3.PROJECT

PRACTICALS

HCP 4.1: Based on HCT 4.1
HCP 4.2: Based on HCT 4.2
SCP 4.1/4.2: Based on SCT 4.1/ 4.2

GULBARGA UNIVERSITY GULBARGA
DEPARTMENT OF STUDIES AND RESEARCH IN STATISTICS

Syllabus for M.Phil Course in Statistics for 1997-98 onwards

PAPER-I(COMPULSORY)
GENERAL RESEARCH METHODOLOGY

a) REAL ANALYSIS:

Series of positive terms,- applications of various tests of convergence.

Uniform convergence: Uniform convergence of sequences, necessary and sufficient condition and its application, uniform convergence of series, M. test, Abel's test (statement) and Dirichlet's test (statement) and its applications, turn by turn integration and differentiation.

b) COMPLEX ANALYSIS:

Complex Integration- fundamental Cauchy theorem (statement), Cauchy Integral formula.
Power series-Cauchy-Hadamard theorem and its applications. Taylor;s series and Laurent;s series.
Calculus of residues-poles and residues, Cauchy;s theorem.
Contour Integration- Evaluation of

$\int_0^{2\pi} f(\cos x, \sin x)dx$ and $\int_{-\infty}^{\infty} f(x)\sin mx\, dx$ and $\int_{-\infty}^{\infty} f(x)\cos mx\, dx$, m>0, and

$\int_{-\infty}^{\infty} f(x)dx.$

c) STATISTICAL INFERECE:

Point Estimation: Sufficiency-factorization theorem and its applications, minimal sufficient statistics and methods of obtaining such statistics.
Unbiasedness – Uniformly minimum variance unbiased estimator (UMVU), Rao Blackwell theorem and its applications. Maximum likelihood method of estimation and its applications, Properties of MLE.
Testing of hypotheses: Generalized N-P Lemma (statement) and its applications in the real parameter case.
Testing in the presence of nuisance parameters in the normal case.
Non-parametric tests: Kolmogorov-Smironow test, Mann-Whitny U-test, Runs test.
Decision theory: as in Chapter 12 of Dudewicz and Satya N. Mishra

d) SAMPLING:

Systematic sampling – Linear systematic sampling, Estimation of the population mean, variance of the estimator and its estimation, comparison with SRS in the presence of linear trend.

Circular and balanced systemtic sampling schemes. Sampling with varying of probabilities – PPSWR and PPSWOR scheme, Horvitz-Thompson estimator, Des Raj estimator, Midzuno scheme of sampling, cumulative total method and Lahiri's methods of sample selection.

Two phase sampling – simple random sampling at the first phase and PPS sampling at the second phase, optimum values of initial sampling size and the sub-sample size.

Two stage sampling-SRSWOR at both stages, SRSWR at the first stage and SRSWOR the second stage, estimation of the pop mean, variance of the estimator and its estimator in the above cases, optimum allocation.

Ratio and regression Methods of estimation-separate and combined estimators in Stratified Sampling.

BOOKS FOR REFERENCE

1. Tom M. Apostal : Mathematical Analysis, Adison Wesley
2. S.C. Malik : Mathematical Analysis, Wiley Eastern Ltd.
3. Shantinarayan : A Course of Mathematical Analysis S. Chand 7 Co.
4. Copson E.T. : Functions of Complex Variables
5. Shantinarayan : Theory of functions of a complex variable. Sultan Chand & Co.
6. Des Raj : Sampling Theory. Tata McGraw Hill Publishing House.
7. M.N. Murthy : Sampling Theory and Methods. Statistical Publishing Society, Calcutta.
8. Sukhatmeetal : Sampling theory of survey with applications. Indian Society of Agricultural Statistics, New Delhi.

9. Robert V Hogg and Allen B. Craig : Introduction to Mathematical Statistics. McMillan.
10. E.L. Lehman : Testing Statistical Hypotheses Wiley.
11. E.L. Lehman : Theory of Point Estimation John Wiley
12. C.R. Rao : Linear Statistical Inference and its applications. Wiley.
13. C. R. Rao. : Advanced Statistical Methods in Biometric Research. Hafner Publishing Co.
14. Zacks S. : The Theory of Statistical Inference. Wiley
15. J.G. Gibbons : Non-parametric Statistical Inference. Mc Graw Hill.
16. V.K. rohatgi : An Introduction to Probability theory and Mathematical Statistics. Wiley Eastern.
17. E.J. dudewicz & S.N. Mishra Modern Mathematical Statistics (1988). John Wiley and sons.

PAPER-II (OPTIONAL)
(ANY ONE OF THE FOLLOWING)

PROBABILITY

Sequence of random variables-convergence in distribution in probability and with probability one slutsky's theorem. Characteristic function- theorem –inversion theorem. Continuity theorem.

Borel – Cantelli lemams andtheir generations. Weak law of large numbers (WLLN) Chebyshev'sWLLN.and Khinthochine's WLLN.

Strong law of large numbers (SLLN) – kolomgrovs strong law of large numbers (SLLN) for (i) independent case and (ii) iid case.

Central limit theorem (CLT) – Linderberg – Feller form (statement), Linderberg Levvy form, Liapunov form.

Limit points , limit superior and limit inferior of a sequence of random variables, Limit set of a sequence of random vectors.

Law of the iterated logarithm for a sequence of iid random variables (statement).

Regularly varying functions and slowly varying functions- Representation for such functions (statement), Asmptomatic properties of regularly varying functions.

Domains of attraction – necessary and sufficient condition for a distribution function to belong to the domain of attraction of a stable law (statement), convergence to types theorem (statement).

Record values and partial maxima of sequence of iid random variables – Limit Laws , – necessary and condition for a distribution function to belong to the domain of attraction of extreme value distributions and record value distributions, joint distribution of record values and the Representation for nth record value in the continuous case.

BOOKS FOR REFFERECE

1.V.K.Rohtagi : An introduction to probability theory and mathematical statistics (1976)
2. Billingsley P : Probability theory(1979) Willy New York.
3.Laha& Rohtagi : Probability theory1979) JhonWilly.
4.Breman L : Probability (1968) Addison Wesley Pub. Co. Reading.
5. Seneta E. (1976): Regulary varying functions . Lecture notes in Mathematics Vol, 508 Springer Verlog Hiedelgberg.
6. De.Haan L. (1970) : On regular variation and its applications to the weak convergence of sample extrems. Mathematical center tacts Vol. 32 Amasterdam.

7. William Feller ; An Introducation to probability theory and its applications Vol.2 Willy Eastern pte. Ltd.

8. Galambos.J(1970) : The asymptotic theory of extreme order Statics , Willey New York.
9. Resnic S.I.(1987) : extreme valiues, regular variation and point proceses Springer Vering.
10. Willam F. Stout (1974) : Almost sure convergence . Academic press
11. B.R Bhat (1981): Modern Probability theory- Willy Eastern Ltd.
12. loeve (1955): Probability theory D. Van Nostrand Princeton N.J
13.Gnedenko B.V and Kolmogorov A.N (1954) : Limit distribuations for sums of independent random variables, addion Wesley Reading Mass.

SQUENTIAL ANALYSIS IN STOCHASTIC PROCESSES

Martingales: both discrete and continous time , Markov time and its elementary properties , Optional sampling theorem.

Poisson process, Some special cases of birth and death process . Brownion motion , Wiener process, Differential equations for a Wiener process , Kolmogorov equations , Fist passage time distribution for Wiener process.
Renewal process; renewal equation, stopping time: Walds equation , Renewal Theorem.

SPRT in continuous time stochastic process.

BOOKS FOR REFFERECE

1. S.Karlin and H.M.Taylor: A first course in stochastic processes(second ed) Academic press.
2. J.Medhi: stochastic process. (second ed), Wiley Eastern Limited, New Delhi.
3. B.K Ghosh; Sequential tests of statistical hypotheses, Adision Wesley.
4. A.Wald: Sequential Analysis, Wiley.
5. A.Govindrajulu (1975) : Sequential Statistical Procedures. Academic press. INC, NewYork.

STOCHASTIC PROCESSES AND OPERATIONS RESEARCH

Description and definition of stochastic processes, Markov chain, transition probability matrix, classification of states , stationery distributions , statistical inference for Markov chains.
Poisson process, birth and death processes, limiting distributions, Renewal process Renewal equation, Renewal (cumulative Renewal) Reward process , Regenerative stochastic processes; Existence of limits , Regenerative Inventory System.

Markov Renewal and semi- Markov Renewal processes: definition and preliminary results, Markov Renewal equation and limiting behavior.

Queueing models: Queueing System, M/M, M/M/s, queueing model, bulk queues,G/M/1,M/G(a,b)/1,M/G/1, M/G/ models.

Inventory theory for single- commodity system:
Deterministic Inventory models and stochastic Inventory models.
Inventory theory for multi commodity system;
Deterministic models - The two commodity problems.
Deterministic models – The multi commodity problems.
Single – period probabilistic Models – The two commodity problem.
Single – period probabilistic Models - The multi commodity problem.

REFFERECES

1. Stochastic processes – by J.Medhi, Wiley Eastern Limited, 2nd edn.
2. Probability Models – by S.M. Ross Academic press. 1989.
3. First course in Stochastic processes by Karlin and Taylor.
4. Stochastic Models – by Taylor & Karlin.
5. Analysis of systems in Operations Research – B.D. Sivazlin and Stantel – Prentice hall, 1975.

DEMOGRAPHY

1. Elements of Stochastic processes and Renewal Theory; Markov chain, Kolmogorov's Theorem, Application of Kolmogorov's differential equation in population models ; certain basic stochastic population models : Poisson process ,pure birth process, pure death process, birth and death processes. Renewal Theory, elementary renewal theorem and its application.
2. Life tables and their use, relationship between age specific death rates and life table mortality rate; construction of abridged life tables using Reed Merrel's method , Greville's method and Kingi method.
   Estimation of life table functions, probability distributions of life table functions and their optimum properties

3. Measurement of population changes : Linear, Geometric Exponential, Gompertz, Logistic population growth models , population estimates and projections, component method , matrix method , Leslie model.
4. Stable and Quasi Stable Populations ; Lotka's model and its derivation, Age structure and birth rate of a stable population , generation time , momentum of population growth . Other important results on stable population. Quasi - Stable population under changing fertility and mortality situations.

5. Fertility: Natural and controlled fertility levels , Coale and Trussel model for the age pattern of fertility, birth intervals and their use. Shepps and Perrin model of human reproductive process.

BOOKS FOR REFFERECE

1. Shryok, Henry S. Jacob S Siegel and associates (1964): The methods and materials of Demography(condensed edition), Academic press, London.
2. Barclay, George W. (1968) : Techniques of population Analysis.
3. Keyfitz N. (1968): Introduction to the mathematics of population. Addion – Wesley Publishing Co. Reading , Massachausetts.
4. Pollard J.H.(1973): Mathematical models for the growth of human populations, Cambridge University press Cambridge.
5. Chiang C.L (1968): Introduction to Stochastic processes in Biostatistics. Jhon Wiley and sons,N.Y
6. Wunsch G.J and M.G. Tarmota (1978); Introduction to Demographic Analysis, Plenum press, N.Y
7. R.Ramkumar (1986) Technical Demography, Wiley Eastern, New Delhi.

8. Sudhendu Biswas (1988): Stochastic processes in Demography and Applications, Wiley Eastern, New Delhi.
9. Anderi Rozer (1968): Multi- regional Mathematical Demography, University of California Press, Berkely.
10. Medhi j. (1994) : Stochastic processes, 2nd Edition, Wiley Eastern New Delhi.

STATISTICAL, QUALITY CONTROL AND RELIABITY THEORY

Control Charts for variables X,R,s and individual measurements control charts.

Control Charts for attributes- Control Charts for fraction nonconforming and nonconformities. Cumulative and exponential weighted moving average control charts.

Acceptance Sampling - Basic concepts of sampling ,single, double, multiple sampling plan for attributes. Curtailed and semi curtailed sampling plans. Q.C, AOQ,ASN and ATI functions.

Acceptance Sampling by variables – Single and double limit plans with known and unknown standard deviation. O.C curves for these plans.

Continuous sampling plans CSP – 1, CSP -2, CSP -3 and multilevel plans. Chain sampling plans and skip – lot sampling plans.

Reliability concepts – time to failure. Reliability function, failure rate,MTTF,IFR and DFR distributions. Failure models – Exponential, Gamma, Pareto, Weibull, Lognormal and Extreme value distributions.

System of independent components – System reliability, non – repairable systems, redundancy, repairable systems.

Censored sampling – type –I and Type – II schemes, reliability estimation and testing reliability hypotheses based on complete and censored samples.

BOOKS FOR REFFERECE

1. Duncan A.J (1967) Quality Control and Industrial Statistics. Taraporewala.Bombay.
2. Grant E.L (1980): Statistical Quality Control MC- Graw Hill.
3. Montogomery D.c(1985): Introduction to Statistical Quality Control John Wiley.
4. Barlow R.E and Proschan F(1975): Statistical theory and Reliability and Life testing . Hoit, Reinnart and Winsion,Inc,New York.
5. Sinha S.K and Kale B.K(1990) : Life testing and Reliability Estimation. Wiley, New York.
6. Mann N.R.Schafer R.E and Singapurwalla N.D(1974): Methods for Statistical Analysis of Reliability and Life Data. Jhon Wiley.

GULBARGA UNIVERSITY GULBARGA
DEPARTMENT OF STUDIES AND RESEARCH IN STATISTICS

Syllabus for Course Work of Ph.D. in Statistics as per regulations of 2009-10

GENERAL RESEARCH METHODOLOGY

Research: Meaning and Definition, Need and Purpose; Types of Research; Barriers to Research.

Identification, selection and formulation of a research problem Hypothesis: Meaning and Definitions. Types Formulation and Testing of hypothesis Research Design: Definition. Types and their characteristics; Preparation of a research proposal.

Research Techniques and Tools: Questionnaire; Schedule; Interview; Observation; Scales and Checklist; Library Records and Reports.

Research Reporting and Evaluation: Structure, Style and Contents; Guidelines for reporting; Style Manuals-Chicago, MLA, APA etc., e-citation; Methods of Research Evaluation.

Uniform convergence: Uniform convergence of sequences, necessary and sufficient condition and its application, uniform convergence of series, M. test, Abel's test (statement) and Dirichlet's test (statement) and its applications, turn by turn integration and differentiation.

Statistical Inference: Point Estimation: Sufficiency-factorization theorem and its applications, minimal sufficient statistics and methods of obtaining such statistics.
Unbiasedness – Uniformly minimum variance unbiased estimator (UMVU), Rao Blackwell theorem and its applications. Maximum likelihood method of estimation and its applications, Properties of MLE.
Testing of hypotheses: Generalized N-P Lemma (statement) and its applications in the real parameter case.
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Non-parametric tests: Kolmogorov-Smironow test, Mann-Whitny U-test, Runs test.
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Ratio and regression Methods of estimation-separate and combined estimators in Stratified Sampling.

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3. Shantinarayan : A Course of Mathematical Analysis S. Chand 7 Co.
4. Copson E.T. : Functions of Complex Variables
5. Shantinarayan : Theory of functions of a complex variable. Sultan Chand & Co.
6. Des Raj : Sampling Theory. Tata McGraw Hill Publishing House.
7. M.N. Murthy : Sampling Theory and Methods. Statistical Publishing Society, Calcutta.
8. Sukhatmeetal : Sampling theory of survey with applications. Indian Society of Agricultural Statistics, New Delhi.
9. Robert V Hogg and Allen B. Craig : Introduction to Mathematical Statistics. McMillan.
10. E.L. Lehman : Testing Statistical Hypotheses Wiley.
11. E.L. Lehman : Theory of Point Estimation John Wiley
12. C.R. Rao : Linear Statistical Inference and its applications. Wiley.
13. C. R. Rao. : Advanced Statistical Methods in Biometric Research. Hafner Publishing Co.
14. Zacks S. : The Theory of Statistical Inference. Wiley