Revised

Choice Based Credit System (CBCS) Syllabus for M.A./M.Sc.Statistics

1st- Semester for Batch 2017 wef 2018 **and onwards BOSPG held on 07/09/2018**

General Instructions for the Candidates

1. The **two** years (**4 semesters**) PG Programmes is of **96** credit weightage i.e. **24** credits/semester (**24×4 = 96**).
2. Out of 24 credits in a semester a candidate has to obtain **12** credits compulsorily from the **Core Courses**, while the remaining 12 credits can be obtained from the **Electives(DCE, GE &OE)** in the following manner:
   - A candidate can obtain a maximum of **8** credits within his /her own Department out of specialization offered by the Department as**Discipline Centric Electives**.
   - **4** credits shall be obtained by the candidate from the **Electives(GE , OE)** offered by the Department other than his/her own. The candidate shall be free to obtain these **4** credits from the **General** or **Open Elective or a Combination of Both.**

SEMESTER – I			
Course Type	**Course Code**	**Title of the Course**	**No. of Credits**
Core (CR)	ST17101CR	Probability and Distribution Theory - I	**04**
	ST17102CR	Sampling Techniques	**04**
	ST17103CR	Statistical Computing	**04**
Discipline Centric Elective (DCE)	ST17104DCE	Stochastic Processes	**04**
	ST17105DCE	Linear Algebra	**02**
	ST17106DCE	Real Analysis	**02**
	ST17107DCE	Practical based on ST17101CR & ST17102CR	**02**
	ST17108DCE	Practical based on ST17103CR	**02**
Generic Elective(GE)	ST17109GE	Statistical Methods	**02**
	ST17110GE	Testing of Hypothesis – I (Parametric)	**02**
Open Elective(OE)	ST17111OE	Time Series Analysis	**02**

PROBABILITY AND DISTRIBUTION THEORY-I

COURSE NO: ST17101CR **No. of Credits-4**

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, and Uniqueness theorem.

UNIT-III

Standard Univariate discrete distributions: Discrete Uniform, Bernoulli, Binomial, Poisson, Negative Binomial, Geometric, Hyper geometric, logarithmic distributions and their structural properties, relations and applications, Marginal and conditional distributions. Some idea of truncations.

UNIT-IV

Univariate Continuous distributions: Uniform, Beta, Gamma, Exponential, Pareto, Weibull, Laplace, Normal, Cauchy and their structural properties, relations and applications, Marginal and conditional distributions. Some idea of truncations.

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.andKotz, (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.

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1st- Semester for Batch 2017 wef 2018 **and onwards BOSPG held on 07/09/2018**

SAMPLING TECHNIQUES

COURSE NO: ST17102CR **No. of Credits-4**

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.

UNIT II

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 III

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-IV

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.

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.

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1st- Semester for Batch 2017 wef 2018 **and onwards BOSPG held on 07/09/2018**

STATISTICAL COMPUTING

COURSE NO: ST17103CR **No. of Credits-4**

UNIT-I

Introduction to computers, Classification of computers, advantages, disadvantages and applications of computers, Basic set up of electronic computers, input and output devices. Basic idea about computer packages (Statistical Packages).

UNIT-II

Statistical Software's: MINITAB reading & Manipulation of data, Commands/Statements in MINITAB, Descriptive Statistics. Basic operations on matrices.Working with Software package MINITAB for graphics, EDA: Histogram, Plot, Box plot, Pi-chart, QQ plot, density plot, and Stem and Leaf.

UNIT-III

Using MINITAB: Correlation&Regression analysis: simple and multiple. Tests of significance, Errors in sampling, Critical region and level of significance, Test of significance of large samples, Test of single proportion, Test of significance of difference of proportions.

UNIT-IV

Using MINITAB: Chi-Square test for independence of attributes and Contingency table, t-test, Paired t-test, Test for correlation in sampling from normal population, F-test, testing of two variance of two univariate normal population.

TEXT BOOKS:

- B. Ryan and B.L. Joiner (2001). MINITAB Handbook, Fourth edition, Duxbury.
- R.A. Thisted (1988): Elements of Statistical Computing, chapman and Hall.
- S.C. Gupta & V.K Kapoor (2012), Fundamentals of Mathematical Statistics, Sultan Chand & Sons.
- Dudewicz, E.J. and Mishra, S.N. (1988): Modern Mathematical Statistics, Willy, Int'l Students edition.

STOCHASTIC PROCESSES

COURSE NO: ST17104DCE **No. of Credits-4**

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.

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 Publications.

LINEAR ALGEBRA

COURSE NO: ST17105DCE **No. of Credits-2**

UNIT-I

Algebra of Matrices, trace of a matrix, trace of AB = trace of BA. Idempotent and nilpotent matrices, Inverse of partitioned matrices, linear independence and dependence of row (column) vectors, orthogonal and unitary matrices. Vector spaces, basis and dimensions, algebra of linear transformation.

UNIT-II

Rank of a matrix, Linear equations, solutions of homogenous and non-homogenous equations, Eigen values and Eigen vectors of a matrix and their determination. Applications of Cayley Hamilton Theorem. Quadratic forms, reduction and classification of quadratic forms, Inner product spaces, orthogonal and orthonormal basis.

TEXT BOOKS:

- 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.

REAL ANALYSIS

COURSE NO: ST17106DCE **No. of Credits-2**

UNIT-I

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. Convergence and divergence of positive term series (simple problems only).

UNIT-II

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. Riemann sum and integral (simple problems). Functions of several variables.

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.

COURSE NO: ST17107DCE No. of Credits-2

PRACTICAL BASED

ON

COURSES

ST17101CR
&
ST17102CR

Using Statistical Software

COURSE NO: ST17108DCE No. of Credits-2

PRACTICAL BASED

ON

COURSE

ST17103CR

Using Statistical Software

STATISTICAL METHODS

COURSE NO: ST17109GE **No. of Credits-2**

UNIT-I

Descriptive Statistics: Measures of central tendency, Characteristic for an ideal measure of dispersion, Measure of dispersion range, quartile deviation, variance, standard deviation, co-efficient of variation, Skewness and Kurtosis.

UNIT-II

Measures of Co-relation: Scatter diagram, Karl Pearson Coefficient of correlation, Rank correlation, Regression, Lines of regression, Regression co-efficient, Fitting of regression lines.

TEXT BOOKS:

- S.C. Gupta & V.K Kapoor (2012), Fundamentals of Mathematical Statistics, Sultan Chand & Sons,
- Dudewicz, E.J. and Mishra, S.N. (1988): Modern Mathematical Statistics, Willy, Int'l Students edition.
- Gupta S. C. and Kapoor V.K. (2001): Fundamental of Applied Statistics.

TESTING OF HYPOTHESIS - I (PARAMETRIC)

Course No: ST17110GE **No. of Credits-2**

UNIT I

The basic idea of significance test, Null and alternative hypothesis, two tailed and one tailed test of hypothesis, Type I & Type II errors, level of significance, critical region, degree of freedom, concept of p-value.

UNIT II

Test for large samples: test of mean, test for difference between mean of two samples, test for difference between the standard deviations of two samples. Tests of proportions: single and difference of proportion, Chi-square test: for independence of attributes and goodness-of-fit.

References:

- Daniel, Wayne W., Bio-statistics: A Foundation for Analysis in the Health Sciences. John Wiley (2005).
- Goon, A.M., Gupta M.K. & Das Gupta, Fundamentals of statistics, Vol.-I &II (2005).
- Dunn, O.J Basic Statistics: A primer for the Biomedical Sciences. (1964, 1977) by John Wiley.

TIME SERIES ANALYSIS

COURSE NO: ST17111OE **No. of Credits-2**

UNIT –I

Introduction to time series, Components of Time Series:Secular Trend, Seasonal Variations, Cyclic Variations, Irregular variation., Mathematical Models of Time Series, Main objectives of analysing Time Series.

UNIT –II

Measurement of Trend, Graphical Methods, Method of Semi-Averages, Method of moving averages, Method of Least squares,fitting by Principle of Least Squares, Merits and Limitations of given methods.

References:

- Gupta S. C. and Kapoor V.K. (2001): Fundamental of Applied Statistics.
- Box, G.E.P. and Jenkins, G.M. (1976): Time Series Analysis-Forecasting and Control, Holden-day, San Francisco.
- Anderson, T.W. (1971): The Statistical Analysis of Time Series, Wiley, N.Y.

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Revised

Choice Based Credit System (CBCS) Syllabus for M.A./M.Sc. Statistics

2nd- Semester for Batch 2017 wef 2018 and onwards BOSPG held on 07/09/2018

General Instructions for the Candidates

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SEMESTER - II			
Course Type	**Course Code**	**Title of the Course**	**No. of Credits**
Core (CR)	ST17201CR	Probability and Distribution Theory – II	**04**
	ST17202CR	Linear Models and Regression Analysis	**04**
	ST17203CR	Advanced Statistical Computing	**04**
Discipline Centric Elective (DCE)	ST17204DCE	Operations Research-I	**04**
	ST17205DCE	Advanced Sampling Techniques	**02**
	ST17206DCE	Inventory and Queuing Theory	**02**
	ST17207DCE	Practical based on ST17201CR & ST17202CR	**02**
	ST17208DCE	Practical based on ST17203CR	**02**
Generic Elective (GE)	ST17209GE	Sampling Theory	**02**
	ST17210GE	Testing of Hypothesis-II(Non-Parametric)	**02**
Open Elective(OE)	ST17211OE	Basic Design of Experiments	**02**

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PROBABILITY AND DISTRIBUTION THEORY - II

COURSENO: ST17201CR **No. of Credits-4**

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,exponential and multinomial distributions and their properties , 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.

Chebyshev's and Kintchinen'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.

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.andKotz, (1972): Distributions in Statistics, vol. III, Houghton and I, II AndMiffin.
- Johnson, Kotz and Kemp (1992): Univariate discrete distribution, John Willy

LINEAR MODELS AND REGRESSION ANALYSIS

COURSE NO: ST17202CR **No. of Credits-4**

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, confidence intervals and prediction intervals, Generalized F test, Generalized t test.

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, Analysis of covariance, estimation and testing ,one way model with one covariance, two way model with two covariance

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.
- Rencher,A.C And Schaalje,G.B(2007),Linear Model in Statistics, John Wiely and Sons.

ADVANCED STATISTICAL COMPUTING

COURSE NO.: ST17203CR **No. of Credits-4**

UNIT-I

R Software: Introduction, Types of functions: Data functions, Summary functions, Elementary functions and graphical functions. Commands/Statements in R for descriptive Statistics, representation of Multivariate data.

UNIT-II

Using R Software's: Correlation & Regression analysis: simple and multiple. Tests of significance, Test of significance of large samples, Test of single proportion, Test of significance of difference of proportions.

UNIT-III

Using R Software's: Difference of mean & proportion, Chi-Square test for independence of attributes and Contingency table, t-test, Paired t-test, Test for correlation in sampling from normal population, F-test, testing of two variance of two univariate normal population.

UNIT-IV

Using R Software's: Simulation Studies, random number generation of various probability distributions. Codes for different programmes in R-Software. Estimation of parameters of different probability functions by using R.

TEXT BOOKS:

- S.C. Gupta & V.K. Kapoor (2012), Fundamentals of Mathematical Statistics, Sultan Chand & Sons.
- Dudewicz, E.J. and Mishra, S.N. (1988): Modern Mathematical Statistics, Willy, Int'l Students edition.
- R Development Core Team (2011), "R: A language and environment for statistical computing," R Foundation for Statistical Computing, Vienna, Austria.
- The R Development Core Team (2011), "R: A language and environment for statistical computing, Reference Index." Version 2.13.0 (2011-04-13).

OPERATIONS RESEARCH - I

Course No: ST17204DCE **No. of Credits-4**

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.

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; 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.

TEXT BOOKS:

- Taha H.A. (1982) Operational Research: An introduction; Macmillan.
- Philips D.T., Ravindran A. and Solberg J. Operation Research, Principles and Practice.
- KantiSwarup, 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; HoldenDay.
- 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

ADVANCED SAMPLING TECHNIQUES

Course No: STM17205DCE **No. of Credits-2**

UNIT- I

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.

UNIT- II

Two-stage sampling: (a) Equal first stage unit; estimation of population mean and its variance and estimates of variance. Comparison with one stage sampling
(b) Unequal first stage unit; estimation of population mean. Expected values and variance of different estimates including the case of probability proportional to size

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 University Press, & IARS.
- Singh, D and Chuddar, F. S. (1986): Theory and Analysis of Sample Survey Design, New Age International Publisher.

INVENTORY AND QUEING THEORY

Course No.: ST17206DCE **No. ofCredit-2**

UNIT- I

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,

UNIT - II

Queuing models-specifications and effectiveness measures.Littles formula, 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.Transient solution of M/M/1 queue.

TEXT BOOKS:

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

REFERENCE BOOKS:

- KantiSwarup, P.K. and Singh,M.M.. (1985) Operation Research; Sultan Chand & Sons.
- 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.
- Kleinrock L. (1975) Queuing Systems Theory Vol.1, John Wiley.
- Saaty T.L.(1961) Elements of Queuing Theory with Applications; McGraw Hill.

COURSE NO: ST17207DCE No. of credits -2

PRACTICAL BASED

ON

COURSES

ST17201CR
&
ST17202CR

Using Statistical Software

COURSE NO: ST17208DCE No. of credits-2

PRACTICAL BASED

ON

COURSE

ST17203CR

Using Statistical Software

SAMPLING THEORY

COURSE NO: **ST17209GE** **No. ofCredits-2**

UNIT-I

Basic concepts of sampling from a finite population; sampling versus complete enumeration; simple random sampling with replacement and without replacement, 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.

UNIT-II

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 un-stratified sampling.Estimation of the gain in precision due to stratification, construction of strata.

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.
- S.C. Gupta & V.K Kapoor (2010), Fundamentals of Applied Statistics, Sultan Chand & Sons,

TESTING OF HYPOTHESIS -II (NON-PARAMETRIC)

Course No: ST17210GE **No. ofCredits-2**

UNIT-I

Non- Parametric Inference: Introduction, Advantages and disadvantages of non- parametric tests. Sign Test-one sample and two samples, Wilcoxon-Signed rank test- one sample and two samples, Wilcoxon –Mann Whitney test ,test of randomness based on total number of runs,Wald –Wilfwitz run test, ARE.

UNIT-II

Empirical distribution functions,Kolmogrov-Smirnov- one sample and two samples test (for samples of equal size), Median test. Mood Test, Ansari – Bradlay Test, ARE, Linear rank statistics, distribution properties of the linear rank statistics.

REFRENCES:

- Mukhopadhayay, P.;Mathematical Statistics.
- Gibbons, J.D and Chakraborty,(2003):Nonpaprametric Statistical Inference,4th edition Marcel Dekker,CRC**.**

BASIC DESIGN OF EXPERIMENTS

Course No: ST17211OE **No. of Credits-2**

UNIT-I

Design of experiments, Principles of Design of experiments (randomization, replication, local control) Assumptions, layout and Analysis of Completely Randomized Design (CRD), Randomized Block Design (RBD), One missing observation in RBD.

UNIT-II

Factorial experiments: General factorial experiments, factorial effects; Main effects and Interactions. Best estimates and testing the significance of factorial effects; study of 2 and 3 factorial experiments in randomized blocks; Yates method for computing different factorial effects.

Text Books:

- S.C. Gupta & V.K Kapoor (2010), Fundamentals of Applied Statistics, Sultan Chand & Sons,
- Alokdey (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.

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Revised

Choice Based Credit System (CBCS) Syllabus for M.A./M.Sc.Statistics

3rd-Semester for Batch 2017 wef 2018 **and onwards BOSPG held on 07/09/2018**

General Instructions for the Candidates

1. The two years (**4 semester**) PG Programmes is of **96** credit weightage i.e. **24** credits/semester (**24×4 = 96**).
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   - A candidate can obtain a maximum of **8** credits within his /her own Department out of specialization offered by the Department as **Discipline Centric Electives**.
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SEMESTER - III			
Course Type	**Course Code**	**Title of the Course**	**No. of Credits**
Core (CR)	ST17301CR	Statistical Inference-I	**04**
	ST17302CR	Multivariate Analysis	**04**
	ST17303CR	Survey Project	**04**
Discipline Centric Elective (DCE)	ST17304DCE	Demography	**04**
	ST17305DCE	Operations Research-II	**02**
	ST17306DCE	Non-Parametric Methods	**02**
	ST17307DCE	Data Analysis Using SPSS	**02**
	ST17308DCE	Practical based on ST17301CR & ST17302CR	**02**
Generic Elective (GE)	ST17309GE	Data Analysis Using Minitab	**02**
	ST17310GE	Standard Probability Distributions - I	**02**
Open Elective(OE)	ST17311OE	Statistical Quality Control	**02**

STATISTICAL INFERENCE – I

COURSE NO: ST17301CR **No. of Credits-4**

UNIT-I

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

UNIT-II

Sufficient and Complete Statistics: Sufficiency, Minimal sufficient statistic, Factorization theorem, Fisher–Neyman criterion. Characterization of distributions. 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: Moments Method, 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: Minimum Chi –square, modified minimum Chi –square and least square estimate.

UNIT-IV

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

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.

MULTIVARIATE ANALYSIS

COURSE NO: ST17302CR **No. of Credits -4**

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.

UNIT-II

Quadratic form and itsdistribution.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 Wishartdistribution.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 ofvariate and it moments. Walk's lambda criterion and its distribution. Mahalanobis D^2statisticsand 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

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 statisticaltheory,
- John Wiley. Seber, G.A.F.(1984): Multivariate observations, Wiley.
- Srivastava, M.S.andKhatri, C.G. (1979): An introduction to multivariate statistics. North Holland. Carter and Srivastava: Multivariate Analysis, North Holland.

COURSE NO.: ST17303CR No. of credits-4

SURVEY PROJECT

Based on Data

Using Statistical Software

DEMOGRAPHY

COURSE NO: ST17304DCE **No. of Credits-4**

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 and Myer's indices. Dependency ratio.

UNIT II

Measure of fertility; relationship between CBR, GFR and TFR. Mathematical models on fertility and human reproduction process, Dandekar's modified binomial and Poisson models. Distributions of time to first birth, William Brass Model, Singh's model and Singh's modified model, inter-live birth intervals and of number of births, 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. Logistic Model for population growth and their fitting to population data. Migration: concepts and rates. Uses of place of birth and duration of residence data.

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.

OPERATIONS RESEACH - II

COURSE NO.: ST17305DCE **No. of credits -2**

UNIT I

Integer Programming: Gomory's Cutting Plane algorithm & branch and bounded method for all integer and mixed integer, Dynamic programming: Single additive constraint; additive separable return, single multiple constraints; additive separable returns, Single additive constraints; multiple separable returns.

UNIT II

Nonlinear programming, Formulation, Lagrange multiplier Technique, Kuhn Tucker necessary and sufficient conditions for optimality of an NLPP, constraint multivariable optimization with inequality constraints. Quadratic Programming problems: Wolfe's and Beale's algorithms for solving quadratic programming problems.

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

REFERENCES:

- Bazara and Shetty (1979) Nonlinear Programming Theory And Algorithms; John Wiley
- KantiSwarup, 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.

NON- PARAMETRIC METHODS

Course No: ST17306DCE **No. ofCredits-2**

UNIT-I

Non- Parametric Inference: Introduction, Advantages and disadvantages of non- parametric tests. Sign Test-one sample and two samples, Wilcoxon-Signed rank test- one sample and two samples, Wilcoxon –Mann Whitney test ,test of randomness based on total number of runs,Wald –Wilfwitz run test, ARE.

UNIT-II

Empirical distributions, Kolmogrov-Smirnov- one sample and two samples test (for samples of equal size), Median test. Mood Test, Ansari – Bradlay Test, ARE, Linear rank statistics, distribution properties of the linear rank statistics.

REFRENCES:

- Mukhopadhayay, P.;Mathematical Statistics.
- Gibbons,J.D and Chakraborty,(2003):Nonpaprametric Statistical Inference,4th edition Marcel Dekker,CRC**.**

DATA ANALYSIS USING SPSS

COURSE NO.: ST17307DCE **No. of credits -2**

UNIT- I

Measurement Scales- Nature of Variables: Types of Data. Introduction to SPSS, entering variables, labelling variables, labelling values, entering string variables, Transformation of variables, Exporting and Importing data files from other packages, selecting cases, Recoding data, computing functions (creating new variables). Measures of Central Tendency and their interpretation, OLAP Cubes, Summary Statistics (overall and for groups of cases), Dispersion, Skewness, Quartiles, Percentiles and Kurtosis. Saving data and output files.
Split files, Weight cases, Graphical Representation of Data- Bar Charts, Stacked Bar, Histogram, Line diagram, Pie diagram, Box Plot, Multiple Box Plot, Error bar, Stem–and-Leaf diagram, Exporting Graphs. Three dimensional Graphs. Missing values analysis. Generating Random variables, Embedded Tables. Basic distributions (Binomial, Poisson, Normal, Exponential etc.) Generating random samples from these distributions. Cross Tabs, odds ratio and risk ratio.

UNIT-II

Correlation Analysis**:** Scatter plot, Karl Pearson's, Spearman's and Partial correlation, Concept of p-value.
Regression Analysis: Introduction to linear models. Simple linear regression involving two variables. Multiple Linear regression including stepwise Regression. Significance of R^2 and Adjusted R^2, significance of Regression Coefficients. Concept of Multicollinearity and Tolerance, and their remedies. Model diagnostics.
Parametric Tests: Normal Probability curve, checking normality assumption using histogram, box plot, quantile (Q-Q), and probability (P-P) plots. Kolmogorov-Semirnov's and Spiro-Wilk's tests for normality. Basic concepts of Testing (hypothesis, types of errors, power, critical value, level of significance), one-sample t-test, independent t-test, paired t-test, one-way &, two-way ANOVA. Repeated ANOVA.

TEXT BOOKS:

S.C. Gupta & V.K Kapoor (2012), Fundamentals of Mathematical Statistics, Sultan Chand & Sons.
Dudewicz, E.J. and Mishra, S.N. (1988): Modern Mathematical Statistics, Willy, Int'l Students edition.
AjaiGaur,S. Statistical methods for practice & research: a guide to data analysis using SPSS

COURSE NO.: ST17308DCE No. of credits -2

PRACTICAL BASED

ON

COURSES

ST17301CR

&

ST17302CR

Using Statistical Software

DATA ANALYSIS USING MINITAB

COURSE NO: ST17309GE **No. of Credits-2**

UNIT-I

Statistical Software's: MINITAB reading and manipulation of data, descriptive statistics. Commands/ Statements in MINITAB, Working with Software Package MINITAB for graphics (Histogram, Plot, Box plot, Pi-chart, QQ plot, density plot, Stem and Leaf). Matrix processing (Basic operations, Eigen Values and inversion of Matrices etc.).

UNIT-II

Using MINITAB: Correlation and Regression analysis: simple and multiple. Simple hypothesis tests (t, χ^2 and F) and analysis of variance.

TEXT BOOKS:

- B. Ryan and B.L. Joiner (2001). MINITAB Handbook, Fourth edition, Duxbury.
- R.A. Thisted (1988): Elements of Statistical Computing, chapman and Hall.
- S.C. Gupta & V.K Kapoor (2012), Fundamentals of Mathematical Statistics, Sultan Chand & Sons.
- Dudewicz, E.J. and Mishra, S.N. (1988): Modern Mathematical Statistics, Willy, Int'l Students edition.

STANDARD PROBABILITY DISTRIBUTIONS - I

COURSE NO: ST17310GE **No. of Credits-2**

UNIT-I

Discrete Random variable, Distribution function, Probability mass function, Mathematical expectation and its properties.

UNIT-II

Important Statistical Discrete distributions: Uniform, Bernoulli, Binomial, Poisson, geometric and their mean and variances, moments and moment generating function.

TEXT BOOKS:

- S.C. Gupta & V.K Kapoor (2012), Fundamentals of Mathematical Statistics, Sultan Chand & Sons,
- Dudewicz, E.J. and Mishra, S.N. (1988): Modern Mathematical Statistics, Willy, Int'l Students edition

STATISTICAL QUALITY CONTROL

Course No: ST17311OE **No. of Credits-2**

UNIT-I:

Meaning and scope of SQC, Applications of SQC, Stewarts control chart, Statistical basis of a control chart, control chart for variables (X bar, R, & S) charts.

UNIT-II:

Control charts for attributes (np, p & C) charts. Operating Characteristic function (OC) and Average Run length (ARL) of X-bar chart. Moving average charts**.**

TEXT BOOKS:

- Biswas, S. (1996). Statistical Quality Control, Sampling Inspection and Reliability; New Age International Publishers.
- Montgomery, D.C. (1985) Introduction to Statistical Quality Control; Wiley.
- Phadke, M.S. (1989) Quality Engineering through Robust Design; Prentice Hall.

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Revised

Choice Based Credit System (CBCS) Syllabus for M.A./M.Sc.Statistics

4th– Semester for Batch 2017 wef 2018 **onwards BOS held on 07/09/2018**

General Instructions for the Candidates

1. The **two** years (**4** semester) PG Programmes is of **96** credit weightage i.e. **24** credits/semester (**24×4 = 96**).
2. Out of **24** credits in a semester a candidate has to obtain **12** credits compulsorily from the **Core Courses**, while the remaining 12 credits can be obtained from the **Electives(DCE, GE &OE)** in the following manner:
   - A candidate can obtain a maximum of **8** credits within his /her own Department out of specialization offered by the Department as Discipline **Centric Electives**.
   - **4** credits shall be obtained by the candidate from the **Electives (GE , OE)** offered by the Department other than his/her own. The candidate shall be free to obtain these **4** credits from the **General** or **Open Elective or A Combination of Both.**

SEMESTER –IV			
Course Type	**Course Code**	**Title of the Course**	**No. of Credits**
Core (CR)	ST17401CR	Statistical Inference-II	**04**
	ST17402CR	Industrial Statistics and Reliability Theory	**04**
	ST17403CR	Design and Analysis of Experiments	**04**
Discipline Centric Elective(DE)	ST17404DCE	Information Theory	**04**
	ST17405DCE	Bayesian Analysis	**02**
	ST17406DCE	Econometrics	**02**
	ST17407DCE	Practical based on ST17402CR	**02**
	ST17408DCE	Practical based on ST17403CR	**02**
Generic Elective(GE)	ST17409GE	Data Analysis Using R Software	**02**
	ST17410GE	Standard Probability Distributions-II	**02**
Open Elective(OE)	ST17411OE	Bio - Statistics	**02**

STATISTICAL INFERENCE –II

COURSE NO: ST17401CR **No. of Credits-4**

UNIT-I

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.

UNIT-II

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.

UNIT-III

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-IV

Sequential Analysis: Definition of Sequential Probability Ratio Test (SPRT). Fundamental relations among α, β, 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.

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.

INDUSTRIAL STATISTICS AND RELIABILITY THEORY

COURSE NO: ST17402CR **No. of Credits-4**

UNIT-I:

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

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 and sequential sampling plan.

UNIT-III:

Capability indices C_p, C_{pk} and C_{pm}. estimation, confidence intervals relating to capability indices for normally distributed characteristics.
Reliability concepts, hazard rate, distribution of longevity and moments. Some important theorems based on reliability theory.

UNIT-IV:

Common life time distributions: exponential, Weibull, gamma, Gumbel and normal distributions. Type I and Type II censored samples. Reliability and hazrad rate 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

DESIGN AND ANALYSIS OF EXPERIMENTS

COURSE NO: ST17403CR **No. of Credits-4**

UNIT-I

Planning of experiment: Nomenclature, Introduction to basic designs and their analysis, Principles of experimental design.Completely Randomized Design (CRD), Randomized Block Design (RBD), Latin Square Design (LSD), missing plot techniquesfor RBD and LSD.

UNIT-II

Analysis of co-variance: Introduction, Analysis of co-variance model, normal equations, assumptions. Analysis of Covariance for Completely Randomized Design (CRD), Randomized Block Design (RBD), Latin Square Design (LSD).Numerical illustrations.

UNIT-III

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

UNIT IV

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

TEXT BOOKS:

- Alokdey (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.

INFORMATION THEORY

COURSE NO: ST17404DCE **No. of Credits -4**

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,Some important generalizations of entropy measures and inequalities and their properties.

TEXT BOOKS:

- Reza,F.M(2012).: 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.
- Yeung,R.W:A,First course of information theory(2004),Kluwer Academics.

BAYESIAN ANALYSIS

COURSE NO: ST17405DCE **No. of Credits-2**

Unit I

Fundamentals of Bayesian Statistics: Conditional probability and its applications in Bayesian analysis, Bayes theorem for events, Bayes factor, Generalized Bayes theorem for events, Bayes theorem for future events, Bayes theorem for random variables, and Sequential nature of Bayes theorem.

Unit II

Prior distribution and types of prior distributions, proper prior, improper prior, conjugate prior, Jeffrey's prior, informative and non-informative priors.
Bayesian method of estimation: Bayes estimation of Binomial, Poisson, exponential, Weibull and normal distributions by using various types of priors.

References:

- Berger, J.O.: Statistical Decision Theory and Bayesian Analysis, Springer Verlag.
- Robert, C.P. and Casella, G.: Monte Carlo Statistical Methods, Springer Verlag.

ECONOMETRICS

COURSE NO: ST17406DCE **No. of credits -2**

Unit- I

Nature, Scope and meaning of Econometrics: Two Variable Linear Regression Model: Assumption, Estimation of Parameters, Tests of Significance and Properties of Estimators-Functional forms of Regression Models – Log linear Models, Semi Log-models and Reciprocal models – Choice of Functional Form.

Unit- II

Serial Correlation & Heteroscedasticity : Econometric modeling: Model Specification and Daignostic Testing, Model selection Criteria, Types of Specification of Error, Consequences of Model Specification of Error, Tests of Specification of errors, Errors of measurements.
Linear Probit Model (LPM): Application of LPM, Logit Model, Probit Model, Dynamic Econometric Model, Autoregressive and distributed Log Models

REFERENCES:

1. Apte, P.G. (1990): Text books of Econometrics, Tata McGraw Hill.
2. Cramer, J.S. (1971): Empirical Econometrics, North Holland.
3. Johnston, J: Econometric Methods, McGraw- Hill Book Co., New York.
4. Maddala, G. S: Econometric, McGraw- Hill Book Co., New York 3rd Rd.
5. Gujarathi, D. N: Basic Econometric, Fourth Edition Tata McGraw- Hill, New Delhi
6. Tintner, G: Econometric, John Wiley & Sons , New York.
7. Wooldridge, Jeffery M: Econometric, Cengage Learning India Pvt. Ltd New Delhi.
8. Madnani, G.M. K. : Introduction to Econometric principles and Applications.Oxford & IBH Publishing Co. Pvt Ltd.New Delhi.

COURSE NO.: ST17407DCE No. of credits-2

PRACTICAL BASED

ON

ST17402CR

Using Statistical Software

COURSE NO.:ST17408DCE No. of credits-2

PRACTICAL BASED

ON

ST17403CR

Using Statistical Software

DATA ANALYSIS USING R SOFTWARE

COURSE NO: ST17409GE **No. of Credits-2**

UNIT-I

Statistical Software R : Reading & Manipulation of data, Commands/Statements in R, different types of functions in R software, Descriptive Statistics, Working with Software package R for graphics, EDA: Histogram, Plot, Box plot, Pi-chart, QQ plot and density plot.

UNIT-II

Using R: Basic operations on matrices. Correlation and regression analysis. t-test for single mean, t-test for significance of difference of means and paired t-test. Chi-Square test for goodness of fit, independence of attributes and Contingency table and F-test.

TEXT BOOKS:

- R.A. Thisted (1988): Elements of Statistical Computing, chapman and Hall.
- S.C. Gupta & V.K Kapoor (2012), Fundamentals of Mathematical Statistics, Sultan Chand & Sons.
- Dudewicz, E.J. and Mishra, S.N. (1988): Modern Mathematical Statistics, Willy, Int'l Students edition.
- Gardener, M (2012) Beginning R: The Statistical Programming Language, Wiley Publications.
- Braun W J, Murdoch D J (2007): A First Course in Statistical Programming with R. Cambridge University Press. New York.

STANDARD PROBABILITYDISTRIBUTION – II

COURSE NO: ST17410GE **No. of Credits-2**

UNIT-I

Continuous Random variable, Distribution function, Probability density function, Mathematical expectation and its properties.

UNIT-II

Important Statistical Continuous distributions: uniform, exponential, gamma and normal distributions, their mean, variances and Particular cases.

TEXT BOOKS:

- S.C. Gupta & V.K Kapoor (2012), Fundamentals of Mathematical Statistics, Sultan Chand& Sons.
- Dudewicz, E.J. and Mishra, S.N. (1988): Modern Mathematical Statistics, Willy, Int'l Students edition.

BIO - STATISTICS

COURSE NO.: ST17411OE **No. of credits-2**

UNIT-I

Epidemiological method**:** Evolution of Epidemiology, Causal relationship, establishing a causal relationship, Prevalence, Incidence, Prevalence versus incidence. Types of study design:- Cross-sectional study ; Case-Control study measures of association in case control studies, cohort studies; measures of association.

UNIT- II

Importance of sample size in research design**:** Diagnostic tests:- Accuracy of a diagnostic test, sensitivity and specificity; predictive values, limitation of predictive values. Bayes theorem, Likelihood ratio. LR of positive tests(LR+) & LR of a negative test(LR-). Post test odds when the test outcome is positive (negative). Tree method for obtaining post test probabilities, Receiver operating characteristics curve.

Books Recommended

- Medical statistics, Principles & Methods, K.R. Sundaram, S.N. Dewidi&Sreenivas, BI publications, pvt. Ltd. New Delhi.
- Bio statistics by Daniel. @#