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

1st- Semester for Batch 2022 wef 2022 and onwards

BOSPG held on 23/05/2022

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 **14** creditscompulsorily from the **Core Courses**, while the remaining **10** credits can beobtained 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 **DisciplineCentric Electives (DCE).**
- **2**credits shall be obtained by the candidate from the **Electives(GE, OE)** offered by the Department other than his/her own. The candidate shall befree to obtain these **2** 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)	ST22101CR	Probability and Distribution Theory - I	**04**
	ST22102CR	Sampling Techniques	**04**
	ST22103CR	Statistical Computing	**04**
	ST22104CR	Applied Statistics	**02**
DisciplineCentric Elective (DCE)	ST22105DCE	Stochastic Processes	**04**
	ST22106DCE	Linear Algebra	**02**
	ST22107DCE	Real Analysis	**02**
	ST22108DCE	Practical based on ST2201CR & ST22102CR	**02**
	ST22109DCE	Practical based on ST22103CR & ST22104CR	**02**
Generic Elective (GE)	ST22110GE	Statistical Methods	**02**
	ST22111GE	Parametric Tests	**02**
Open Elective (OE)	ST22112OE	Time Series Analysis	**02**

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

1st- Semester for Batch 2022 wef 2022 and onwards

BOSPG held on 23/05/2022

PROBABILITY AND DISTRIBUTION THEORY-I

COURSE NO: ST22101CR **No. of Credits-4**

Course Objectives: To introduce concepts of probability distribution.

Course Outcomes: Students who successfully complete this course will be able to:

- Understand the basic concepts of Probability theory.
- Understand the concepts of discrete and continuous Probability distributions.
- Identiy the distributions by uniqueness theorem.

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, propertiesof 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 functionof a random variable. Related Examples.

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 valuedrandom variables. Inversion formula, and Uniqueness theorem. Related Examples.

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. Examples related to discrete distributions.

UNIT-IV

Univariate Continuous distributions: Uniform, Beta, Gamma, Exponential, Pareto, Weibull,Laplace, Normal, Cauchy and their structural properties, relations and applications, Marginaland conditional distributions. Examples based on continuous distributions.

RECOMMENDED TEXT BOOKS & REFERENCES:

- Dudewicz, E.J. and Mishra, S.N. (1988): Modern Mathematical Statistics, Willy, Int'lStudents edition
- Rohatgi, V.K. (1994): An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern.
- S.C. Gupta & V.K Kapoor (2012), Fundamentals of Mathematical Statistics, Sultan Chand& Sons.
- Rao, R.C. (1973): Linear Statistical Inference and its Applications, 2/e, Wiley Eastern.
- 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.

SAMPLING TECHNIQUES

COURSE NO: ST22102CR **No. of Credits-4**

Course Objectives: To introduce concepts of sampling theory.

Course Learning outcomes: Students who successfully complete this course will be able to:

- Understand the basic concepts of sampling theory.
- Formulate and calculate estimators of population mean, population ratio, population total for SRs, Systematic and cluster sampling.
- Estimate the convenient sample size under different sampling strategies.
- Compare various sampling procedures interms of variance of estimators.
- Handle the practical uses of arising insamplingstudies.

UNIT I

Basic ideas and distinctive features of sampling: Review of important terminology used in sampling.Concept of Bias, mean square error, Relative efficiency. Simple random sampling withand without replacement. Estimators of population proportion. Determination of sample size. SRS as applied to qualitative characteristic.

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 precisiondue 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 lineartrend. 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.

RECOMMENDED TEXT BOOKS & REFERENCES:

- 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 UniversityPress, & IARS.
- Singh, D and Chuddar, F. S. (1986): Theory and Analysis of SampleSurvey Design, New Age International Publisher.

STATISTICAL COMPUTING

COURSE NO: ST22103CR **No. of Credits-4**

Course objectives: To learn data analysis using MINITAB.

Course outcomes: After successful completion of this course, the students will be able to:

- Study large number of real data sets.
- Apply the Minitab for statistical data analysis and graphics.
- Find solutions of problems of optimization through Minitab.
- Transfer textbook knowledge to practical situations.

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 and Manipulation of data, Commands/Statements in MINITAB, Descriptive Statistics. 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: Basic operations on matrices. Correlation and Regression analysis: simple and multiple. 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.

RECOMMENDED TEXT BOOKS & REFERENCES:

- 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.

APPLIED STATISTICS

COURSE NO: ST22104CR. **No. of Credits-2**

Course objectives: To introduce the concepts of Time Series and Index Numbers.

Course outcomes: After successful completion of this course, the students will be able to:

- Apply the the Time Series data to find the trend .
- Analyze Time Series data inorder to check the behaviour of trend.
- Understand the applications of Index Numbers.

UNIT –I

Introduction and history of time series, Trend, Linear and Non- Linear trend, periodic changes, Seasonal Variations, Analysis of time series, Mathematical Models of Time Series, Uses of the time series. Measurement of Trend,Free hand curve method, Semi-Average method, Moving average method, Method of least squares, fitting of straight line by Least Squares, Merits and Limitations of given methods.

UNIT –II

Index number: Definition and applications of index number. Construction of Index numbers and problems related to computation of Index numbers. Use of averages, simple aggregative and Weighted average methods, Laspeyre's, Paasche's, Drobish-Bowley price index number and Fishers' index number. Criteria for good index number: Mathematical Tests: Unit test, Time Reversal test, Factor Reversal tests and Circular test of index numbers.

RECOMMENDED TEXT BOOKS & 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.

@#

STOCHASTIC PROCESSES

COURSE NO: ST22105DCE **No. of Credits-4**

Course objectives: To introduce the concepts of stochastic process.

Course outcomes: After successful completion of this course, the students will be able to:

- Understand the concepts of Markov Chain.
- Apply the Poisson processes and related distributions.
- Understand the concepts of Galton-Watson branching process.

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 ruinat 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.

RECOMMENDED TEXT BOOKS & REFERENCES:

- 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 StochasticProcesses, 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: ST22106DCE **No. of Credits-2**

Course objectives: To introduce the concepts of linear algebra.

Course objectives: To expose the students to the study of matrices, Linear function and their representations through the survey of matrices and vector spaces..

To make students aware of representing statistical data in the matrix forms and then analysing interms of linear algebraic tools and techniques.

UNIT-I

Algebra of Matrices, trace of a matrix, tr(AB)= tr(BA), types of matrices: symmetric, skew symmetric, Hermetian, Skew-Hermetian, idempotent, nilpotent, orthogonal and Unitary matrices. Inverse of square matrix, Inverse of partitioned matrices. Rank of matrix, characteristic and minimal equation, Cayley-Hamilton Theorem and its Applications. Eigen values and Eigen vectors.

UNIT-II

Linear equations, solution of homogenous and non-homogenous equations. Vector spaces, basis and Dimensions . Linear Transformations and their matrix representation. Inner product spaces, orthogonal and orthonormal basis. Quadratic forms, reduction and classification of quadratic forms.

RECOMMENDED TEXT BOOKS & REFERENCES:

- Grabill, Walter(1976). Matrices with Applications in Statistics, 2nd Ed.Wadsworth.
- Roa,C.R.(1973), Linear Statistical Inference and its Applications, 2nd Ed.John Wileyand Sons,Inc.
- Searel, S.R.(1982).Matrix Algebra useful for Statistics. John Wiely and Sons,Inc.
- Aziz, A, Rather, N.A. and Zargar, B.A.: Elementary Matrix Algebra, KBD(Kashmir Book Depo)
- Shanti Narayan, A text book of matrices, Narosa Publ. linear independence and linear dependence of row (column) vectors.

REAL ANALYSIS

COURSE NO: ST22107DCE **No. of Credits-2**

Course objectives: To introduce the concepts of real analysis.

Course objectives: To study the behaviour and properties of Real numbers, Sequence and Series of real numbers and realvalued functions inorder to tackle daily life problems arising from physical phenemenon .

To study different properties of distribution and density functions in Statistics using Real ananalysis.

UNIT-I

Finite, countable and uncountable sets, bounded and unbounded sets, Archimedean property, ordered field, completeness of R, sequence and series, limit supremum andlimit infimum of a bounded sequence. Convergence and divergence of positive term series, comparison, root and ratio tests for the convergence of series. Cauchy-Schwarz Inequality, Chebyshev's Inequality, Central limit theorem.

UNIT-II

Limit, Continuity, uniform continuity of functions of one variable, the algebra of continuous functions, monotonic functions, types of discontinuities, infinite limits and limits at infinity. Differentiability, Rolle's Theorem, Mean Value Theorems, Riemann sum and integral (simple problems). Functions of several variables. Limit and continuity of functions of several variables.

RECOMMENDED TEXT BOOKS & REFERENCES:

- 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: ST22108DCE No. of Credits-2

PRACTICAL BASED ON COURSES

ST22101CR & ST22102CR

Using Statistical Software

COURSE NO: ST22109DCE No. of Credits-2

PRACTICAL BASED ON COURSES

ST22103CR & ST22104CR

Using Statistical Software

STATISTICAL METHODS

COURSE NO: ST22110GE **No. of Credits-2**

Course objectives: To introduce the concepts of descripitive statistics.

Course outcomes: Students who successfully complete the course will be able to:

- Understand the measures of central tendency and their applications.
- Understand the measures of dispersion and their usage.
- Understand the concepts of correlation and regresssion.

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.

RECOMMENDED TEXT BOOKS & REFERENCES:

- 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.

@#

PARAMETRIC TESTS

Course No: ST22111GE **No. of Credits-2**

Course objectives: To introduce the concepts of Testing of Hypothesis.

Course outcomes: Students who successfully complete the course will be able to:

- Formulate the hypothesis test and then apply appropriate statistic.
- Determine the probalilityof making type-I and type-II error.
- Understand the logic and framework of the inference of hypothesing testing.

UNIT I

Principles of test of significance , Null and alternative hypothesis, two tailed and onetailed 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 fordifference between the standard deviations of two samples. Tests of proportions: single anddifference of proportion, Chi-square test: for independence of attributes and goodness-of-fit.

RECOMMENDED TEXT BOOKS & 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: ST22112OE **No. of Credits-2**

Course objectives: To introduce the concepts of Time Series.

Course outcomes: After successful completion of this course, the students will be able to:

- Understand the concepts of Components of Time Series.
- Apply the the Time Series data to find the trend .
- Analyze Time Series data inorder to check the nature of trend.

UNIT –I

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

RECOMMENDED TEXT BOOKS & 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.

@#

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

2nd - Semester for Batch 2022 wef 2022 and onwards

BOSPG held on 23/05/2022

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 **14** credits compulsorily from the **Core Courses**, while the remaining **10** 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 (DCE)**.
   - **2** 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 **2** credits from the **General** or **Open Elective or a Combination of both.**

SEMESTER – II			
Course Type	**Course Code**	**Title of the Course**	**No. of Credits**
Core (CR)	ST22201CR	Probability and Distribution Theory – II	**04**
	ST22202CR	Linear Models and Regression Analysis	**04**
	ST22203CR	Statistical Computing using R	**04**
	ST22204CR	Advanced Sampling Techniques	**02**
Discipline Centric Elective (DCE)	ST22205DCE	Operations Research - I	**04**
	ST22206DCE	Actuarial Sciences	**02**
	ST22207DCE	Inventory and Queuing Theory	**02**
	ST22208DCE	Practical based on ST22201CR & ST22202CR	**02**
	ST22209DCE	Practical based on ST22203CR & ST22204CR	**02**
Generic Elective (GE)	ST22210GE	Sampling Theory	**02**
	ST22211GE	Non-Parametric Tests	**02**
Open Elective (OE)	ST22212OE	Design of Experiments	**02**

PROBABILITY AND DISTRIBUTION THEORY - II

COURSENO: ST22201CR. **No. of Credits-4**

Course objectives: To Introduce the advanced concepts of probability theory.

Course outcomes: On successful completion of this course, the students will be able to

- Describe the advanced techniques of Probability theory including LLN.
- Apply the results of advanced Probability in statistical theory.

UNIT-I

Sampling distributions: Chi-square distribution and its properties and applications. Test of significance of Chi-square. Relation of Chi-square distribution with the other distributions. Examples based on Chi-square distribution. Non-central Chi-square distribution and related examples.

UNIT-II

Sampling distributions: F distribution and its properties and applications. Test of significance of F. Relation of F distribution with the other distributions. Examples based on F distribution. Non-central F-distribution and related examples.

UNIT-III

Sampling distributions: Z-distribution & Z-test and its properties and applications. t distribution and its properties and applications. Test of significance of Z and t. Relation of z & t distribution with the other distributions. Examples based on t distribution and Z test. Non-central t-distribution and related examples.

UNIT-IV

Bivariate distributions: Bivariate normal distribution and multinomial distributions and their properties, marginal and conditional distributions. Expectations and conditional expectations, covariance. examples.

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.

Weak law of large numbers (WLLNs): Condition for the WLLNs. Strong law of large number (SLLN) and examples.

RECOMMENDED TEXT BOOKS & REFERENCES:

- 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
- 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: ST22202CR **No. of Credits-4**

Course objectives: To introduce basic and advance concepts of general linear model.

Course outcomes: On successful completion of this course, the students will be able to

- Describe the concepts of linear models in real applications of statistics modelling
- Apply concepts of linear models to illustrate its application areas like design of experiments, econometrics, survival analysis and demography.

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

RECOMMENDED TEXT BOOKS & REFERENCES:

- 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.

STATISTICAL COMPUTING USING R

COURSE NO.: ST22203CR **No. of Credits-4**

Course objectives: This Course is developed to help the students to learn various advanced techniques of data analysis in R Software.

Course outcomes: After successful completion of this course, the students will be able to:

- Have full knowledge of R software.
- Find solutions of problems of optimization through R.
- Articulate statistical modelling using R.
- Apply these modelling tools in Statistical/Machine learning.

UNIT-I

Introduction to R language, R as a calculator, Vectorization, notation and naming. Creation of data object, vector, factor and data frame. Extraction operators in R, data import/export, manipulation of data, Summary of data and statistical graphics with R. Representation of Multivariate data in R.

UNIT-II

Managing matrices in R: creating matrices, adding on to matrices, adding attributes to matrices, sub-setting matrices. Correlation and Regression analysis in R: simple and multiple. Tests of significance, Test of single proportion, Test of significance of difference of proportions.

UNIT-III

Using R Software's: Chi-Square tests: The Chi-Square distribution: Chi-Squared goodness of fit tests, Chi-Squared tests of independence and Chi-Squared tests of homogeneity. t-test for single mean, difference of means and paired t-test. Test for correlation in sampling from normal population, F-test, testing of two variances of two univariate normal population.

UNIT-IV

Simulation Studies using R Software, random number generation of various probability distributions. Codes for different programmes in R-Software. Estimation of parameters of different probability functions by using R. Linear Programming with R, Optimization with R.

RECOMMENDED TEXT BOOKS & REFERENCES:

- Bradley C. Boehmke (2016): Data Wrangling with R. Springer.
- E.J. Dudewicz and S.N. Mishra. (1988): Modern Mathematical Statistics, Willy, Int'l Students edition.
- John Verzani. (2005): Using R for Introductory Statistics. Chapman & Hall/CRC.
- S.C. Gupta and V.K. Kapoor (2012): Fundamentals of Mathematical Statistics, Sultan Chand & Sons.

ADVANCED SAMPLING TECHNIQUES

Course No: STM22204CR **No. of Credits-2**

Course objectives: To introduce the concepts of sample surveys and designs.

Course outcomes: On successful completion of this course, the students will be able to

- Use double samples to collect information for ratio and regression estimation.
- Compute the estimators when double sampling is used to collect information for stratification.
- Use two stage sampling under equal/ unequal first stage units.

UNIT- I

Double Sampling: Double Sampling for Stratification including estimation of variance. Variance of ratio and regression estimates in double sampling. 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

RECOMMENDED TEXT BOOKS & REFERENCES:

- 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.

OPERATIONS RESEARCH - I

Course No: ST22205DCE **No. of Credits-4**

Course objectives: To introduce the basic and advanced concepts of Operations Research

Course outcomes: After successful completion of this course, the students will be able to:

- Formulate the LPP of the industrial problems.
- Describe the technique of Operations Research
- Apply the Operation Research in decision making.

UNIT I

Definition and scope of Operational research, Necessity of Operations Research in Industry; phases in Operations Research. Formulation of Linear programming problems (LPP), Cannonical and standard form of LPP, Basic definitions of LPP. Methods of solving LPP: Graphical method, Simplex method, Big-M method, Two-phase method and Extreme point theorems; Revised Simplex Method.

UNIT II

Duality in Linear programming problem, Symmetric and asymmetric dual problems, Unrestricted variables in dual LPP. Relationship between Primal and Dual LPP. Duality theorems: Weak duality theorem, Optimality criterion theorem, Unboundedness theorem, Fundamental theorem of duality, Complementary Slackness theorem and Complementary Slackness conditions and their applications. Dual Simplex Method.

UNIT III

Introduction to game theory. Strategy and its types. Decision Making in the face of competition, two–person, Zero sum games, payoff matrix. Maximin and Minimax principles. Games with pure and mixed strategies, existence of solution and uniqueness of value in zero-sum games, finding solutions in 2x2. Dominance principle, finding solutions in 2xm and mx2 type 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.

RECOMMENDED TEXT BOOKS & REFERENCES:

- 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.
- 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

ACTUARIAL SCIENCE

Course No.: ST22206DCE **No. of Credit-2**

Course objectives: To introduce the concepts of Acturial Science.

Course outcomes: After successful completion of this course, the students will be able to:

- Understand the concepts of Markov processes.
- Describe the technique of Gompertz-Makeham laws of mortality.

UNIT I

Survival models, sickness and marriage models in terms of Markov processes, force of mortality, hazard rate. Actuarial symbols tp_x and tq_x and integral formulas, Gompertz-Makeham laws of mortality, life tables

UNIT II

Lifetime distributions and estimation, Failure rate, mean residual life and their elementary properties, types of censoring, Estimation of survival function, Kaplan-Meier estimate, Nelson-Aalen estimate and their applications, Semi-parametric regression for failure rate, Cox proportional hazard model

RECOMMENDED TEXT BOOKS & REFERENCES:

- Cox, D.R. and Oakes, D., Analysis of Survival Data, Chapman and Hall, New York.
- Gross A.J. and Clark, V. A., Survival Distributions: Reliability, Applications in the Biomedical Sciences, John Wiley and Sons.
- Elandt – Johnson, R.E. Johnson N.L., Survival models and Data Analysis, John Wiley and Sons
- Miller, R.G., Survival Analysis (Wiley)
- Zacks, S., Reliability

INVENTORY AND QUEING THEORY

Course No.: ST22207DCE **No. of Credit-2**

Course objectives: To introduce the elementary and advanced concepts of queuing theory.

Course outcomes: On successful completion of this course, the students will be able to

- Describe the applied concepts of the stochastic process in the analysis of various queuing models.
- Apply the queuing models in various real-life problems

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.

RECOMMENDED TEXT BOOKS & REFERENCES:

- Taha H.A. (1982) Operational Research: An introduction; Macmillan.
- 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: ST22208DCE No. of credits -2

PRACTICAL BASED ON COURSES

ST22201CR & ST22202CR

Using Statistical Software

COURSE NO: ST22209DCE No. of credits-2

PRACTICAL BASED ON COURSES

ST22203CR & ST22204CR

Using Statistical Software

SAMPLING THEORY

COURSE NO: **ST22210GE** **No. of Credits-2**

Course objectives: To introduce the concepts of sample surveys and techniques.

Course outcomes: On successful completion of this course, the students will be able to

- Understand the methods of sampling.
- Apply the methods in data collections.
- Apply these techniques in Data Analysis.

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.

RECOMMENDED TEXT BOOKS & REFERENCES:

- 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,

NON – PARAMETRIC TESTS

Course No: ST22211GE **No. of Credits-2**

Course objectives: To Introduce the concepts of non-parametric tests.

Course outcomes: On successful completion of this course, the students will be able to

- Describe the techniques of non-parametric tests.
- Apply the non-parametric test in statistical theory and related fields.
- Identify the distribution based on non-parametric tests.

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.

UNIT-II

Test of randomness based on total number of runs, Wald –Wilfwitz run test. Empirical distribution functions, Kolmogrov-Smirnov- one sample and two samples test (for samples of equal size)

RECOMMENDED TEXT BOOKS & REFERENCES:

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

DESIGN OF EXPERIMENTS

Course No: ST22212OE **No. of Credits-2**

Course objectives: To introduce the elementary and advanced concepts of design and analysis of experiments.

Course outcomes: On successful completion of this course, the students will be able to

- Describe the techniques of design of experiments in real life scenario.
- Apply the response surface methodology in different application areas like food science, quality improvement, etc.

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.

RECOMMENDED TEXT BOOKS & REFERENCES:

- 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,
- Mcmillain Joshi.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.

@#

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

3rd - Semester for Batch 2022 wef 2022 and onwards

BOSPG held on 23/05/2022

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 **14** credits compulsorily from the **Core Courses**, while the remaining **10** 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 (DCE)**.
- 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 **2** credits from the **General** or **Open Elective or a Combination of both.**

SEMESTER – III			
Course Type	**Course Code**	**Title of the Course**	**No. of Credits**
Core (CR)	ST22301CR	Statistical Inference – I	**04**
	ST22302CR	Multivariate Analysis	**04**
	ST22303CR	Survey Project	**04**
	ST22304CR	Order Statistics	**02**
Discipline Centric Elective (DCE)	ST22305DCE	Demography	**04**
	ST22306DCE	Operations Research – II	**02**
	ST22307DCE	Bio – Statistics	**02**
	ST22308DCE	Practical based on ST22301CR & ST22302CR	**02**
	ST22309DCE	Data Analysis using SPSS	**02**
Generic Elective (GE)	ST22310GE	Data Analysis using Statistical Software	**02**
	ST22311GE	Discrete Probability Distributions	**02**
Open Elective (OE)	ST22312OE	Statistical Quality Control	**02**

STATISTICAL INFERENCE – I

COURSE NO: ST22301CR **No. of Credits-4**

Course objectives: To introduce the concepts of statistical inference.

Course outcomes: On successful completion of this course, the students will be able to

- Describe the concepts of statistical inference.
- Apply the statistical inference tools in real data analysis including sample surveys, design of experiments, and econometrics.

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 sample. Determination of confidence interval based on large samples. Relation between confidence estimation and hypothesis testing. Bayesian Interval estimation.

RECOMMENDED TEXT BOOKS & REFERENCES:

- 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)
- 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: ST22302CR **No. of Credits -4**

Course objectives: To introduce the elementary and advanced concepts of multivariate analysis tools.

Course outcomes: On successful completion of this course, the students will be able to

- Describe the multivariate analysis tools in relation to univariate tools
- Apply multivariate statistical methods in various applications.

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

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

UNIT-III

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

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

UNIT-IV

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

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.

RECOMMENDED TEXT BOOKS & REFERENCES:

- 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 Mc Graw Hill.
- Sharma, S. (1996): Applied multivariate technique, Wiley
- Muirhead, R. J. (1982): Aspects of multivariate statistical theory,
- John Wiley. Seber, G.A.F. (1984): Multivariate observations, Wiley.
- Srivastava, M.S. and Khatri, C.G. (1979): An introduction to multivariate statistics. North Holland. Carter and Srivastava: Multivariate Analysis, North Holland.

COURSE NO: ST22303CR No. of Credits-4

SURVEY PROJECT

Using Statistical Software

ORDER STATISTICS

COURSE NO.: ST22304CR **No. of credits -2**

Course objectives: To introduce the basis order statistics.

Course outcomes: On successful completion of this course, the students will be able to

- Demonstrate the understanding of order statistics.
- Understand the marginal and joint distribution functions.

UNIT-I

Single Order Statistics: Cumulative distribution function, probability density function, structural properties and applications. Distribution of extremes. Distribution of median and range and their related examples. The expected value of a random variable between two consecutive order statistics is 1/(n+1).

UNIT-II

Joint order statistics: Joint probability density function of two order statistic, Marginal and conditional distribution of order statistics, extreme value laws and their properties. Correlation between extremes and related examples. Distribution of Range and other systematic statistics

RECOMMENDED TEXT BOOKS & REFERENCES:

- 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.
- H.A. David, H.N. Nagaraja (2004): Order Statistics, Willy, Third Edition.
- B.C. Arnold, N. Balakrishnan, H. N. Nagaraja (2008): A First Course in Order Statistics, Society for Industrial and Applied Mathematics

DEMOGRAPHY

COURSE NO: ST22305DCE **No. of Credits-4**

Course Objectives: The main aim of this course is to describe current population trends, in terms of fertility, mortality and population growth.

Course Outcomes: After successful completion of this course, student will be able to:

- Recognize principle sources of demographic data and evaluate their strengths and weaknesses.
- Deliberate the demographic importance of age structures and the repercussion of variations in age structure.
- Classify the various components of population change, including the effects of changing birth, death and migration rates, and demonstrate their influences on age structure.
- Construct and interpret complete and abridged life tables.

UNIT I

Introduction and definition of vital Statistics, coverage and content errors in demographic data, use of balancing equations, Chandrasekharan-Deming formula to check completeness of registration data. Dependency ratio. Accuracy of age data on sex and age: Whipple's and Myer's indices.

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. Relationship between life table functions and their estimation. Relationship between abridged life table functions. Greville's and Reed-Merrel's methods.

UNIT IV

Migration: concepts and rates. Uses of place of birth and duration of residence data. Population projection: Logistic growth model, fitting of logistic growth model by the method of three points. Frejka's component method. Logistic Model for population growth and their fitting to population data. Use of Leslie matrix.

RECOMMENDED TEXT BOOKS & REFERENCES:

- 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.: ST22306DCE **No. of credits -2**

Course Objectives: To introduce the advanced concepts of Operations Research

Course outcomes: On successful completion of this course, the students will be able to

- Describe the technique of Integer Programming.
- Understand the concepts of Nonlinear programming.
- Understand the concepts of Quadratic Programming problems.

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.

RECOMMENDED TEXT BOOKS & REFERENCES:

- Taha H.A. (1982) Operational Research: An introduction;
- Macmillan. Hadley G.(1964) Nonlinear and Dynamic Programming; Addision Wesley.
- Kabmboj ,Puri,N,C;Mathematical Programming
- 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.

BIO - STATISTICS

COURSE NO.: ST22307OE **No. of credits-2**

Course Objectives: To introduce the advanced concepts of Bio-Statistics.

Course outcomes: On successful completion of this course, the students will be able to

- Understand the concepts of cohort studies and measures of association.
- Understand the concepts of Diagnostic tests.

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.

RECOMMENDED TEXT BOOKS & REFERENCES:

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

@#

COURSE NO: ST22308DCE No. of credits -2

PRACTICAL BASED ON COURSES

ST22301CR & ST22302CR

Using Statistical Software

COURSE NO: ST22309DCE No. of credits -2

PRACTICAL BASED ON

Data Analysis using SPSS

Summary Statistics. Graphical Representation of Data- Bar Charts, Stacked Bar, Histogram, Line diagram, Pie diagram, Box Plot, Exporting Graphs. Basic concepts of Testing (hypothesis, types of errors, power, critical value, level of significance), concept of p-value, one-sample t-test, independent t-test, paired t-test, one way &, two-way ANOVA.
Correlation Analysis: Scatter plot, Karl Pearson's, Spearman's and Partial correlation. Regression Analysis: Introduction to linear models. Simple linear regression involving two variables.
Basic distributions (Binomial, Poisson, Normal, Exponential etc.) Generating random samples from these distributions. Parametric Tests: Normal Probability curve, checking normality assumption using histogram, box plot and quantile (Q-Q) plots. Kolmogorov-Semirnov's and SpiroWilk's tests for normality.

RECOMMENDED BOOKS & REFERENCES

- 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.
- Ajai Gaur,S. Statistical methods for practice & research: a guide to data analysis using SPSS

DATA ANALYSIS USING STATISTICAL SOFTWARE

COURSE NO: ST22310GE **No. of Credits-2**

Course objectives: To learn basic concepts of Statistical package MINITAB.

Course outcomes: After successful completion of this course, the students will be able to:

- Perform data analysis in Minitab.
- Apply the Minitab for graphics.

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).

UNIT-II

Using MINITAB: Matrix processing (Basic operations, Eigen Values and inversion of Matrices etc.). Correlation and Regression analysis: simple and multiple. Simple hypothesis tests (t, χ^2 and F).

RECOMMENDED TEXT BOOKS & REFERENCES:

- 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.

DISCRETE PROBABILITY DISTRIBUTIONS

COURSE NO: ST22311GE **No. of Credits-2**

Course objectives: To understand the basic elements of probability theory.

Course outcomes: On successful completion of this course, the students will be able to

- Provide a foundation for understandings of probability courses.
- Apply the theory of probability in applications of statistics.

UNIT-I

Discrete Random variable, Distribution function, Probability mass function. Mathematical expectation, Moments, moment generating function and their properties.

UNIT-II

Standard Discrete distributions: Uniform, Bernoulli, Binomial, Poisson, geometric and their mean, variances, moments and moment generating function properties and relations.

RECOMMENDED TEXT BOOKS & REFERENCES:

- 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: ST18312OE **No. of Credits-2**

Course objectives: To introduce the elementary concepts of Statistical Quality Control.

Course outcomes: After successful completion of this course, the students will be able to:

- Apply suitable SQC techniques and tools to control processes at various phases of work problems.

UNIT-I

Meaning and scope of SQC, Applications of SQC, Schwartz control chart, Statistical basis of a control chart, control chart for variables ($\bar{X}$, R and S) charts.

UNIT-II

Control charts for attributes (np, p & c) charts. Natural Tolerance and Specification Limits. Operating Characteristic function (OC) and Average Run length (ARL) of $\bar{X}$ chart. Moving average charts**.**

RECOMMENDED TEXT BOOKS & REFERENCES:

- 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.

@#

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

4th- Semester for Batch 2022 wef 2022 and onwards

BOSPG held on 23/05/2022

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 **14** credits compulsorily from the **Core Courses**, while the remaining **10** 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 (DCE)**.
- **2** 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 **2** 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)	ST22401CR	Statistical Inference – II	**04**
	ST22402CR	Industrial Statistics and Reliability Theory	**04**
	ST22403CR	Design and Analysis of Experiments	**04**
	ST22404CR	Non - Parametric Methods	**02**
Discipline Centric Elective (DE)	ST22405DCE	Information Theory	**04**
	ST22406DCE	Bayesian Inference	**02**
	ST22407DCE	Econometrics	**02**
	ST22408DCE	Practical based on ST22401CR & ST22402CR	**02**
	ST22409DCE	Practical based on ST22403CR & ST22404CR	**02**
Generic Elective (GE)	ST22410GE	Data Analysis Using R Software	**02**
	ST22411GE	Continuous Probability Distributions	**02**
Open Elective (OE)	ST22412OE	Bio – Statistics	**02**

STATISTICAL INFERENCE – II

COURSE NO: ST22401CR **No. of Credits-4**

Course objectives: To introduce the advanced concepts of statistical inference.

Course outcomes: On successful completion of this course, the students will be able to

- Describe the concepts of testing of hypothesis and NP Lemma.
- Understand the concepts of MP and UMP tests.
- Describe the concepts of LRT and SPRT.
- Apply the statistical inference tools in real data analysis.

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, Most Powerful tests for simple null against simple alternative hypothesis. Examples based on two kinds of errors. Applications of Neyman Pearson Lemma.

UNIT-II

Uniformly most powerful (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 (MLR) property.

UNIT-III

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

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

UNIT-IV

Sequential Analysis: Definition of Sequential Probability Ratio Test (SPRT). Fundamental relations among alpha, beta, 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. Applications based on Normal, Poisson, Binomial and Exponential distributions.

RECOMMENDED TEXT BOOKS & REFERENCES:

- 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)
- 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 Edit
- 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: ST22402CR **No. of Credits-4**

Course objectives: The aim of this course is to introduce the elementary and advanced concepts of statistical quality control and reliability theory.

Course outcomes: After successful completion of this course, the students will be able to:

- Sketch the techniques of statistical quality control.
- Apply suitable SQC techniques and tools to improve the quality of production.
- Exhibit the basic concepts of reliability and maintenance theory in real-life situations.
- Reflect these tools in application areas like system reliability & maintenance analysis.

UNIT-I:

Meaning and scope of SQC, Stewarts control chart, Statistical basis of a control chart, control chart for variables ($\overline{X}$, R, & S) charts. Control charts for attributes (np, p & C) charts. Natural Tolerance and Specification Limits. Moving average charts. Operating Characteristic function and Average Run length of $\overline{X}$ 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 hazard rate of a system with independent units connected in (a) series and (b) Parallel systems.

RECOMMENDED TEXT BOOKS & REFERENCES:

- 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: ST22403CR **No. of Credits-4**

Course objectives: To introduce the elementary and advanced concepts of design and analysis of experiments.

Course outcomes: On successful completion of this course, the students will be able to

- Describe the techniques of design of experiments in real life scenario.
- Apply the response surface methodology in different application areas like food science, quality improvement, etc.

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 techniques for 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.

RECOMMENDED TEXT BOOKS & REFERENCES:

- 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.

NON – PARAMETRIC METHODS

Course No: ST22404CR **No. of Credits-2**

Course objectives: To Introduce the concepts of non-parametric tests.

Course outcomes: On successful completion of this course, the students will be able to

- Describe the techniques of non-parametric tests.
- Apply the non-parametric test in statistical theory and related fields.
- Identify the distribution based on non-parametric tests.

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.

RECOMMENDED TEXT BOOKS & REFERENCES:

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

INFORMATION THEORY

COURSE NO: ST22405DCE. **No. of Credits -4**

Course objectives: To introduce the elementary and advanced concepts of Information theory.

Course outcomes: On successful completion of this course, the students will be able to

- Describe the techniques of Entropy.
- Understand the concepts of Shannon's fundamental inequalities.
- Understand the concepts of Markov chain.

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. 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.

RECOMMENDED TEXT BOOKS & REFERENCES:

- 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 INFERENCE

COURSE NO: ST22406DCE **No. of Credits-2**

Course Objectives: The aim of this course is to provide the understanding of the fundamentals of Bayesian inference including concept of subjectivity and priors by examining some simple Bayesian models and linear regression in a Bayesian framework.

Course Outcomes: After successful completion of this course, student will be able to:

- Ascertain the concepts of the Bayesian approach.
- Use different types of priors, and they will have the ability to do basic data analysis.
- Calculate posterior probabilities using Bayes' theorem.
- Apply the Bayesian inference to real life scenario.

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.

RECOMMENDED TEXT BOOKS & 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: ST22407DCE **No. of credits -2**

Course objectives: To introduce the elementary and advanced concepts of econometric

Course outcomes: On successful completion of this course, the students will be able to

- Describe the concept of econometric modelling.
- Apply the econometric tools in the analysis of cross-section, time series and panel data

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 & Heteros cedasticity : 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

RECOMMENDED TEXT BOOKS & REFERENCES:

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

COURSE NO: ST22408DCE No. of credits - 2

PRACTICAL BASED ON COURSES

ST22401CR & ST22402CR

Using Statistical Software

COURSE NO.: ST22409DCE No. of credits-2

PRACTICAL BASED ON COURSES

ST22403CR & ST22404CR

Using Statistical Software

DATA ANALYSIS USING R SOFTWARE

COURSE NO: ST22410GE **No. of Credits-2**

Course objectives: To introduce the basis and advanced elements of the R- Software

Course outcomes: On successful completion of this course, the students will be able to

- Demonstrate the understanding of R- Software
- Apply the R- Software for statistical data analysis and graphics

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.

RECOMMENDED TEXT BOOKS & REFERENCES:

- 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.

CONTINUOUS PROBABILITY DISTRIBUTIONS

COURSE NO: ST22411GE **No. of Credits-2**

Course objectives: To understand the basic concepts of continuous probability distributions.

Course outcomes: On successful completion of this course, the students will be able to

- Provide a foundation for understandings of probability courses.
- Apply the theory of probability in applications of statistics.

UNIT-I

Continuous Random variable, Distribution function, Probability density function, Mathematical expectation, Moments, moment generating function and their properties.

UNIT-II

Standard Continuous distributions: uniform, exponential, gamma and normal distributions, their mean, variances, Moments, moment generating function and their properties and relation.

RECOMMENDED TEXT BOOKS & REFERENCES:

- 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.: ST22412OE **No. of credits-2**

Course Objectives: To introduce the advanced concepts of Bio-Statistics.

Course outcomes: On successful completion of this course, the students will be able to

- Understand the concepts of cohort studies and measures of association.
- Understand the concepts of Diagnostic tests.

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.

RECOMMENDED TEXT BOOKS & REFERENCES:

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

@#