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**

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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.

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