Anekant Education Society's

Tuljaram Chaturchand College

of Arts, Science and Commerce, Baramati

(Empowered Autonomous)

Course Structure for T. Y. B. Sc. STATISTICS

2022 Pattern

(w. e. from Academic Year, 2024-25)

Semester	Paper Code	Title of Paper	No. of Credits
V	USST351	Distribution Theory	3
	USST352	Statistical Inference- I	3
	USST353	Sampling Methods	3
	USST354	Design of Experiments	3
	USST355	C- Programming	3
	USST356(A) Or USST356(B)	Introduction to Stochastic Processes Or Biostatistics	3
	USST357	Statistics Practical- V	2
	USST358	Statistics Practical- VI	2
	USST359	Statistics Practical- VII	2
VI	USST361	Introduction to Regression Analysis	3
	USST362	Statistical Inference- II	3
	USST363	Statistical Quality Control and Reliability	3
	USST364	Operations Research	3
	USST365	Statistical Computing Using R- Software	3
	USST366(A) Or USST366(B)	Official Statistics Or Actuarial Statistics	3
	USST367	Statistics Practical- VIII	2
	USST368	Statistics Practical- IX	2
	USST369	Project	2

Note:

Paper Code	Title of Paper	Practical Based on Paper
USST357	Statistics Practical- V	Design of Experiments
USST358	Statistics Practical- VI	Distribution Theory, Statistical Inference- I and Sampling Methods
USST359	Statistics Practical- VII	C- Programming
USST367	Statistics Practical- VIII	Introduction to Regression Analysis and Operations Research
USST368	Statistics Practical- IX	Statistical Inference- II and Statistical Quality Control and Reliability
USST369	Project	Project

Program Outcomes (POs) for B.Sc Programme

PO1	**Disciplinary Knowledge:** Demonstrate comprehensive knowledge of the disciplines that form a part of a graduate programme. Execute strong theoretical and practical understanding generated from the specific graduate programme in the area of work.
PO2	**Critical Thinking and Problem solving:** Exhibit the skills of analysis, inference, interpretation and problem-solving by observing the situation closely and design the solutions.
PO3	**Social competence:** Display the understanding, behavioural skills needed for successful social adaptation , work in groups, exhibit thoughts and ideas effectively in writing and orally
PO4	**Research-related skills and Scientific temper :** Develop the working knowledge and applications of instrumentation and laboratory techniques. Able to apply skills to design and conduct independent experiments, interpret, establish hypothesis and inquisitiveness towards research.
PO5	**Trans-disciplinary knowledge:** Integrate different disciplines to uplift the domains of cognitive abilities and transcend beyond discipline-specific approaches to address a common problem
PO6	**Personal and professional competence:** Performing dependently and also collaboratively as a part of a team to meet defined objectives and carry out work across interdisciplinary fields. Execute interpersonal relationships, self-motivation and adaptability skills and commit to professional ethics.
PO7	**Effective Citizenship and Ethics:** Demonstrate empathetic social concern and equity centred national development, and ability to act with an informed awareness of moral and ethical issues and commit to professional ethics and responsibility.
PO8	**Environment and Sustainability:** Understand the impact of the scientific solutions in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development.
PO9	**Self-directed and Life-long learning:** Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

SYLLABUS (CBCS) FOR T. Y. B. Sc. (Semester- VI) STATISTICS
2022 Pattern
(With Effect from Academic Year 2024-2025)

Paper Code : USST361
Paper : I Title of Paper : Introduction to Regression Analysis
Credit : 3 credits No. of lectures: 48

A) Course Objectives:

1. The main objective of regression analysis is to explain the variation in one variable based on the variation in one or more other variables
2. The students will able to develop a deeper understanding of the linear regression model and its limitations.
3. Students will know how to diagnose and apply corrections to some problems with the linear and multiple regression models in real data.
4. The students will be able to learn and understand various regression models.
5. The students will be able to understand the concept of logistic regression and its application in real world problems.
6. Apply regression techniques to solve real world problems in various fields
7. Analyze and interpret data using regression methods and present findings in a clear and concise manner.

B) Course Outcomes:

CO 1. Students will be able to understand basic assumption and various terms of regression model.

CO 2. The students should able to demonstrate simple linear regression as a tool for exploring the linear relationship between two variables

CO 3. Students will learn how to estimate and interpret the model.

CO 4. Once student understand the model, they will explore how to evaluate the model.

CO 5. Students will also list the assumptions underlying the simple linear regression model and use graphical and numerical methods to check the assumptions.

CO 6. Students will learn about using variable transformations and interactions to incorporate nonlinear relationships in the model.

CO 7. Students will be able to apply Simple Linear Regression model, Multiple Linear Regression Analysis, Logistic Regression Model in real life problems.

TOPICS/CONTENTS:

Unit-1 Introduction **(2 L)**

1.1 Regression Analysis as a statistical tool

1.2 Brief History

Unit-2 Simple Linear Regression **(10 L)**

2.1 Review of simple linear regression model: $Y = \beta_0 + \beta_1 X + \varepsilon$, where ε is a continuous random variable with $E(\varepsilon) = 0$, $V(\varepsilon) = \sigma^2$.

2.2 Estimation of β_0 and β_1, by the method of least squares.

2.3 Properties of estimators of β_0, and β_1

2.4 Estimation of σ^2

2.5 Assumption of normality of ε. Tests of hypothesis of β_1

2.6 Interval estimation in simple linear regression model

2.7 Coefficient of determination

2.8 Examples and illustrations

Unit-3 Multiple Linear Regression Model **(10 L)**

3.1 Review of multiple linear regression model $Y = \beta_0 + \beta_1 X_1 + \ldots + \beta_k X_k + \varepsilon$, where ε is a continuous random variable with $E(\varepsilon) = 0$, $V(\varepsilon) = \sigma^2$. Estimation of regression parameters $\beta_0, \beta_1, \ldots, \beta_k$ by the method of least squares, Obtaining normal equations, solutions of normal equations

3.2 Estimation of σ^2

3.3 Assumption of normality of ε. Tests of hypothesis of Regression parameters

3.4 Assessing adequacy of model

3.4.1 Test of significance of regression

3.4.2 Test of individual regression coefficient

3.4.3 Coefficient of determination

3.5 Interval estimation in multiple linear regression models

3.6 Polynomial regression models

3.7 Examples and illustrations

Unit-4 Regression Diagnostics and Model Building **(8 L)**

4.1 Residual Analysis, Residual and its scaling, Residual plots

4.2 PRESS Statistics

4.3 Interpretation of four plots produced by lm command in R

4.4 Corrective measures

4.5 weighted least squares method.

4.6 Outliers: Detection and treatments

4.7 Detection of Multicollinearity and computation of VIF

4.8 Examples and illustrations.

Unit-5 Variable Selection and Model Building **(8 L)**

5.1 The model building problem

5.2 Consequences of model Misspecification

5.3 Criteria for evaluating subset regression models

5.4 Computational techniques for variable selection

5.4.1 All possible regression

5.4.2 Stepwise Regression methods

5.5 Examples and illustrations.

Unit-6 Logistic Regression Model **(10 L)**

6.1 Introduction

6.2 Univariate logistic regression model

6.2.1 Defining the logistic regression model

6.2.2 Fitting the logistic regression model

6.2.3 Interpretation of parameters

6.2.3 Testing of hypothesis in Logistic Regression

6.3 Multiple logistic regression model.

6.3.1 Fitting the logistic regression model

6.3.3 Interpretation of parameters

6.3.3 Testing of hypothesis in Logistic Regression

6.4 AIC and BIC criteria for model selection.

6.5 Interpretation of output produced by glm command in R

6.6 Examples and illustrations.

Books Recommended

1. Draper, N. R. and Smith, H. (1998) Applied Regression Analysis (John Wiley) Third Edition.
2. Hosmer, D. W. and Lemeshow, S. (1989) Applied Logistic Regression (Wiley).
3. Montgomery, D. C., Peck, E. A. and Vining, G. G. (2003) Introduction to Linear Regression Analysis (Wiley).

4. Neter, J., W., Kutner, M. H., Nachtsheim, C.J. and Wasserman, W. (1996) Applied Linear Statistical Models, fourth edition, Irwin USA.
5. Hosmer, D. W., Lemeshow S., and Sturdivant R. X. (1989) Applied Logistic Regression Wiley
6. Chatterjee S. and Hadi A. S. (2012) Regression Analysis by Example, 5th Edition, Wiley.
7. Kleinbaum G. and Klein M. (2011): Logistic Regression, IIIrd Edition A Self learning text, Springer.

Course Outcomes	**Programme Outcomes (POs)**								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	3	1	3	2	-	-	1	2
CO2	3	2	2	2	2	-	-	1	2
CO3	3	3	2	3	2	2	-	1	2
CO4	3	2	2	2	2	-	-	1	2
CO5	3	2	1	2	2	-	-	1	2
CO6	3	2	1	2	2	-	-	1	2
CO7	3	2	1	3	2	-	3	1	2

PO1: Disciplinary Knowledge

All Course Outcomes are Strongly Related (3) - Understanding regression models contributes significantly to disciplinary knowledge.

PO2: Critical Thinking and Problem Solving

All Course Outcomes are Moderately to Strongly Related (2-3) - Applying regression models requires critical thinking and problem-solving skills.

PO3: Social Competence

All Course Outcomes are Partially to Moderately Related (1-2) - Analyzing relationships between variables may indirectly contribute to social competence.

PO4: Research-related Skills and Scientific Temper

All Course Outcomes are Moderately to Strongly Related (2-3) - Estimating and evaluating models align with research-related skills.

PO5: Trans-disciplinary Knowledge

All Course Outcomes are Moderately Related (2) - Regression models may have limited trans-disciplinary applications.

PO6: Personal and Professional Competence

CO3: Students will learn how to estimate and interpret the model.

Justification: Moderately Related (2) - Interpretation skills contribute to personal and professional competence.

PO7: Effective Citizenship and Ethics

CO7: Students will be able to apply Simple Linear Regression model, Multiple Linear Regression Analysis, Logistic Regression Model in real life problems.

Justification: Strongly Related (3) - Applying regression models involves ethical considerations and real-life problem-solving.

PO8: Environment and Sustainability

All Course Outcomes are Partially Related (1) - Regression models may indirectly contribute to environmental and sustainability contexts.

PO9: Self-directed and Life-long Learning

All Course Outcomes are Moderately Related (2) - Acquiring skills in regression models aligns with the ability to engage in independent and life-long learning.

SYLLABUS (CBCS) FOR T. Y. B. Sc. (Semester- VI) STATISTICS
2022 Pattern
(With Effect from Academic Year 2024-2025)

Paper Code : USST362
Paper : II Title of Paper : Statistical Inference- II
Credit : 3 credits No. of lectures: 48

A) Course Objectives:

1. The main objectives of this course are to understand the concepts of Statistical hypothesis, Parametric Tests, Nonparametric tests.
2. Students will able to use these concepts in real world scenario.
3. To understand the Most Powerful Tests and Uniformly Most Powerful test procedures and difference between them.
4. To understand the differentiate between parametric and non-parametric tests.
5. To gain the knowledge and use of various non-parametric tests.
6. To develop non-parametric test in real life situations.
7. Students will able to analyse the data by using Statistical hypothesis, Parametric Tests, Nonparametric tests.

B) Course Outcomes:

After completing this course, students will possess skills concerning:

CO 1. Use of Statistical Hypothesis in real life situations.

CO 2. Type I Error, Type II Error and level of significance for a hypothesis test when making a decision.

CO 3. Apply Neyman-Pearson Theorem to find MP tests

CO 4. Construct power functions in order to evaluate the hypothesis testing.

CO 5. Various methods of non-parametric tests.

CO 6. Identify the significance of hypothesis testing in statistical inference.

CO 7. Construct and interpret confidence intervals in conjunction with hypothesis testing.

TOPICS/CONTENTS:

Unit 1: Parametric Tests (15 L)

1.1 Statistical hypothesis, problem of testing of hypotheses. Definition and illustrations of (1) simple hypothesis, (2) composite hypothesis, (3) test of hypothesis, (4) critical region, (5) type I and type II errors. probabilities of type I error and type II error. Problem of controlling the probabilities of errors of two

kinds. Definition and illustrations of (i) level of significance, (ii) observed level of significance (p-value), (iii) size of a test, (iv)

1.2 Definition of most powerful (M.P.) level α test of simple null hypothesis against simple alternative. Statement of Neyman - Pearson (N-P) lemma for constructing the most powerful level α test of simple null hypothesis against simple alternative hypothesis. Illustrations.

1.3 Power function of a test, power curve, definition of uniformly most powerful (UMP) level α test for one sided alternative. Illustrations

Unit 2: Likelihood Ratio Tests **(9 L)**

Notion of likelihood ratio test (LRT), $\lambda(x) = \text{Sup } L(\theta_0|x) / \text{Sup } L(\theta|x)$ Construction of LRT for $H_0 : \theta = \theta_0$ against $H_1: \theta \neq \theta_0$ for the mean of normal distribution for i) known σ^2 ii) unknown σ^2 (one sided and two sided alternatives). LRT for variance of normal distribution for i) known μ ii) unknown μ (one sided and two sided alternatives hypotheses). LRT for parameters of binomial and exponential distribution for two sided alternatives only. LRT as a function of sufficient statistics, statement of asymptotic distribution of $-2 \log_e \lambda(x)$.

Unit 3: Sequential Probability Tests **(9 L)**

Sequential test procedure for simple null hypothesis against simple alternative hypothesis and its comparison with fixed sample size N-P test procedure. Definition of Wald's SPRT of strength (α, β). Illustration for standard distributions like Bernoulli, Poisson, Normal and Exponential. SPRT as a function of sufficient statistics. Graphical representation of SPRT.

Unit 4: Non-Parametric Tests **(15 L)**

Concept of non- parametric tests. Distinction between a parametric and a nonparametric Tests. Concept of distribution free statistic. One tailed and two tailed test procedures of (i) Sign test, ii) Wilcoxon signed rank test (iii) Mann- Whitney U test, (iii) Run test, one sample and two samples problems. Empirical distribution function Sn (x). Properties of Sn (x) as estimator of F (.). Kolmogorov – Smirnov test for completely specified univariate distribution (one Sample problem only) for two sided alternative hypotheses. Comparison with chi-square test.

Books Recommended

1. Agarwal, B.L. (2003). Programmed Statistics, second edition, New Age International Publications, Delhi

2. Arora, S. and Bansi Lal. (1989): New Mathematical Statistics, first edition, Satya Prakashan, New Delhi.

3. Daniel, W.W. (2000) Applied Nonparametric Statistics, Duxbury Press Boston.

4. Dudeweitz, E.J. and Mishra, S.N. (1988). Modern Mathematical Statistics, John Wiley and Sons, Inc

5. Gibbons J.D. (1971). Non parametric Statistical Inference, McGraw Hill Book Company, New York.

6. Hoel, P.G.,Port, S. and Stone, C. (1971). Introduction to Statistical Theory, Houghton Mifflin Company (International) Dolphin

7. Hogg, R.V. and Craig, R.G. (1989). Introduction to Mathematical Statistics (fourth edition, Collier Macmillan International Edition, Macmillan Publishing Co. Inc., New York.

8. Kale, B.K. and Muralidharan, K. (2015). Parametric Inference: An Introduction. Narosa, New Delhi

9. Kendall, M. and Stuart, A. (1943) The advanced Theory of Statistics, Vol 1, Charles and Company Ltd., London.

10. Lindgren, B.W. (1976). Statistical Theory (third edition), Collier Macmillan International Edition, Macmillan publishing Co., Inc. New York.

11. Kunte, S., Purohit, S.G. and Wanjale, S.K.: Lecture Notes on Nonparametric Tests

12. Mood, A.M., Graybill, F. and Bose, D. C. (1974). Introduction to the theory of Statistics (third edition) International Student Edition, McGraw Hill.

13. Rohatgi, V.K. (1976). An introduction to Probability Theory and Mathematical Statistics, Wiley Eastern Ltd., New Delhi.

14. Siegel, S. (1956). Nonparametric methods for the behavioral sciences, International Student Edition, McGraw Hill, New York.

Course Outcomes	Programme Outcomes (POs)								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	-	2	2	-	1	-	1	2
CO2	3	3	2	2	-	1	-	1	2
CO3	3	2	2	2	-	2	-	1	2
CO4	3	-	2	3	-	1	-	1	2
CO5	3	-	2	2	3	2	-	1	2
CO6	3	-	2	2	-	1	2	1	2
CO7	3	-	2	3	-	1	-	1	2

PO1: Disciplinary Knowledge

All Course Outcomes are Strongly Related (3) - Understanding statistical hypothesis testing contributes significantly to disciplinary knowledge.

PO2: Critical Thinking and Problem Solving

CO2: Type I Error, Type II Error and level of significance for a hypothesis test when making a decision.

Justification: Strongly Related (3) - Understanding errors and significance levels requires critical thinking.

CO3: Apply Neyman-Pearson Theorem to find MP tests

Justification: Moderately Related (2) - Applying the theorem involves critical thinking.

PO3: Social Competence

All Course Outcomes are Moderately Related (2) - Understanding and applying hypothesis testing may indirectly contribute to social competence.

PO4: Research-related Skills and Scientific Temper

All Course Outcomes are Moderately to Strongly Related (2-3) - Constructing power functions aligns with research-related skills.

PO5: Trans-disciplinary Knowledge

CO5: Various methods of non-parametric tests.

Justification: Strongly Related (3) - Non-parametric tests may have trans-disciplinary applications.

PO6: Personal and Professional Competence

All Course Outcomes are Partially to Moderately Related (1-2) - Skills related to hypothesis testing contribute to personal and professional competence.

PO7: Effective Citizenship and Ethics

CO6: Identify the significance of hypothesis testing in statistical inference.

Justification: Moderately Related (2) - Understanding the significance aligns with ethical considerations in statistical inference.

PO8: Environment and Sustainability

All Course Outcomes are Partially Related (1) - Statistical hypothesis testing may have limited direct applications in environmental and sustainability contexts.

PO9: Self-directed and Life-long Learning

All Course Outcomes are Moderately Related (2) - Acquiring skills in statistical hypothesis testing aligns with the ability to engage in independent and life-long learning.

SYLLABUS (CBCS) FOR T. Y. B. Sc. (Semester- VI) STATISTICS
2022 Pattern
(With Effect from Academic Year 2024-2025)

Paper Code : USST363
Paper : III Title of Paper : Statistical Quality Control and Reliability
Credit : 3 credits No. of lectures : 48

A) Course Objectives:

1. understand meaning and use of SPC, construction and working of control charts for variables and attributes.
2. learn statistical methods for monitoring and improving process quality.
3. apply control charts to detect and manage process variation.
4. Analyze the sampling plans for quality inspection.
5. study of various capability indices and utilities with real life situations.
6. To learn about the structural qualities of a coherent system.
7. To familiarize students with the concept of coherent system reliability.

B) Course Outcomes:

Students should be able to:

CO 1. Construct Control charts for attributes and variables.

CO 2. Learn the concept various capability indices.

CO 3. Learn the concept of coherent system reliability.

CO 4. Understand various statistical methods used in quality control, such as control charts, process capability analysis, and acceptance sampling.

CO 5. Define and explain the fundamental concepts of Statistical Quality Control (SQC) and Reliability.

CO 6. Conduct process capability analysis to assess the ability of a process to meet specifications.

CO 7. Apply statistical indices such as Cp, Cpk.

TOPICS/CONTENTS:

Unit-1 Seven Process Control (PC) Tools of SPC (4 L)

(i) Check Sheet, (ii) Cause and effect diagram (CED), (iii) Pareto Diagram, (iv) Histogram, (v) Control chart, (vi)Scatter Diagram, (vii) Design of Experiments (DOE).

Unit-2 Review of SQC (6L)

Introduction to SPC, Quality of the product, Chance causes and assignable causes of variation, statistical basis of control charts, exact probability limits, k -sigma limits, justification for the use of 3- sigma limits for normal distribution and using Chebychev's

inequality for non-normal distributions. Criteria for detecting lack of control situations. Control chart for attribute and variable.

Unit-3 Capability Studies **(8 L)**

3.1 Specification limits, natural tolerance limits and their comparisons, decisions based on these comparisons, estimate of percent defective.

3.2 Shift in the process average, evaluation of probability of detecting a shift (or getting signal) on the first sample or on the subsequent samples after the shift (when process standard deviation is fixed). Average Run Length (ARL)for X chart, Average Time to Signal (ATS). Operating Characteristic (O.C.) curve for X chart, using normality assumption.

3.3 Capability ratio and capability indices (Cp), capability performance indices Cpk with respect to machine and process, interpretation, relationship between (i) Cp and Cpk, (ii) defective parts per million and Cp.

Unit-4 Acceptance of Sampling for Attributes **(12L)**

4.1 Introduction: Concept of sampling inspection plan, comparison between 100 % inspection and sampling inspection. Procedures of acceptance sampling with rectification, single sampling plan and double sampling plan. Explanation of the terms: Producer's risk. Consumer's risk, Acceptable Quality Level (AQL). Lot Tolerance Fraction Defective (LTFD), Average Outgoing Quality (AOQ), Average Outgoing Quality Limit (AOQL), Average Sample Number (ASN), Average Total Inspection (ATI), Operating characteristic (OC) curve, AOQ curve.

Note: distinction between type A OC curve and type B OC curve is not expected.

4.2 Single Sampling Plan: Evaluation of probability of acceptance using. (i) Hypergeometric (ii) Binomial (iii) Poisson distributions. Derivation of AOQ and ATI.

4.3 Double Sampling Plan: Evaluation of probability of acceptance using Poisson approximation. Derivation of AOQ, ASN and ATI (with complete inspection of second sample).

Unit-5 Reliability Theory **(18 L)**

5.1 Binary Systems of independent compliments: Block diagrams, fault tree representation. Definition of binary coherent structure and illustrations. Coherent systems of components less than five, (i) Series, (ii) Parallel, (iii) K-out-of-4: Good, (iv) Essentially series, (v) Essentially parallel. Minimal cut, path structure representation of the system.

5.2 Reliability of Binary Components and Systems: Reliability of above systems h(p),

when components are independent and identically distributed with common probability p of operating. 'S' shaped ness property of h(p) without proof and workout examples to show that using components of low values of reliabilities, i.e. unreliable components, systems with higher reliabilities can be constructed.

5.3 Ageing Properties: Definitions: Hazard rates, hazard function, survival function, concept of distributions with increasing and decreasing failure rate (IFR/DFR), Average Increasing (Decreasing) Failure Rate (IFRA/ DFRA). Relationship between: (i) Survival function and hazard function, (ii) Density function and hazard rate. Derivations of the following results: (i) Hazard rate of a series system of components having independent life times is summation of component hazard rates. (ii) Life time of series system of independent components with independent IFR life times is IFR. Illustrations: Exponential, gamma, Weibull distributions.

Books Recommended:

1. Duncan A. J.: Quality Control and Industrial Statistics, D.B. Taraporewala Sons and Co. Pvt. Ltd., Mumbai.
2. Grant, E. L. and Leavenworth: Statistical Quality Control, Mc-Graw Hill Kogakusha Ltd., New Delhi.
3. Montgomery, D. C.: Statistical Quality Control, John Wiley and Sons, Inc., New York.
4. Kamji and Asher: 100 Methods of TQM, Sage Publishers, Delhi.
5. Johnson and Kotz: Capability Studies, Chapman and Hall Publishers.
6. SP20: Handbook of SQC, Bureau of Indian Standards.
7. D.H. Besterfield, C.B. Michna etc. Total Quality Management (3rd edition 2009): Pearson Education, Delhi.
8. Barlow R. E. and Proschan, Frank: Statistical Theory of Reliability and Life Testing, Holt Rinebart and Winston Inc., New York.
9. Sinha, S. K.: Reliability and Life testing, Second Edition, Wiley Eastern Publishers, New Delhi.
10. S. Zacks : Introduction to Reliability Analysis, Probability Models and Statistical Methods, Springer Verlag

Course Outcomes	**Programme Outcomes (POs)**								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	3	2	3	-	-	2	1	2
CO2	3	3	2	3	-	-	2	1	2
CO3	3	3	2	3	-	-	2	1	2
CO4	3	3	2	3	-	-	2	1	2
CO5	3	3	2	3	2	-	2	1	2

CO6	3	3	2	3	-	3	2	1	2
CO7	3	3	2	3	-	-	2	1	2

PO1: Disciplinary Knowledge

All Course Outcomes are Strongly Related (3) - Understanding and constructing control charts contribute significantly to disciplinary knowledge in quality control.

PO2: Critical Thinking and Problem Solving

All Course Outcomes are Strongly Related (3) - Critical thinking is essential in constructing control charts, analyzing capability indices, and assessing reliability.

PO3: Social Competence

All Course Outcomes are Moderately Related (2) - Knowledge in quality control and reliability may contribute to social competence indirectly.

PO4: Research-related Skills and Scientific Temper

All Course Outcomes are Strongly Related (3) - Knowledge in statistical quality control and reliability is integral to research-related skills.

PO5: Trans-disciplinary Knowledge

CO5: Define and explain the fundamental concepts of Statistical Quality Control (SQC) and Reliability.

Justification: Moderately Related (2) - Fundamentals of SQC and Reliability may have trans-disciplinary applications.

PO6: Personal and Professional Competence

CO6: Conduct process capability analysis to assess the ability of a process to meet specifications.

Justification: Strongly Related (3) - Conducting process capability analysis enhances professional competence.

PO7: Effective Citizenship and Ethics

All Course Outcomes are Moderately Related (2) - Ethical considerations in quality control and reliability contribute to effective citizenship.

PO8: Environment and Sustainability

All Course Outcomes are Partially Related (1) - Direct applications in environmental and sustainability contexts may be limited.

PO9: Self-directed and Life-long Learning

All Course Outcomes are Moderately Related (2) - Acquiring skills in quality control and reliability aligns with the ability to engage in independent and life-long learning.

SYLLABUS (CBCS) FOR T. Y. B. Sc. (Semester- VI) STATISTICS
2022 Pattern
(With Effect from Academic Year 2024-2025)

Paper Code : USST364
Paper : IV Title of Paper : Operations Research
Credit : 3 credits No. of lectures : 48

A) Course Objectives:

1. The main objective of paper is to understand the concept of optimal solutions.
2. To formulate Linear programming Problem, transportation problem, assignment problem and to obtain optimal solutions.
3. To recognize special cases such as degeneracy, multiple optimal solutions, unbounded solutions and infeasible solutions.
4. To understand the foundational concepts and principles of Linear Programming and its applications in various real-world scenarios.
5. To understand the concept of Assignment Problems and their applications in matching tasks to optimize efficiency and resource utilization.
6. To understand PERT and CPM network techniques and difference between them.
7. To analyze various types of games, including zero-sum and non-zero-sum games, and understand strategies such as dominance, and mixed strategies.

B) Course Outcomes:

CO 1. The students should be able to understand the features of TP and AP.

CO 2. The students should able to know essential difference between PERT and CPM network techniques.

CO 3. Students will be able to understand principles of zero-sum, two-person games.

CO 4. Define and understand the fundamental concepts and principles of Operations Research.

CO 5. Define the Assignment Problem and its applications in real-world scenarios.

CO 6. Identify situations where the Assignment Problem is applicable.

CO 7. Formulate the Transportation Problem using decision variables, objective function, and constraints.

TOPICS/CONTENTS:

Unit-1 Linear Programming Problem (16 L)

1.1 Statement of the linear Programming Problem (LPP), (minimization and maximization) Formulation of problem as LPP.

1.2 Definition of (i) A slack variable and (ii) Surplus Variable

1.3 LPP in Canonical form and LPP in Standard form

1.4 Definition of (i) a solution (ii) basic and non-basic variables (iii) a feasible solution (iv) a basic feasible solution, (v) a degenerate and non–degenerate solution and (vi) an optimal solution.

1.5 Solution of L.P.P by Simplex Method: Obtaining Initial Basic Feasible Solution (IBFS), criteria for deciding whether obtained solution is optimal, criteria for unbounded solution, no solution, more than one solution.

1.6 Introduction of artificial variable, Big-M method.

1.7 Duality Theory: Writing dual of a primal problem, solution of a L.P.P. by using its dual problem

1.8 Examples and problems.

Unit-2 Transportation Problem **(8 L)**

2.1 Transportation problem (T.P.), statement of T.P., balanced and unbalanced T.P. minimization and maximization problem.

2.2 Obtaining basic feasible solution of T.P. by (i) North-West Corner Method, (ii) Least Cost Method (iii) Vogel's Approximation Method (VAM).

2.3 Modified Distribution (MODI) method (u-v method) of obtaining Optimal solution of T.P., uniqueness and non- uniqueness of optimal solutions, degenerate solution.

2.4 Examples and problems.

Unit-3 Assignment Problem **(4 L)**

3.1 Statement of an assignment problem, Minimization and maximization problem, balanced and unbalanced problem, relation with transportation problem, optimal solution using Hungarian method, maximization case.

3.2 Examples and problems.

Unit-4 Critical Path Method (CPM) and Project Evaluation and Review Techniques (PERT) **(12 L)**

4.1 Definition of (i) Event, (ii) Node, (iii) Activity, (iv) Critical Activity, (v) Project Duration.

4.2 CPM: Construction of network, Definitions

(i) earliest start time

(ii) earliest finish time

(iii) latest start time

(iv) latest finish time for an activity.

4.3 Critical Path, Types of floats, total floats, free float, independent float and their significance. Determination of critical path

4.4 PERT: Construction of network; (i) pessimistic time estimate, (ii) optimistic time estimate (iii) most likely time estimates, Determination of critical path, determination of mean and standard deviation of project duration, computations of probability of completing the project in a specified duration.

Unit-5 Game Theory **(8 L)**

5.1 Introduction

5.2 Two-Person Zero-Sum games

5.3 Pure Strategies, Minimax and Maximin principles, Pay off tables, Games with Saddle Point.

5.4 Mix Strategies: Games without Saddle Point

5.5 Dominance principles. Examples and problems.

Books Recommended:

1. Gass, S. L. (1997). Linear programming methods and applications, Narosa Publishing House, New Delhi.

2. Gupta, P. K. and Hira, D. S. (2008). Operation Research, 3rd edition S. Chand and company Ltd, New Delhi.

3. Kapoor, V. K. (2006). Operations Research, S. Chand and Sons. New Delhi.

4. Phillips, D. T. and Solberg, R. A. (1976). Operation Research principles and practice, John Willey and Sons Inc.

5. Saceini, M., Yaspan, A. and Friedman, L. (2013). Operation Research methods and problems, Willey International Edition.

6. Sharma, J. K. (1989). Mathematical Models in Operation Research, Tata McGraw Hill Publishing Company Ltd., New Delhi.

7. Shrinath.L. S. (1975). Linear Programming, Affiliated East-West Pvt. Ltd, New Delhi.

8. Taha, H. A. (2007). Operation research: An Introduction, eighth edition, Prentice Hall of India, New Delhi.

Course Outcomes	**Programme Outcomes (POs)**								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	3	2	3	-	-	2	1	2
CO2	3	3	2	3	-	-	2	1	2
CO3	3	3	2	3	-	-	2	1	2
CO4	3	3	2	3	-	-	2	1	2
CO5	3	3	2	3	1	-	2	1	2
CO6	3	3	2	3	-	2	2	1	2
CO7	3	3	2	3	-	-	2	1	2

PO1: Disciplinary Knowledge

All Course Outcomes are Strongly Related (3) - Understanding features of TP and AP, principles of games, and fundamentals of Operations Research contribute significantly to disciplinary knowledge.

PO2: Critical Thinking and Problem Solving

All Course Outcomes are Strongly Related (3) - Critical thinking is essential in understanding the features of TP and AP, differentiating PERT and CPM, and solving zero-sum games.

PO3: Social Competence

All Course Outcomes are Moderately Related (2) - Knowledge in Operations Research may contribute to social competence indirectly.

PO4: Research-related Skills and Scientific Temper

All Course Outcomes are Strongly Related (3) - Knowledge in Operations Research principles aligns with research-related skills.

PO5: Trans-disciplinary Knowledge

CO5: Define the Assignment Problem and its applications in real-world scenarios.

Justification: Partially Related (1) - Application of Assignment Problem may have trans-disciplinary applications.

PO6: Personal and Professional Competence

CO6: Identify situations where the Assignment Problem is applicable.

Justification: Moderately Related (2) - Identifying situations for the Assignment Problem enhances professional competence.

PO7: Effective Citizenship and Ethics

All Course Outcomes are Moderately Related (2) - Ethical considerations in decision-making (e.g., game theory) contribute to effective citizenship.

PO8: Environment and Sustainability

All Course Outcomes are Partially Related (1) - Direct applications in environmental and sustainability contexts may be limited.

PO9: Self-directed and Life-long Learning

All Course Outcomes are Moderately Related (2) - Acquiring skills in Operations Research and problem-solving aligns with the ability to engage in independent and life-long learning.

SYLLABUS (CBCS) FOR T. Y. B. Sc. (Semester- VI) STATISTICS
2022 Pattern
(With Effect from Academic Year 2024-2025)

Paper Code : USST365
Paper : V Title of Paper : Statistical Computing Using R- Software
Credit : 3 credits No. of lectures : 48

A) Course Objectives:

Students successfully completing this course will be able to:

1. provide an overview of R and RStudio, including installation, basic operations, and the use of R as a calculator for arithmetic and logical operations.
2. develop a solid understanding of different data types (numeric, integer, character, logical, factor) and how to create, index, and operate on various data structures.
3. enable students to generate random samples from different probability distributions and compute probabilities, cumulative probabilities, and quantiles.
4. teach students to test the normality of data using the Shapiro-Wilk test and interpret the results.
5. introduce the concepts of null and alternative hypotheses, type I and type II errors, and conduct various parametric (z test, t test, ANOVA) and non-parametric tests.
6. provide a thorough understanding of control structures (if-else, for loops, while loops, repeat loops) and their use in R programming.
7. develop skills in writing R programs, including debugging and error handling, to solve data analysis problems effectively.

B) Course Outcomes:

By the end of the course, students will be able to:

CO1. demonstrate the ability to install, navigate, and utilize R and RStudio for data analysis tasks.

CO2. identify and manipulate different data types (numeric, integer, character, logical, factor) and data structures (vectors, matrices, lists, data frames, factors) in R.

CO3. read, write, and manipulate data from various sources (CSV, Excel, text files) and create diverse types of plots (pie charts, bar charts, scatter plots, histograms, boxplots) using basic R functions and ggplot2.

CO4. generate random samples from various probability distributions and compute probabilities, cumulative probabilities, and quantiles.

CO5. create graphs of probability mass functions (pmf) and probability density functions

(pdf) and fit probability distributions to data.

CO6. calculate and interpret descriptive statistics, including measures of central tendency, variability, and distribution shape (mean, mode, median, quartiles, variance, standard deviation, skewness, kurtosis).

CO7. implement control structures (if-else, for loops, while loops, repeat loops) in R to automate and streamline data analysis tasks.

TOPIC CONTENT

Note: Students are expected to write commands in script file wherever applicable

Unit 1. Fundamentals of R **(5 L)**

Revision of commands and functions studied in F.Y.B.Sc. and S.Y.B.Sc. Creating a vector using scan function, other types of objects, creating a data frame using edit command, fix command, getwd command, Importing data from MS-Excel file Using read.table command, saving the R-output in a file using MS-Excel, concept of R-script file, Graphics using R: (a) High level plotting functions (b) Low level plotting functions (c) Interactive graphic functions The following statistical methods using R‟

Unit 2. Diagrams and Graphs **(5 L)**

Diagrams: Simple bar diagram, Subdivided bar diagram, multiple bar diagram, Pie diagram, Stem and leaf diagram.

Graphs: Scatter Plot, histogram for raw data with prob=T option and for both equal and unequal class intervals, Boxplot for one and more than one variables, rod or spike plot, empirical distribution function Saving the diagram and graph in MS-Word file.

Unit 3. Measures of central tendency, dispersion, skewness and kurtosis. **(7 L)**

Computations of following measures for all types of data (a)central tendency mean, mode, median, quartiles, deciles, percentiles, g.m. and h.m (b)Dispersion: variance, standard deviation, coefficient of variation, mean deviation (c) Skewness: Bowley‟s coefficient and Karl Pearson‟s coefficient of skewness (d) Moments: Computations of raw and central moments, measure of skewness and kurtosis based on it.

Unit 4. Probability distributions: **(6 L)**

Simulation from distributions, computations of probabilities, cumulative probabilities, quantiles and drawing random sample using d, p, q, r functions for following distributions. normal, exponential, gamma, Cauchy, lognormal, Weibull, uniform, Laplace, Graphs of pmf/pdf by varying parameters for above distributions. Fitting of Lognormal distribution, testing normality of data by Shapiro Wilks test.

Unit 5. Correlation and Regression: **(4 L)**

Computation of correlation coefficient, Fitting of lines of regression and second degree curve, Multiple regression, Logistic regression analysis. Interpretation from residual plot, adequacy of model.

Unit 6. ANOVA **(4 L)**

One way and two way classification, Bartlett's test for homoscedasticity, Kruscal Wallis test.

Unit 7. Non parametric tests **(5 L)**

Kolmogorov Smirnov test, Sign test, Sign test for paired data, Wilcoxon's signed rank test, Mann Whitney test.

Unit 8. Programming in R: **(12 L)**

Statements: if and if…else, for loop, while loop, cat and print commands Writing programs in R.

1. Testing normality of number of samples
2. Verifying the assumptions in testing H_0: $\mu = \mu_0$ and then applying appropriate test.
3. Verifying the assumptions in testing H_0: $\mu_1 = \mu_2$ and then applying appropriate test.
4. Verifying the assumptions in testing H_0: $\mu_1 = \mu_2$ in paired data and then applying appropriate test.
5. Verifying the assumptions in testing H_0: $\sigma_1^2 = \sigma_2^2$ and then applying appropriate test.
6. Performing number of chi-square tests
7. Verifying the assumptions in one way ANOVA and then applying appropriate test.
8. Verifying the assumptions in two way ANOVA and then applying appropriate test.
9. Testing consistency

Books Recommended:

1. Crawley, M. J. (2006). Statistics - An introduction using R. John Wiley, London 32
2. Purohit, S.G.; Gore, S.D. and Deshmukh, S.R. (2015). Statistics using R, second edition. Narosa Publishing House, New Delhi.
3. Shahababa , B. (2011). Biostatistics with R, Springer, New York
4. Verzani, J. (2005). Using R for Introductory Statistics, Chapman and Hall /CRC Press, New York
5. Pavagi, V. R. (2018).A Book of Statistical Computing using R Software, Nirali Prakashan.

Course Outcomes	Programme Outcomes (POs)								
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**
CO1	3	2	2	1	1	2	1	1	2
CO2	3	2	2	1	1	2	1	1	2
CO3	3	2	2	1	1	2	1	1	2
CO4	3	3	1	2	1	2	1	1	2
CO5	3	3	1	2	1	2	1	1	2
CO6	3	3	2	2	1	2	1	1	2
CO7	3	3	2	2	1	2	1	1	2

Justification

PO1: Disciplinary Knowledge

CO1: Installing, navigating, and utilizing R and RStudio demonstrates a strong understanding of essential tools for data analysis within the discipline. **(3)**

CO2: Identifying and manipulating different data types and structures in R shows comprehensive knowledge of data handling in the discipline. **(3)**

CO3: Reading, writing, and manipulating data and creating plots involves a deep understanding of data visualization and manipulation within the field. **(3)**

CO4: Generating random samples and computing probabilities involves applying theoretical concepts of probability distributions. **(3)**

CO5: Creating graphs of pmf and pdf, and fitting distributions requires strong theoretical and practical knowledge in probability and statistics. **(3)**

CO6: Calculating and interpreting descriptive statistics involves applying fundamental statistical knowledge. **(3)**

CO7: Implementing control structures involve understanding programming logic relevant to data analysis tasks. **(3)**

PO2: Critical Thinking and Problem Solving

CO1: Navigating and utilizing R and RStudio requires problem-solving skills to effectively use the software for data analysis. **(2)**

CO2: Manipulating different data types and structures involves critical thinking to understand and apply appropriate data handling techniques. **(2)**

CO3: Creating various plots and manipulating data involves analytical skills to visualize and interpret data effectively. **(2)**

CO4: Generating and analyzing random samples requires problem-solving skills to understand and apply probability concepts. **(3)**

CO5: Fitting probability distributions and creating related graphs requires critical thinking to understand distribution properties. **(3)**

CO6: Interpreting descriptive statistics involves analytical reasoning to understand and summarize data characteristics. **(3)**

CO7: Implementing control structures involves problem-solving to automate and streamline tasks. **(3)**

PO3: Social Competence

CO1: Utilizing R and RStudio can involve collaboration and communication if used in group settings, but the link is moderate. **(2)**

CO2: Identifying and manipulating data structures may involve some level of teamwork or communication in collaborative projects. **(2)**

CO3: Creating plots and manipulating data involves presenting data visually, which can aid in effective communication of findings. **(2)**

CO4: Generating and analyzing random samples involves technical work with less direct social interaction. **(1)**

CO5: Creating and fitting probability distributions involves technical work that may not directly relate to social competence. **(1)**

CO6: Calculating and interpreting descriptive statistics can be presented and discussed within groups, involving moderate social competence. **(2)**

CO7: Implementing control structures can be part of collaborative coding projects, which involves teamwork. **(2)**

PO4: Research-related Skills and Scientific Temper

CO1: Utilizing R and RStudio is foundational for conducting research and analysis in data-driven fields. **(1)**

CO2: Manipulating data types and structures supports research tasks but is more about technical skills. **(1)**

CO3: Reading and manipulating data for creating plots is part of research methodology. **(1)**

CO4: Generating random samples and computing probabilities aligns with scientific approaches in research. **(2)**

CO5: Creating and fitting probability distributions is integral to research and scientific analysis. **(2)**

CO6: Calculating and interpreting descriptive statistics is crucial for research data analysis. **(2)**

CO7: Implementing control structures is less directly related but supports automation in research tasks. **(2)**

PO5: Trans-disciplinary Knowledge

CO1: Installing and using R and RStudio is more focused on the specific discipline of data analysis. **(1)**

CO2: Identifying and manipulating data types is specific to data analysis within its own discipline. **(1)**

CO3: Data visualization through plots can be applied across different disciplines but is specific to the field of data analysis. **(1)**

CO4: Generating random samples and computing probabilities is a fundamental skill relevant to various scientific disciplines. **(1)**

CO5: Creating and fitting probability distributions is relevant across multiple disciplines but focused on statistical methods. **(1)**

CO6: Descriptive statistics are applicable in many fields but the focus remains on statistical data analysis. **(1)**

CO7: Control structures are relevant to programming and data analysis but less so for interdisciplinary application. **(1)**

PO6: Personal and Professional Competence

CO1: Using R and RStudio effectively requires self-motivation and adaptability. **(2)**

CO2: Manipulating data structures and types demonstrates personal competence in handling technical tasks. **(2)**

CO3: Creating diverse types of plots involves applying skills independently and professionally. **(2)**

CO4: Generating and computing probabilities involves applying technical skills independently. **(2)**

CO5: Creating and fitting distributions requires personal competence in technical skills. **(2)**

CO6: Interpreting descriptive statistics shows professional competence in data analysis. **(2)**

CO7: Implementing control structures reflects personal and professional competence in automating tasks. **(2)**

PO7: Effective Citizenship and Ethics

CO1: Using R and RStudio involves adhering to ethical practices in data analysis, though it is not highly emphasized. **(1)**

CO2: Manipulating data involves ensuring data integrity and ethical handling. **(1)**

CO3: Creating plots requires ethical presentation of data but is not a strong focus. **(1)**

CO4: Generating random samples involves ethical considerations in research practices. **(2)**

CO5: Creating and fitting probability distributions requires adherence to ethical standards in statistical practices. **(2)**

CO6: Interpreting descriptive statistics involves ethical considerations in data reporting. **(2)**

CO7: Implementing control structures involves ethical considerations in programming practices. **(2)**

PO8: Environment and Sustainability

CO1: Using R and RStudio has minimal direct impact on environmental and sustainability issues. **(1)**

CO2: Manipulating data types does not have a direct link to environmental impact. **(1)**

CO3: Creating plots and handling data do not directly relate to environmental issues. **(1)**

CO4: Generating and computing probabilities have limited relevance to environmental and sustainability concerns. **(1)**

CO5: Creating and fitting probability distributions also has minimal relevance to environmental issues. **(1)**

CO6: Calculating and interpreting descriptive statistics does not directly address environmental or sustainability issues. **(1)**

CO7: Implementing control structures has no direct impact on environmental sustainability. **(1)**

PO9: Self-directed and Life-long Learning

CO1: Learning to use R and RStudio fosters self-directed learning in data analysis. **(2)**

CO2: Identifying and manipulating data types contributes to ongoing learning and adaptation in data handling. **(2)**

CO3: Creating diverse plots and handling data supports continuous learning in data visualization. **(2)**

CO4: Generating and computing probabilities enhances self-directed learning in statistical methods. **(2)**

CO5: Creating and fitting distributions contributes to life-long learning in statistical techniques. **(2)**

CO6: Calculating and interpreting descriptive statistics supports ongoing learning in data analysis. **(2)**

CO7: Implementing control structures contributes to life-long learning in programming and automation. **(2)**

SYLLABUS (CBCS) FOR T. Y. B. Sc. (Semester- VI) STATISTICS
2022 Pattern
(With Effect from Academic Year 2024-2025)

Paper Code : USST366(A)
Paper : VI (A) Title of Paper : Official Statistics
Credit : 3 credits No. of lectures : 48

A) Course Objectives:

1. Indian official statistics pertaining to agriculture, industry and concept of national income and methods of computation.
2. Understanding the functioning of official statistics.
3. Search, evaluation and use of metadata and ability to judge the quality of data on this basis.
4. Use of adequate statistical standards in research
5. Ability to critically evaluate the importance and impact of methods and tools on quality in official statistics
6. Understand the structure and function of national and international Statistical system.
7. Apply official statistical methods and concepts to analyze real-world issues and challenges.

B) Course outcomes:

CO 1. Students become familiar with institutional, legal and organizational bases, and principles of functioning of official statistics.

CO 2. Students able to understand the fundamentals of measurement in official statistics.

CO 3. Students able to judge implications of these bases for the functioning of official statistics and quality of data in official statistics, especially with regard to limitations that arise from measurement and processes of statistical production.

CO 4. Identify the key principles and purposes of producing official statistical data.

CO 5. Understand the factors influencing demand and supply in different markets.

CO 6. Apply official statistical methods and concepts to analyze real-world issues and challenges.

CO 7. Understand how statistical information influences decision-making at different levels.

TOPICS/CONTENTS:

Unit-1 Indian Official Statistics **(18 L)**

1.1 Agricultural Statistics in India

(I) Statistics of land utilization

(II) Statistics of crop output

(III) Miscellaneous of crop output (not to be studied in detail)

(IV) Indices of agricultural production. Defects of Indian agricultural statistics.

1.2 Price Statistics:

Usefulness of price statistics, wholesale price statistics, index number of wholesale prices. Retail price statisticslabour bureau index, number of retail prices for urban and rural areas, consumer price index for industrial workers, non-manual employees and agricultural labourers, limitations of price statistics.

1.3 Industrial Statistics: primary sources of industrial statistics, statistics collected (description in brief), limitations of industrial statistics, index number of industrial productions. Method of compilation. Index number of industrial profits revised series.

1.4 Educational Statistics: Description of different statistics relating to education, compiled and published by the ministry of education of the India Govt. Number of educational institutions, education of scheduled castes, tribes and backwards classes. Number of scholars, number of teachers, examination result. Sources of publications, critical study of educational statistics in India.

Unit 2 National Income **(4 L)**

2.1 Definition (three approaches: product, income and expenditure). Methods of estimating national income: product method, income method, expenditure method and social accounting method.

Unit 3 Economic Time Series **(11 L)**

3.1 Components of time series

3.2 Decomposition of time series- Additive and multiplicative model with their merits and demerits, Illustrations of time series.

3.3 Measurement of trend by method of free-hand curve, method of semi-averages and method of least squares (linear, quadratic and modified exponential).

3.4 Measurement of seasonal variations by methods of ratio to trend

3.5 Link relative method

3.6 Examples and problem

Unit 4 Demand and Supply Analysis (11 L)

4.1 Demand: meaning, statement of law, assumptions, exceptions and determinants of demand, individual and market demand.

4.2 Supply: meaning, statement of law, assumptions, exceptions and determinants of supply, individual and market supply

4.3 Elasticity of demand: definition: i) price elasticity of demand ii) income elasticity of demand iii) cross elasticity of demand

4.4 Method of measuring elasticity of demand: i) percentage method, ii) point method iii) total outlay method iv) ARC Method

4.5 Demand forecasting: meaning need and methods of forecasting

4.6 Examples and problems

Unit 5 Pareto and Lognormal laws of income distribution (4 L)

Books Recommended:

1. Gupta S.C. & Kapoor V. K.: Fundamentals of Applied Statistics, S. Chand Sons, New Delhi.
2. Goon, Gupta, Dasgupta: Fundamentals of Statistics, Vol-II, The World Press Pvt. Ltd., Calcutta 1986.
3. Parimal Mukhopadhyay: Applied Statistics, Books and Allied (P) Ltd, Kolkata,2005.
4. Biswas D.(2009) Probability and Statistics (Vol-I) New Central Book Agency Ltd.
5. Guide to current Indian Official Statistics, Central Statistical Office, GOI, New Delhi.(Refer website-http://mospi.nic.in/).

Course Outcomes	**Programme Outcomes (POs)**								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	3	3	3	-	-	3	2	2
CO2	3	3	3	3	-	-	3	2	2
CO3	3	3	3	3	-	-	3	2	2
CO4	3	3	3	3	-	-	3	2	2
CO5	3	3	3	3	2	-	3	2	2
CO6	3	3	3	3	-	3	3	2	2
CO7	3	3	3	3	-	-	3	2	2

PO1: Disciplinary Knowledge

All Course Outcomes are Strongly Related (3) - Understanding the institutional, legal, and organizational bases of official statistics contributes significantly to disciplinary knowledge.

PO2: Critical Thinking and Problem Solving

All Course Outcomes are Strongly Related (3) - Critical thinking is crucial in understanding the implications of measurement processes, quality of data, and the factors influencing demand and supply.

PO3: Social Competence

All Course Outcomes are Strongly Related (3) - Effective communication of thoughts and ideas in the context of official statistics contributes significantly to social competence.

PO4: Research-related Skills and Scientific Temper

All Course Outcomes are Strongly Related (3) - Inferencing from scientific literature, formulating hypotheses related to official statistics, and understanding research-related skills align with this program outcome.

PO5: Trans-disciplinary Knowledge

CO5: Understand the factors influencing demand and supply in different markets.

Justification: Moderately Related (2) - Factors influencing demand and supply have applications in various disciplines, contributing partially to trans-disciplinary knowledge.

PO6: Personal and Professional Competence

CO6: Apply official statistical methods and concepts to analyze real-world issues and challenges.

Justification: Strongly Related (3) - Applying statistical methods to real-world issues enhances personal and professional competence.

PO7: Effective Citizenship and Ethics

All Course Outcomes are Strongly Related (3) - Demonstrating empathetic social concern and ethical considerations in decision-making align with the nature of official statistics.

PO8: Environment and Sustainability

All Course Outcomes are Moderately Related (2) - Understanding the impact of official

statistical solutions in societal and environmental contexts contributes partially to this outcome.

PO9: Self-directed and Life-long Learning

All Course Outcomes are Moderately Related (2) - Acquiring the ability to engage in independent and life-long learning is supported by the understanding of official statistical principles.

SYLLABUS (CBCS) FOR T. Y. B. Sc. (Semester- VI) STATISTICS
2022 Pattern
(With Effect from Academic Year 2024-2025)

Paper Code : USST366(B)
Paper : VI (B) Title of Paper : Actuarial Statistics
Credit : 3 credits No. of lectures : 48

A) Course Objectives:

1. The main objective of this course is to learn and understand various concepts involved in Actuarial Statistics.
2. Students should be able to describe, explain and apply the fundamental theories of actuarial statistics as they apply in life insurance, endowment insurance, n-year term life insurance.
3. Students should be able to apply appropriate modeling techniques for lifetime random variables involved in the field of insurance.
4. To understand and apply statistical methods for analyzing and modeling insurance risks.
5. Acquire skills in calculating premiums and reserves for various insurance products.
6. Use life tables to estimate life expectancy and assess the risk for life insurance products.
7. To understand the concept of annuities , including the calculation of present value and future value for different types annuities

B) Course outcomes:

Students should be able to

CO 1. identify and analyze consequences of events involving risk and uncertainty.

CO 2. calculate survival function, curtate future lifetime, force of mortality.

CO 3. calculate various payments from life tables using principle of equivalence, net premiums.

CO 4. develop critical thinking skills in assessing and managing risks in various actuarial contexts.

CO 5. apply the time value of money concept to annuities.

CO 6. calculate the present value and future value of a series of cash flows.

CO 7. calculate premiums for various types of annuities, considering factors such as interest rates and mortality rates.

TOPICS/CONTENTS:

Unit-1 Insurance Business (3 L)

1.1 Insurance companies as business organizations.

1.2 Role of insurance business in Economy.

1.3 Concept of risk, types of risk, characteristics of insurable risk.

1.4 Working of insurance business, introduction of terms such as premium, policy, policyholder and benefit.

1.5 Role of Statistics in insurance.

1.6 Insurance business in India.

Unit-2 Feasibility of Insurance Business (4 L)

2.1 Measurement of adverse financial impact, expected value principle.

2.2 Concept of utility function

2.3 Feasibility of insurance business.

2.4 Illustrative examples.

Unit-3 Survival Distribution and Life Tables (12 L)

3.1 Time- until death random variable, its d.f. and survival function in actuarial notation.

3.2 Force of mortality.

3.3 Interrelations among d.f., survival function, force of mortality and p.d.f.

3.4 Curtate future life random variable, its p.m.f. and survival function in actuarial notation.

3.5 Construction of life table using random survivorship approach.

Unit-4 Models for Life Insurance (11 L)

4.1 Theory of compound interest, effective rate of interest, discount factor.

4.2 Insurance payable at the end of the year of death, present value random variable, actuarial present value.

4.3 Derivation of actuarial present value for n-year term life insurance, whole life insurance and endowment insurance.

Unit-5 Annuities (10 L)

5.1 Annuities – certain, annuity due, annuity immediate.

5.2 Discrete life annuities: n-year temporary life annuity due and a whole life annuity due, present value random variables of the payment, and their actuarial present values.

Unit- 6 Benefit Premiums (8 L)

6.1 Concept of a loss random variable.

6.2 Equivalence principle

6.3 Computation of fully discrete premium for n-year term life insurance, whole life insurance and endowment insurance.

6.4 Variance of loss random variable

Books Recommended

1. Bowers N.L. Jr., H.S.Gerber, J.C. Hickan, D.A.Jones, C.J.Nesbitt, (1997). Actuarial Mathematics, Society of Actuaries, U.S.

2. Deshmukh, S. R. (2009). Actuarial Statistics, Universities Press, Hyderabad, India.

3. Actuarial Mathematics, Society of Actuaries,ltasca,lllinois,U.S.A.2nd Ed.(1997)

4. Spurgeon E.T. (1972); Life Contingencies, Cambridge University Press. Neill, A. Life Contingencies, Heinemann

Course Outcomes	**Programme Outcomes (POs)**								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	3	2	2	-	-	2	2	2
CO2	3	3	2	2	-	-	2	2	2
CO3	3	3	2	2	-	-	2	2	2
CO4	3	3	2	2	-	3	2	2	2
CO5	3	3	2	2	3	-	2	2	2
CO6	3	3	2	2	-	-	2	2	2
CO7	3	3	2	2	-	-	2	2	2

PO1: Disciplinary Knowledge

All Course Outcomes are Strongly Related (3) - Demonstrating comprehensive knowledge of actuarial principles contributes significantly to disciplinary knowledge.

PO2: Critical Thinking and Problem Solving

All Course Outcomes are Strongly Related (3) - Critical thinking is crucial in calculating survival functions, curtate future lifetime, and assessing and managing risks in actuarial contexts.

PO3: Social Competence

All Course Outcomes are Moderately Related (2) - Effective communication of thoughts and ideas in writing and orally in the context of actuarial principles contributes partially to social competence.

PO4: Research-related Skills and Scientific Temper

All Course Outcomes are Moderately Related (2) - Understanding and applying scientific concepts like calculating payments from life tables aligns with research-related skills.

PO5: Trans-disciplinary Knowledge

CO5: Apply the time value of money concept to annuities.

Justification: Strongly Related (3) - Time value of money has applications in various financial disciplines, contributing significantly to trans-disciplinary knowledge.

PO6: Personal and Professional Competence

CO4: Develop critical thinking skills in assessing and managing risks in various actuarial contexts.

Justification: Strongly Related (3) - Developing critical thinking skills in assessing and managing risks enhances personal and professional competence.

PO7: Effective Citizenship and Ethics

All Course Outcomes are Moderately Related (2) - Demonstrating ethical considerations in decision-making in actuarial contexts contributes partially to effective citizenship and ethics.

PO8: Environment and Sustainability

All Course Outcomes are Moderately Related (2) - Understanding the impact of actuarial solutions in societal and environmental contexts contributes partially to this outcome.

PO9: Self-directed and Life-long Learning

All Course Outcomes are Moderately Related (2) - Acquiring the ability to engage in independent and life-long learning is supported by the understanding of actuarial principles.

SYLLABUS (CBCS) FOR T. Y. B. Sc. (Semester- VI) STATISTICS
2022 Pattern
(With Effect from Academic Year 2024-2025)

Paper Code : USST367
Paper : VII Title of Paper : Statistics Practical- VIII
Credit : 2 credits

A) Course Objectives:

1. To learn and understand various regression models, like simple linear regression model, multiple linear regression model, polynomial regression model, logistic regression model, etc.
2. To estimate the parameters of the regression model and perform residual diagnostics.
3. To find an appropriate subset of regressors for the model.
4. Logistic regression aims to measure the relationship between a categorical dependent variable and one or more independent variables.
5. To find optimal solution of the LPP by simplex and Big- M method
6. To find optimal solution of the Transportation and Assignment Problem.
7. To construct network diagrams of project and obtain critical path.

B) Course outcomes:

CO 1. Students will be able to interpret the regression model and predict the response variable.

CO 2. Students should able to determine critical path and floats associated with non-critical activities and events along with total project completion time.

CO 3. Students should be able to understand the importance of using PERT and CPM techniques for project management.

CO 4. Analyze and discuss case studies that demonstrate the application of OR techniques to address practical challenges.

CO 5. Formulate regression models based on practical problems and research questions.

CO 6. Apply techniques for variable selection, including stepwise regression and regularization methods.

CO 7. Understand and apply logistic regression for binary and multinomial outcomes.

Sr. No.	Title of Experiments
1.	Simple Linear Regression Analysis and Diagnostics by Residual Plots
2.	Multiple Linear Regression Analysis and Diagnostics by Residual Plots
3.	Variable Selection and Model Building- I (Forward Selection, Backward Elimination)
4.	Logistic Regression
5.	Linear programming problem- I (Simplex Method)
6.	Linear programming problem- II (Big- M Method)
7.	Transportation Problem
8.	Assignment problem
9.	Critical Path Method (CPM) and Project Evaluation and Review Techniques (PERT)
10.	Simulations

Co-Po Mapping with Justification

Course Outcomes	Programme Outcomes (POs)								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	-	-	-	-	-	-	2	2
CO2	3	3	-	-	-	-	-	2	2
CO3	3	-	2	-	-	-	-	2	2
CO4	3	-	-	3	-	-	-	2	2
CO5	3	-	-	-	2	-	-	2	2
CO6	3	-	-	-	-	3	-	2	2
CO7	3	-	-	-	-	-	2	2	2

PO1: Disciplinary Knowledge

CO1: Students will be able to interpret the regression model and predict the response variable.

Justification: Strongly Related (3) - Comprehensive knowledge of regression models contributes significantly to disciplinary knowledge.

PO2: Critical Thinking and Problem Solving

CO2: Students should able to determine the critical path and floats associated with non-critical activities and events along with the total project completion time.

Justification: Strongly Related (3) - Determining critical paths and floats requires critical thinking and problem-solving skills.

PO3: Social Competence

CO3: Students should be able to understand the importance of using PERT and CPM

techniques for project management.

Justification: Moderately Related (2) - Understanding project management techniques contributes partially to social competence.

PO4: Research-related Skills and Scientific Temper

CO4: Analyze and discuss case studies that demonstrate the application of OR techniques to address practical challenges.

Justification: Strongly Related (3) - Analyzing case studies and applying operational research techniques align with research-related skills.

PO5: Trans-disciplinary Knowledge

CO5: Formulate regression models based on practical problems and research questions.

Justification: Moderately Related (2) - Formulating regression models contributes partially to trans-disciplinary knowledge.

PO6: Personal and Professional Competence

CO6: Apply techniques for variable selection, including stepwise regression and regularization methods.

Justification: Strongly Related (3) - Applying techniques for variable selection enhances personal and professional competence.

PO7: Effective Citizenship and Ethics

CO7: Understand and apply logistic regression for binary and multinomial outcomes.

Justification: Moderately Related (2) - Understanding and applying logistic regression contributes partially to effective citizenship and ethics.

PO8: Environment and Sustainability

All Course Outcomes are Moderately Related (2) - Understanding the impact of regression models and project management techniques contributes partially to this outcome.

PO9: Self-directed and Life-long Learning

All Course Outcomes are Moderately Related (2) - Acquiring the ability to engage in independent and life-long learning is supported by understanding regression models, project management techniques, and operational research applications.

SYLLABUS (CBCS) FOR T. Y. B. Sc. (Semester- VI) STATISTICS
2022 Pattern
(With Effect from Academic Year 2024-2025)

Paper Code : USST368
Paper : VIII Title of Paper : Statistics Practical- IX
Credit : 2 credits

A) Course Objectives:

The objectives of this course are to understand the concepts of

1. Statistical hypothesis, Parametric Tests, Nonparametric tests
2. Differentiate between parametric and non-parametric tests
3. Study of various capability indices and utilities with real life situations.
4. Students will learn about the structural qualities of a coherent system.
5. Hypothesis testing using parametric test and non-parametric test, including calculation of test statistics and p values.
6. Design and analyze single sampling plans for attributes and variables.
7. Estimate reliability measures, including reliability coefficients and confidence intervals

B) Course Outcomes:

After completing this course, students will possess skills concerning:

CO 1. Use of Statistical Hypothesis in real life situations.

CO 2. Type I Error, Type II Error, construct power functions and level of significance for a hypothesis test when making a decision.

CO 3. Learn the concept various capability indices.

CO 4. Learn the concept of coherent system reliability.

CO 5. Interpret the results of hypothesis tests, including p-values and significance levels.

CO 6. Apply hypothesis testing techniques to analyze and draw conclusions from real-world datasets.

CO 7. Apply SQC techniques to monitor and improve process quality in diverse industries.

Sr. No.	Title of Experiments
1.	Testing of hypothesis- I (Probability of type I error and type II error, power of a test)
2.	Testing of hypothesis (Construction of MP and UMP test, plotting of power function of a test)
3.	Non- parametric tests- I (Sign test, Wilcoxon's signed rank test, Mann-Whitney U test)
4.	Non- parametric tests- II (Run test, median test, Kolmogorov- Smirnov test)
5.	SPRT- I (Bernoulli, Binomial, Poisson, Hypergeometric Distributions)
6.	SPRT- II (Normal, Exponential Distribution)
7.	Capability Studies
8.	Single sampling plan for attributes (OC curve, AOQ, AOQL, ATI using Poisson distribution).
9.	Double sampling plan for attribute (OC curve, AOQ, AOQL, ATI, ASN using Poisson distribution)
10.	Reliability

Course Outcomes	Programme Outcomes (POs)								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	-	-	-	-	-	-	1	2
CO2	3	3	-	-	-	-	-	2	1
CO3	3	-	2	-	-	-	-	1	1
CO4	3	-	-	2	-	-	-	1	1
CO5	3	-	-	-	1	-	-	2	2
CO6	3	-	-	-	-	3	-	1	1
CO7	3	-	-	-	-	-	2	1	1

PO1: Disciplinary Knowledge

CO1: Use of Statistical Hypothesis in real-life situations.

Justification: Strongly Related (3) - Understanding and applying statistical hypothesis contributes significantly to disciplinary knowledge.

PO2: Critical Thinking and Problem Solving

CO2: Type I Error, Type II Error, construct power functions and level of significance for a hypothesis test when making a decision.

Justification: Strongly Related (3) - Constructing power functions and considering errors require critical thinking and problem-solving skills.

PO3: Social Competence

CO3: Learn the concept of various capability indices.

Justification: Moderately Related (2) - Understanding capability indices contributes partially to social competence.

PO4: Research-related Skills and Scientific Temper

CO4: Learn the concept of coherent system reliability.

Justification: Moderately Related (2) - Understanding coherent system reliability contributes partially to research-related skills.

PO5: Trans-disciplinary Knowledge

CO5: Interpret the results of hypothesis tests, including p-values and significance levels.

Justification: Partially Related (1) - Interpretation of hypothesis test results contributes partially to trans-disciplinary knowledge.

PO6: Personal and Professional Competence

CO6: Apply hypothesis testing techniques to analyze and draw conclusions from real-world datasets.

Justification: Strongly Related (3) - Applying hypothesis testing techniques enhances personal and professional competence.

PO7: Effective Citizenship and Ethics

CO7: Apply SQC techniques to monitor and improve process quality in diverse industries.

Justification: Moderately Related (2) - Applying SQC techniques contributes partially to effective citizenship and ethics.

PO8: Environment and Sustainability

All Course Outcomes are Partially to Moderately Related (1-2) - Understanding statistical concepts contributes partially to environment and sustainability.

PO9: Self-directed and Life-long Learning

All Course Outcomes are Partially to Moderately Related (1-2) - Acquiring statistical skills supports self-directed and life-long learning.

SYLLABUS (CBCS) FOR T. Y. B. Sc. (Semester- VI) STATISTICS

2022 Pattern

(With Effect from Academic Year 2024-2025)

Paper Code : USST369
Paper : IX Title of Paper : Project
Credit : 2 credits

A) Course Objectives:

1. The student will develop skills for data analysis.
2. Students should be able to identify the statistical tools, models for analyze the data.
3. develop proficiency in using statistical software packages like R, Excel for data analysis and visualization.
4. improve the ability to communicate statistical findings effectively through written reports and presentations
5. apply advanced statistical techniques to analyze the research data and draw meaningful conclusions
6. interpret the results of the analysis and discuss their implications in the context of the project questions/objectives.
7. develop the ability to critically evaluate existing statistical literature and research studies in the field.

B) Course outcomes:

CO 1. Student will able to sole real life situation by using statistical techniques.
CO 2. Student will be exploring their algorithmic approaches to problem solving.
CO 3. Adhere to ethical standards in data handling, analysis, and reporting.
CO 4. Reflect on the project experience, including challenges faced and lessons learned.
CO 5. Identify areas for improvement and future directions for the research topic.
CO 6. Contribute to statistical literacy and awareness.
CO 7. Demonstrate a commitment to continuous learning by staying updated on emerging statistical techniques and tools.

Guideline for Project:

1. For project maximum 5 students are allowed in a group.
2. Project: Equivalent to 10 practical. Statistical techniques have to use for Data Analysis and make report in dissertation form.
3. Students have to prepare project report and have to submit one copy for the assessment to the examiner.
4. Project Evaluation:
   i) Internal Evaluation: 40 Marks
   ii) External Evaluation: 60 Marks
5. In order to acquaint the students with applications of statistical methods in various fields such as industries, agricultural sectors, government institutes, etc. at least one Study Tour for T.Y. B.Sc. Statistics students may be arranged.

Course Outcomes	**Programme Outcomes (POs)**								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	-	-	-	-	-	-	2	3
CO2	3	3	-	-	-	-	-	2	2
CO3	3	-	2	-	-	-	-	1	3
CO4	3	-	-	2	-	-	-	1	2
CO5	3	-	-	-	2	-	-	2	2
CO6	3	-	-	-	-	3	-	1	3
CO7	3	-	-	-	-	-	2	1	2

PO1: Disciplinary Knowledge

CO1: Student will able to solve real-life situations by using statistical techniques.

Justification: Strongly Related (3) - Solving real-life situations using statistical techniques contributes significantly to disciplinary knowledge.

PO2: Critical Thinking and Problem Solving

CO2: Student will be exploring their algorithmic approaches to problem-solving.

Justification: Strongly Related (3) - Exploring algorithmic approaches requires critical thinking and problem-solving skills.

PO3: Social Competence

CO3: Adhere to ethical standards in data handling, analysis, and reporting.

Justification: Strongly Related (2) - Adhering to ethical standards contributes to social competence.

PO4: Research-related Skills and Scientific Temper

CO4: Reflect on the project experience, including challenges faced and lessons learned.

Justification: Moderately Related (2) - Reflection on project experience contributes partially to research-related skills.

PO5: Trans-disciplinary Knowledge

CO5: Identify areas for improvement and future directions for the research topic.

Justification: Moderately Related (2) - Identifying areas for improvement contributes partially to trans-disciplinary knowledge.

PO6: Personal and Professional Competence

CO6: Contribute to statistical literacy and awareness.

Justification: Strongly Related (3) - Contributing to statistical literacy enhances personal and professional competence.

PO7: Effective Citizenship and Ethics

CO7: Demonstrate a commitment to continuous learning by staying updated on emerging statistical techniques and tools.

Justification: Moderately Related (2) - Commitment to continuous learning contributes partially to effective citizenship and ethics.

PO8: Environment and Sustainability

All Course Outcomes: Partially to Moderately Related (1-2) - Understanding statistical concepts contributes partially to environment and sustainability.

PO9: Self-directed and Life-long Learning

All Course Outcomes: Moderately to Strongly Related (2-3) - Applying statistical techniques and continuous learning contribute to self-directed and life-long learning