K. J. SOMAIYA COLLEGE OF SCIENCE AND COMMERCE

AUTONOMOUS – Affiliated to University of Mumbai

Re-accredited "A' Grade by NAAC

Vidyanagar, Vidyavihar, Mumbai 400 077

Syllabus for S. Y. B. Sc.

Program: B.Sc.

Course: Statistics

Choice Based Credit System (CBCS)

From the academic year 2019-20

Semester III

Course (Paper)	Course Name	Course Code
I	Probability Distribution–I	19US3ST1
II	Sampling techniques	19US3ST2
DSE I	Operations Research	19US3ST3-E1
DSE II	Time Series Analysis and Forecasting	19US3ST3-E2
Practical	Practicals based on all three courses	19US3STP

Semester IV

Course (Paper)	Course Name	Course Code
I	Probability and Sampling distributions	19US4ST1
II	Analysis of variance and Design of experiments	19US4ST2
DSE III	Project management and industrial statistics	19US4ST3-E1
DSE IV	Research Methodology	19US4ST3-E2
Practical	Practicals based on all three courses	19US4STP

Structure of syllabus: S. Y. B. Sc. Statistics

From [2019-20]

Semester	Course No	Course Title	Course code	Credits	Hours	Period (50 min)	Unit/ Module	Lectures (50 MINUTES)	Examination		
THEORY									Int. Marks	Ext. Marks	Total Marks
III	I	Probability Distribution –1	**19US3ST1**	2	30	36	1	12	40	60	100
							2	12			
							3	12			
	II	Sampling techniques	**19US3ST2**	2	30	36	1	12	40	60	100
							2	12			
							3	12			
	III	Operations Research	**19US3ST3-E1**	2	30	36	1	12	40	60	100
							2	12			
							3	12			
		Time Series Analysis and Forecasting	**19US3ST3-E2**	2	30	36	1	12	40	60	100
							2	12			
							3	12			
Practicals											
III	I	Practicals based on 3 courses	19US3STP	1	2.5	3					50
	II			1	2.5	3					50
	III			1	2.5	3					50

Structure of syllabus: S. Y. B. Sc. Statistics

From [2019-20]

Semester	Course No	Course Title	Course code	Credits	Hours	Period (50 min)	Unit/ Module	Lectures (50 MINUTES)	Examination		
THEORY									Int. Marks	Ext. Marks	Total Marks
IV	I	Probability and Sampling distributions	19US4ST1	2	30	36	1	12	40	60	100
							2	12			
							3	12			
	II	Analysis of variance and Design of experiments	19US4ST2	2	30	36	1	12	40	60	100
							2	12			
							3	12			
	III	Project management and industrial statistics	19US4ST3-E1	2	30	36	1	12	40	60	100
							2	12			
							3	12			
		Research Methodology	19US4 ST3-E2	2	30	36	1	12	40	60	100
							2	12			
							3	12			
Practicals											
III	I	Practicals based on 3 courses	19US4STP	1	2.5	3					50
	II			1	2.5	3					50
	III			1	2.5	3					50

S.Y. B.Sc. SEM III/IV: Credits per Semester

Course	Credit
	Theory
I	02
II	02
III	02
Practical	03
Total	09
Per subject 9 credit	Total = 09 * 2 = 18

Evaluation pattern: Theory

For each course I, II and III

External (60 M) + Internal (40 M)

External: End Semester Examination

Paper Pattern: S. Y. B.Sc. Semester III/ IV

External : 60 Marks Duration : 2 hrs.

Question No.	Module	Marks (With Max Option)	Marks (Without Option)
Q1	I	30	20
Q2	II	30	20
Q3	III	30	20

Internal: 40 Marks:

1. 25 marks – continuous evaluation
2. 15 marks – Project/ Presentation / Assignment

Evaluation pattern: Practical

Practical Evaluation: 50 Marks practical examination at the end of each semester per paper.

Semester III

Course-I (Paper I)

Course title: Probability Distribution–I

Course Credit: 2 (Teaching: 30 hrs/ 36 L)

Course code: 19US3ST1

After completion of this course the student should be able to

CO1: Develop problem-solving techniques needed, to accurately calculate, probabilities using moment generating functions and cumulant generating functions

CO2: Know the most widely used discrete probability distributions such as binomial, poisson, uniform, geometric, negative binomial, and hypergeometric, truncated binomial and truncated poisson and recognize them in applications.

CO3: Understand concept of bivariate probability distributions and Jacobian transformation.

Module 1 : MGF, CGF, Binomial and Poisson distribution (12L)

Learning Objective :

1. To learn the technique such as Moment Generating Function (MGF) and Cumulant Generating Function (CGF) methods for obtaining the raw moments of the distributions.
2. To obtain various measures of the Bernoulli, Binomial and Poisson distribution using MGF and CGF

Learning Outcome :

- A student will be able to find the moments of the distribution using suitable method
- A student will be able to obtain various measures using MGF and CGF and understand the relationship between Bernoulli, binomial and Poisson distribution.

1.1 Moment Generating Functions (MGF):

Definition (discrete and continuous random variables), probability distribution from MGF, raw moments from MGF, properties of MGF : i) MGF of aX + b ii) MGF of sum of two independent r.v.s. along with the generalization iii) Uniqueness property (only statement).

1.1 Cumulant Generating Function (CGF) :

Definition, cumulants from CGF, properties of CGF : i) Effect of shift of origin and scale ii) Additive property of cumulants iii) relationship between cumulants and the moments

1.2 Bernoulli distribution :

Definition, MGF, CGF, moments, cumulants, mean, variance, skewness and kurtosis, additive property

1.3 Binomial distribution:

Definition, MGF, CGF, moments, cumulants, mean, variance, mode, skewness and kurtosis, recurrence relationship for binomial probabilities, recurrence relationship for raw and central moments, additive property, fitting of the distribution

1.4 Poisson distribution:

Definition, MGF, CGF, moments, cumulants, mean, variance, skewness and kurtosis, mode, recurrence relationship for poisson probabilities, recurrence relationship for raw and central moments, additive property, conditional distribution of X given X + Y where X and Y are independent, fitting of the distribution

Module 2 : Uniform, Geometric, Negative binomial, Hypergeometric, Truncated binomial distribution (12L)

Learning Objective :

1. To obtain various measures of Geometric, Negative Binomial, Uniform distribution using MGF / CGF method
2. To derive the distribution of Hypergeometric distribution
3. To understand the concept of the truncated distribution

Learning Outcome :

- A student will be able to apply various properties of MGF to the Geometric, Negative Binomial, Uniform distribution
- A student will be able to apply hypergeometric distribution
- A student will be able to obtain the distribution of truncated Binomial and truncated Poisson distribution

2.1 Uniform Distribution:

Definition, MGF, mean, variance, skewness, fitting of the distribution

2.2 Geometric Distribution (two forms):

Definition, mean, mode, variance, distribution function, MGF, CGF, lack of memory property

2.3 Negative Binomial Distribution (NBD) :

Definition, derivation of p.m.f., alternate form of NBD, MGF, CGF, mean, variance, skewness and kurtosis, recurrence relationship for NBD probabilities, NBD(k, p) as sum of 'k' i.i.d. geometric variables with parameter 'p', Poisson distribution as a limiting case of NBD, fitting of the distribution

2.4 Hypergeometric distribution:

Definition, derivation of p.mf., mean, variance, binomial distribution as a limiting case of hypergeometric distribution, fitting of the distribution

2.5 Truncated probability Distribution:

Definition, Binomial and Truncated Poisson Distribution (truncated at O), derivation of p.m.f., mean.

Module 3 : Joint probability function and transformation of variables (12L)

Learning Objective :

1. To learn probability distribution involving two random variables
2. To apply MGF method to bivariate distribution
3. To obtain the distribution of the transformed variables

Learning Outcome :

1. A student will be able to obtain marginal, conditional distributions
2. A student will be able to check the independence of the variables using MGF
3. A student will be able to derive the distribution of the transformed variables.

3.1Joint Probability function:

Discrete and continuous bivariate random variables, their probability function along with the properties. Marginal and conditional Distributions. Independence of Random Variables. Conditional Expectation & Variance. Regression Function. Coefficient of Correlation.

3.2 MGF of bivariate r.v.:

Definition, joint raw moments, M.G.F. of marginal distribution of r.v.s., properties

3.3 Transformation of Random Variables:

Probability distribution of functions of bivariate r.v.s using Jaccobian of transformation.

Practical Sem-III

Course Code: 19US3STP

Paper- I

1 Moment Generating Function
2 Cumulant generating Function
3 Bernoulli, Binomial Distributions
4 Poisson distribution
5 Uniform, geometric distribution
6 Negative binomial and hypergeometric distribution
7 Fitting binomial and poisson distributions, uniform, negative binomial distribution
8 Bivariate Probability Distributions, Marginal & Conditional distributions, Conditional Mean, Conditional Variance, Correlation.
9 Transformation of bivariate random variables

References and Additional Reading:

1.Introduction to the theory of statistics: A. M. Mood, F.A. Graybill, D. C. Boyes, Third Edition; McGraw-Hill Book Company.

2.Introduction to Mathematical Statistics: R.V.Hogg, A.T. Craig; Fourth Edition; Collier McMillanPublishers.

3.John E. Freund's Mathematical Statistics: I. Miller, M. Miller; Sixth Edition; Pearson Education Inc.

4.Introduction to Mathematical Statistics: P.G. Hoel; Fourth Edition; John Wiley & Sons Inc.

5.Fundamentals of Mathematical Statistics: S.C. Gupta, V.K. Kapoor; Eighth Edition; Sultan Chand & Sons.

6.Mathematical Statistics: J.N. Kapur, H.C. Saxena; Fifteenth Edition; S. Chand & Company Ltd.

7.An Outline of Statistical Theory Vol. I: A.M. Goon, M.K. Gupta, B. DasGupta; Third Edition; TheWorldPress Pvt. Ltd.

8.Statistical Methods Using R Software :V. R. Pawagi and Saroj A. Ranade ;Nirali Publications.

9. Statistics Using R. S. G. Purohit, S. D. Gore, and S. R. Deshmukh. Narosa Publishing House.

Semester III

Course-II

Course title: Theory of sampling

Course Credit: 2 (Teaching: 30 hrs/ 36 L)

Course code: 19US3ST2

After completion of this course the student should be able to
CO1: Understand the objectives of a sample survey
CO2: Know the common sampling techniques such as simple random sample, stratification, systematic sampling, cluster sampling; recognize and understand when it is appropriate to use each technique
CO3: Make inferences about a population
CO4: Learn when to use and how to implement sampling designs that are more complex than a simple random sample
CO5: Estimate sample size for given margin of error
CO6: Understand how we can compare sampling designs or estimators, and know what properties make a "better" design or estimator

Module 1 : Introduction to Design of Sample Surveys and Simple Random Sample (12L)

Learning Objective :

1. To explain the different concepts used in sampling
2. To make aware of the different Statistical Organizations
3. To help in applying the basic techniques of sampling.

Learning Outcome :

Learner will be able to

1. Distinguish between simple random sampling with and without replacement.
2. Understand the nature of work carried out in the different Statistical Organisations.
3. Prepare a questionnaire for sampling & census survey.
4. Estimate the mean and variance of the population values.

1.1 Introduction to Design of Sample Surveys.

Types of Data:

Primary & Secondary Data

Methods for collection of data: Direct & Indirect Method, Questionnaire, Scheduling, Interview, E-survey (Google forms), Merits & Demerits.

Basic definitions: Population, Population unit, Sample, Sample unit, Parameter, Statistic, Estimator, Bias, Unbiasedness, Mean square error, Relationship between MSE & Variance, Standard error.

Survey: Census survey, Sample Survey. Steps in conducting a sample survey with examples on designing appropriate Questionnaire.

Errors: Concepts of Sampling and Non-sampling errors.

Recognised Institutes: NSSO, CSO, IIPS and their functions.

Types of Sampling: Probability and Non Probability sampling.

1.2 Simple Random Sampling: (SRS).

Definition: Sampling with & without replacement for variables (WR/WOR).

Methods to select Simple random sample: Lottery method & use of Random numbers to select Simple random sample.

Estimation: Population mean & total. Expectation & Variance of theEstimators, Unbiased Estimator of variance of these estimators. (WR/WOR).

Estimation of population proportion. Expectation & Variance of the estimators, Unbiased estimator of variance of these estimators. (WR/WOR).

Sample Size: Estimation of Sample size based on a desired accuracy in case of SRS for variables & attributes. (WR/WOR).

Module 2 : Stratified Random Sampling, Cluster sampling, Two-stage and multistage sampling **(12L)**

Learning Objective :

To explain the difference between Stratified & Cluster Sampling and situations where such methods will be suitable.

Learning Outcome :

Learner will be able to

1. Distinguish between Stratified & Cluster Sampling
2. Estimate the sample size in case of proportional & optimum allocation.
3. Find efficiency of Stratified & Cluster Sampling over Simple Random Sampling.

2.1 Stratified Random Sampling.

Concept: Need for Stratification of population with suitable examples. Definition of Stratified Sample. Advantages of stratified Sampling.

Estimation: Population mean& total in case of Stratified Random Sampling, Variance of the Unbiased Estimators, Unbiased Estimators of variances of these estimators.

Allocation: Proportional allocation, Optimum allocation with and without varying costs.

Efficiency: Comparison of Simple Random Sampling, Stratified Random Sampling using Proportional allocation & Neyman allocation.

2.2 Cluster Sampling.

Estimation: Population Mean & total, Expectation of the estimators in Cluster Sampling with equal cluster sizes.

2.3 Two-Stage Sampling & Multi-Stage Sampling:

Concept only.

Module 3 : Ratio, Regression and Systematic sampling (12L)

Learning Objective :

1. To help improve the estimates using methods of Ratio & Regression.
2. To obtain sample using systematic sampling.

Learning Outcome :

Learner will be able to

1. To estimate the population parameters with increased precision.
2. To apply systematic sampling in suitable situations.
3. Compare the different sampling techniques.

3.1 Ratio Estimation assuming SRSWOR.

Concept & Estimation: Ratio Estimators for population Ratio, Mean & Total. Expectation & MSE of the Estimators. Estimators of MSE. Uses of Ratio Estimator.

3.2 Regression Estimation assuming SRSWOR

Concept & Estimation: Regression Estimators for population Mean & Total. Expectation &Variance of the Estimators assuming known value of regression coefficient 'b'. Estimation of 'b'. Resulting variance of the estimators. Uses of regression Estimator.

Efficiency: Comparison of Ratio, Regression & mean per Unit estimators.

3.3 Systematic Sampling.

Concept:

Systematic Sampling Procedure. Notations and Terminology. Variance of the estimated mean. Comparison of SRS &Stratified Sampling with Systematic Sampling.

3.4 Introduction to Circular Systematic Sampling.

Practical Sem-III

Course Code: 19US3STP

Paper- II

1. SRSWR & SRSWOR (Variables & Attributes)
2. C.I. & estimation of sample size.
3. Stratified Random Sampling
4. Cluster Sampling
5. Ratio & Regression Method of Estimation
6. Systematic Sampling

References and Additional Reading:

1. Sampling Techniques: W.G. Cochran; 3rd Edition; Wiley(1978)

2. Sampling Theory and methods: M.N. Murthy; Statistical Publishing Society. (1967)

3. Sampling Theory: Des Raj; McGraw Hill Series in Probability and Statistics. (1968).

4. Sampling Theory of Surveys with Applications: P.V. Sukhatme and B.V. Sukhatme; 3rd Edition; Iowa State University Press (1984).

5. Fundamentals of Applied Statistics: S. C. Gupta and V.K. Kapoor; 3rd Edition; Sultan Chand And Sons (2001).

6. Theory and Analysis of Sample Survey Designs: Daroga Singh, F.S.Chaudhary, Wiley Eastern Ltd. (1986).

7. Sampling Theory and Methods: S. Sampath, Second Edition (2005),Narosa.

8. Theory and Methods of Survey Sampling: ParimalMukhopadhyay, (1998), Prentice Hall Of India Pvt. Ltd.

Semester III

Course-III (DSE I)

Course title: Operations Research

Course Credit: 2 (Teaching: 30 hrs/ 36 L)

Course code: 19US3ST3-E1

After completion of this course the student should be able to
CO1: Translate real-world problems, into a mathematical model.
CO2: Formulate linear programming problem (LPP) in standard form, and use of the simplex method, Big M Method to solve them
CO3: Use duality to solve LPP
CO4: Understand optimization techniques in transportation, assignment, sequencing problems
CO5: Understand decision making under conflict

Module 1 : Linear programming problem (12L)

Learning Objective :

1) Understand LPP

2) Mathematical formulation of LPP

3) Methods of finding optimum solution to LPP

Learning Outcome :

1. Formulate the LPP.

2. Conceptualize the feasible region.

3. Solve the LPP with two variables using graphical method.

4. Solve the LPP using simplex method.

5. Formulate the dual problem from primal.

1.1 Linear Programming Problem :

Definition of LPP, Mathematical Formulation of LPP, Concepts of Solution, Feasible Solution, Basic Feasible Solution, Degenerate solution, Non-degenerate solution, Optimal solution, slack variable, Standard form of LPP

1.2 Graphical Solution for problems with two variables, Simplex method of solving problems with two or more variables. Big M method.

1.3 Concept of Duality, Its use in solving L.P.P. Relationship between optimum solutions to Primal and Dual. Economic interpretation of Dual.

Module II : Transportation and Assignment Problem (12L)

Learning Objective :

1) Understand Transportation Problem

2) Learn Methods of solving Transportation Problem

3) Understand Travelling Salesman Problem

4) Understand Assignment Problem

5) Learn Methods of solving Assignment problem

6) Apply all these methods in real life problems

Learning Outcome :

A student will be able to solve

1) Transportation Problem and Travelling Salesman Problem and use it real life problems.

2) Solve Assignment Problem.

2.1 Transportation Problem:

Concept, Mathematical Formulation, Concepts of Solution, Feasible Solution, Balanced and Unbalanced Transportation Problem.

2.2 Initial Basic Feasible Solution by North-West Corner Rule, Matrix Minima Method, Vogel's Approximation Method. Optimal Solution by MODI Method Problems involving unique solution, multiple solutions, degeneracy, maximization, prohibited route(s)

2.3 Assignment Problem:

Concept, Mathematical Formulation Balanced and unbalanced problem, relation with T.P. Solution by: Complete Enumeration Method and Hungarian method. Maximization type Assignment problems. Problems involving Prohibited routes. Travelling Salesman Problem.

Module III: Sequencing Problem and Game Theory (12L)

Learning Objective :

1) Understand Sequencing Problem

2) Learn Method of solving Sequencing Problem

3) Understand Two person Zero Sum game

4) Learn Method of solving Two person Zero Sum game

Learning Outcome :

A student will be able to

1) Solve Sequencing Problem

2) Apply it real life problems.

2) Solve Two person zero sum game in reality.

3.1 Sequencing Problem:

Processing n Jobs through 2 and 3 Machines.

3.2 Game Theory :

Definitions of two persons Zero Sum Game , Saddle point, value of the game, Pure and Mixed strategy, Optimal solution of two person zero sum games, Dominance property, Derivation of formulae for(2X2) game. Graphical solution of (2Xn) and (mX2) games, Reduction of game theory to LPP.

Practical Sem-III

Course Code (DSE 1): 19US3STP

Paper- III

1. Formulation and Graphical Solution of L.P.P.
2. Simplex Method
3. Duality
4. Transportation Problem
5. Assignment Problem
6. Sequencing Problem
7. Game Theory

References and Additional Reading:

1. Operations Research: Kantiswaroop and Manmohan Gupta. 4th Edition; S Chand & Sons. (1980)

2. Mathematical Models in Operations Research: J K Sharma, Tata McGraw Hill Publishing Company Ltd.(1989)

3. Operations Research: S.D.Sharma.11th edition, KedarNath Ram Nath& Company.(2001)

4. Operations Research: H. A.Taha.6th edition, Prentice Hall of India.8th edition (2008)

5. Quantitative Techniques for Managerial Decisions: J.K.Sharma, (2001), MacMillan India ltd.

Semester III

Course-III (DSE-2)

Course title: Time Series Analysis and Forecasting

Course Credit: 2 (Teaching: 30 hrs/ 36 L)

Course code: 19US3ST3-E2

After completion of this course the student should be able to
CO1: Understand of basic concepts in time series analysis
CO2: Apply the knowledge on real world time series and forecast problems
CO3: Understand various forecasting techniques and knowledge on modern statistical methods for analyzing time series data.
CO4: Understand the fundamental advantage and necessity of forecasting in various situations.
CO5: Know how to choose an appropriate forecasting method in a particular environment.
CO6: Improve forecast with better statistical models based on statistical analysis

Module 1 : Univariate methods in time series (12L)

Learning Objective :

1) To revise basic concepts of time series analysis.
2) To introduce additive and multiplicative model in detail.
3) To introduce different smoothing methods.

Learning Outcome :

At the end of this course, students will be able to:
1) define time series data and its four basic components.
2) Analyse the time series data and can separate the different components of time series.
3) explain the additive and multiplicative models.
4) smooth the given time series data using different smoothing methods.

1.1 Setting the stage

1.2 Simple smoothing methods

1.3 Decomposition method

1.4 Holt's and Winters' smoothing methods

Module II : Regression methods in time series (12L)

Learning Objective :

1) To review simple regression.
2) To introduce coefficient of determination
3) To introduce multiple regression and statistical inference in multiple regression.
4) Variable selection in multiple regression.

Learning Outcome :

At the end of this course, students will be able to:
1) explain simple regression.
2) interpret coefficient of determination.
3) analyse data using multiple regression.
4) understand different variable selection methods in multiple regression.

2.1 Review simple regression

2.2 RMSE and Coefficient of Determination

2.3 Introduction to Multiple Regression

2.4 Statistical Inference in Multiple Regression

2.5 Comparative Analysis Using Regression

2.6 Variable Selection in Multiple Regression

2.7 Model Selection in Regression

2.8 Checking Regression Models

2.9 Autocorrelation in Regression

2.10 ARIMA Models Identification

Module III : Introduction to Time Series Modelling (12L)

Learning Objective :

1) To describe stationary processes and need of stationary processes.

2) To introduce autocovariance, autocorrelation functions and partial autocorrelation function.
3) To introduce Autoregressive Integrated Moving Average (ARIMA) models.

Learning Outcome :

At the end of this course, students will be able to:
I) explain stationary processes: strict and weak stationary processes.
2) define and estimate autocovariance, autocorrelation coefficients and partial autocorrelation function.
3) plot correlogram and interpret it.
4) get idea about different ARIMA models.
5) explore the properties of AR, MA, ARMA, ARIMA models
5) make proper choice of models for further studies.

3.1 ARMA Models

3.2 Identification of ARMA models

3.3 ARIMA Models

3.4 ARIMA Models Identification

3.5 Building better models from ARIMA

3.6 Parameter Estimation and Diagnostic checking

3.7 Forecast using ARIMA models

3.8 Modelling Seasonal Data

3.9 Intervention Analysis

Practical Sem-III

Course Code (DSE II): 19US4STP

Paper- III

- Practical based on univariate methods
- Practical based on regression methods
- Practical based on ARIMA Models

REFERENCES:

- "Forecasting and Time Series", 4th Edition, by Bowerman and O'Connell, Duxbury

Semester IV

Course-I

Course title: Probability and Sampling distributions

Course Credit: 2 (Teaching: 30 hrs/ 36 L)

Course code: 19US4ST1

At the end of the course a student will be able to:

CO1: Recognize the importance of the central limit theorem and understand when it is appropriate to use normal approximations for the distribution of a statistic
CO2: Know the most widely used continuous probability distributions such as rectangular, normal, beta type I and II, gamma, chi-square, t and F and recognize them in applications.
CO3: Construct exact and approximate confidence intervals.

Module 1 : Rectangular, Normal, Beta distribution (12L)

Learning Objective :

1. To know the most widely used continuous probability distributions such as rectangular, normal, beta type I and II, gamma
2. Recognize the importance of the central limit theorem and understand when it is appropriate to use normal approximations for the distribution of a statistic

Learning Outcome :

1. A student will be able to understand the relationship between various transformations of the random variables following normal, beta type I and II, gamma
2. A student will be able to apply Central Limit Theorem to the suitable situation

1.1 Rectangular distribution:

Definition, MGF, mean, variance

1.2 Normal distribution:

Definition, MGF, CGF, Mean, Median, Mode, Standard deviation, Moment Generating function, Cumulant Generating function, Moments & Cumulants (up to fourth order), odd and even ordered central moments, skewness & kurtosis, Mean absolute deviation, distribution of linear function of independent Normal variables. Fitting of Normal Distribution.

1.3 Central Limit theorem for i.i.d. random variables with proof.

1.4 Beta distribution of type I:

Definition, raw moments, mean, variance, mode

1.5 Beta distribution of type II:

Definition, raw moments, mean, variance, mode, inter-relations between beta type I and type II distributions

Module 2 : Exponential, Gamma, Chi-square distribution (12L)

Learning Objective :

1. To learn the various forms of the exponential, Gamma and chi-square distributions
2. To learn various applications of chi square distribution

Learning Outcome :

- A student will be able to relate the exponential, Gamma and chi square distribution by changing the parameters appropriately
- A student will be able to apply chi square test

2.1 Exponential distribution:

Definition, moments, MGF, CGF, mean, mode, variance, skewness and kurtosis, memory less property

2.2 Gamma distribution (with Single & Double parameter)

Definition, raw moments, mean, variance, mode, MGF, CGF, skewness and kurtosis, Distribution of X+Y, X/Y, X/ (X + Y)

2.3 Chi-Square Distribution:

Definition, Concept of degrees of freedom. Mean, Median, Mode, variance, MGF, CGF, additive property, Sampling distributions of sample mean and sample variance and their independence for a sample drawn from Normal distribution, distribution of U / V, U / (U+V) where U and Y are independent chi square variates.

2.4 Applications of Chi-Square:

Confidence interval for the variance of a Normal population, Test of significance for specified value of variance of a Normal, population. Test for goodness of fit, Test for independence of attributes.

Module 3 : t-distribution and F distribution (12L)

Learning Objective :

1. To learn probability distribution of t and F variate
2. To learn various applications of t and F distributions

Learning Outcome :

1. A student will be able to apply t and F distributions as per the demand of the problem

3.1 t-distribution:

Definition, derivation, Mean, Median, Mode, variance, MGF, CGF, odd and even ordered central moments, asymptotic properties, Student's t.

3.2 Applications of t:

Confidence interval for: Mean of Normal population, difference between means of two independent Normal populations having the same variance, test of significance of: mean of a Normal population, difference in means of two Normal populations based on: (i) independent sample s with equal variances.(ii) unequal variances.

3.3F-distribution:

Definition, derivation of the distribution, MGF, CGF, Mean, Mode, variance. Distribution of: Reciprocal of an F variate. Interrelationship of F with: t-distribution, Chi-square distribution & Normal distribution.

3.4 Applications of F:

Confidence interval for ratio of variances of two independent Normal populations, Test for equality of variances of two independent Normal populations.

Practical Sem-IV

Course Code: 19US4STP

Paper- I

1 Rectangular distribution,
2 Normal Distribution.
3 Central Limit Theorem.
4 Beta distribution of type I and II
5 Exponential distribution
6 Gamma distribution.
7 chi-square distribution
8 t distribution.
9 F distribution.

References and Additional Reading:

1.Introduction to the theory of statistics: A. M. Mood, F.A. Graybill, D. C. Boyes, Third Edition; McGraw-Hill Book Company.

2.Introduction to Mathematical Statistics: R.V.Hogg, A.T. Craig; Fourth Edition; Collier McMillan Publishers.

3.John E. Freund's Mathematical Statistics: I. Miller, M. Miller; Sixth Edition; Pearson Education Inc.

4.Introduction to Mathematical Statistics: P.G. Hoel; Fourth Edition; John Wiley & Sons Inc.

5.Fundamentals of Mathematical Statistics: S.C. Gupta, V.K. Kapoor; Eighth Edition; Sultan Chand & Sons.

6.Mathematical Statistics: J.N. Kapur, H.C. Saxena; Fifteenth Edition; S. Chand & Company Ltd.

7.An Outline of Statistical Theory Vol. 1: A.M. Goon, M.K. Gupta, B. DasGupta; Third Edition; TheWorldPress Pvt. Ltd.

8.Statistical Methods Using R Software :V. R. Pawagi and Saroj A. Ranade ;Nirali Publications.

9. Statistics Using R. S. G. Purohit, S. D. Gore, and S. R. Deshmukh. Narosa Publishing House.

Semester IV

Course-II

Course title: Analysis of variance and Design of experiments

Course Credit: 2 (Teaching: 30 hrs/ 36 L)

Course code: 19US4ST2

After completion of this course the student should be able to
CO1: understand the principles of randomisation, replication, local control and theory of designing experiments
CO2: understand and use the terminology of experimental designs
CO3: present and discuss the concept of an experimental design
CO4: Explore the general theory of factorial and block designs and understand this theory sufficiently to find appropriate designs for specific applications

Module 1 : Introduction to ANOVA-One way and Two way classification (12L)

Learning Objective :

To discuss the concept of fixed effect model with respect to one-way and two-way classification.

Learning Outcome :

Learner will be able to

1. Distinguish between fixed effect & random effect model.
2. Analyse the significance of the factors in case of one-way & two-way classification.
3. Estimate the parameters, various sum of squares, expectation of various sum of squares & variance of the estimators.

1.1 Introduction to Analysis of Variance

Introduction: Use of analysis of variance, Cochran's Theorem. Fixed effect and Random effect model.

1.2 Analysis of variance One-way classification (Fixed Effect Model).

Concept: One way classification with equal & unequal observations per class,

Mathematical Model, Assumptions, Hypothesis to be tested.

Estimation: Least square estimators of the parameters, Various Sum of Squares,

Expectation of various sums of squares, Variance of the estimators

Analysis: F- test, Analysis of variance table

Post Analysis: Concept of Contrast, S.E., Critical Difference & C.I.

1.3 Analysis of variance Two-way classification (Fixed Effect Model).

Concept: Two-way classification with one observation per cell. Mathematical Model, Assumptions, Hypothesis to be tested.

Estimation: Least square estimators of the parameters, Various Sum of Squares,

Expectation of various sums of squares, Variance of the Estimators

Analysis: F- test, Analysis of variance table.

Post Analysis: Critical Difference

Module 2 : Introduction to designs of experiment, CRD, RBD, BIBD

Learning Objective :

To explain the various concepts & principles in experimental designs.

Learning Outcome :

Learner will be able to

1. Understand the terminologies used in the designs of experiments.
2. Apply the different designs in suitable situations.
3. Estimate the missing values.
4. Compare the efficiency of one design over other.

2.1 Introduction to Design of Experiments.

Concepts: Experiments, Experimental unit, Treatment, Yield, Block, Replicate, Experimental Error, Precision.

Principles of Design of Experiments: Replication, Randomization & Local Control. Choice of size, shape of plots & blocks in agricultural & non-agricultural experiments.

Efficiency of design D1 with respect to design D2.

2.2 Completely Randomized Design (CRD)

Concept of C.R.D.: Mathematical Model, Assumptions, Hypothesis to be tested.

Estimation: Least square estimators of the parameters, Expectation of various sums of squares, Variance of the estimators

Analysis :F-test, Analysis of variance table.

2.3 Randomized Block Design (RBD).

Concept of R.B.D.: Mathematical Model, Assumptions, Hypothesis to be tested.

Estimation: Least square estimators of the parameters, Expectation of various sums of squares, Variance of the estimators

Analysis: F-test, Analysis of variance table.

Efficiency: RBD relative to a CRD.

Missing plot technique: One missing observation in case of RBD.

2.4 Balanced Incomplete Block Design (BIBD).

Concept: Parameters of BIBD, Incidence Matrix, Parametric relations

Symmetry: Necessary & Sufficient Condition, Theorem.

Resolvable BIBD & Affine Resolvable BIBD.

Module 3 : LSD, Factorial experiments

Learning Objective :

To explore the general theory of factorial designs and its applications.

Learning Outcome :

Learner will be able to

1. Differentiate between block designs & factorial designs.
2. Estimate the parameters in case of multiway classification.
3. Calculate the various treatment effects.

3.1 Latin Square Design (LSD).

Concept of C.R.D.: Mathematical Model, Assumptions, Hypothesis to be tested.

Estimation: Least square estimators of the parameters, Expectation of various sums of squares, Variance of the estimators

Analysis: F-test, Analysis of variance table.

Efficiency: Efficiency of the design relative to RBD, CRD.

Missing plot technique: One missing observation in case of LSD.

3.2 Factorial Experiments.

3.3 Concept: Definition, Purpose & Advantages.

2^k Experiments: 2^2, 2^3 Experiments. Calculation of Main & interaction Effects. Yates' method.

Analysis: Analysis of 2^2& 2^3 factorial experiments in RBD & LSD.

Practical Sem-IV

Course Code: 19US4STP

Paper- II

1. One-way Classification
2. Two-way Classification
3. CRD
4. RBD
5. Missing plot RBD
6. LSD
7. Missing plot LSD
8. Factorial Experiments

References and Additional Reading:

1. Experimental Designs: W.G. Cochran and G.M.Cox; Second Edition;John Wiley and Sons.

2. The Design and Analysis of Experiments: Oscar Kempthorne, John Wiley and Sons.

3. Design and Analysis of Experiments: Douglas C Montgomery; 6th Edition; John Wiley & Sons.

4. Design and Analysis of Experiments: M.N.Das and N.C.Giri, 2nd Edition; New Age International (P) Limited;1986.

5. Experimental Design, Theory and Application: Walter T Federer; Oxford & IBH Publishing Co. Pvt. Ltd.

6. Fundamentals of Applied Statistics: S.C.Gupta and V.K.Kapoor; 3rd Edition; Sultan Chand and Sons (2001).

7. Statistical Principles in Experimental Design: B.J. Winer, McGraw Hill Book Company.

Semester IV

Course-III (DSE III)

Course title: Project management and industrial statistics

Course Credit: 2 (Teaching: 30 hrs/ 36 L)

Course code: 19US4ST3-E1

After completion of this course the student should be able to
CO1: Understand the role and application of CPM, PERT for project scheduling
CO2: Know how to compute the critical path and the project completion time
CO3: Understand the concept and need for crashing
CO4: Understand the concepts of statistical process control and quality control
CO5: Draw control charts for attributes and variables
CO6: Understand difference between producer's and consumer's risk
CO7: Understand the concept of acceptance sampling, OC curves
CO8: Understand the concept of data mining

Module 1 : CPM, PERT, Project cost analysis (12L)

Learning Objective :

1) To Understand Project scheduling and applying it.

2) To do Project cost analysis

Learning Outcome :

A student will be able to find Critical path in the project and hence can schedule project accordingly.

1.1 CPM , PERT: Introduction, Basic concepts of network analysis

1.2 Definitions: Activity, Event, Dummy activity, Predecessor and successor activities and events. Rules for drawing network, Fulkerson's Rule. Bar Diagram (Gnatt Chart) and Network Diagram. Slack time and Float times. Critical path Method (CPM), Project evaluation review technique (PERT).

1.3 Project cost analysis

Module II : Control charts, Acceptance sampling (12L)

Learning Objective :

1) Understand problems related to quality in industries and find solution to them statistically.

Learning Outcome :

Student will be able to

I) Find out root cause of the problem

2) Apply statistical techniques to improve quality of the product.

2.1 Control Charts : Meaning and purpose of Statistical Process Control(SPC), quality of the product, need of process control, statistical process control, on line process control methods (control charts) and offline process control methods (Sampling schemes and plans) as lot control method.

2.2 Seven Process Control (PC) Tools of SPC

(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).

2.3 Control Charts

Chance causes and assignable causes of variation statistical basis of control charts.

Criteria for detecting lack of control situations:

(i) A point outside the control limits

(ii) Non random pattern of variation of the following type

(a) A run of seven or more points above or below central line.

(b) Presence of cycle or linear trends etc.

Process quality control of attributes and variables. X , R, p, c, np charts, their uses. p-chart with variable sample size. Problems involving setting up standards for future use.

Process capability Ratio C p , C pk

2.4 Lot Acceptance Sampling Plans by Attributes:

Introduction: Concept of sampling inspection plan, comparison betweenIOO% inspection and sampling inspection.

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.

2.5 Single Sampling Plan: Evaluation of probability of acceptance using (i) Hypergeometric (ii) Binomial (iii) Poisson distributions. Derivation of AOQ and ATI. Graphical determination of AOQL, determination of a single sampling plan

2.6 Double Sampling Plan : Evaluation of probability of acceptance . Derivation of AOQ, ASN and ATI (with complete inspection of second sample). Graphical determination of AOQL.

2.7 Comparison of single sampling plan and double sample plan.

Module III: Data mining (12L)

Learning Objective :

1) Understand data cleaning, data visualization.

2) Understand supervised and unsupervised learning.

3) Classification of data.

Learning Outcome :

Student will be able to clean the data, visualize data and classify it by applying various statistical techniques.

3.1 Data Mining: Data preparation for knowledge discovery: Data understanding and data cleaning tools, Data transformation, Data Discretization, Data Visualization.

3.2: Data Mining Process: CRISP and SEEMA; Concept of training data, testing data and validation of model. Supervised and unsupervised learning techniques: Problem of classification, classification techniques: k nearest neighbor, Naïve Bayes rule for two class problem with only one attribute variable, cluster analysis using k-means with illustration for bivariate data.

Practical Sem-IV

Course Code (DSE III): 19US4STP

Paper- III

1. CPM-PERT: Construction of Network
2. Finding Critical Path. Computing Probability of Project completion
3. Project cost analysis
4. Updating
5. Control Charts for attributes
6. Control Charts for variables
7. Acceptance Sampling Plans
8. Data Mining: k-nearest neighbor technique for classification
   k-means technique for clustering

REFERENCES:

1. Statistical Quality Control: E.L.Grant. 2nd edition, McGraw Hill, (2000)

2. Quality Control and Industrial Statistics: Duncan. 3rd edition, D.Taraporewala sons & company. (1970)

3. Quality Control: Theory and Applications: Bertrand L. Hansen, (1973),Prentice Hall of IndiaPvt. Ltd..

4. PERT and CPM, Principles and Applications: Srinath. 2nd edition, East-west press Pvt. Ltd. (1975)

5. Operations Research: Kantiswaroop and Manmohan Gupta. 4th Edition; S Chand & Sons. (1980)

6. Mathematical Models in Operations Research : J K Sharma, (1989), Tata McGraw Hill

Publishing Company Ltd.

7. Operations Research: S.D.Sharma.11th edition, KedarNath Ram Nath& Company. (2001)

8. Operations Research: H. A.Taha., 6th edition, Prentice Hall of India.(2008)

Semester IV

Course-III (DSE IV)

Course title: Research Methodology

Course Credit: 2 (Teaching: 30 hrs/ 36 L)

Course code: 19US4ST3-E2

After completion of this course the student should be able to

1) Understand some basic concepts of research and its methodologies
2) Understand basic concepts of sampling
3) write a research report and thesis

Module I : Scientific methods and Research Design (12L)

Learning Objective :

1. To familiarize with basic of research and the research process.
2. To introduce with different types of studies
3. To discuss about different Research design

Learning Outcome :

1. Understanding on various kinds of research, objectives of doing research, research process, research designs

1.1 Definition of Scientific Research: Assumptions, Operations and Aims of Scientific Research.

1.2 Research Processes: Conceptual, Empirical and Analytical.

• Phases of Research: Essential Criteria of Scientific Research Method.

1.3 Observational Studies: Descriptive, explanatory, and exploratory, monitoring and evaluative studies.

1.4 Experimental Studies: Pre experimental design, True experimental Design, Pre-test & post-test designs, Follow-up or longitudinal design, Panel Studies.

Module II : Methods of Data Collection (12L)

Learning Objective :

1) To discuss the concepts and procedures of data collection and sampling.

Learning Outcome :

I) Understanding on method of data collection required for project

2.1 Quantitative Methods: Checklist schedules, questionnaire (mail method, interviews through telephone, internet and computers), interview schedule (face-to-face interviews or personal interviews), Questionnaire/interview schedule design and construction: Principles of constructing a questionnaire/ interview schedule, Types of questions, framing of questions (simple, delicate, personal matter), sequencing of sections and questions and Interview techniques.

2.2 Qualitative Method: Walk through and observation (participatory and non-participatory), Social mapping, key informant interview, In-depth interviews, Focus group discussion, content analysis, free listing, pile sorting, projective techniques, mechanical devices (camera, tape recorder), mystery client technique.

2.3 Complete enumeration versus sampling. Concept of sampling unit, sampling frame and sampling design. Sampling methods: Simple random sampling, stratified sampling, systematic sampling, cluster sampling, and purposive sampling. Sampling and non-sampling errors, sample size determination.

Module III : Writing research proposal and report (12L)

Learning Objective :

I) To discuss the different steps involved in writing research proposal and report

Learning Outcome :

I) Understanding on writing a research proposal and report effectively

Purpose of a proposal/report Content of proposal/report: Introduction, Review of Literature, Objectives and conceptual framework, Sources of data, Methods of data collection and analysis, Summary, conclusions and recommendations. Footnotes, References/Bibliography, Appendices and Glossary

Practical Sem-IV

Course Code (DSE IV): 19US4STP

Paper- III

- Research Design-I
- Research Design-II
- Method of data collection
- Data analysis
- Sampling

Reference:

1) R. Kothari (2009): Research Methodology: Methods & Techniques (Second Revised Edition), New Age International Publishers, New Delhi

2) Royce A. Singleton and Bruce C. Straits, (1999): Approaches to Social Research, Oxford, Oxford University Press

3) Mukherji, P.N., (1999): Methodologies in Social Science, Sage Publications, New Delhi.