SOPHIA COLLEGE, (AUTONOMOUS)

Affiliated to

UNIVERSITY OF MUMBAI

Programme: STATISTICS

Programme Code: SBASTT

S.Y.B.A.

2022-23

(Choice Based Credit System with effect from the year 2022-23)

Programme Outline: SYBA (SEMESTER III)

Course Code	Unit No	Name of the Unit	Credits
SBASTT301		STATISTICAL METHODS -1	2
	1	Elementary Probability Theory	
	2	Concept of Discrete random variable and properties of its probability distribution	
	3	Standard Discrete Distributions	
SBASTT302		OPERATIONS RESEARCH AND INDUSTRIAL STATISTICS-1	2
	1	Linear Programming Problem	
	2	Transportation Problem	
	3	Assignment Problem and sequencing	
SBASTTP3		STATISITCS PRACTICAL	2
	1	Statistical Methods-1 based on the syllabus.	
	2	Operations Research And Industrial Statistics -1 based on the syllabus.	

Programme Outline: SYBA (SEMESTER IV)

Course Code	Unit No	Name of the Unit	Credits
SBASTT401		STATISTICAL METHODS -2	2
	1	Continuous random variable and Standard Continuous Distributions.	
	2	Basic Concepts of Sampling and Estimation theory	
	3	Testing of Hypothesis	
SBASTT402		OPERATIONS RESEARCH AND INDUSTRIAL STATISTICS-2	2
	1	PERT& CPM Analysis	
	2	Game Theory	
	3	Decision Theory	
SBASTTP4		STATISTICS PRACTICAL	2
	1	Statistical Methods-2 based on the syllabus.	
	2	Operations Research And Industrial Statistics-2 based on the syllabus.	

Preamble:

In the current context, possessing a solid understanding of various statistical concepts has become crucial. Statisticians are constantly in demand in the software, research, industry, and education sectors. The various statistics course syllabi have been designed so that students can become competent in an extensive spectrum of statistical processes at the completion of each course. These techniques can be applied to further research while also applying statistical tools appropriately to a diversity of data sets in order to derive some reliable results.

Different environments require for different applications of statistics. Quantitative results in various areas of research are referred to as statistics. The study of statistics is an important domain of knowledge that focuses on various techniques of collecting, presenting, analyzing, and interpreting data. It is the science of data-driven learning. The subject provides tools to facilitate decision-making in uncertain situations. Decision-making can be rendered simpler by statistics, which measures uncertainties and chance. In addition to building the foundations for the development of essentially every contemporary field, its descriptive and inferential responsibilities offer a variety of unconventional career possibilities, from financial analysis to sports analysis. The main goal of the curriculum is to get students ready to enter into a promising professional life even after graduation.

Large volumes of data have been processed by computers over the past 20 years, and more complex methods of statistical analysis may be applied efficiently resulting in reliable results. Therefore, a number of fields, including agriculture, business, management, economics, finance, insurance, education, biotechnology, and medical science, among others, rely heavily on statistical techniques and procedures.

Statistics can be divided into three broad categories, (1) descriptive statistics, which summarizes and describes data; (2) inferential statistics, that arrives at decisions about the population based on sample; and (3) operations research, that utilizes statistics in the fields of industrial and management.

PROGRAMME OBJECTIVES

PO 1	To teach students methods for effective data collection, organization, and summarization skills as well as analysis and interpretation approaches.
PO 2	Introduce students to regression analysis to model relationships between variables and make predictions.
PO 3	To provide students with a understanding of fundamental concepts - probability, random variables, and distributions.
PO 4	Encourage students to use statistical techniques to solve practical issues and assess the reliability of statistical findings in order to develop their critical thinking abilities.

PROGRAMME SPECIFIC OUTCOMES

PSO 1	The learner will be able to understand the fundamentals of statistics, including the key concepts of probability theory, probability distributions, distribution theory, statistical inference, significance testing, and operations research.
PSO 2	The learner will be able apply the concepts taught in the practicals and will be able to analyse and evaluate data as well as come to reliable conclusions. This will prepare pupils for real-world situations.
PSO 3	Apply statistical, operations research, probability theory, time series, designs of experiments, and other principles to real-world issues.

PSO 4	Know how statistics are used in fields like finance, sociology, science, and economics, among others.

SEMESTER 3

NAME OF THE COURSE	STATISTICAL METHODS -1	
CLASS	SYBA	
COURSE CODE	SBASTT301	
NUMBER OF CREDITS	2	
NUMBER OF LECTURES PER WEEK	3	
TOTAL NUMBER OF LECTURES PER SEMESTER	45	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	50	50
PASSING MARKS	20	20

COURSE OBJECTIVES:

CO 1.	To understand the basic concepts of probability and compute probability in various situations.
CO 2.	To learn the various concepts involved in creating the probability distribution of discrete random variables.
CO 3.	To learn the properties of the standard probability distributions of discrete random variables.
CO 4.	To fit appropriate distribution to the given data sets and interpret the results.

COURSE LEARNING OUTCOMES:

CLO 1.	The learner will be able to differentiate between random and non-random experiments.
CLO 2.	The learner will be able to compute the probabilities of various types of events.
CLO 3.	The learner will be able to understand the concepts of a discrete random variable and its probability distribution.
CLO 4.	The learner will be able to compute different measures of the probability distribution using techniques involving discrete random variables.
CLO 5.	The learner will be able to apply standard discrete probability distributions to data based on real life situations.

UNIT 1	Elementary Probability Theory : (15 LECTURES)
1.1	Trial, random experiment, sample point and sample space.
1.2	Definition of an event. Operation of events, mutually exclusive and exhaustive events.
1.3	Classical (Mathematical) and Empirical definitions of Probability and their properties.
1.4	Theorems on Addition and Multiplication of probabilities.
1.5	Independence of events, pairwise and mutual independence for three event, Conditional probability
1.6	Bayes theorem and its applications.
UNIT 2	Discrete random variable and properties of probability distribution : (15 LECTURES)
2.1	Random variable. Definition and properties of probability distribution and cumulative distribution function of discrete random variable
2.2	Raw and Central moments (definition only) and their relationship.(upto order four).
2.3	Concepts of Skewness and Kurtosis and their uses.
2.4	Expectation and Variance of a random variable. Theorems on Expectation & Variance.
2.5	Concept of Generating function, Moment Generating function, Cumulant Generating function, Probability generating function - M.G.F. and C.G.F- Definition & Properties.
2.6	Joint probability mass function of two discrete random variables, Marginal and conditional distributions. Covariance and Coefficient of Correlation. Independence of two random variables.
UNIT 3	Standard Discrete Probability Distributions (15 LECTURES)
3.1	Discrete Uniform Distribution– Definition, derivation of their mean and variance.
3.2	Bernoulli Distribution, Binomial distribution – Definition and properties, derivation of their mean and variance .
3.3	Poisson distribution – Definition and properties, derivation of their mean and variance. Poisson approximation to Binomial distribution(statement only).
3.4	Hyper geometric distribution- Derivation of their mean and variance, Binomial approximation to hyper geometric distribution(statement only).
3.5	Fitting of distribution.

REFERENCES

- Medhi J. : Statistical Methods, An Introductory Text, Second Edition, New Age International Ltd.
- Agarwal B.L. : Basic Statistics, New Age International Ltd.
- Spiegel M.R. : Theory and Problems of Statistics, Schaum' s Publications series. Tata McGraw-Hill.
- Kothari C.R. : Research Methodology, Wiley Eastern Limited.
- David S. : Elementary Probability, Cambridge University Press.
- Hoel P.G. : Introduction to Mathematical Statistics, Asia Publishing House.
- Hogg R.V. and Tannis E.P. : Probability and Statistical Inference, McMillan Publishing Co. Inc.
- Pitan Jim : Probability, Narosa Publishing House.

- Goon A.M., Gupta M.K., Dasgupta B. : Fundamentals of Statistics, Volume II : The World Press Private Limited, Calcutta.

NAME OF THE COURSE	Operations Research And Industrial Statistics - 1	
CLASS	SYBA	
COURSE CODE	SBASTT302	
NUMBER OF CREDITS	2	
NUMBER OF LECTURES PER WEEK	3	
TOTAL NUMBER OF LECTURES PER SEMESTER	45	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	50	50
PASSING MARKS	20	20

COURSE OBJECTIVES:

CO 1.	To orient students with different optimization techniques which will influence the overall quality of decisions.
CO 2.	To learn different mathematical models for efficient allocation of limited resources
CO 3.	To learn techniques to minimize the cost of transporting goods from different sources to different destinations.
CO 4.	To understand the methods of solving different assignment problems.
CO 5.	To learn techniques to sequence the various jobs in order to minimize the total time taken for processing the jobs.

COURSE LEARNING OUTCOMES:

CLO 1.	The learner will be able to formulate a mathematical model for a given data.
CLO 2.	The learner will be able to solve and find optimum solution to a linear programming problem graphically and using mathematical techniques.
CLO 3.	The learner will be able to obtain the dual model of the given problem.
CLO 4.	The learner will be able to find optimal solutions using various methods to a transportation problem.
CLO 5.	The learner will be able to formulate an assignment problem and solve using Hungarian method.
CLO 6.	The learner will be able to process a solution to a sequencing problem using Johnson's method

UNIT 1	Linear Programming Problem(L.P.P): (15 LECTURES)
1.1	Definition, Mathematical Formulation(Maximization and Minimization) Concepts of Solution, Feasible Solution, Basic Feasible Solution, Optimal solution, Slack, Surplus & Artificial variable
1.2	Standard form, Canonical form
1.3	Graphical Method & Simplex Algorithm to obtain the solution to an L.P.P. Problems

	involving Unique Solution, Multiple Solution, Unbounded Solution and Infeasible Solution.
1.4	Big M method.
1.5	Concept of Duality & its economic interpretation
UNIT 2	Transportation Problem (15 LECTURES)
2.1	Definition, Mathematical Formulation Concepts of Feasible solution, Basic feasible solution, Optimal and multiple solutions.
2.2	Initial Basic Feasible Solution using North-West Corner rule, Matrix Minima Method , Vogel's Approximation Method.
2.3	MODI Method for optimality.
2.4	Problems involving unique solution, multiple solutions, degeneracy, maximization, prohibited route(s) and production costs, Unbalanced Transportation problem.
UNIT 3	Assignment Problem and Sequencing (15 LECTURES)
3.1	Definition, Mathematical formulation. Solution by Hungarian Method. Unbalanced Assignment problems.
3.2	Problems involving Maximization & prohibited assignments
3.3	Travelling salesman problem
3.4	**Sequencing :** Processing n Jobs through 2 and 3 Machines and 2 jobs through m Machines.

REFERENCES

- Schaum Series book in O.R. Richard Broson. 2nd edition Tata Mcgraw Hill Publishing Company Ltd.
- Operations Research: Methods and Problems: Maurice Sasieni, Arthur Yaspan and Lawrence Friedman,(1959), John Wiley & Sons.
- Mathematical Models in Operations Research : J K Sharma, (1989), Tata McGraw Hill Publishing Company Ltd.
- Principles of Operations Research with Applications to Management Decisions: Harvey M. Wagner, 2nd Edition, Prentice Hall of India Ltd.
- Operations Research: S.D.Sharma.11th edition, KedarNath Ram Nath& Company.
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- PERT and CPM, Principles and Applications: Srinath. 2nd edition, East-west press Pvt. Ltd.
- Kantiswarup, P.K. Gupta, Manmohan : Operations Research, Twelth edition, Sultan Chand & sons
- Bronson R. : Theory and problems of Operations research, First edition, Schaum's Outline series
- Vora N. D. : Quantitative Techniques in Management, Third edition, McGraw Hill Companies.
- Bannerjee B. : Operation Research Techniques for Management, First edition, Business Books

NAME OF THE COURSE	STATISTICS PRACTICALS	
CLASS	SYBA	
COURSE CODE	SBASTTP3	
NUMBER OF CREDITS	2	
NUMBER OF LECTURES PER WEEK	6	
TOTAL NUMBER OF LECTURES PER SEMESTER	45	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	20	80
PASSING MARKS	-	40

UNIT 1	STATISTICAL METHODS-1 (15 SESSIONS)
1.1	Probability.
1.2	Discrete Random Variables
1.3	Bi-variate Probability Distributions.
1.4.	Binomial distribution
1.5	Poisson distribution
1.6	Hyper geometric distribution
1.7	Practicals Using EXCEL and R- Binomial, Poisson, Hyper geometric distribution
UNIT 2	Operations Research And Industrial Statistics -1 (15 SESSIONS)
2.1	Formulation and Graphical Method
2.2	Simplex Method
2.3	Transportation
2.4	Assignment
2.5	Sequencing

ASSESSMENT DETAILS:

Internal Assessment (50 marks)

One written test of 25 mark and one project work of 25 mark will be conducted.

Semester End Examination – External Assessment (50 marks)

At the end of the semester, Theory examination of 2 hours duration and 50 marks based on the three units shall be held for each course.

Pattern of **Theory question** paper at the end of the semester for **<u>each course</u>**.

Questions	Sub-questions	Maximum marks

Q1	Part A: two theory sub-questions each one is of 6 marks and attempt any one. Part B: Three sub-questions, each one is of 4 marks and attempt any two.	14 each
Q2		
Q3		
Q4	There shall be 3 sub-questions each one is of 4 marks and attempt any 2.	8
Total marks		50

Practical Assessment (for papers with practicals)

- Practical exam will be held on two days. Each session will be of two hours.
- The students are allowed to write the paper if the attendance for practicals is more than 75%
- To appear in the practical exam, students must bring a properly certified journal.

Programme Outline: SYBA (SEMESTER IV)

Course Code	Unit No	Name of the Unit	Credits
SBASTT401		STATISTICAL METHODS--2	2
	1	Continuous random variable and Standard Continuous Distributions.	
	2	Basic Concepts of Sampling and Estimation theory	
	3	Testing of Hypothesis	
SBASTT402		OPERATIONS RESEARCH AND INDUSTRIAL STATISTICS-2	2
	1	PERT& CPM Analysis	
	2	Game Theory	
	3	Decision Theory	
SBASTTP4		STATISTICS PRACTICAL	2
	1.	Statistical Methods —2 based on the syllabus.	
	2.	Operations Research And Industrial Statistics -2 based on the syllabus.	

SEMESTER 4

NAME OF THE COURSE	STATISTICAL METHODS-2	
CLASS	SYBA	
COURSE CODE	SBASTT401	
NUMBER OF CREDITS	2	
NUMBER OF LECTURES PER WEEK	3	
TOTAL NUMBER OF LECTURES PER SEMESTER	45	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	50	50
PASSING MARKS	20	20

COURSE OBJECTIVES:

CO 1.	To learn the various concepts involved in creating the probability distribution of continuous random variables..
CO 2.	To learn the properties of the standard probability distributions of continuous random variables.
CO 3.	To understand the significance of the normal distributions and its application in data analysis.
CO 4.	To introduce two branches of Statistical Inferential theory – Estimation theory and Testing of hypothesis.
CO 5.	To assess population characteristics on the basis of sample using estimation and hypothesis testing theory

COURSE LEARNING OUTCOMES:

CLO 1.	The learner will be able to create a probability density function and compute the cumulative distribution function for a continuous random variable.
CLO 2.	The learner will be able to apply the properties of standard continuous probability distributions to different data based on situations.
CLO 3.	The learner will be able to distinguish between point estimation and interval estimation of the population parameters.
CLO 4.	The learner will be able to frame a hypothesis and compute the probabilities of error that could arise while testing.
CLO 5.	The learner will be able to test the hypothesis by examining one or two random samples of the population.

UNIT 1	Continuous random variable and Standard Continuous Distributions (15 LECTURES)
1.1	Concept of Continuous random variable and properties of its probability distribution
1.2	Probability density function and cumulative distribution function – Properties and its graphical representation.
1.3	Expectation of a random variable and its properties. Measures of location, dispersion, skewness and kurtosis. Raw and central moments , M.G.F. and C.G.F- Definition and properties.
1.4	Rectangular Distribution- Derivations of mean, median and variance
1.5	Exponential (location scale parameter) - Derivations of mean, median and variance' memory less property of exponential distribution
UNIT 2	Normal Distribution , Sampling and Estimation theory: (15 LECTURES)
2.1	Gaussian (Normal) distribution- Properties of Normal distribution, Normal approximation to Binomial and Poisson distribution(statement only) , Use of normal tables.
2.2	Concept of Parameter and Statistic, estimator and estimate
2.3	Sampling distribution.
2.4	Concept of bias and standard error of an estimator.
2.5	Central Limit theorem (statement only).
2.6	Sampling distribution of sample mean and sample proportion. (For large sample only)
2.7	Standard errors of sample mean and sample proportion.
2.8	Point and Interval estimate (Confidence interval) of single mean, single proportion from sample of large size.
UNIT 3	Testing of hypothesis (15 LECTURES)
3.1	Concept of Statistical hypothesis
3.2	Null and alternate hypothesis
3.3	Simple and Composite Hypothesis
3.4	Types of errors, Critical region, Level of significance.
3.5	Large sample tests (using central limit theorem) • For testing specified value of population mean • For testing specified value in difference of two means • For testing specified value of population proportion • For testing specified value of difference of population proportion
3.6	Application of Chi-Square Distribution: • Test of Goodness of Fit • Contingency Table • Test of independence in a contingency table and Yates Correction • Derivation of a test statistic for a 2 x 2 contingency table.

References:

- Medhi J. : Statistical Methods, An Introductory Text, Second Edition, New Age International Ltd.
- Agarwal B.L. : Basic Statistics, New Age International Ltd.
- Spiegel M.R. : Theory and Problems of Statistics, Schaum' s Publications series.Tata McGraw-Hill.
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- Pitan Jim : Probability, Narosa Publishing House.
- Goon A.M., Gupta M.K., Dasgupta B. : Fundamentals of Statistics, Volume II : The World Press Private Limited, Calcutta.

NAME OF THE COURSE	OPERATIONS RESEARCH AND INDUSTRIAL STATISTICS -2	
CLASS	SYBA	
COURSE CODE	SBASTT402	
NUMBER OF CREDITS	2	
NUMBER OF LECTURES PER WEEK	3	
TOTAL NUMBER OF LECTURES PER SEMESTER	45	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	50	50
PASSING MARKS	20	20

COURSE OBJECTIVES:

CO 1.	To understand the techniques of planning , scheduling and controlling the various factors of different activities of a project.
CO 2.	To be acquainted with skills in strategy planning and decision making.
CO 3.	To learn the techniques of evaluating the different options available for performing a task.
CO 4.	To analyze situations in which players make decisions that puts them in the most preferred position.
CO 5.	To learn to create and evaluate different strategies involved in planning using techniques of game theory.

COURSE LEARNING OUTCOMES:

CLO 1.	The learner will be able to construct activity networks for the project using probabilistic and deterministic time estimates
CLO 2.	The learner will be able to identify the critical activities of the project using different techniques
CLO 3.	The learner will be able to optimize the project cost and time (any two variables).

CLO 4.	The learner will be able to update the project schedule after incorporating the changes in various factors of the activities.
CLO 5.	The learner will be able to distinguish between pure strategy and mixed strategy game and finding optimum game strategy.
CLO 6.	The learner will be able to understand different decision –making models and make effective decisions.

UNIT 1	CPM and PERT (15 LECTURES)
1.1	Concept of project as an organized effort with time management.
1.2	Objective and Outline of the techniques.
1.3	Diagrammatic representation of activities in a project.
1.4	Gantt Chart and Network Diagram.
1.5	Slack time and Float times. Determination of Critical path.
1.6	Probability consideration in project scheduling.
1.7	Project cost analysis. Updating.
UNIT 2	Game Theory: (15 LECTURES)
2.1	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.
2.2	Graphical solution of (2xn) and (mx2) games. Reduction of game theory to LPP
UNIT 3	Decision Theory (15 LECTURES)
3.1	Decision making under uncertainty: Laplace criterion, Maximax (Minimin) criterion, Maximin (Minimax) criterion, Hurwitz α criterion, Minimax Regret criterion. Decision making under risk: Expected Monetary Value criterion, Expected Opportunity Loss criterion, EPPI, EVPI.
3.2	Bayesian Decision rule for Posterior analysis.
3.3	Decision tree analysis along with Posterior probabilities.

REFERENCES

- Schaum Series book in O.R. Richard Broson. 2nd edition Tata Mcgraw Hill Publishing Company Ltd.
- Operations Research: Methods and Problems: Maurice Sasieni, Arthur Yaspan and Lawrence Friedman,(1959), John Wiley & Sons.
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NAME OF THE COURSE	STATISTICS PRACTICALS	
CLASS	SYBA	
COURSE CODE	SBASTTP4	
NUMBER OF CREDITS	2	
NUMBER OF LECTURES PER WEEK	6	
TOTAL NUMBER OF LECTURES PER SEMESTER	45	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	20	80
PASSING MARKS	-	40

UNIT 1	STATISTICAL METHODS-2 (15 SESSIONS)
1.1	Continuous Random Variables
1.2	Uniform and Exponential distribution
1.3	Normal Distribution
1.4.	Estimation and Sampling Theory
1.5	Testing of Hypothesis
1.6	Test of Significance
1.7	Practicals Using EXCEL and R
UNIT 2	Operations Research And Industrial Statistics -2 (15 SESSIONS)
2.1	CPM-Drawing Network
2.2	CPM- Determination of Critical Path and related problems
2.3	PERT
2.4	Game Theory-1
2.5	Game Theory -2
2.6	Decision Theory Under Uncertainty
2.7	Decision Theory Under Risk
2.8	Decision Tree Analysis

ASSESSMENT DETAILS:
Internal Assessment (50 marks)

One written test of 25 mark and one project work of 25 mark.

Semester End Examination – External Assessment (50 marks)

At the end of the semester, Theory examination of 2 hours duration and 50 marks based on the three units shall be held for each course.

Pattern of **Theory question** paper at the end of the semester for **<u>each course</u>**.

Questions	Sub-questions	Maximum marks
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Q2		
Q3		
Q4	There shall be 3 sub-questions each one is of 4 marks and attempt any 2.	8
Total marks		50

Practical Assessment (for papers with practicals)

- Practical exam will be held on two days. Each session will be of two hours.
- The students are allowed to write the paper if the attendance for practicals is more than 75%
- To appear in the practical exam, students must bring a properly certified journal.