



BHARATHIDASAN UNIVERSITY, TIRUCHIRAPPALLI - 620 024

B.Sc. STATISTICS

Choice Based Credit System -

Learning Outcomes Based Curriculum Frame Work (CBCS - LOCF)

(Applicable to the candidates admitted from the academic year 2026-27 onwards)

Sem.	Part	Course	Title	Ins. Hrs	Credit	Exam Hours	Marks		Total
							Int.	Ext.	
I	I	Ability Enhancement Course - I (AEC - I)	(Tamil\$/Other Languages+#)	6	3	3	30	70	100
	II	Ability Enhancement Course - II (AEC - II)	English Course - I	6	3	3	30	70	100
	III	Core Course - 1 (CC 1)	Descriptive Statistics	4	4	3	30	70	100
		Core Practical - 1 (CP 1)	Statistics Practical - I	4	4	3	40	60	100
		Allied Course - 1 (AC 1)	Mathematics	4	4	3	30	70	100
		Allied Practical - 1 (AP 1)	Mathematics	2	**	**	**	**	**
	IV	Value Education		2	2	3	30	70	100
		Interdisciplinary Course - 1 (IDC 1) #	One Course from Outside Department	2	2	3	30	70	100
TOTAL				30	22	-	-	-	700
II	I	Ability Enhancement Course - III (AEC - III)	(Tamil\$/Other Languages+#)	6	3	3	30	70	100
	II	Ability Enhancement Course - IV (AEC - IV)	English Course -II	6	3	3	30	70	100
	III	Core Course - 2 (CC 2)	Probability Theory	4	4	3	30	70	100
		Core Practical - 2 (CP 2)	Statistics Practical - II	4	4	3	40	60	100
		Allied Course - 2 (AC 2)	Mathematics	4	4	3	30	70	100
		Allied Practical - 1 (AP 1)	Mathematics	2	4	3	40	60	100
	IV	Skill Enhancement Course - 1 (SEC 1) ##	Naan Mudhalvan Course / SEC (List Enclosed)	2	2	3	30	70	100
		Interdisciplinary Course - 2 (IDC 2) #	One Course from Outside Department	2	2	3	30	70	100
TOTAL				30	26	-	-	-	800

III	I	Ability Enhancement Course - V (AEC - V)	(Tamil\$/Other Languages+#)	6	3	3	30	70	100
	II	Ability Enhancement Course - VI (AEC - VI)	English Course - III	6	3	3	30	70	100
	III	Core Course - 3 (CC 3)	Theoretical Discrete Distributions	4	4	3	30	70	100
		Core Practical - 3 (CP 3)	Statistics Practical - III	4	4	3	40	60	100
		Allied Course - 3 (AC 3)	Statistical Computation using R	4	4	3	30	70	100
		Allied Practical - 2 (AP 2)	Statistical Computation using Python	2	**	**	**	**	**
	IV	Skill Enhancement Course - 2 (SEC 2) ##	Naan Mudhalvan Course / SEC (List Enclosed)	2	2	3	30	70	100
		Interdisciplinary Course - 3 (IDC 3) \$\$	One Course from Outside Department	2	2	3	30	70	100
		Health and Wellness @		-	1	-			100
TOTAL			30	23	-	-	-	800	
IV	I	Ability Enhancement Course - V (AEC - V)	(Tamil\$/Other Languages+#)	6	3	3	30	70	100
	II	Ability Enhancement Course - VI (AEC - VI)	English Course - III	6	3	3	30	70	100
	III	Core Course - 4 (CC 4)	Theoretical Continuous Distributions	4	4	3	30	70	100
		Core Practical - 4 (CP 4)	Statistics Practical - IV	4	4	3	40	60	100
		Allied Practical - 2 (AP 2)	Statistical Computation using Python	2	4	3	40	60	100
		Allied Practical - 3 (AP 3)	Statistical Data Analysis using R	4	4	3	40	60	100
	IV	Skill Enhancement Course - 3 (SEC 3) ##	Naan Mudhalvan Course / SEC (List Enclosed)	2	2	3	30	70	100
		Interdisciplinary Course - 4 (IDC 4) \$\$	One Course from Outside Department	2	2	3	30	70	100
	TOTAL			30	26	-	-	-	800

V	III	Core Course - 5 (CC 5)	Design of Experiments	4	4	3	30	70	100
		Core Course - 6 (CC 6)	Statistical Inference - I	5	4	3	30	70	100
		Core Course - 7 (CC 7)	Sampling Theory	5	4	3	30	70	100
		Core Course - 8 (CC 8) (Any one)	1. Statistical Quality Control (or) 2. Official Statistics	5	4	3	30	70	100
		Core Practical - 5 (CP 5)	Statistics Practical - V	5	4	3	40	60	100
	IV	Skill Enhancement Course - 4 (SEC 4)	Any one from the List (List Enclosed)	2	2	3	30	70	100
		Skill Enhancement Course - 5 (SEC 5) ##	Naan Mudhalvan Course / SEC (List Enclosed)	2	2	3	30	70	100
		Introduction to Disaster Management		2	2	3	30	70	100
		Summer Internship / Industrial Activity @@	(with Viva-Voce)	-	2	-	20	80	100
	TOTAL			30	28	-	-	-	900
VI	III	Core Course - 9 (CC 9)	Statistical Inference - II	4	4	3	30	70	100
		Core Course - 10 (CC 10)	Operations Research	5	4	3	30	70	100
		Core Practical - 6 (CP 6)	Statistics Practical - VI	5	4	3	40	60	100
		Core Project Work	Project Work (with Viva- Voce)	6	4	3	20	80	100
	IV	Value Added Course	General Studies for Competitive Examinations	2	1	-	30	70	100
		Skill Enhancement Course - 6 (SEC 6)	Any one from the List (List Enclosed)	2	2	3	30	70	100
		Skill Enhancement Course - 7 (SEC 7) ##	Naan Mudhalvan Course / SEC (List Enclosed)	2	2	3	30	70	100
		Environmental Studies		2	2	3	30	70	100
		Gender Studies		2	1	3	30	70	100
		Extension Activities*		-	1	-	-	-	-
	TOTAL			30	25	-	-	-	900
GRAND TOTAL			180	150	-	-	-	4900	

List of Allied Courses: Mathematics

First Year	Second Year
1. Mathematics	1. Statistical Computation using R 2. Statistical Computation using Python (Practical) 3. Statistical Data Analysis using R (Practical)

SKILL ENHANCEMENT COURSE (SEC)			
Sl. No.	Title of paper	Sl. No.	MANDATORY Naan Mudhalvan Scheme ##
1.	Introduction to Machine Learning	1.	2nd Semester
2.	Introduction to Big Data Analytics	2.	3rd Semester
3.	Introduction to Data Science	3.	4th Semester
4.	Introduction to Biostatistics	4.	5th Semester
5.	Demography	5.	6th Semester
6.	Time Series and Index Numbers		
7.	Regression Analysis		

INTERDISCIPLINARY COURSE (IDC) FOR WHO HAVE OPT TAMIL AS PART-I (for other Department Students only)	
1st Semester	Quantitative Aptitude - I
2nd Semester	Quantitative Aptitude - II
3rd Semester	Statistics for Competitive Examinations - I
4th Semester	Statistics for Competitive Examinations - II

INTERDISCIPLINARY COURSE (IDC) # FOR WHO HAVE NOT OPT TAMIL AS PART-I		
Those who have studied Tamil up to 10 th + 2 but opt for other languages in degree	1st Semester	Special Tamil - I
	2nd Semester	Special Tamil - II
Those who have not studied Tamil in school level	1st Semester	Basic Tamil - I
	2nd Semester	Basic Tamil - II
Those students who opt for either special Tamil (or) Basic Tamil as IDCs, have to choose 2 more IDCs courses in their 3 rd and 4 th Semester from Outside his/her department.		

INTERDISCIPLINARY COURSE (IDC) \$\$ FOR NCC CADETS ONLY	
NCC Course is a Compulsory Course for the NCC Cadets in the 3rd Semester:	NCC Course is a Compulsory Course for the NCC Cadets in the 4th Semester:
Introduction to NCC	1. Special Subject Army (or) 2. Special Subject Navy (or) 3. Special Subject Air force
Those students who opt for NCC Courses as IDCs, have to choose 2 more IDCs courses in their 1st and 2nd Semester from Outside his/her department.	

Summary of Curriculum Structure of UG Programmes

Sl. No.	Part	Types of the Courses	No. of Course s	Credits for each Course	No. of Credits	Marks
1.	I	Ability Enhancement Course	4	3	12	400
2.	II	Ability Enhancement Course	4	3	12	400
3.	III	Core Course	10	4	40	1000
4.		Core Practical	6	4	24	600
5.		Allied Course (AC)	3	4	12	300
6.		Allied Practical (AP)	3	4	12	300
7.		Core Project Work (CPW)	1	4	4	100
8.	IV	Skill Enhancement Course (SEC)	7	2	14	700
9.		Interdisciplinary Course (IDC)	4	2	8	400
10.		Value Education	1	2	2	100
11.		Health and Wellness	1	1	1	100
12.		Introduction to Disaster Management	1	2	2	100
13.		Summer Internship / Industrial Activity	1	2	2	100
14.		Value Added Course	1	1	1	100
15.		Environmental Studies	1	2	2	100
16.		Gender Studies	1	1	1	100
17.		Extension Activities (NCC / NSS / Sports / Anti Drug Cell / YRC & Any Other Activities)	--	1	1	--
	Total		49	--	150	4900

\$ For those who have studied Tamil upto 10th +2 (Regular Stream)

+ Syllabus for other Languages should be on par with Tamil at degree level

Those who have studied Tamil upto 10th +2 but opt for other languages in degree level under Part - I should study special Tamil and those who have not studied Tamil in the school level should study Basic Tamil in Part – IV under the Interdisciplinary Course.

** Examination at the end of the next semester

Naan Mudhalvan Scheme: As per the Naan Mudhalvan Scheme instructions, 5 courses from 2nd to 6th semester should be studied under Skill Enhancement Course.

\$\$ NCC Course is one of the Choices in the Interdisciplinary Course. Only the NCC Cadets are eligible to choose this course. However, NCC Course is a Compulsory Course for the NCC Cadets.

@ Health and Wellness: Assessments:

- Use self-reflective worksheets to assess their understanding
- submit the worksheets to internal audit / external audit
- Every student's activity report should be documented and the same have to be assessed by the Physical Director with Mentor. The evaluation should be for 100 marks. No examination is required.

Scheme of Evaluation:

Part	Description	Marks
A	Report	40
B	Attendance	20
C	Activities (Observation During Practice)	40
Total		100

@@ Summer Internship / Industrial Activity

Internship will be carried out during the summer vacation after the second year. Viva-Voce will be conducted by the college and Marks shall be sent to the University and the same will be included in the 5th semester Mark Statement.

Summer Internship / Industrial Activity & Project Work

Scheme of Evaluation:

Description	Marks
Report	80
Viva-Voce	20
Total	100

*

Extension Activities shall be outside instruction hours.

PROGRAMME OUTCOMES:

The Courses in the Department of Statistics will enable the student

- To develop the skills to analyze complex statistical data coming from the various fields like industry, marketing, finance, agriculture and business.
- To implement data analysis strategies to develop efficient models for various theoretical postulations.
- Understand the intricacies of statistical testing and its applications in real life problems.
- To develop, design and analyze experiments in empirical research.
- To develop soft skills and practicing professional ethics.
- Analyze every large data set in the context to real-world problems and interpret results using data analytics.
- Understand the optimization and computational techniques for the solution of the real-life problems.

COURSE OUTCOMES:

- Each course, in all the Programmes, has been designed and kept in accordance with the instructions of UGC and fulfills the requirements of the academic and industrial needs. By opt these courses students may be able to qualify the various esteemed competitive examinations like CSIR-NET, UGC-NET, GATE, ISS, IAS, PCS and many others.
- These programmes offered by the department are highly employable and enable the students to take positions in various Institutes / Universities/ Industries for research and development and serve the society.

PROGRAM SPECIFIC OUTCOME:

- The courses in the Department are designed to in calculate analytic and decision-making aptitude among the students. Having an advanced and upgraded knowledge of Statistics from both the theoretical and practical aspects, the students who pass out are well equipped in managing and analyzing various types of data. The education imparted in Statistics is aimed to inculcate statistical thinking in young minds for better future planning and welfare of society and to contribute to the society through excellence in statistical education and research.
- Students after completing these courses may be able to start their career with various Academia and Industry Interface. It may provide a platform to all the students to get experiential learning in this material world. The students may also able to develop decision making problems and suggest the best solution to attain the decision in R&D sector jobs.

PO1	Communication Skill: Mandatory language courses facilitate to become proficient in communication, culturally aware, and more employable in both Indian and global contexts. Improve presentations skill, debates, and professional communication.
PO2	Disciplinary Knowledge: Learn in-depth complex scientific concepts, demonstrate their ability to explain and apply their knowledge. Consistent in learning by earning extra credits in specialized courses within the science domain and enhance disciplinary knowledge.
PO3	Critical thinking: Field and academic visits will help students to develop observation skills, grasping ability, collect and interpret data and propose models that will help them to understand hypotheses and conclusions.
PO4	Analytical Reasoning: Through interactions, students will develop skills of critical reading of texts, identifying gaps in knowledge, formulating scientific questions, and on will recognizing the synthesis of new ideas.
PO5	Scientific Reasoning: Skill oriented courses will provide details on principles, conduct of proper calibration and use of scientific instrumentation and appropriate use of scientific techniques in experimental design.
PO6	Self-directed Learning: Preparation of field reports helps them to present their results and discussion in a written format that is typically required for their future professions.
PO7	Reflective Thinking: All core courses with laboratory components will provide exposure to a wide range of research techniques, therein enhancing their understanding of the application of techniques in their domain.
PO8	Problem Solving: Students will develop the ability to reason, apply numerical concepts, and equations in their fields of study for interpreting scientific data and drawing relevant scientific conclusions.
PO9	Research-related Skills: Students undertaking a internship will have the opportunity to design, develop and execute their own research ideas in their experiments, thus expanding their knowledge of research methods and laboratory skills.
PO10	Lifelong Learning: Ability to understand the gaps in knowledge and skill, adapt to technological change, engage in self-directed learning.

First Year	Core Course 1	Semester I
Code:	DESCRIPTIVE STATISTICS (Theory)	Credits: 4
COURSE OBJECTIVES:		
The learning objectives include: • To summarize the data and to obtain its salient features from the vast mass of actual data. • To visualize the data through graphical and diagrammatic representations. • To analyze univariate and bivariate data. • To understand the concept of comparative analysis and linearity.		
UNIT-I: Introduction to Statistics Meaning - Definition - Importance - Scope - Functions - Limitations. UNIT-II: Diagrammatic and Graphical Representation Diagrammatic representations of data - Bar diagrams, Simple, Component, Multiple and Percentage, Pie diagrams. Graphical representations - Histogram, Frequency Curve, Frequency Polygon and Ogives (Construction and Uses). UNIT-III: Measures of Central Tendency Measures of Central Tendency - Arithmetic Mean, Median, Mode, Geometric Mean and Harmonic Mean - Derivation of their properties, Merits and Demerits and Problems. UNIT-IV: Measures of Dispersion Measures of dispersion - Range, Quartile deviation, Mean deviation, Standard deviation and Coefficient of variation. Skewness - Concept, Measures of skewness - Karl Pearson's and Bowley's coefficient of skewness. Moments - Raw and Central. Kurtosis - Concept and Measures of Kurtosis and Problems. UNIT-V: Correlation and Regression Correlation - Definitions, Types and Properties of Correlation Coefficient (Statement and Proof). Scatter diagrams, Karl Pearson's co-efficient of correlation and Spearman's rank correlation. Regression lines and its properties - Uses and Problems. UNIT-VI: Current Contours (For Continuous Internal Assessment Only) Case study and Problems relating to all the above units. Expert lectures, Seminars - Webinars.		
REFERENCES:		
1. Gupta S.C. and Kapoor V.K. (2013), Fundamentals of Mathematical Statistics. Sultan Chand & Sons, New Delhi. 2. Gupta S.P. (1995), Statistical Methods, Sultan Chand & Sons, New Delhi.		

COURSE OUTCOMES:

On the successful completion of the course, students will be able to,

C01: Concepts of statistical population and sample, variables and attributes.

C02: Tabular and graphical representation of data based on variables.

C03: Conditions for the consistency and criteria for the independence of data based on attributes.

C04: Measures of central tendency, dispersion, skewness and kurtosis.

C05: Moments and their use in studying various characteristics of data.

Course Outcomes	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10
C01	1	3	2	3	1	1	1	3	1	2
C02	1	3	3	3	2	1	1	3	2	2
C03	1	3	3	3	2	1	2	3	2	2
C04	1	3	3	3	2	1	2	3	2	2
C05	1	3	3	3	2	1	2	3	2	3

First Year	Core Practical 1	Semester I
Code:	STATISTICS PRACTICAL - I (Practical)	Credits: 4
COURSE OBJECTIVES:		
The learning objectives include: • Definition and scope of Statistics, concepts of statistical population and sample. • Quantitative and qualitative data in attributes, variables, • Scale of measurements in nominal, ordinal, interval and ratio. • Tabular and graphical presentation on histogram and ogives. • Calculation of the quartile, mean and standard deviations, skewness and correlation.		
PRACTICAL PROBLEMS:		
• Diagrammatic representations of data: Bar diagrams, Simple, Component, Multiple and percentage, Pie diagrams. • Graphical representations: Histogram, Frequency Curve, Frequency Polygon and Ogives. • Measures of Central Tendency: Arithmetic Mean, Median, Mode, Geometric Mean and Harmonic Mean for raw and grouped data. • Measures of Dispersion: Quartile, Mean and Standard Deviations and their coefficients. • Measures of Skewness: Karl Pearson's and Bowley's coefficient of skewness. • Measures of Kurtosis: Calculation of measures of kurtosis. • Calculation of Coefficient of Correlation: Karl Pearson's and Spearman's Rank. • Finding the two regression equations X on Y and Y on X, and estimating unknown values of X and Y.		
REFERENCES:		
1. Gupta S.C. and Kapoor V.K. (2013), Fundamentals of Mathematical Statistics. Sultan Chand & Sons, New Delhi. 2. Gupta S.P. (1995), Statistical Methods, Sultan Chand & Sons, New Delhi.		

COURSE OUTCOMES:

Upon successful completion of this course the students would be able:

CO1: Tabular and graphical representation of data based on variables.

CO2: Conditions for the consistency and criteria for the independence of data based on attribute.

CO3: Measure of central tendency, dispersion, skewness and kurtosis.

CO4: Moments and their use in studying various characteristics of data.

CO5: Calculate the quartile, mean and standard deviations, skewness and correlation.

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	3	2	3	1	1	1	3	1	2
CO2	1	3	3	3	2	1	1	3	2	2
CO3	1	3	3	3	2	1	2	3	2	2
CO4	1	3	3	3	2	1	2	3	2	2
CO5	1	3	3	3	2	1	2	3	2	3

First Year	INTERDISCIPLINARY COURSE 1	Semester I
Code:	QUANTITATIVE APTITUDE - I (Theory)	Credits:2
COURSE OBJECTIVES:		
• To understand the properties of numbers and apply HCF and LCM techniques in problem-solving. • To develop accuracy and efficiency in solving problems involving decimal fractions and simplification. • To apply concepts of square roots, cube roots, and averages in quantitative aptitude problems. • To analyse and solve problems related to numbers and ages using logical reasoning and mathematical methods. • To understand and apply concepts of surds, indices, and percentages in practical and competitive examination problems.		
UNIT-I: Numbers - H.C.F and L.C.M. of Numbers. (Chapter – 1 & 2)		
UNIT-II: Decimal Fractions – Simplification. (Chapter – 3 & 4)		
UNIT-III: Square Roots and Cube Roots – Average. (Chapter – 5 & 6)		
UNIT-IV: Problems on Numbers - Problems on Ages. (Chapter – 7 & 8)		
UNIT-V: Surds & Indices – Percentage. (Chapter – 9 & 10)		
REFERENCES: 1. R.S. Aggarwal (2010), Quantitative Aptitude for Competitive Examinations, S.Chand Co. Ltd., Chennai. 2. Abhijit Guha (2005), Quantitative Aptitude, Tata McGraw Hill Publishing Company Limited, New Delhi. 3. https://nptel.ac.in		

COURSE OUTCOMES:

On the successful completion of the course, students will be able to,

CO1: Understand number systems and compute H.C.F and L.C.M of numbers for arithmetic problem solving.

CO2: Apply decimal fractions and simplification techniques in numerical computations.

CO3: Solve problems involving square roots, cube roots and averages using arithmetic methods.

CO4: Analyse and solve problems related to numbers and ages using logical and arithmetic reasoning.

CO5: Apply concepts of surds, indices and percentages in mathematical and practical applications.

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	3	2	3	1	1	1	3	1	2
CO2	1	3	3	3	2	1	1	3	2	2
CO3	1	3	3	3	2	1	2	3	2	2
CO4	1	3	3	3	2	1	2	3	2	2
CO5	1	3	3	3	2	1	2	3	2	3

First Year	Core Course 2	Semester II
Code:	PROBABILITY THEORY (Theory)	Credits: 4
COURSE OBJECTIVES: The learning objectives include: • The purpose is to familiarize the students about the basic concepts required for further studies of advanced curriculum. • Enable the students to understand and study random phenomena mathematically. • To understand the concept of probability and random variables and its applications.		
UNIT-I: Introduction to Probability Concept of Random experiment - Trial - Sample point - Sample space, Event, Algebra of events, Mutually exclusive - Exhaustive events. Definition of probability, Classical, Statistical and Axiomatic approach - Properties of probability, Theorems on probability - Addition theorem of probability - Conditional probability - Multiplication theorem - Baye's theorem - simple problems.		
UNIT-II: Univariate Random Variable Concept of Random variables - Discrete and Continuous random variables, Probability mass function - Probability density function. Distribution function - properties - Simple problems.		
UNIT-III: Bi-variate Random variable Bi-variate distribution - Distribution function of bi-variate random variable and its properties - Joint probability and density functions - Marginal and Conditional distributions - Independence of random variable - Simple problems.		
UNIT-IV: Mathematical Expectation Mathematical expectation - Discrete and Continuous random variables - Properties - Moments - Variance - Properties - Covariance - Simple problems.		
UNIT-V: Generating Functions Moment generating function - Properties and uses - Cumulants - Characteristic functions - Properties - Simple examples - Inversion theorem and Uniqueness theorem - statement only.		
UNIT-VI: Current Contours (For Continuous Internal Assessment Only) Industry Expert Lecture.		
REFERENCES: 1. Gupta S.C. and Kapoor V.K. (2013), Fundamentals of Mathematical Statistics. Sultan Chand & Sons, New Delhi. 2. Kapur J.N. and Saxena H.C. (1989), Mathematical Statistics, Sultan Chand & Sons, New Delhi. 3. Marek. Fisz, (1961), Probability Theory and Mathematical Statistics, John Wiley and Sons.		

COURSE OUTCOMES:

On the successful completion of the course, students will be able to,

CO1: After completing this course, there should be a clear understanding.

CO2: The fundamental concept of expectation for univariate and bivariate random variables with their distributions and properties.

CO3: MGF, Cumulant generating function and characteristic function.

CO4: Discrete probability distributions with their properties.

CO5: Continuous probability distributions with their properties.

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	3	2	3	1	1	1	3	1	2
CO2	1	3	3	3	2	1	1	3	2	2
CO3	1	3	3	3	2	1	2	3	2	2
CO4	1	3	3	3	2	1	2	3	2	2
CO5	1	3	3	3	2	1	2	3	2	3

First Year	CORE PRACTICAL - 2	Semester II
Code:	Statistics Practical - II (Practical)	Credits: 4
COURSE OBJECTIVES: The learning objectives include: • Random experiments. • Classical and axiomatic probability problems. • Calculation of theorem based problems in addition, multiplication and Baye's' theorems. • Calculation of problems on discrete and continuous random variables. • Calculation of bivariate, marginal and conditional distributions in independence of random variable and mathematical expectation.		
PRACTICAL PROBLEMS: • Random experiment: Trial, Sample point and Sample space, Event, Algebra of events and Mutually exclusive and Exhaustive events. • Probability Problems: Classical, Statistical and Axiomatic approach and its properties of probability. • Theorems based problems: Simple problems of addition theorem of probability, Conditional probability, Multiplication theorem and Bayes' theorem. • Problems on Discrete and Continuous random variables: Finding probabilities, Distribution functions and Moments. • Simple problems of Bi-variate distribution: Distribution function of random variable, Joint probability function and Joint probability density function. • Simple problems of Marginal and Conditional distributions in independence of random variable. • Simple problems of mathematical expectation: Discrete and Continuous random variables, Moments, Variance and Covariance.		
REFERENCES: 1. Gupta S.C. and Kapoor V.K. (2013), Fundamentals of Mathematical Statistics. Sultan Chand & Sons, New Delhi. 2. Kapur J.N. and Saxena H.C. (1989), Mathematical Statistics, Sultan Chand & Sons, New Delhi. 3. Marek. Fisz, (1961), Probability Theory and Mathematical Statistics, John Wiley & Sons.		

COURSE OUTCOMES:

On the successful completion of the course, students will be able to,

CO1: The fundamental concept of expectation for univariate with their distributions.

CO2: The fundamental concept of expectation for bivariate random variables with their distributions and properties.

CO3: Moment generating function and characteristic function.

CO4: Cumulant generating function and characteristic function.

CO5: Discrete and Continuous random variables.

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	3	2	3	1	1	1	3	1	2
CO2	1	3	3	3	2	1	1	3	2	2
CO3	1	3	3	3	2	1	2	3	2	2
CO4	1	3	3	3	2	1	2	3	2	2
CO5	1	3	3	3	2	1	2	3	2	3

First Year	SKILL ENHANCEMENT COURSE 1	Semester II
Code:	INTRODUCTION TO MACHINE LEARNING (Theory)	Credit: 2
COURSE OBJECTIVE: The learning objectives include: - To understand the fundamental concepts of machine learning. - To learn basic supervised and unsupervised learning techniques. - To understand the process of evaluating machine learning models.		
UNIT-I: Introduction to Machine Learning Introduction to Artificial Intelligence and Machine Learning – Need for Machine Learning – Types of Machine Learning: Supervised, Unsupervised and Reinforcement Learning – Machine Learning Process – Applications of Machine Learning – Advantages and Limitations of Machine Learning.		
UNIT-II: Supervised Learning Introduction to Supervised Learning– Regression and Classification – Linear Regression (Basic Concepts) – Logistic Regression (Basic Concepts) – Decision Trees – k-Nearest Neighbours (k-NN) – Naïve Bayes Classifier – Applications of Supervised Learning.		
UNIT-III: Unsupervised Learning Introduction to Unsupervised Learning – Difference between Supervised and Unsupervised Learning – Clustering – K-Means Clustering – Hierarchical Clustering – Principal Component Analysis (Basic Concepts) – Applications of Unsupervised Learning.		
UNIT-IV: Artificial Neural Networks Introduction to Artificial Neural Networks – Biological and Artificial Neurons – Perceptron — Introduction to Deep Learning – Applications of Neural Networks.		
UNIT-V: Model Evaluation Data Collection and Preparation – Training and Testing Data – Introduction to Model Evaluation – Accuracy, Precision and Recall.		
Unit-VI: Current Contours (for Continuous Internal Assessment Only) Contemporary Developments Related to the Course during the Semester Concerned.		
REFERENCES: - Dutt S., Chandramouli S. and Das A. K. (2019). Machine Learning. Pearson Education India Pvt. Ltd. - Alpaydin E. (2014). Introduction to Machine Learning (3rd Edition). MIT Press. - Rashid T. (2016). Make Your Own Neural Network. Create Space Independent Publishing Platform. - Shalev-Shwartz S. and Ben-David S. (2014). Understanding Machine Learning: From Theory to Algorithms. Cambridge University Press. - Hastie T., Tibshirani R. and Friedman J. (2009). The Elements of Statistical Learning: Data Mining, Inference, and Prediction (2nd Edition). Springer. - Aggarwal C.C. (2014). Data Clustering: Algorithms and Applications. CRC Press. - Bishop C.M. (2006). Pattern Recognition and Machine Learning. Springer.		

8. Raschka S. and Mirjalili V. (2019). Python Machine Learning (3rd Edition). Packt Publishing.

COURSE OUTCOMES:

On the successful completion of the course, students will be able to,

CO1: Explain the concepts of machine learning.

CO2: Apply machine learning concepts in various domains.

CO3: Implement basic supervised and unsupervised learning techniques.

CO4: Differentiate between supervised and unsupervised learning techniques.

CO5: Evaluate simple machine learning models.

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	3	2	3	1	1	1	3	1	2
CO2	1	3	3	3	2	1	1	3	2	2
CO3	1	3	3	3	2	1	2	3	2	2
CO4	1	3	3	3	2	1	2	3	2	2
CO5	1	3	3	3	2	1	2	3	2	3

First Year	INTERDISCIPLINARY COURSE 2	Semester II
Code:	QUANTITATIVE APTITUDE - II	Credits:2
(Theory)		
COURSE OBJECTIVES:		
• To understand and apply concepts of profit, loss, ratio, and proportion in quantitative problem solving. • To develop proficiency in solving partnership and chain rule problems. • To apply mathematical techniques for solving time and work and pipes and cistern problems. • To analyse and solve problems involving time, distance, and trains. • To solve aptitude problems related to boats and streams and alligation or mixture.		
UNIT-I:		
Profit & Loss–Ratio & Proportion. (Chapter–11&12)		
UNIT-II:		
Partnership–Chain Rule. (Chapter–13&14)		
UNIT-III:		
Time & Work–Pipes & Cistern. (Chapter–15&16)		
UNIT-IV:		
Time & Distance – Problems on Trains. (Chapter–17&18)		
UNIT-V:		
Boats & Streams – Alligation or Mixture. (Chapter–19&20)		
REFERENCES:		
1. R.S. Aggarwal (2010), Quantitative Aptitude for Competitive Examinations, S. Chand Co. Ltd., Chennai. 2. Abhijit Guha (2005), Quantitative Aptitude, Tata McGraw Hill Publishing Company Limited, New Delhi. 3. https://nptel.ac.in		

COURSE OUTCOMES:

On the successful completion of the course, students will be able to,

CO1: Apply concepts of profit & loss and ratio & proportion in solving arithmetic and commercial problems.

CO2: Solve problems involving partnership and chain rule using mathematical reasoning.

CO3: Analyse and solve problems related to time & work and pipes & cisterns using quantitative techniques.

CO4: Apply concepts of time & distance and train problems in practical and analytical situations.

CO5: Solve problems involving boats & streams and alligation or mixture using arithmetic methods.

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	3	2	3	1	1	1	3	1	2
CO2	1	3	3	3	2	1	1	3	2	2
CO3	1	3	3	3	2	1	2	3	2	2
CO4	1	3	3	3	2	1	2	3	2	2
CO5	1	3	3	3	2	1	2	3	2	3

Second Year	CORE COURSE 3	Semester III
Code:	THEORETICAL DISCRETE DISTRIBUTIONS (Theory)	Credits: 4
COURSE OBJECTIVES: The learning objectives include: - To expose the various important discrete probability models. - Real life situations where these distributions provide appropriate models.		
UNIT-I: Binomial Distribution Binomial distribution - Definition, Concept and Derivation of moments, Moment generating function, Additive property, Characteristic function and Recurrence relation for moments. Fitting of Binomial distribution - Simple problems.		
UNIT-II: Poisson Distribution Poisson distribution - Definition, Concept, Derivation of moments, Moment generating function, Recurrence relation for moments and Poisson distribution as a limiting case of Binomial distribution, Fitting of Poisson distribution - Simple problems.		
UNIT-III: Negative Binomial Distribution Negative Binomial distribution - Definition, Derivation of constants and Poisson distribution as a limiting case of the Negative Binomial distribution. Logarithmic series distribution (concept only).		
UNIT-IV: Geometric Distribution Geometric distribution - Definition, Moments, Derivation of moment generating function and Lack of memory property. Power series distribution (concept only).		
UNIT-V: Hyper Geometric Distribution Hyper Geometric distribution - Definition, Derivation of mean and variance approximation to Binomial distribution and Recurrence relation. Multinomial distribution (concept only).		
UNIT-VI: Current Contours (For Continuous Internal Assessment Only) Industry Expert Lecture.		
REFERENCES: - Gupta S.C. and Kapoor V.K. (2013), Fundamentals of Mathematical Statistics. Sultan Chand & Sons, New Delhi. - Gupta S.P. (1995), Statistical Methods, Sultan Chand & Sons, New Delhi.		

COURSE OUTCOMES:

On the successful completion of the course, students will be able to,

CO1: Match the discrete probability distributions with real life situations.

CO2: Derive the moment generating functions of the discrete probability distributions.

CO3: Deduce the cumulate generating functions and characteristics functions of the discrete probability distributions.

CO4: Obtain the moments of DPD using recurrence relations.

CO5: Expose the various important discrete probability models.

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	3	2	3	1	1	1	3	1	2
CO2	1	3	3	3	2	1	1	3	2	2
CO3	1	3	3	3	2	1	2	3	2	2
CO4	1	3	3	3	2	1	2	3	2	2
CO5	1	3	3	3	2	1	2	3	2	3

Second Year	CORE PRACTICAL 3	Semester III
Code:	STATISTICS PRACTICAL - III (Practical)	Credits: 4
COURSE OBJECTIVES: The learning objectives include:		
- To apply real life data in the various important discrete probability models. - To know the real life situations where these distributions provide appropriate models.		
PROBLEMS BASED ON THE FOLLOWING TOPICS		
- Binomial distribution - Mean, Variance, Fitting and Related problems. - Poisson distribution - Mean, Variance, Fitting and Related problems. - Negative Binomial distribution - Mean, Variance, Fitting and Related problems. - Hyper Geometric distribution - Mean, Variance, Fitting and Related problems. - Geometric and Uniform distribution - Mean, Variance, Fitting and Related problems.		
REFERENCES:		
1. Gupta S.C. and Kapoor V. K. (2013), Fundamentals of Mathematical Statistics. Sultan Chand & Sons, New Delhi. 2. Gupta S.P. (1995), Statistical Methods, Sultan Chand & Sons, New Delhi.		

COURSE OUTCOMES:

On the successful completion of the course, students will be able to,

CO1: Match the discrete probability distributions with real life situations.

CO2: Derive the moment generating functions of the discrete probability distributions.

CO3: Deduce the cumulate generating functions and characteristics functions of the discrete probability distributions.

CO4: Obtain the moments of DPD using recurrence relations.

CO5: Build the DPD using recurrence probabilities.

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	3	2	3	1	1	1	3	1	2
CO2	1	3	3	3	2	1	1	3	2	2
CO3	1	3	3	3	2	1	2	3	2	2
CO4	1	3	3	3	2	1	2	3	2	2
CO5	1	3	3	3	2	1	2	3	2	3

Second Year	ALLIED COURSE 3	Semester III
Code:	STATISTICAL COMPUTATION USING R (Theory)	Credits: 4
COURSE OBJECTIVES		
• Master Base R: Understand core programming concepts like vectors, matrices, and data frames. • Wrangle Data: Learn to import, clean, and manipulate real-world datasets. • Visualize Insights: Generate publication-quality plots and exploratory graphics. • Build Models: Implement and interpret linear regression models.		
UNIT-I: Introduction to the R Environment		
Introduction to R and R Studio: Installation and setup, R workspace and working directories, Managing R packages, Basic data types (Numeric, Character, Logical), Data Structures (Vectors, Matrices, Factors, Lists, Data frames), Basic arithmetic and Indexing.		
UNIT-II: Data Import and Wrangling		
Importing data from external files (.csv, .txt, .xlsx), Handling missing values (NA), Filtering rows and Selecting variables, Renaming columns, Merging and Joining datasets, Introducing the tidy verse package ecosystem (specifically dplyr).		
UNIT-III: Descriptive Statistics and Data Visualization		
Computing summary statistics (Mean, Median, Mode, Variance, Standard Deviation, Quartiles), Frequency tables, Base R graphics (Histograms, Bar plots, Scatter plots, Box plots), Advanced data visualization using the ggplot2 package (geoms, aesthetics and facets).		
UNIT-IV: Probability Distributions		
Working with probability distributions (Normal, Binomial and Poisson) using d, p, q, and r functions.		
UNIT-V: Correlation and Linear Regression		
Covariance and Correlation coefficients (Pearson and Spearman), Simple linear regression modeling using lm(), Interpreting model coefficients (R^2 and Residual analysis).		
UNIT-VI: Current Contours (For Continuous Internal Assessment Only)		
Industry Expert Lecture.		
REFERENCES:		
1. Hadley Wickham, Mine Çetinkaya - Rundel, and Garrett Golemund (2023), R for Data Science (2nd Edition), O'Reilly Media. 2. John Braun W. and Duncan J. Murdoch (2016), A First Course in Statistical Programming with R (3rd Edition), Cambridge University Press. 3. Norman Matloff (2011), The Art of R Programming: A Tour of Statistical Software Design, No Starch Press. 4. Peter Dalgaard (2008), Introductory Statistics with R (2nd Edition), Springer. 5. Michael J. Crawley (2012), The R Book (2nd Edition), Wiley.		

COURSE OUTCOMES:

On the successful completion of the course, students will be able to,

CO1: Navigate R Studio, create data structures, and extract specific data subsets.

CO2: Clean raw datasets and prepare them for structured statistical analysis.

CO3: Summarize variables numerically and construct informative, layered charts.

CO4: Build predictive linear models and evaluate their statistical significance.

CO5: Chart, compute and interpret the structural linear relationships linking paired numerical continuous variables.

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	3	2	3	1	1	1	3	1	2
CO2	1	3	3	3	2	1	1	3	2	2
CO3	1	3	3	3	2	1	2	3	2	2
CO4	1	3	3	3	2	1	2	3	2	2
CO5	1	3	3	3	2	1	2	3	2	3

Second Year	ALLIED PRACTICAL COURSE 2	Semester III & IV
Code:	STATISTICAL COMPUTATION USING PYTHON (Practical)	Credits: 4
COURSE OBJECTIVES • Python Foundations: Master variable types, loops, logic, and arrays for calculation. • Central Tendency Computation: Write custom and library-driven logic to compute averages. • Dispersion Modeling: Quantify data spread, variations, skewness, and distribution shapes. • Bivariate Association: Calculate, interpret, and plot correlation structures between variables. • Package Mastery: Build fluency with foundational math and data libraries like NumPy, Pandas, Matplotlib, and Seaborn.		
UNIT-I: Introduction to Python for Statistical Math Environment setup (Jupyter Notebook, Google Colab), Variables, Basic mathematical operators and Expressions, Collections for statistical grouping (Lists, Tuples), Conditional expressions (if-elif-else), Loops (for, while) for iterative computation, Writing basic formulas as reusable custom functions.		
UNIT-II: Measures of Central Tendency Mathematical algorithms vs Built-in functions, Calculating the Arithmetic Mean, Weighted Mean, Geometric Mean and Harmonic Mean, Finding the Median and Mode for grouped and ungrouped datasets, Utilizing the built-in statistics module and Numpy arrays for structural indexing.		
UNIT-III: Measures of Dispersion Concept of data spread, Computing absolute and Relative measures of dispersion, Range, Quartile Deviation and Mean Deviation, Sample and Population Variance, Standard Deviation, Calculating the Coefficient of Variation (CV) to compare dataset consistency.		
UNIT-IV: Moments, Skewness and Kurtosis Computation of raw and central moments, Karl Pearson's and Bowley's coefficients of skewness, Measuring distribution peakedness (Kurtosis), Introducing the scipy.stats library for immediate statistical descriptive summaries, Formatting structural outputs using Pandas Data Frames.		
UNIT-V: Correlation and Exploratory Visualization Bi-variate analysis concepts, Visualizing distributions using univariate plots (Histograms, Box plots) via Matplotlib, Creating scatter plots via Seaborn, Calculating Karl Pearson's correlation coefficient.		
UNIT-VI: Current Contours (For Continuous Internal Assessment Only) Industry Expert Lecture.		

REFERENCES:

1. Wes McKinney (2022), Python for Data Analysis (3rd Edition), O'Reilly Media.
2. Christian Heumann, Michael Schomaker and Shalabh (2016), Introduction to Statistics and Data Analysis, Springer.
3. Allen B. Downey (2014), Think Stats: Exploratory Data Analysis (2nd Edition), O'Reilly Media / Green Tea Press.
4. Jake Vander Plas (2022), Python Data Science Handbook (2nd Edition), O'Reilly Media.

COURSE OUTCOMES:

On the successful completion of the course, students will be able to,

CO1: Write basic functional code to process sets of numerical inputs.

CO2: Compute and evaluate various averages of numerical distributions using custom loop algorithms and libraries.

CO3: Quantify the variation, consistency, and stability of experimental statistical groups

CO4: Evaluate the geometric shape, symmetry, and tail-heaviness of real-world datasets.

CO5: Chart, compute and interpret the structural linear relationships linking paired numerical continuous variables.

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	3	2	3	1	1	1	3	1	2
CO2	1	3	3	3	2	1	1	3	2	2
CO3	1	3	3	3	2	1	2	3	2	2
CO4	1	3	3	3	2	1	2	3	2	2
CO5	1	3	3	3	2	1	2	3	2	3

Second Year	SKILL ENHANCEMENT COURSE 2	Semester III
Code:	INTRODUCTION TO BIG DATA ANALYTICS	Credits: 2
COURSE OBJECTIVES: The learning objectives include:		
• To understand the fundamentals and importance of Big Data in modern applications. • To acquire knowledge of Big Data technologies and Hadoop architecture. • To learn the concepts of NoSQL databases and their applications. • To understand the basics of MongoDB and Cassandra databases. • To gain an overview of Big Data analytics using Hadoop and Spark frameworks.		
UNIT – I: Introduction to Big Data Data – Types of Data: Structured, Semi-structured and Unstructured – Sources of Data – Big Data: Evolution – Definition – Characteristics (5Vs) – Need – Challenges – Applications – Introduction to Data Analytics and Business Intelligence.		
UNIT – II: Hadoop Framework Introduction to Hadoop – Need – Features – Architecture – Components – Distributed File System – Ecosystem – Hadoop 1 and Hadoop 2 (Basic Comparison) – Advantages and Limitations.		
UNIT – III: NoSQL Databases Introduction to NoSQL – Features – Types of NoSQL Databases (Key-Value, Document, Column Family and Graph Databases) – Advantages and Disadvantages – Applications – Introduction to Map Reduce Concept – Overview of YARN.		
UNIT – IV: MongoDB and Cassandra MongoDB: Introduction – Features – Data Types – Documents and Collections – Advantages – Applications – Real-life Uses. Cassandra: Introduction – Features – Data Model – Architecture (Basic) – Advantages – Applications– Real-life Uses – Comparison between MongoDB and Cassandra.		
UNIT – V: Big Data Analytics Using Hadoop and Spark Introduction to Big Data Analytics – Hadoop Framework for Data Processing – Working Principle of Hadoop – Introduction to Apache Spark – Features of Spark – Spark Architecture (Basic) – Hadoop vs Spark – Applications of Spark in Data Analytics – Big Data Case Studies in Healthcare, Banking, E-Commerce and Social Media – Future Trends in Big Data Analytics.		
Unit VI: Current Contours (for Continuous Internal Assessment Only) Contemporary Developments Related to the Course during the Semester Concerned. \		
REFERENCES: 1. Seema Acharya and Subhashini Chellappan (2016), Big Data and Analytics, Wiley India Pvt. Ltd. 2. Mike Frampton (2015), Mastering Apache Spark, Packt Publishing. 3. Tom White (2015), Hadoop: The Definitive Guide, O'Reilly Media, 4th Edition. 4. Mohammed Guller (2015), Big Data Analytics with Spark, Apress. 5. Donald Miner and Adam Shook (2012), Map Reduce Design Patterns, O'Reilly Media.		

COURSE OUTCOMES:

On the successful completion of the course, students will be able to,

CO1: Explain the concepts, characteristics, challenges, and applications of Big Data.

CO2: Describe the architecture and components of the Hadoop framework.

CO3: Differentiate SQL and NoSQL databases and explain the applications of MongoDB and Cassandra.

CO4: Demonstrate the basic concepts of MapReduce and Apache Spark for Big Data processing.

CO5: Identify suitable Big Data technologies for solving real-world data analytics problems.

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	3	2	3	1	1	1	3	1	2
CO2	1	3	3	3	2	1	1	3	2	2
CO3	1	3	3	3	2	1	2	3	2	2
CO4	1	3	3	3	2	1	2	3	2	2
CO5	1	3	3	3	2	1	2	3	2	3

Second Year	INTERDISCIPLINARY COURSE 3	Semester III
Code:	STATISTICS FOR COMPETITIVE EXAMINATIONS - I	Credits:2
(Theory)		
COURSE OBJECTIVES: The learning objectives include: • To understand the basic concepts of Statistics. • To apply descriptive statistical techniques for data analysis. • To understand the concepts of correlation and regression. • To learn the fundamentals of probability. • To develop problem-solving skills for Statistics competitive examinations.		
UNIT – I: Gathering data, Methods of collection, Tabulation, Graphical presentation, Frequency distributions.		
UNIT – II: Mean, Median, Mode, Quartiles, Deciles, Percentiles, Range, Quartile deviations, Mean deviation, Standard deviation, Relative dispersion.		
UNIT – III: Types of moments, Skewness, Kurtosis.		
UNIT – IV: Scatter diagrams, Correlation coefficients, Regression lines, Spearman's rank correlation, Multiple correlations.		
UNIT – V: Basic Concepts of Probability, Sample Space, Events, Addition and Multiplication Laws of Probability, Conditional Probability and Bayes' Theorem (Elementary Problems).		
REFERENCES: 1. Gupta, S.C. and Kapoor, V.K. (2020). Fundamentals of Mathematical Statistics. 12th Edition, Sultan Chand & Sons, New Delhi. 2. Agarwal, B.L. (2021). Programmed Statistics (Questions–Answers). 3rd Edition, New Age International (P) Ltd., New Delhi. 3. Gupta, S.C. and Kapoor, V.K. (2024). Fundamentals of Applied Statistics. 12th Edition, Sultan Chand & Sons, New Delhi.		

COURSE OUTCOMES:

On the successful completion of the course, students will be able to,

C01: Understand the basic concepts and methods of Statistics.

C02: Apply descriptive statistical techniques to summarize and interpret data.

C03: Analyze relationships between variables using correlation and regression.

C04: Solve elementary probability problems using basic probability laws.

C05: Apply fundamental statistical concepts to solve competitive examination problems.

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
C01	1	3	2	3	1	1	1	3	1	2
C02	1	3	3	3	2	1	1	3	2	2
C03	1	3	3	3	2	1	2	3	2	2
C04	1	3	3	3	2	1	2	3	2	2
C05	1	3	3	3	2	1	2	3	2	3

Second Year	CORE COURSE 4	Semester IV
Code:	THEORETICAL CONTINUOUS DISTRIBUTIONS	Credits: 4
(Theory)		
COURSE OBJECTIVES: The learning objectives include: To expose the various important continuous probability models and real life situations where these distributions provide appropriate models.		
UNIT-I: Concepts of Normal Distribution Normal Distribution - Introduction, limiting form of Binomial distribution. Characteristics of Normal distribution and its Curve. Derivation of Mean, Median, Mode, Moments and Moment generating function.		
UNIT-II: Advances in Normal Distribution Derivation of Cumulants generating function, Additive property of Normal distribution, Mean Deviation about Mean and Points of inflection of Normal Curve, Importance of Normal distribution – Fitting of Normal distribution - Simple problems.		
UNIT-III: Gamma and Beta Distribution Beta distribution of first and second kind - Derivation of moments, β_1 , β_2 and Harmonic mean. Gamma distribution – Definition and Derivation of moment generating function, Cumulant generating function, Moments and Additive property of Gamma distribution.		
UNIT-IV: Rectangular and Exponential Distribution Rectangular distribution - Introduction and Derivation of moments, Moment generating function and Mean Deviation about Mean. Exponential distribution – Definition, Derivation of moment generating function and Lack of memory property. Concept of Weibull distribution, Cauchy distribution and Bi-variate Normal distribution.		
UNIT-V: Sampling Distribution Sampling distribution - Concept of t, chi-square and F distribution - Derivation of these distributions, Constants and Moment generating function - Relationship between t, chi-square and F distribution.		
UNIT-VI: Current Contours (For Continuous Internal Assessment Only) Industry Expert Lecture.		
REFERENCES: - Gupta S.C. and Kapoor V.K. (2013), Fundamentals of Mathematical Statistics, Sultan Chand and Sons Publications, New Delhi. - Johnson N.L. and Kotz S.(1969), Distributions in Statistics-Discrete Distributions, John Wiley & Sons, New York		

COURSE OUTCOMES:

On the successful completion of the course, students will be able to,

CO1: Learn the characteristics of Normal distributions.

CO2: Learn the relationship between beta and Gamma distribution.

CO3: Know the memory less property of Exponential distribution.

CO4: Obtain the difference of two sample tests.

CO5: Understand why Exponential distribution possesses memory less property.

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	3	2	3	1	1	1	3	1	2
CO2	1	3	3	3	2	1	1	3	2	2
CO3	1	3	3	3	2	1	2	3	2	2
CO4	1	3	3	3	2	1	2	3	2	2
CO5	1	3	3	3	2	1	2	3	2	3

Second Year	CORE PRACTICAL 4	Semester IV
Code:	STATISTICS PRACTICAL - IV (Practical)	Credits: 4
COURSE OBJECTIVES: The learning objectives include:		
- To apply real life data in the various important continuous probability models. - To know the real life situations where these distributions provide appropriate models.		
PROBLEMS BASED ON THE FOLLOWING TOPICS		
- Normal distribution - Mean, Variance, Fitting and Related problems. - Beta distribution - Mean, Variance, Fitting and Related problems. - Rectangular distribution - Mean, Variance, Fitting and Related problems. - Exponential distribution - Mean, Variance, Fitting and Related problems. - Gamma distribution - Mean, Variance, Fitting and Related problems.		
REFERENCES:		
- Gupta S.C. and Kapoor V.K. (2013), Fundamentals of Mathematical Statistics. Sultan Chand & Sons, New Delhi. - Gupta S.P. (1995), Statistical Methods, Sultan Chand & Sons, New Delhi.		

COURSE OUTCOMES:

On the successful completion of the course, students will be able to,

CO1: Learn the characteristics of Normal distributions.

CO2: Learn the relationship between beta and Gamma distribution.

CO3: Know the memory less property of Exponential distribution.

CO4: Obtain the difference of two sample tests.

CO5: Understand why Exponential distribution possesses memory less property.

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	3	2	3	1	1	1	3	1	2
CO2	1	3	3	3	2	1	1	3	2	2
CO3	1	3	3	3	2	1	2	3	2	2
CO4	1	3	3	3	2	1	2	3	2	2
CO5	1	3	3	3	2	1	2	3	2	3

Second Year	ALLIED PRACTICAL COURSE 3	Semester IV
Code:	STATISTICAL DATA ANALYSIS USING R (Practical)	Credits: 4
COURSE OBJECTIVES:		
To provide hands-on experience in collecting, visualizing, and analyzing data using R software.		
UNIT-I: Introduction to R and Data Management		
Theoretical Overview: Basics of R environment, data structures (Vectors, Matrices, Data frames) and Input/ Output workflows.		
R Practical: Installation of R, R Studio and Setting up working directories. Basic Arithmetic Operations, Vector creation and Matrix Manipulations. Creating, Indexing and Sub setting Data Frames. Importing data from external files (.csv, .xlsx, .txt). Handling missing values (NA) and Filtering data.		
UNIT-II: Descriptive Statistics and Data Visualization		
Theoretical Overview: Classification, Summarization and Graphical representation of univariate data.		
R Practical: Frequency distribution construction for Continuous and Discrete variables. Calculating Measures of Central Tendency: Mean, Median and Mode. Calculating Measures of Dispersion: Range, Quartile Deviation, Standard Deviation and Variance. Generating standard visual plots: Bar Charts, Pie Charts and Line Graphs. Exploratory data visualizations: Histograms, Density Plots and Box Plots.		
UNIT-III: Bi-variate Data Analysis (Correlation & Regression)		
Theoretical Overview: Evaluating associations and Dependencies between two numeric variables.		
R Practical: Constructing scatter plots to visually examine variable relationships. Computing Karl Pearson's Coefficient of Correlation. Computing Spearman's Rank Correlation (with and without tied ranks). Fitting a Simple Linear Regression model using the lm() function. Extracting regression coefficients, Plotting the regression line over data points and Forecasting values.		
UNIT-IV: Probability Distributions		
Theoretical Overview: Basic probability distribution applications.		
R Practical: Generating Probability Mass Functions (PMF) and Cumulative distributions for Binomial Distribution (dbinom, pbinom). Generating and Plotting Poisson Distribution properties (dpois, ppois).		
UNIT-V: Continuous Distributions		
Theoretical Overview: Normal Distribution with curve regions.		
R Practical: Working with Normal Distribution curve regions (dnorm, pnorm, qnorm). Checking data normality using Q-Q plots.		
REFERENCES:		
1. Peter Dalgaard (2008), Introductory Statistics with R, 2 nd Edition, Springer, New York.		

COURSE OUTCOMES:

On the successful completion of the course, students will be able to,

CO1: Write basic functional code to process sets of numerical inputs.

CO2: Compute and evaluate various averages of numerical distributions using custom loop algorithms and libraries.

CO3: Quantify the variation, consistency, and stability of experimental statistical groups.

CO4: Evaluate the geometric shape, symmetry, and tail-heaviness of real-world datasets.

CO5: Chart, compute and interpret the structural linear relationships linking paired numerical continuous variables.

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	3	2	3	1	1	1	3	1	2
CO2	1	3	3	3	2	1	1	3	2	2
CO3	1	3	3	3	2	1	2	3	2	2
CO4	1	3	3	3	2	1	2	3	2	2
CO5	1	3	3	3	2	1	2	3	2	3

Second Year	SKILL ENHANCEMENT COURSE 3	Semester IV
Code:	INTRODUCTION TO DATA SCIENCE (Theory)	Credits: 2
COURSE OBJECTIVES: The learning objectives include:		
• To understand the fundamental concepts of data science. • To learn the basic techniques of data collection, analysis and visualization. • To understand the applications of data science in various domains.		
UNIT-I: Fundamentals of Data Science Introduction to Data Science – Need and Benefits of Data Science – Types of Data – Data Science Process – Role of a Data Scientist.		
UNIT-II: Data Collection and Exploratory Data Analysis Data Collection – Data Sources – Data Cleaning – Data Transformation – Exploratory Data Analysis – Introduction to Model Building.		
UNIT-III: Machine Learning Workflow Machine Learning – Types of Machine Learning – Supervised Learning – Unsupervised Learning – Semi-supervised Learning – Basic Machine Learning Workflow.		
UNIT-IV: Big Data and Data Visualization Introduction to Big Data – Big Data Ecosystem – Data Storage – Data Visualization – Charts, Graphs and Dashboards.		
UNIT-V: Applications of Data Science Applications of Data Science in Healthcare, Finance, Agriculture, Business and Education – Case Studies – Ethics and Challenges in Data Science.		
Unit-VI: Current Contours (for Continuous Internal Assessment Only) Contemporary Developments Related to the Course during the Semester Concerned.		
REFERENCES: 1. Roger Peng (2016), The Art of Data Science, Lulu.com. 2. Murtaza Haider, Getting Started with Data Science – Making Sense of Data with Analytics, IBM Press, E-book. 3. Davy Cielen, Arno D.B. Meysman and Mohamed Ali (2016), Introducing Data Science: Big Data, Machine Learning, and More, Using Python Tools, Dreamtech Press. 4. Annalyn Ng and Kenneth Soo, Numsense (2017), Data Science for the Layman: No Math Added. 5. Cathy O'Neil and Rachel Schutt (2013), Doing Data Science: Straight Talk from the Frontline, O'Reilly Media. 6. Lillian Pierson (2017), Data Science for Dummies.		

COURSE OUTCOMES:

On the successful completion of the course, students will be able to,

CO1: Explain the fundamental concepts of data science.

CO2: Apply basic data science techniques to simple data analysis problems.

CO3: Demonstrate the process of data collection, preparation and exploratory data analysis.

CO4: Differentiate between supervised, unsupervised and semi-supervised learning.

CO5: Illustrate the applications of data science in various domains.

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	3	2	3	1	1	1	3	1	2
CO2	1	3	3	3	2	1	1	3	2	2
CO3	1	3	3	3	2	1	2	3	2	2
CO4	1	3	3	3	2	1	2	3	2	2
CO5	1	3	3	3	2	1	2	3	2	3

Second Year	INTERDISCIPLINARY COURSE 4	Semester IV
Code:	STATISTICS FOR COMPETITIVE EXAMINATIONS - II	Credits:2
(Theory)		
COURSE OBJECTIVES: The learning objectives include: • To understand probability distributions and random variables. • To learn the principles of sampling and statistical inference. • To apply hypothesis testing techniques. • To understand the analysis of variance. • To understand the construction and uses of index numbers.		
UNIT – I: Random variables, binomial, Poisson, normal, exponential, and joint distributions.		
UNIT – II: Population and sample, sampling techniques, errors, sampling distributions, central limit theorem.		
UNIT – III: Estimation, testing of hypotheses, standard errors, t-test, z-test, chi-square test, F-test.		
UNIT – IV: One-way classification, Two-way classification		
UNIT – V: Construction, Types, Formulae, Uses (e.g., cost of living index).		
REFERENCES: 1. Gupta, S.C. and Kapoor, V.K. (2020). Fundamentals of Mathematical Statistics. 12th Edition, Sultan Chand & Sons, New Delhi. 2. Agarwal, B.L. (2021). Programmed Statistics (Questions–Answers). 3rd Edition, New Age International (P) Ltd., New Delhi. 3. Gupta, S.C. and Kapoor, V.K. (2024). Fundamentals of Applied Statistics. 12th Edition, Sultan Chand & Sons, New Delhi.		

COURSE OUTCOMES:

On the successful completion of the course, students will be able to,

C01: Understand probability distributions and random variables.

C02: Apply sampling methods and statistical inference techniques.

C03: Perform estimation and hypothesis testing.

C04: Analyze data using analysis of variance.

C05: Construct and interpret index numbers.

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
C01	1	3	2	3	1	1	1	3	1	2
C02	1	3	3	3	2	1	1	3	2	2
C03	1	3	3	3	2	1	2	3	2	2
C04	1	3	3	3	2	1	2	3	2	2
C05	1	3	3	3	2	1	2	3	2	3

Third Year	CORE COURSE 5	Semester V
Code:	DESIGN OF EXPERIMENTS (Theory)	Credits: 4
COURSE OBJECTIVES:		
• The learning objectives include: • To design and conduct experiments. • To analyze and interpret data.		
UNIT-I: Analysis of Variance		
Analysis of Variance: Definition and Assumptions. Cochran's Theorems (statement only) ANOVA – One-way and Two-way classifications (with one observation per cell). Experimental error.		
UNIT-II: Design of Experiment		
Design of Experiment: Need, Terminology, Randomization, Replication and Local control, Completely Randomized Design (CRD), Randomized Block Design (RBD), Latin Square Design (LSD) - Estimation of missing values in RBD and LSD (one and two).		
UNIT-III: Factorial Experiment		
Factorial experiment - Main effects and Interactions, Definitions of contrast and Orthogonal Contrast - Analysis of 2^2 and 2^3 experiments.		
UNIT-IV: Confounding		
Confounding in Factorial Design - Total Confounding and Partial Confounding in 2^3 experiments.		
UNIT-V: ANCOVA		
Analysis of co-variance for a one-way layout with one concomitant variable - RBD with one concomitant variable.		
UNIT-VI: CURRENT CONTOURS: (For Continuous Internal Assessment Only):		
Industry Expert Lectures on abstract ideas and rigorous methods in mathematical analysis can be applied to practical problems arising in science and technology.		
REFERENCES:		
1. Gupta S.C. and Kapoor V.K. (2013), Fundamentals of Applied Statistics, Sultan Chand & Sons, New Delhi. 2. Douglas C. Montgomery (2010), Design and Analysis of Experiment, Wiley International Edition, India. 3. Cochran W.G. and Cox G.M. (1957), Experimental Designs, Wiley International Edition, India.		

COURSE OUTCOMES:

On the successful completion of the course, students will be able to,

C01: The fundamental concepts of design of experiments.

C02: Introduction to planning valid and economical experiments with in given resources. Completely randomized design.

C03: Randomized block design. Latin square design.

C04: Balanced incomplete block design.

C05: Full and confounded factorial designs with two and three levels. Fractional factorial designs with two levels.

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
C01	1	3	2	3	1	1	1	3	1	2
C02	1	3	3	3	2	1	1	3	2	2
C03	1	3	3	3	2	1	2	3	2	2
C04	1	3	3	3	2	1	2	3	2	2
C05	1	3	3	3	2	1	2	3	2	3

Third Year	CORE COURSE 6	Semester V
Code:	STATISTICAL INFERENCE - I (Theory)	Credits: 4
COURSE OBJECTIVES: The learning objectives include - Drawing inference about the unknown population parameters based on random samples. - Validating our estimation / inference about the population using hypothesis testing.		
UNIT-I: Introduction to Estimation Introduction to Estimation theory - Definition of Parameter space, Estimate and Estimator. Characteristics of estimator - Unbiasedness - Definition and Simple problems. Consistency - Definition, Problem based on Normal and Poisson distribution. Invariance property of Consistency, Sufficient Condition for Consistency.		
UNIT-II: Efficiency and Sufficiency Efficient Estimators - Definition of efficiency, Most efficient estimator, Minimum Variance Unbiased estimator. Sufficiency - Definition, Rao-Blackwell theorem, Crammer-Rao inequality, Statement of Neyman factorization theorem, Invariance property of sufficient estimator (simple problems).		
UNIT-III: Methods of Estimation Methods of Estimation: Definition - Likelihood functions and M.L.E., Properties of M.L.E (simple problems) - Hazoor Bazar's theorem.		
UNIT-IV: Methods of Moments Methods of Minimum Variance, Methods of moments and Methods of least squares - Simple problems.		
UNIT-V: Interval Estimation Interval estimation - Definition of Confidence Limits, Confidence Co-efficient, Confidence Interval and Confidence Intervals for large samples (simple problems).		
UNIT-VI CURRENT CONTOURS (For Continuous Internal Assessment Only): Research and Development problems related to various fields of Inferential Statistics with practical knowledge of computer software.		
REFERENCES: - Gupta S.C. and Kapoor V.K. (2013), Fundamentals of Mathematical Statistics, Sultan Chand and Sons Publications, New Delhi. - Rohatgi V.L. (1979), An introduction to probability theory and Mathematical Statistics, Wiley Eastern limited. - Lehmann E.L. (1986), Testing of Statistical Hypothesis, John Wiley. - Gibbons J.D. (2010), Non-Parametric Statistical Inference, Duxbury.		

COURSE OUTCOMES:

On the successful completion of the course, students will be able to,

CO1: Different methods of finding point estimators for unknown population parameters.

CO2: Maximum Likelihood Estimation, Method of moments, Method of minimum and modified chi-square.

CO3: Explain the concepts Unbiasedness, Consistency, Efficiency, Sufficiency.

CO4: Methods to develop/find best point estimators based on the desirable properties

CO5: Using Cramer-Rao inequality, Rao-Blackwell theorem and Lehmann-Scheffe theorem.

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	3	2	3	1	1	1	3	1	2
CO2	1	3	3	3	2	1	1	3	2	2
CO3	1	3	3	3	2	1	2	3	2	2
CO4	1	3	3	3	2	1	2	3	2	2
CO5	1	3	3	3	2	1	2	3	2	3

Third Year	CORE COURSE 7	Semester V
Code:	SAMPLING THEORY (Theory)	Credits: 4
COURSE OBJECTIVES:		
The learning objectives include: • To understand the concept of sampling distributions and their applications in statistical inference and the process of hypothesis testing. • To have a clear understanding of when to apply various tests of hypothesis about population parameters using sample statistics and draw appropriate conclusions from the analysis. • To amalgamate the intellectual facts of the sampling techniques to implement in projects and to motivate the students in carrying out the field projects in scientific manner and statistical skills. • To convey some extended concepts in sampling to encourage the students in industrial and research aspects.		
UNIT-I: Introduction to Sampling Theory Basic concept of sample survey - Introduction, Definitions and Preliminaries, Fields of application of sampling techniques and Limitations, Census and Sample surveys, Advantages and Disadvantages, Principles of sampling theory, Principal steps in a sample survey. Probability and Non-probability sampling, Sampling unit, Sampling frame, Sampling and Non-sampling errors.		
UNIT-II: Simple Random Sampling Simple random sampling, Procedures of selecting a random sample, Estimation of population parameters, Estimation of population proportion, Estimation of sample size.		
UNIT-III: Stratified Random Sampling Stratified random sampling – Introduction, Principles of Stratification, Advantages of stratification, Estimation of population mean and its Variance. Estimation of variance, Allocation of sample size in different strata - Equal allocation, Neyman allocation, Optimum Allocation and Proportional Allocation. Relative Precision of Stratified random sampling with simple random sampling.		
UNIT-IV: Systematic Sampling Systematic sampling – Introduction, Sample selection procedures, Advantages and Disadvantages, Estimation of mean and its Sampling Variance, Comparison of simple random sampling and Stratified random sampling with Systematic sampling.		
UNIT-V: Ratio and Regression Estimators Ratio estimators - Introduction, Definitions and Notations, Bias of Ratio estimators, Comparison of the ratio estimate with the mean per unit. Regression estimators – Introduction, Difference estimator, Regression estimator, Comparison with the mean per unit and Ratio estimators.		
UNIT-VI: Current Contours (For Continuous Internal Assessment Only) Research and Analytical problems on various applications of the industrial uses.		

REFERENCES:

1. Gupta S.C. and Kapoor V.K. (2013), Fundamentals of Applied Statistics, Sultan Chand and Sons Publications, New Delhi.
2. Daroga Singh and Choudry F.S. (1986), Theory and Analysis of Sample survey Design, Wiley Eastern Ltd., New Delhi.
3. Murthy M.N. (1976), Sampling Theory and Methods – Statistical Publishing Society, Calcutta.
4. Cochran W.G. (1984), Sampling Techniques, Wiley Eastern Ltd.
5. Des Raj (1976), Sampling Theory, Tata-McGraw Hill.

COURSE OUTCOMES:

On the successful completion of the course, students will be able to,

CO1: Accomplish research oriented concepts given for sampling techniques

CO2: Explain the usage of sampling techniques in projects

CO3: To use sampling techniques in industrial use.

CO4: To Explain the Concepts of Types of Sampling.

CO5: To face central government examination like Indian Statistical Service and other competitive examinations.

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	3	2	3	1	1	1	3	1	2
CO2	1	3	3	3	2	1	1	3	2	2
CO3	1	3	3	3	2	1	2	3	2	2
CO4	1	3	3	3	2	1	2	3	2	2
CO5	1	3	3	3	2	1	2	3	2	3

Third Year	CORE COURSE 8	Semester V
Code:	1. STATISTICAL QUALITY CONTROL (Theory)	Credits: 4
COURSE OBJECTIVES: The learning objectives include: - This course will help students to learn techniques and approach of SQC being used in industry to manufacture goods and services of high quality at low cost. - This course will also give exposure to six sigma and Index Numbers.		
UNIT-I: Introduction to SQC Introduction to SQC - Chance and Assignable causes of variation - Benefits of SQC - Process and Product control - Tools for SQC - Control chart for variables - X-Bar and R charts.		
UNIT-II: Process Control Control chart for attributes - Control chart for fraction defective (p-chart) - Control chart for number of defectives (d-chart, for fixed and variable sample size) - Control chart for number of defects per unit (c-chart) - Natural tolerance limit and Specification limits.		
UNIT-III: Product Control Acceptance sampling by Attributes - Acceptance Quality Level (A.Q.L) - Lot Tolerance Proportion or Percent Defective (LTPD) - Process Average Fraction Defective (p) - Consumer's Risk (β) - Producer's Risk (α) - Rectifying Inspection Plan - Average Outgoing Quality Level (AOQL).		
UNIT-IV: Sampling Plans Operating Characteristic Curve (OC-curve) - Average Sample Number (ASN) - Average Amount of Total Inspection (ATI) - Single sampling plan - Determination of 'n' and 'c', AOQL, OC-curve - Double sampling plan - ASN and ATI of double sampling plan - Single sampling Vs double sampling plan.		
UNIT-V: Sequential Sampling Sequential Sampling - Sequential Probability Ratio Test (SPRT) - ASN Function of sequential sampling plan.		
UNIT-VI: Current Contours (For Continuous Internal Assessment Only) Traditional quality inspection activities in industry, receiving inspection, process inspection in industrial applications.		
REFERENCES: - Gupta S.C. and Kapoor V.K. (2014), Fundamentals of Applied Statistics, 4th Edition, Sultan Chand & Sons, New Delhi. - Ehrlich H.B. (2002), Transactional Six Sigma and Lean Servicing, 2nd Edition, St. Lucie Press. - Goon A.M., Gupta M.K. and Dasgupta B. (2002), Fundamentals of Statistics, Vol. I & II, 8th Edition, The World Press, Kolkata. - David H. (1995), ISO Quality Systems Handbook, 2nd Edition, Butter worth Heinemann Publication. - Montgomery D.C. (2009), Introduction to Statistical Quality Control, 6th Edition, Wiley India Pvt. Ltd.		

COURSE OUTCOMES:

On the successful completion of the course, students will be able to,

CO1: Understand Basic Concepts of SQC.

CO2: To learn techniques and approach of SQC being used in industry.

CO3: Explain the Concepts of Process Control and its chart.

CO4: Understand the Concepts of Product Control and its chart

CO5: Explain the Concepts of Sampling Plans.

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	3	2	3	1	1	1	3	1	2
CO2	1	3	3	3	2	1	1	3	2	2
CO3	1	3	3	3	2	1	2	3	2	2
CO4	1	3	3	3	2	1	2	3	2	2
CO5	1	3	3	3	2	1	2	3	2	3

Third Year	CORE COURSE 8	Semester V
Code:	2. OFFICIAL STATISTICS (Theory)	Credits: 4
COURSE OBJECTIVES: • To familiarize students with the collection and compilation. • To understand dissemination of official data. • To gain the knowledge for the functioning of national and international statistical systems.		
UNIT-I: Introduction to Official Statistics & Statistical Systems Concepts: Meaning, Nature and Importance of Official Statistics. Principles of Official Statistics (UN Fundamental Principles). National Framework: Organizational structure of the Indian Statistical System. Role and Functions of the Ministry of Statistics and Programme Implementation (MoSPI). National Statistical Office (NSO) – CSO and NSSO wings. National Statistical Commission (NSC). International Framework: Brief overview of international agencies (UNSTAT, IMF, World Bank, ILO, WHO) and their coordination with national systems.		
UNIT-II: Population and Demographic Statistics Population Census: History, Nature and Methods of the Indian Population Census. Features, Coverage and Scheduling. Vital Statistics: Civil Registration System (CRS), Sample Registration System (SRS). Rates and Ratios: Crude Birth Rate (CBR), Crude Death Rate (CDR), Infant Mortality Rate (IMR) and Total Fertility Rate (TFR). Registries: National Population Register (NPR) and Aadhar system basics. Controlling and monitoring population data.		
UNIT-III: Economic Statistics (National Income & Production) National Income: Concepts of GDP, GNP, NDP, NNP, and Per Capita Income. Gross Value Added (GVA). Methods of estimating national income (Product, Income, and Expenditure methods). Base year revisions. Industrial Statistics: Annual Survey of Industries (ASI) – scope and coverage. Index of Industrial Production (IIP) – computation, composition, and uses. Agricultural Statistics: Land use statistics, crop estimation surveys, agricultural census, and yield estimation.		
UNIT-IV: Price, Labor and Socio-Economic Indicators Price Indices: Wholesale Price Index (WPI), Consumer Price Index (CPI) (Rural, Urban, Combined, Industrial Workers). Construction and utility of these indices. Labor and Employment: Periodic Labour Force Survey (PLFS) – concepts of labor force, workforce, unemployment rate, and activity statuses (Usual Status, CWS). Socio-Economic Surveys: National Sample Surveys (NSS) rounds on consumer expenditure, health, education, and poverty estimation concepts.		
UNIT-V: National Accounts, Data Quality and Dissemination System of National Accounts (SNA): Basic structure, sequence of accounts, and satellite accounts. Data Quality: Sources of errors in official data (sampling and non-sampling errors). Post-enumeration surveys for quality checks. Dissemination: Open Data Initiatives, National Data Sharing and Accessibility Policy (NDSAP). Meta data standards. Introduction to Sustainable Development		

Goals (SDGs) and National Indicator Framework (NIF).

UNIT-VI: Current Contours (For Continuous Internal Assessment Only)

Industry Expert Lectures.

REFERENCES:

1. Guide to Official Statistics – Central Statistical Office, Ministry of Statistics and Programme Implementation, GoI.
2. Indian Official Statistical System – Saluja, M.R., Publication Information Centre, New Delhi.
3. National Account Statistics (Sources and Methods) – Central Statistical Organisation, MoSPI.
4. Reports of the National Statistical Commission (NSC) – Government of India.
5. Annual Reports and Periodic Labour Force Survey (PLFS) Reports – MoSPI, Government of India (Latest Editions).

COURSE OUTCOMES:

On the successful completion of the course, students will be able to,

CO1: To familiarize with the concepts of collection and compilation of data.

CO2: To understand dissemination of official data.

CO3: To gain the knowledge of the functioning of national and international statistical systems.

CO4: To Explain the Concepts of Price, Labor and Socio-Economic Indicators.

CO5: To Understand the concepts of Economic Statistics (National Income & Production).

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	3	2	3	1	1	1	3	1	2
CO2	1	3	3	3	2	1	1	3	2	2
CO3	1	3	3	3	2	1	2	3	2	2
CO4	1	3	3	3	2	1	2	3	2	2
CO5	1	3	3	3	2	1	2	3	2	3

Third Year	CORE PRACTICAL 5	Semester V
Code:	STATISTICS PRACTICAL - V (Practical)	Credits: 4
COURSE OBJECTIVES: The learning objectives include: - Experimental designs: Role, historical perspective, terminology, experimental error, basic principles, uniformity trials, fertility contour maps, - Choice of size and shape of plots and blocks. - Missing plot technique (for both RBD and LSD) for one missing observation only, variance of the difference between two estimated treatment effects out of which one has the missing observation (for both RBD and LSD). Practical work.		
PROBLEMS BASED ON THE FOLLOWING TOPICS - Simple Random Sampling. - Stratified Random Sampling with proportional allocation and optimum allocation. - Systematic Random Sampling. - Completely Randomized Design (CRD). - Randomized Block Design (RBD). - Latin Square Design (LSD). - Estimation of missing values in RBD and LSD (one and two). - Factorial Experiment-Analysis of 2^2 and 2^3 experiments. - M.L.E. - Confidence Intervals for large samples.		
REFERENCES: - Gupta S.C. and Kapoor V.K. (2013), Fundamentals of Mathematical Statistics, Sultan Chand and Sons Publications, New Delhi. - Rohatgi V.L. (1979), An introduction to probability theory and Mathematical Statistics, Wiley Eastern limited. - Daroga Singh and Chaudhary F.S. (1986), Theory and Analysis of Sample survey Design, Wiley Eastern Ltd., New Delhi.		

COURSE OUTCOMES:

On the successful completion of the course, students will be able to,

CO1: Understand fundamentals concepts of design and analysis.

CO2: Solve Fractional factorial designs with two levels.

CO3: Understand BIBD and its types (full and confounded).

CO4: Solve Factorial and Fractional factorial designs.

CO5: Practical work based on the design and analysis

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	3	2	3	1	1	1	3	1	2
CO2	1	3	3	3	2	1	1	3	2	2
CO3	1	3	3	3	2	1	2	3	2	2
CO4	1	3	3	3	2	1	2	3	2	2
CO5	1	3	3	3	2	1	2	3	2	3

Third Year	SKILL ENHANCEMENT COURSE 4	Semester V
Code:	INTRODUCTION TO BIOSTATISTICS (Theory)	Credits: 2
COURSE OBJECTIVES: The learning objectives include: • To find numerical solutions to scientific data. • To analyses and interpret scientific data using numerical and mathematical equations. • To recognize the definition of statistics, the subject's relation with the other sciences. • To know how to collect data relating to variable/variables. • To calculate descriptive statistics for an appropriate data.		
UNIT-I: Introduction to Biostatistics Biostatistics - Definition, statistical methods, biological measurement, kinds of biological data, functions of statistics and limitation of statistics – Application of statistics in various field, biology, medicine, etc...		
UNIT-II: Data Collection and Representation Collection of data, sampling and sampling design, classification and tabulation, Variables vs. Attributes – Primary vs. secondary data - types of representations, Different types of chart and diagrams, graphic–bar diagrams, pie diagrams and curves.		
UNIT-III: Central Tendency Measures of central tendency, mean, median, mode, geometric mean, harmonic mean, quartile, deciles, percentiles. (Concept formulae and their calculations)		
UNIT-IV: Dispersion and Deviation Measures of dispersion and variability-changes. Deviations – Mean deviation, standard deviation, coefficient of variation, Loren Zen's curve – Gini Index.		
UNIT-V: Skewness and ANOVA Skewness, Kurtosis, Moments, Meaning, test of skewness, characteristics of dispersion and skewness. Measures of skewness, objectives. Karl Pearson's Coefficient of skewness, Bocoly's coefficient of skewness. Software's - ANOVA, SPSS, Sigma plot.		
Unit-VI: Current Contour (For continuous internal assessment only) Contemporary Developments Related to the Course during the Semester Concerned.		
REFERENCES: 1. Bernard Rosner (2010). Fundamentals of Biostatistics, 7th Edition, Cengage Learning. 2. Maicello Pagano and Kimberlee Gauvreau (2000), Principles of Biostatistics, 2nd Edition, Duxbury Press. 3. Jerrold H Zar (2010). Biostatistical Analysis, 5th Edition, Prentice Hall. 4. https://academic.oup.com/biostatistics.		

COURSE OUTCOMES:

On the successful completion of the course, students will be able to,

CO1: Create graphs using scientific data and to communicate important information about data.

CO2: Interpret the data in the form of graphs and familiarize with widely used statistical databases.

CO3: Know basic concepts of probability and statistics.

CO4: Know the application and limitations of different statistical methods.

CO5: Get conceptual understanding of modern statistical tools and software's available.

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	3	2	3	1	1	1	3	1	2
CO2	1	3	3	3	2	1	1	3	2	2
CO3	1	3	3	3	2	1	2	3	2	2
CO4	1	3	3	3	2	1	2	3	2	2
CO5	1	3	3	3	2	1	2	3	2	3

Third Year	SKILL ENHANCEMENT COURSE 5	Semester V
Code:	DEMOGRAPHY (Theory)	Credit: 2
COURSE OBJECTIVES: The learning objectives include: - To understand the basic concepts and scope of Demography. - To identify the various sources of demographic data. - To study the population growth pattern of the world and India. - To understand the components of population change. - To explain the theories of population growth and migration. - To explain the concept fertility and calculate its measures CBR, GFR, TFR, ASFR, GRR and NRR.		
UNIT-I: Demography Definition - Importance of demographic data – Sources of demographic data - Population census - Uses - Registration method - Vital registration - Population register - Records - Sample surveys - International publications – Demography in sociology, Economics and Health planning.		
UNIT-II: Fertility Measurements Mortality – Mortality measures - Crude Death Rate (CDR), Age, Sex and Cause Specific Death Rates - Standardized Death Rate - Infant mortality rate - Simple problems.		
UNIT-III: Mortality Measurements Small sample test – student's t test –test for single mean, difference between means, paired 't' test and observed sample correlation co-efficient.		
UNIT-IV: Life Table and Migration Life Table - Assumptions - Description of various columns of a Life table – Relationship between life table functions - Construction of a Life table - Uses of a Life table - Simple Problems. Migration – Definition - Types of Migration - Effects of Migration.		
UNIT-V: Population Projection Types - Methods of population projection – Importance - limitations – Population estimates and projection – Mathematical Method – Arithmetic Method and Geometric Method - Growth Component Method – Logistic curve – Basic ideas of Stationary and Stable population.		
UNIT-VI: Current Contours (For Continuous Internal Assessment Only) Research and development problems related to various fields of demographical data with practical knowledge of computer software.		
REFERENCES: - Mishra D.E (2001), An Introduction to the Study of Population, South India publishers, Madras. - Goon A.M., Gupta M.K. and Das Gupta B. (2009), Fundamentals of Statistics, Vol. II, 8th Edition, The World Press, Kolkata. https://nptel.ac.in/courses/109/104/109104045/2 https://swayam.gov.in/nd1_noc19_hs39/preview3		

5. <https://population.un.org/wpp/>
6. <https://www.prb.org/>
7. <https://censusindia.gov.in/>

COURSE OUTCOMES:

On the successful completion of the course, students will be able to,

CO1: Summarize the concepts of demography.

CO2: Understand mortality and calculate its measures CDR, ASDR, SDR and IMR.

CO3: Describe Life Table and solve numericals of Life Table.

CO4: Explain the theories of population growth and migration.

CO5: Explain various types, importance and methods for estimation of population projection.

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	3	2	3	1	1	1	3	1	2
CO2	1	3	3	3	2	1	1	3	2	2
CO3	1	3	3	3	2	1	2	3	2	2
CO4	1	3	3	3	2	1	2	3	2	2
CO5	1	3	3	3	2	1	2	3	2	3

Third Year	CORE COURSE 9	Semester VI
Code:	STATISTICAL INFERENCE - II (Theory)	Credits: 4
COURSE OBJECTIVES: The learning objectives include:		
• Drawing inference about the unknown population parameters based on random samples. • Validating our inference about the population using hypothesis testing.		
UNIT-I: Introduction to Hypothesis Statistical hypothesis – Simple and composite, null and alternative hypothesis, critical region, level of significance, type of errors and power of test (simple problems). Steps involved in testing of hypothesis. Neyman-Pearson lemma (statement and proof).		
UNIT-II: Large Sample Test Large sample test – Test for single proportion, Difference between proportions, Single mean, Difference between means and Difference between standard deviation.		
UNIT-III: Small Sample Test Small sample test - Student's t test - Test for single mean, Difference between means, Paired t test and Observed sample correlation co-efficient.		
UNIT-IV: Testing of Significance (F-test) Snedecor's F test - Test for equality of two population variance - Testing the significance of an observed multiple correlation co-efficient, Observed sample correlation ratio and Linearity of regression (concepts only).		
UNIT-V: Non-parametric Tests Non-parametric test - Chi-square test - Independence of attributes and goodness off it. One sample tests - Sign test and Run test for randomness, Two sample tests - Sign, median and Mann-Whitney U test – K-W test - Simple problems.		
UNIT-VI: Current Contours (For Continuous Internal Assessment Only) Research and development problems related to various fields of inferential statistics with practical knowledge of computer software.		
REFERENCES: 1. Gupta S.C. and Kapoor V.K. (2013), Fundamentals of Mathematical Statistics, Sultan Chand and Sons Publications, New Delhi. 2. Rohatgi V.L. (1979), An introduction to probability theory and Mathematical Statistics, Wiley Eastern limited. 3. Lehmann E.L. (1986), Testing of Statistical Hypothesis, John Wiley.		

COURSE OUTCOMES:

On the successful completion of the course, students will be able to,

CO1: Students will be able to identify the appropriate null and alternative hypotheses.

C02: Students will be able to identify simple or composite for a given study objective.

C03: Validate inference about the population using hypothesis testing.

C04: Students will be able to identify the type I and type II errors.

C05: Students will be able to solve Non-Parametric test problems.

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
C01	1	3	2	3	1	1	1	3	1	2
C02	1	3	3	3	2	1	1	3	2	2
C03	1	3	3	3	2	1	2	3	2	2
C04	1	3	3	3	2	1	2	3	2	2
C05	1	3	3	3	2	1	2	3	2	3

Third Year	CORE COURSE 10	Semester VI
Code:	OPERATIONS RESEARCH (Theory)	Credits: 4
COURSE OBJECTIVES: The learning objectives include: To study various operational research techniques and models.		
UNIT-I: Introduction to Operations Research Operations Research - Meaning, nature, history, scope and limitations. Linear Programming Problem (LPP)- General form, standard form and canonical form, basic solution, basic feasible solution, optimum solution. Assumption and mathematical formulation of LPP. Graphical solution of LPP – Unique and special cases – Simplex method and Big-M method.		
UNIT-II: Transportation Problem and Assignment Problem Transportation Problem (T.P.)–Meaning, balanced and unbalanced transportation problem. Initial basic feasible solution (IBFS) – North-West Corner Rule (NWC), Least Cost Method (LCM) and Vogel’s Approximation Method (VAM)and MODI method to solve an Transportation problem. Maximization case in Transportation problem. Assignment problem (A.P.) – Meaning, Balanced and Unbalanced Assignment problem – Hungarian method to solve an Assignment problem. Maximization case in Assignment problem.		
UNIT-III: Game Theory Theory of Games – Basic definition – Maximin and Minimax criterion – Solution of games with saddle points – Two-by-Two (2x2) Games without saddle point–principle of dominance–problems based on dominance rule–Graphical method for (2xn) and (mx2) games.		
UNIT-IV: Sequencing Problem Sequencing problem – Meaning, procedure for solving sequencing problems – Processing ‘n’ jobs through two machines, Processing ‘n’ jobs observation through ‘m’ machines and processing of two jobs through ‘m’ machines.		
UNIT-V: Network Analysis by PERT/CPM Network analysis by CPM/PERT: Basic Concept – Constraints in network – Construction of the network – Time calculations – Concept of slack and float in Network analysis – Network crashing – Finding optimum project duration and minimum project cost.		
UNIT-VI: Current Contours (For Continuous Internal Assessment Only) Research and analytical problems on various applications of the industrial issues.		
REFERENCES: - Kanti Swarup, Gupta P.K. and Manmohan (2020), Operations Research, Sultan Chand & Sons, New Delhi. - Taha H.A. (1992), An Introduction to Operations Research, Colliat Macmillan.		

COURSE OUTCOMES:

On the successful completion of the course, students will be able to,

CO1: Understand the fundamental concepts of operational research techniques.

CO2: Understand the basic concepts of Linear programming.

CO3: Solve Transportation and assignment problems

CO4: Solve sequencing problems.

CO5: Solve Network Analysis by PERT/CPM.

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	3	2	3	1	1	1	3	1	2
CO2	1	3	3	3	2	1	1	3	2	2
CO3	1	3	3	3	2	1	2	3	2	2
CO4	1	3	3	3	2	1	2	3	2	2
CO5	1	3	3	3	2	1	2	3	2	3

Third Year	CORE PRACTICAL 6	Semester VI
Code:	STATISTICS PRACTICAL - VI (Theory)	Credits: 4
COURSE OBJECTIVES: The learning objectives include:		
- To impart the analytical skills compassing the statistical methods, predictive analytics, data mining, and machine learning using software and its implications in data science. - To give adequate acquaintance with the technical world to elevate the job competency.		
PROBLEMS BASED ON THE FOLLOWING TOPICS		
- Small sample test - Student's t-test - Test for single mean, Difference between means, Paired t-test and Observed sample correlation co-efficient. - Large sample test – Test for single proportion, Difference between proportions, Single mean, Difference between means and Difference between standard deviation. - Snedecor's F test - Test for equality of two population variance - Testing the significance of an observed multiple correlation co-efficient, Observed sample correlation ratio and Linearity of regression (concepts only). - Non-parametric test - Chi-square test - Independence of attributes and goodness off it. One sample tests - Sign test and Run test for randomness, Two sample tests - Sign, median and Mann-Whitney U test – K-W test - Simple problems.		
REFERENCES:		
- Alan Agresti (2002), Categorical Data Analysis. John Wiley & Sons. - Gardener (2017), Beginning R - The Statistical Programming Language, 1st Edition, Wiley India Pvt Ltd. https://cran.r-project.org/doc/contrib/Faraway-PRA.pdf		

COURSE OUTCOMES:

On the successful completion of the course, students will be able to,

CO1: Students will gain the statistical software knowledge and machine learning which is essential required for projects in all disciplines.

CO2: The content develops research oriented concepts and skills in students about data science required for data analytics. Data scientist job in IT sectors will be enriched.

CO3: The content of the syllabus includes the statistical techniques used in market analytics, research analytics and financial analytics.

CO4: The students will be motivated to do research work.

CO5: The students will get the insights of theory as to use the applications of theory in real time problems through software and summarize the results.

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	3	2	3	1	1	1	3	1	2
CO2	1	3	3	3	2	1	1	3	2	2
CO3	1	3	3	3	2	1	2	3	2	2
CO4	1	3	3	3	2	1	2	3	2	2
CO5	1	3	3	3	2	1	2	3	2	3

Third Year	CORE PROJECT WORK	Semester VI
Code:	PROJECT WORK (WITH VIVA-VOCE)	Credits: 4
The candidate shall be required to take up a Project Work by group or individual and submittal the end of the final year. The Head of the Department shall assign the Guide who, in turn, will suggest the Project Work to the students in the beginning of the final year. A copy of the Project Report will be submitted to the University through the Head of the Department on or before the date fixed by the University. The Project will be evaluated by an internal and an external examiner nominated by the University. The candidate concerned will have to defend his/her Project through a Viva-Voce.		
ASSESSMENT / EVALUATION / VIVA-VOCE:		
1. PROJECT REPORT EVALUATION (Both Internal & External)		
I. Plan of the Project - 20 marks		
II. Execution of the Plan / Collection of Data / Organization of Materials / Hypothesis, Testing etc. and presentation of the report. - 45 marks		
III. Individual initiative - 15 marks		
2. Viva-Voce/Internal & External - 20 marks		
TOTAL - 100 marks		
Passing Minimum:		
Project	Vivo-Voce 20 Marks 40% out of 20 Marks (i.e. 8 Marks)	Dissertation 80 Marks 40% out of 80 marks (i.e. 32 marks)
A candidate who gets less than 40% in the Project must resubmit the Project Report. Such candidates need to defend the resubmitted Project at the Viva-Voce within a month. A maximum of two chances will be given to the candidate.		

Third Year	SKILL ENHANCEMENT COURSE 6	Semester VI
Code:	TIME SERIES AND INDEX NUMBERS (Theory)	Credits: 2
COURSE OBJECTIVES:		
The learning objectives include: • This course will help students to know the applications of statistics and learn and apply these techniques in the core course of their study. • This course will give exposure to four applied fields of statistics viz. Time series and index numbers. • They will be having hands on practice of working on the data related to above mentioned fields.		
UNIT-I: Secular Trend Analysis of Time Series–Its definition and uses, additive and multiplicative models in time series, components of time series – secular trend, seasonal variation, cyclic variations and irregular fluctuations - Definition and concepts. Measurement of trend – graphic method, method of semi-averages, method of moving averages and method of least squares. Fitting of straight line trend.		
UNIT-II: Seasonal Variations Measurement of Seasonal Variations – Method of Simple Averages, Ratio to Moving Average method by additive and multiplicative model, Ratio to Trend Method and Link Relative Method - Simple Problems.		
UNIT-III: Introduction to Index Numbers Index Numbers – Definition and uses, types of index numbers, problems involved in the construction of index numbers. Construction of simple index numbers – Simple aggregate method and simple average of price relatives using A.M.& G.M. Construction of weighted index numbers–Laspeyre’s, Paasche’s, Dorbish-Bowley, Marshall-Edge worth and Fisher’s ideal index numbers - Simple problems.		
UNIT-IV: Testing of Index Number Definition of deflation, splicing, inflation, and real wages. Construction of weighted average of price relative’s index numbers using A.M. & G.M. Fixed base index numbers and chain base index numbers. Tests of adequacy of good Index number – Time reversal test, factor reversal test, unit test and cyclic test - Simple problems.		
UNIT-V: Demand Analysis Demand Analysis: Introduction - Definition of demand and supply - Laws of demand and supply - Equilibrium Price-Giffen’s paradox. Price elasticity of demand and supply: Definition, interpretation and simple problems.		
UNIT-VI: Current Contours (For Continuous Internal Assessment Only) Industry expert lectures-predictive modelling in data analytics and demographical analysis of real time problems.		

REFERENCES:

1. Gupta S.C. and Kapoor V.K. (2013), Fundamentals of Mathematical Statistics. Sultan Chand & Sons, New Delhi.
2. Gupta S.P. (1995), Statistical Methods, Sultan Chand & Sons, New Delhi.
3. Goon A.M., Gupta M.A. and Das Gupta (1987), Fundamentals of Statistics, Sultan Chand & Sons, New Delhi.

COURSE OUTCOMES:

On the successful completion of the course, students will be able to,

CO1: Understand and identify the problems in the construction of various types of index numbers.

CO2: Appreciate various tests of adequacy and the uses of index numbers.

CO3: Understand the concept of consumer price index and identify the limitations of index numbers.

CO4: Decompose a time series into trend, seasonal, cyclical and irregular components and understand the theoretical basis of different methods of time series analysis including decomposition.

CO5: Define supply and demand analysis and explain the associated functions and relations between them.

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	3	2	3	1	1	1	3	1	2
CO2	1	3	3	3	2	1	1	3	2	2
CO3	1	3	3	3	2	1	2	3	2	2
CO4	1	3	3	3	2	1	2	3	2	2
CO5	1	3	3	3	2	1	2	3	2	3

Third Year	SKILL ENHANCEMENT COURSE 7	Semester VI
Code:	REGRESSION ANALYSIS (Theory)	Credits: 2
COURSE OBJECTIVES:		
The learning objectives include: • This course will help students to know the linear regression and least square analysis. • This course will give exposure to test for lack of fit, Multicollinearity and non-linear regression.		
UNIT-I: Simple Linear Regression Simple linear regression - Assumptions, Estimation of model parameters, Standard error of estimators, Testing of hypotheses on slope and intercept (β's), Interval estimation of model parameters, Prediction interval of a new observation, Coefficient of determination, Regression through origin. UNIT-II: Least Square Analysis and Test of Hypothesis Standard Gauss Markov setup, Least square estimation of model parameters, Variance Covariance of least squares estimators, Estimation of error variance. Tests of hypotheses - Significance of regression (ANOVA, R^2 and adjusted R^2), General linear hypotheses - Confidence intervals and regions, Prediction intervals, Detecting hidden interpolation. UNIT-III: Test for lack of fit Test for Lack of fit of the model. Durbin-Watson test for autocorrelation. Analytical methods for selecting a transformation generalized and Weighted least squares - Detection of influential observations - Cooks statistic, DFFITS, DFBETAS. UNIT-IV: Multicollinearity Multicollinearity – Sources, effects, Diagnostics, Methods of dealing with Multicollinearity (collection of additional data, model respecification, Ridge regression). Selection of variables – Forward selection, Backward elimination and Step-wise regression (algorithms only). UNIT-V: Non-linear Regression Non-linear regression - Transformation to a linear model, Uses and Limitations, Initial estimates (starting values), Parameter estimation using iterative procedures - Gauss-Newton, Steepest Descent, Marquardt's compromise. Count data - Poisson regression – Variables selection -Non-parametric regression. UNIT-VI: Current Contours (For Continuous Internal Assessment Only) Industry expert lectures- predictive modelling in linear and non-linear regression analysis of real time problems.		
REFERENCES: 1. Douglas C. Montgomery, Elizabeth A. Peck, G. Geoffrey Vining (2021), Introduction to Linear Regression Analysis, 6th Edition, Wiley. 2. Norman R. Draper, Harry Smith (1998), Applied Regression Analysis, Wiley. 3. John F. Monahan (2008), A Primer on Linear Models, CRC Press. 4. Andre I. Khuri (2009), Linear Model Methodology, CRC Press.		

COURSE OUTCOMES:

On the successful completion of the course, students will be able to,

C01: Understand and identify the problems in linear regression models.

C02: Understand and identify the problems in non-linear regression models.

C03: Understand the concept of Least Square Analysis.

C04: Understand the concept of methods of dealing with multicollinearity.

C05: Understand the concept of test of hypothesis and lack of fit.

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
C01	1	3	2	3	1	1	1	3	1	2
C02	1	3	3	3	2	1	1	3	2	2
C03	1	3	3	3	2	1	2	3	2	2
C04	1	3	3	3	2	1	2	3	2	2
C05	1	3	3	3	2	1	2	3	2	3