UNIVERSITY OF KERALA

Four Year Under Graduate Programme
(UoK FYUGP)

Syllabus

Major Discipline STATISTICS

May 2024

ABOUT THE DISCIPLINE

Statistics is the science of collecting, analyzing, interpreting, and presenting data. Statistics is a powerful tool that can be used to gain insights from data. It is an essential part of many fields of study and is becoming increasingly important in the world today. Statistics, far from being a dry collection of numbers, is a dynamic discipline that empowers us to understand the world around us. Imagine a vast ocean of information - statistics equips us with the tools to navigate this sea, extract meaningful patterns, and draw insightful conclusions. It's a systematic framework for transforming raw numbers into knowledge. The impact of statistics extends far beyond mere numbers. It permeates nearly every aspect of our lives. In the realm of business, it informs marketing strategies, product development, and financial forecasting. Governments rely on statistics to assess economic trends, allocate resources effectively, and formulate public policies based on social demographics and healthcare data. Even in fields like sports, statistics are used to analyze player performance, optimize training regimens, and predict game outcomes.

The ever-growing volume of data generated by the digital age underscores the increasing importance of statistics. This "age of big data" necessitates advanced statistical models and computational tools to handle complex datasets. Fields like machine learning leverage statistical algorithms to extract knowledge from vast datasets, fuelling innovation across industries.Statistics courses delve into the fascinating world of data, equipping students with the tools to collect, analyze, interpret, and draw meaningful conclusions from information. The course lays a solid foundation in probability theory, the bedrock of statistics. The student will explore concepts like random events, probability distributions, and statistical inference, allowing them to understand the likelihood of events and make informed predictions. The student will delve into a diverse toolbox of statistical methods, including hypothesis testing, regression analysis, time series analysis, and non-parametric statistics. These methods empower you to analyze real-world data, identify patterns, and test hypotheses.

The courses hones student's critical thinking skills, allowing them to approach problems logically and systematically. They will learn to identify relevant data, choose the appropriate statistical methods, and interpret results in a meaningful way. In today's data-driven world, effectively communicating findings is crucial. The course equips with data visualization skills, allowing them to present complex information in clear and compelling ways using charts, graphs, and other visual tools.The demand for skilled statisticians is skyrocketing across various sectors. This course prepares the students for a rewarding career in data analysis, research, and decision-making. They will gain the expertise to work in fields like finance, healthcare, marketing, government, and scientific research. Statistics transcends disciplinary boundaries. The courses encourages them to collaborate with researchers and professionals from various fields, fostering a well-rounded understanding of how data can be used effectively in different contexts.

Modern statistical analysis often involves specialized software. The course introduces them to statistical software packages like R, Python, Spread sheet software, equipping them with the technical skills to manipulate and analyze large datasets efficiently.

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Graduate Attributes

Graduate attributes bridge the gap between academia and the real world, fostering lifelong learning and meaningful contributions. They denote the skills, competencies and high-level qualities that a student should acquire during their university education. Apart from gathering content knowledge, these attributes go beyond the assimilation of information to its application in various contexts throughout a graduate's life. It aims in inculcating the art of critical thinking, problem solving, professionalism, leadership readiness, teamwork, communication skills and intellectual breadth of knowledge. The University of Kerala envisages to pave the path in guiding the student's journey to shape these attributes uniquely, making them integral to personal growth and success in various spheres of life. The University strives to ensure that these graduate attributes are not just checkboxes, but they play a pivotal role in shaping the students into capable, compassionate and responsible individuals with a high degree of social responsibility.

Programme Outcomes (PO)

No.	Programme Outcomes (POs)
PO-1	**Critical thinking** ○ analyze information objectively and make a reasoned judgment ○ draw reasonable conclusions from a set of information, and discriminate between useful and less useful details to solve problems or make decisions ○ identify logical flaws in the arguments of others ○ evaluate data, facts, observable phenomena, and research findings to draw valid and relevant results that are domain-specific
PO-2	**Complex problem-solving** ○ solve different kinds of problems in familiar and no-familiar contexts and apply the learning to real-life situations ○ analyze a problem, generate and implement a solution and to assess the success of the plan ○ understand how the solution will affect both the people involved and the surrounding environment

PO-3	**Creativity**
	○ produce or develop original work, theories and techniques ○ think in multiple ways for making connections between seemingly unrelated concepts or phenomena ○ add a unique perspective or improve existing ideas or solutions ○ generate, develop and express original ideas that are useful or have values
PO-4	**Communication skills**
	○ convey or share ideas or feelings effectively ○ use words in delivering the intended message with utmost clarity ○ engage the audience effectively ○ be a good listener who are able to understand, respond and empathize with the speaker ○ confidently share views and express himself/herself
PO-5	**Leadership qualities**
	○ work effectively and lead respectfully with diverse teams ○ build a team working towards a common goal ○ motivate a group of people and make them achieve the best possible solution. ○ help and support others in their difficult times to tide over the adverse situations with courage
PO-6	**Learning 'how to learn' skills**
	○ acquire new knowledge and skills, including 'learning how to learn skills, that are necessary for pursuing learning activities throughout life, through self-paced and self-directed learning ○ work independently, identify appropriate resources required for further learning ○ acquire organizational skills and time management to set self-defined goals and targets with timelines ○ inculcate a healthy attitude to be a lifelong learner
PO-7	**Digital and technological skills**
	○ use ICT in a variety of learning and work situations, access, evaluate, and use a variety of relevant information sources ○ use appropriate software for analysis of data ○ understand the pitfalls in the digital world and keep safe from them
PO-8	**Value inculcation**
	○ embrace and practice constitutional, humanistic, ethical, and moral values in life including universal human values of truth, righteous conduct, peace, love, nonviolence, scientific temper, citizenship values ○ formulate a position/argument about an ethical issue from multiple perspectives ○ identify ethical issues related to work, and follow ethical practices, including avoiding unethical behaviour such as fabrication, falsification or misrepresentation of data, or committing plagiarism, and adhering to intellectual property rights ○ adopt an objective, unbiased, and truthful actions in all aspects of work

Programme Specific Outcomes (PSO)

No.	Upon completion of the programme the graduate will be able to	PO No.
PSO-1	**Knowledge in Statistical Theory and Application in day to day life** - Apply statistical theory and methodologies to analyse and interpret data encountered in day-to-day life situations. - Utilize statistical reasoning to make informed decisions, solve problems and assess risks in personal, professional, and societal contexts.	PO-1 PO-2
PSO-2	**Proficiency in Data Analysis and Statistical Modelling Skills** - Demonstrate proficiency in collecting, organizing and analyzing data using statistical methods and software tools. - Apply appropriate statistical techniques to different types of data sets to derive meaningful insights and draw conclusions. - Develop skills in building statistical models to describe, analyze and interpret real-world phenomena. - Utilize regression analysis, time series analysis and other modelling techniques to make predictions and forecast future trends	PO-1 PO-2 PO-7
PSO-3	**Research and Problem-Solving Abilities** - Apply statistical reasoning and problem-solving techniques to address research questions and real-world problems in various domains. - Design and conduct statistical experiments, surveys and studies to investigate hypotheses and test theories.	PO-2 PO-3 PO-6
PSO-4	**Proficiency in Digital Statistical Skills** -Use information and communication technology (ICT) in various statistical learning and work situations, accessing, evaluating and utilizing a variety of relevant statistical information sources. -Utilize appropriate statistical software for data analysis and interpretation.	PO-6 PO-7
PSO-5	**Communication and Presentation Skills** - Communicate statistical findings, interpretations and conclusions	PO-4 PO-7

		effectively to both technical and non-technical audiences. - Prepare clear and concise reports, presentations and visualizations to communicate statistical results and insights.	
PSO-6		**Value Inculcation in Statistical Practice** -Embrace and practice constitutional, humanistic, ethical and moral values in statistical work. -Formulate positions or arguments about ethical issues in statistical practice from multiple perspectives. -Identify ethical issues related to statistical work and follow ethical statistical practices. -Adopt objective, unbiased and truthful actions in all statistical aspects of work.	PO-5 PO-8

DETAILS OF PROGRAMME

SEMSTER	COURSE CODE	COURSE TITLE	THEORY	PRACTICAL	TOTAL	Allotted hours Per week
				CREDITS		
	UK1DSCSTA101	BUSINESS DATA ANALYTICS I	3	1	4	5
	UK1DSCSTA102	QUANTITATIVE DATA ANALYTICS I	4	0	4	4
	UK1DSCSTA103	GEOSTATISTICS I	3	1	4	5
	UK1DSCSTA104	BEHAVIOURAL DATA ANALYTICS I	4	0	4	4
	UK1DSCSTA105	ELEMENTARY STATISTICS	4	0		4
FIRST	UK1DSCSTA106	ELEMENTS OF STATISTICAL THEORY	3	1	4	5
	UK1DSCSTA107	BASIC STATISTICS I	3	1	4	5
	UK1DSCSTA108	FUNDAMENTALS OF STATISTICS	3	1	4	5
	UK1DSCSTA109	DESCRIPTIVE STATISTICS AND PROBABILITY	3	1	4	5
	UK1DSCSTA110	STATISTICAL METHODS	3	1	4	5
	UK1DSCSTA111	DESCRIPTIVE STATISTICS WITH R	3	1	4	5
	UK1MDCSTA101	EXPERIMENTAL DESIGNS FOR SCIENCE	2	1	3	4
	UK1MDCSTA102	SURVEY DESIGNS AND ANALYSIS FOR SOCIAL SCIENCES	2	1	3	4
	UK2DSCSTA101	BUSINESS DATA ANALYTICS II	3	1	4	5
	UK2DSCSTA102	QUANTITATIVE DATA ANALYTICS II	4	0	4	4
	UK2DSCSTA103	GEOSTATISTICS II	3	1	4	5
	UK2DSCSTA104	BEHAVIOURAL DATA ANALYTICS-II	4	0	4	4
	UK2DSCSTA105	STATISTICAL TOOLS FOR DATA ANALYSIS	3	1	4	5
	UK2DSCSTA106	ELEMENTARY DATA ANALYSIS TECHNIQUES	3	1	4	5
	UK2DSCSTA107	BASIC STATISTICS II	4	0	4	4
SECOND	UK2DSCSTA108	INTRODUCTION TO LINEAR MODELS AND COMBINATORIAL ANALYSIS	3	1	4	5
	UK2DSCSTA109	STANDARD DISTRIBUTIONS, CORRELATION AND REGRESSION	3	1	4	5
	UK2DSCSTA110	STATISTICAL METHODS II	3	1	4	5
	UK2DSCSTA111	DATA ANALYSIS USING R- I	3	1	4	5
	UK2MDCSTA101	BIVARIATE AND CATEGORICAL DATA ANALYSIS	2	1	3	4

	UK2MDCSTA102	DATA INTERPRETATION AND QUANTITATIVE REASONING	3	0	3	3
	UK2MDCSTA103	INTRODUCTION TO MACHINE LEARNING	3	0	3	3
THIRD	UK3DSCSTA201	BUSINESS STATISTICS- III	3	1	4	5
	UK3DSCSTA202	QUANTITATIVE DATA ANALYTICS -III	4	0	4	5
	UK3DSCSTA203	GEOSTATISTICS-III	3	1	4	5
	UK3DSCSTA204	BEHAVIOURAL DATA ANALYTICS-III	4	0	4	5
	UK3DSCSTA205	STATISTICAL TOOLS FOR DATA ANALYSIS-II	3	1	4	5
	UK3DSCSTA206	BASIC STATISTICS-III	3	1	4	5
	UK3DSCSTA207	STATISTICAL INFERENCE AND RANDOM PROCESS	3	1	4	5
	UK3DSCSTA208	STATISTICAL INFERENCE	3	1	4	5
	UK3DSCSTA209	PROBABILITY AND DISTRIBUTIONS - I	3	1	4	5
	UK3DSCSTA210	DATA ANALYSIS USING R- II	3	1	4	5
	UK3DSESTA201	APPLIED STATISTICS	3	1	4	5
	UK3DSESTA202	INTRODUCTION TO DATA ANALYSIS SOFTWARES	3	1	4	5
	UK3DSESTA203	INTRODUCTION TO OPERATIONAL RESEARCH AND LINEAR PROGRAMMING	4	0	4	5
	UK3VACSTA201	DATA VISUALISATION AND INTERPRETATION	2	1	3	4
	UK3VACSTA202	AN INTRODUCTION TO R	2	1	3	4
FOURTH	UK4DSCSTA201	PROBABILITY AND DISTRIBUTIONS - II	3	1	4	5
	UK4DSCSTA202	LIMIT THEOREMS AND SAMPLING DISTRIBUTIONS	3	1	4	5
	UK4DSESTA201	OFFICIAL STATISTICS	4	0	4	4
	UK4DSESTA202	ACTUARIAL SCIENCE	4	0	4	4
	UK4DSESTA203	ADVANCED LINEAR PROGRAMMING	4	0	4	4
	UK4SECSTA201	STATISTICAL ANALYSIS USING PYTHON	2	1	3	4
	UK4SECSTA202	STATISTICAL ANALYSIS USING R	2	1	3	4
	UK4VACSTA201	BIG DATA ANALYSIS	3	0	3	3
	UK4VACSTA202	STUDY DESIGN IN RESEARCH	3	0	3	3
	UK4VACSTA203	DATA ANALYSIS USING SPREADSHEETS	2	1	3	4
FIFTH	UK5DSCSTA301	THEORY OF ESTIMATION	2	2	4	6
	UK5DSCSTA302	TESTING OF HYPOTHESIS	2	2	4	6
	UK5DSCSTA303	SAMPLE SURVEY METHODS	2	2	4	6
	UK5DSESTA301	STATISTICAL QUALITY CONTROL	3	1	4	5
	UK5DSESTA302	ECONOMETRICS	4	0	4	4
	UK5DSESTA303	MEDICAL STATISTICS	4	0	4	4

	UK5DSESTA304	OPERATION RESEARCH	4	0	4	4
	UK5DSESTA305	OPTIMIZATION TECHNIQUES	4	0	4	4
	UK5DSESTA306	BIO STATISTICS	4	0	4	4
	UK5SECSTA301	DATA ANALYSIS WITH R	3	1	4	5
	UK5SECSTA302	REPORT WRITNG USING LATEX	3	1	4	5
	UK6DSCSTA301	MACHINE LEARNING	4	0	4	4
	UK6DSCSTA302	DESIGN OF EXPERIMENTS	2	2	4	6
	UK6DSCSTA303	BASICS OF MULTIVARIATE ANALYSIS	3	1	4	5
	UK6DSESTA301	NONPARAMETRIC METHODS	3	1	4	5
SIXTH	UK6DSESTA302	QUEUING THEORY	4	0	4	4
	UK6DSESTA303	RELIABILITY AND SURVIVAL ANALYSIS	4	0	4	4
	UK6DSESTA304	DECISION AND GAME THEORY	4	0	4	4
	UK6DSESTA305	ORDER STATISTICS	4	0	4	4
	UK6DSESTA306	REGRESSION METHODS	3	1	4	5
	UK6SECSTA301	STATISTICAL COMPUTING WITH R	2	1	3	4
	UK6SECSTA302	STATISTICAL COMPUTING WITH PYTHON	2	1	3	4
	UK7DSCSTA401	ADVANCED MULTIVARIATE METHODS	3	1	4	5
	UK7DSCSTA402	STOCHASTIC PROCESS	4	0	4	4
	UK7DSCSTA301	STATISTICS AND RESEARCH METHODOLOGY	4	0	4	4
SEVENTH	UK7DSCSTA302	STATISTICAL INFERENCE	3	1	4	5
	UK7DSCSTA303	TIME SERIES ANALYSIS	3	1	4	5
	UK7DSCSTA304	BASIC STATISTICAL TECHNIQUES FOR ALL DISCIPLINES	3	1	4	5
	UK7DSESTA401	ADVANCED DISTRIBUTION THEORY	4	0	4	4
	UK7DSESTA402	ADVANCED PROBABILITY THEORY	4	0	4	4
	UK7DSESTA403	INVENTORY MANAGEMENT AND QUEUING THEORY	4	0	4	4

University of Kerala

Discipline	STATISTICS				
Course Code	UK1DSCSTA101				
Course Title	BUSINESS DATA ANALYTICS-I				
Type of Course	**DSC**				
Semester	I				
Academic Level	100 – 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2hours	5
Pre-requisites	NIL				

COURSE OUTCOMES

Up on Completion of the course, students should be able to:		Cognitive level	PSO Addressed
CO1	Explain the relevance of Statistics in Business	Understand	PSO -1
CO2	Explain different types of data, collection of data	Understand	PSO -1
CO3	Distinguish between different sampling methods	Understand	PSO -1
CO4	Visualize the data and interpret the information contained	Apply	PSO -2, PSO -4, PSO -5
CO5	Compute various descriptive statistics measures	Apply	PSO -1, PSO -2, PSO -4, PSO -5

COURSE CONTENT

Module	Content	Hrs
I	**Introduction**	5
	Meaning of Business Statistics. Applications of Statistics in various fields of business. Definition of data. Definition and sources of Primary and Secondary data. Design of questionnaire and schedules, Scaling Techniques-Nominal, ordinal, Ratio and Interval.	
II	**Data Collection Methods and Sampling Methods**	10
	Definition of Population and Sample. Methods of data collection- Census method and Sampling method. Advantages of sampling method over census method. Probability sampling: Simple random sampling (without replacement and with replacement) and Stratified random sampling, Systematic sampling, cluster sampling, multistage sampling (procedure with examples only and no need of estimation). Non-probability sampling: convenient sampling, purposive sampling, judgement sampling, quota sampling, snowball sampling (definitions and examples only).	
III	**Presentation and Visualization of Data:**	15

	Classification and tabulation, types of classification, types of tabulation frequency distribution and frequency table, discrete and continuous frequency distribution, relative frequency table, cumulative frequency table, Diagrammatic and graphical representation of data, different types of bar diagram, pie-diagram, histogram, frequency polygon, frequency curve, Ogives	
IV	**Measures of central tendency and Dispersion**	**15**
	Arithmetic Mean, Median, Mode, Geometric Mean, Harmonic Mean (definition, formula, numerical examples, merits and demerits). Partition values – Quartiles, Deciles, Percentiles, (definition, formula, numerical examples, uses), Percentile Rank and its uses. Graphical representation of partition values. **Measures of dispersion** – Standard Deviation, Mean deviation and Coefficient of Variation (Concepts, uses and problems) ; Lorenz curve - Uses and limitations. **Skewness and Kurtosis:** Skewness - Definition, Types of skewness, measures of skewness- Pearson and Bowley's measure; Kurtosis – Definition, Types of kurtosis, Coefficient measure of kurtosis (Moment measures of skewness and kurtosis not required).	
V	**Practicum**	**30**
	Practical Demonstration of the examples of modules III and IV, using spread sheet software	

PRACTICAL/LABWORK
List of Practical worksheets
1. Presentation and visualization of Data
2. Measures of Central tendency.
3. Measures of Dispersion

REFERENCES
1. Gupta, S. C., & Kapoor, V. K. (2020). Fundamentals of mathematical statistics. Sultan Chand & Sons.
2. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2016). Fundamentals of Statistics, Vol. I, 8th Ed. The World Press, Kolkata.
3. Sharma J K, (2013). Fundamentals of Business Statistics, Second Edition, Vikas Publishing House Private Limited.
4. Siegel, Andrew, (2013). Practical Business Statistics, Irwin McGraw Hill International 4th Edition
5. www.libreoffice.org
6. Berk, K. N., & Carey, P. (1998). Data Analysis with Microsoft Excel. Pacific Grove, CA: Duxbury Press.

Name of the Course: BUSINESS DATA ANALYTICS-I
Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)	Practical (P)

CO 1	Explain the relevance of statistics in business	PSO -1, PO -1	Understand	F, C	L	
CO 2	Explain different types of data, collection of data	PSO -1, PO -1	Understand	C	L	
CO 3	Distinguish between different sampling methods	PSO -1, PO -1	Understand	C	L	
CO 4	Visualize the data and interpret the information contained	PSO 1,2,4, 5 PO -1, 2, 4, 6,7	Apply	C, P	L	P
CO 5	Compute various descriptive statistics measures	PSO -1, 2, 4,5 PO -1, 2, 4, 6,7	Apply	C, P	L	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO 1	1						1							
CO 2	1						1							
CO 3	1						1							
CO 4	2	2		2	2		2	1		2		1	2	
CO 5	1	2		2	1		2	1		2		1	2	

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar

- Internal Examination
- Practical Evaluation
- End Semester Examinations

Mapping of COs to Assessment Rubrics :

	Internal Exam	Quiz / Assignment/ Discussion / Seminar	Practical Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓	✓	✓
CO 5	✓	✓	✓	✓

University of Kerala

Discipline	STATISTICS				
Course Code	UK1DSCSTA102				
Course Title	QUANTITATIVE DATA ANALYTICS-I				
Type of Course	**DSC**				
Semester	I				
Academic Level	100 – 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites					

COURSE OUTCOMES

	Up on Completion of the course, students should be able to:	Cognitive level	PSO addressed
CO1	Explain the functions and objectives of NSO and other Statistical Organizations	Understand	PSO 6
CO2	Plan and execute small research investigations	Apply	PSO 3, 5,6
CO3	Apply various methods of collecting primary and secondary data	Apply	PSO 3, 5
CO4	Use various data visualization Methods	Apply	PSO1, 2, 5
CO5	Interpret various measures of mathematical and positional averages	Analyse	PSO1 ,2 5

COURSE CONTENT

Module	Content	Hrs
I	**Origin and Development of Statistics**	10
	Origin and history of Statistics, importance and scope of Statistics in Economics (Not for examination), Definition of Statistics in Singular and Plural sense, functions, limitations and misuse of Statistics **Brief Introduction to Indian Statistical System**: Overview of Ministry of Statistics and Programme Implementation (MOSPI), objectives and functions of National Statistical Office (NSO), Overview of Statistical System in Kerala: Activities and functions of Directorate of Economics and Statistics in Kerala.	
II	**Methods of Data Collection**	15
	Nominal, ordinal, interval and ratio scales of measurement, Primary data and Methods of collecting primary data along with its merits and demerits, Secondary data and sources of secondary data, scrutiny of secondary data, census and sample surveys, advantages and limitations of sampling, Probability sampling - Selection of sample using simple random sampling, stratified random sampling, systematic sampling, cluster sampling, multistage sampling (procedure with examples only and no need of estimation). Non probability	

	sampling: -convenient sampling, purposive sampling, judgement sampling, quota sampling, snowball sampling (definitions and examples only)		
III	**Presentation and Visualization of Data:**	**15**
	Classification and tabulation, types of classification, types of tabulation, frequency distribution and frequency table, discrete and continuous frequency distribution, relative frequency table, cumulative frequency table. Diagrammatic and graphical representation of data: different types of bar diagram, pie-diagram, histogram, frequency polygon, frequency curve, Ogives and their uses.	
IV	**Measures of central tendency and Dispersion**	**20**
	Arithmetic Mean, Median, Mode, Geometric Mean, Harmonic Mean (definition, formula, numerical examples, merits and demerits). Partition values – Quartiles, Deciles, Percentiles, (definition, formula, numerical examples, uses), Percentile Rank and its uses. Graphical representation of partition values. **Measures of dispersion** – Standard Deviation, Mean deviation and Coefficient of Variation (Concepts, uses and problems) ; Lorenz curve - Uses and limitations. **Skewness and Kurtosis:** Skewness - Definition, Types of skewness, measures of skewness- Pearson and Bowley's measure; Kurtosis – Definition, Types of kurtosis, Coefficient measure of kurtosis (Moment measures of skewness and kurtosis not required)	

REFERENCES

1. Elhance D.N., Veena Elhance and B.M. Agarwal (2018). Fundamentals of Statistics, Kitab Mahal Publications, New Delhi.
2. S.P. Gupta (2019). Statistical Methods, Sultan Chand & Sons, New Delhi
3. S.C.Gupta and V.K.Kapoor (2021). Fundamentals of Mathematical Statistics, Sultan Chand & Sons, New Delhi
4. Goon, Gupta, Das Gupta (2016). Fundamentals of Statistics, The World Press
5. Ministry of Statistics and Program Implementation. www. mospi.gov.in
6. https://ecostat.kerala.gov.in/

Name of the Course: QUANTITATIVE DATA ANLYSIS-I
Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)	Practical (P)
CO1	Explain the functions and objectives of NSO and other Statistical Organizations	PSO 6 PO 5 ,8	Understand	C	L	
CO2	Plan and execute small research investigations	PSO 3, 5, 6 PO 2, 3, 4, 7	Apply	C,P	L	
CO3	Apply various methods of collecting primary and secondary data	PSO 3, 5 PO 3, 4 ,7	Apply	P,C	L	
CO4	Use various data visualization Methods	PSO 1, 2, 5 PO 1, 2, 5, 7	Apply	P,C	L	

	CO5	Interpret various measures of mathematical and positional averages	PSO 1 ,2, 5 PO 1, 5, 7	Analyse	C,P	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1						1					1			1
CO2			1		1	1		1	2	1			1	
CO3			3		2				1	1			1	
CO4	2	3			2		1	1			1		1	
CO5	1	3			1		1				1		1	

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Internal Examination
- Practical Evaluation
- End Semester Examinations

Mapping of COs to Assessment Rubrics :

	Internal Exam	Quiz / Assignment Discussion / Seminar	Practical Evaluation	End Semester Exam
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6	✓	✓		✓

Discipline	STATISTICS
Course Code	UK1DSCSTA103
Course Title	GEO STATISTICS-I
Type of Course	**DSC**
Semester	I
Academic Level	100 – 199

Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	NIL				

COURSE OUTCOMES

	Up on completion of the course, students should be able to:	Cognitive level	PSO Addressed
CO1	Explain the need of Statistics in geography	Understand	PSO 1
CO2	Describe the difference between qualitative and quantitative variables and classify measurements based on their scale.	Understand	PSO 1,3
CO3	Discuss different techniques of classification of data	Understand	PSO 1
CO4	Apply various diagrammatic and graphical tools to represent a data.	Apply	PSO 1, 2, 3, 4
CO5	Explain primary data, secondary data, the concepts of data collection, sampling frame and various sampling methods like simple random sampling, systematic and stratified sampling.	Understand	PSO 1, 3
CO6	Calculate various measures of central tendency and dispersion	Apply	PSO 1,2, 3,4
CO7	Interpret the skewness and kurtosis of a data set.	Apply	PSO 1,2, 3,4
CO8	Apply least square method to fit a straight line and Calculate and interpret the values of correlation coefficients of bivariate data sets.	Analyse	PSO 1,2,3, 4

COURSE CONTENT

Module	Content	Hrs
I	**Introduction**	5
	Role of Statistics in Geography, Constants and Variables, Qualitative and Quantitative Variables, Data- Scales of Measurements (Nominal, Ordinal, Interval and Ratio), Classification of Data- geographical classification,	

		Chronological classification, Qualitative and Quantitative classification, Diagrammatic and Graphical Representation of Data- Bar Diagram, Pie Diagram, Histogram and Stem and Leaf Plot.	
II	**Data Collection Methods**		10
	Population, Sample, Census, Primary Data, Secondary Data, Sample Unit, Sampling Frame. Probability Sampling- Simple Random Sampling (Definition and examples only), Stratified Sampling (Definition and examples only) and Systematic Sampling (Definition and examples only), Sampling and Non-Sampling Errors.		
III	**Measures of Central tendency and Dispersion**		15
	Arithmetic Mean, Median and Mode (Concepts and problems on raw data only, Mathematical derivation is not required). **Measures of Dispersion:** Standard Deviation, Mean Deviation, Coefficient of Variation and Its significance (Concepts and problems on raw data only, Mathematical derivation is not required), Skewness and Kurtosis (Definition Only).		
IV	**Bivariate Data**		15
	Scatter Diagram, Curve Fitting- Principle of Least Squares, Fitting of Straight Line, Correlation, Karl Pearson's Correlation Coefficient (formula and interpretation only) and Spearmen's Rank Correlation Coefficient (formula and interpretation only), Regression, Regression Lines (Concepts and Problems, Mathematical derivation not required)		
V	**Practicum**		30
	Practical using spread sheet application of the Modules I, III and IV.		

PRACTICAL/LABWORK
List of Practical worksheet
1. Problems on measures of Central tendency(raw data only)
2. Problems on Measures of Dispersion (raw data only)
3. Diagrams and graphs.
4. Correlation analysis
5. Regression Lines

REFERENCES

1. Agarwal, B.L. (2006). Basic Statistics, 4th Edition, New Age International(P) Ltd, New Delhi.
2. Burt, J. E., Barber, G. M., & Rigby, D. L. (2009). Elementary statistics for geographers. Guilford Press.
3. Gupta S.C and Kapoor, V.K. (1990). Fundamentals of Mathematical Statistics, Sultan Chand and Sons, New Delhi.
4. Gupta S.P (2004). Statistical Methods, Sultan Chand and Sons, New Delhi.
5. Medhi J (2000) Statistical Methods - An introductory text, New Age International(P), Ltd, New Delhi.
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7. Berk, K. N., & Carey, P. (1998). Data Analysis with Microsoft Excel. Pacific Grove, CA: Duxbury Press.
8. Gupta, S.C. and Kapoor, V.K. (2002). Fundamentals of Applied Statistics, Sultan Chand & Co. New Delhi.

Name of the Course: GEO STATISTICS-I
Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)	Practical (P)
CO 1	Explain the need of Statistics	PSO 1 PO 1	Understand	F, C	L	
CO2	Describe the difference between qualitative and quantitative variables and classify measurements based on their scale.	PSO 1,3 PO 1,6	Under stand	F,C	L	
CO3	Discuss different techniques of classification of data	PSO 1 PO 1	Under stand	F,C	L	P
CO4	Apply various diagrammatic and graphical tools to represent a data.	PSO 1, 2, 3, 4 PO 2,3,6,7	Apply	C,P	L	P
CO5	Explain primary data, secondary data, the concepts of data collection, sampling frame and various sampling methods like simple random sampling, systematic and stratified sampling.	PSO 1, 3 PO 1,2	Under stand	F,C	L	
CO6	Calculate various measures of central tendency and dispersion	PSO 1,2, 3,4 PO 1,2,4,6, 7	Apply	C,P	L	P
CO7	Interpret the skewness and kurtosis of a data set.	PSO 1,2, 3,4 PO 1,2,4,6, 7	Apply	P,C	L	P
CO8	Apply least square method to fit a straight line and Calculate and interpret the values of correlation coefficients of bivariate data sets.	PSO 1,2,3, 4 PO 1,2,4,6, 7	Analy se	P,M	L	P

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO 1	2						1							
CO 2	2		1				1					1		
CO 3	1						1					1		
CO 4	2	1	1	1			2	1						
CO 5	2		3				2	2				2	2	
CO 6	2	2	1	1			1	2				1	1	
CO 7	2	2	1	1			1	2					1	
CO 8	2	1	1	1			2	2	2			1	1	

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Examination
- Practical Evaluation
- End Semester Examinations

Mapping of COs to Assessment Rubrics :

	Internal Exam	Quiz / Assignment Discussion / Seminar	Practical Evaluation	End Semester Exam
CO 1	✓	✓		✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓		✓
CO 4	✓	✓	✓	✓
CO 5	✓	✓		✓
CO 6	✓	✓	✓	✓
CO 7	✓	✓	✓	✓
CO 8	✓	✓	✓	✓

University of Kerala

Discipline	STATISTICS				
Course Code	UK1DSCSTA104				
Course Title	**BEHAVIOURAL DATA ANALYTICS-I**				
Type of Course	**DSC**				
Semester	I				
Academic Level	100 – 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-		4
Pre-requisites					

Course outcomes

	On completion of the course, the students should be able to:	Cognitive level	PSO addressed
CO1	Understand scope and functions of statistics.	Remember	PSO 1
CO2	Understand different data collection techniques.	Understand	PSO 1,2,3
CO3	Classify and visualize data	Apply	PSO1,2,3,4
CO4	Carry out some descriptive measures of central tendency and dispersion	Apply	PSO1,2,3,4
CO5	Understand the concept of skewness and kurtosis	Understand	PSO1,2,3

Course content

Module	Content	Hrs
I	**Introduction**	**10**
	Introduction: Meaning of Statistics, Functions of Statistics, Need and Importance of Statistics in Psychology. Limitations of Statistics. **Collection of Data**: Primary data and secondary data, Choice between primary and secondary data. Sources of secondary data, Precaution in the use of secondary data. Questionnaire and Schedules; Census and sampling method (Definition and comparison); Methods of sampling –Probability sampling: Simple random Sampling(Definitions and examples only), Stratified sampling(Definitions and examples only), systematic sampling (Definitions and examples only), Multistage sampling (Definitions and examples only); Nonprobability Sampling- convenient sampling, judgement sampling and purposive sampling(Definitions and examples only).	
II	**Classification and Tabulation**	**10**

		Classification and Tabulation: Meaning and objective of classification, Types of classification: geographical classification, Chronological classification, Qualitative and Quantitative classification. Types of variables in measurement: Discrete and continuous (definition and examples). Formation of discrete and continuous frequency distribution. Cumulative frequency tables. Scales of measurements: nominal, ordinal, interval and ratio scales with suitable examples from Psychology.	
III	**Diagrams and Graphs**	**15**
	Diagrammatic Representations: Bar diagrams- different types, Pie diagram, Pictograms and cartograms. **Graphical representations:** Histogram, Frequency polygon, frequency curve, Ogives.	
IV	**Descriptive Statistics**	**25**
	Measures of Central Tendency: Arithmetic mean, median and mode (Definitions and numerical problems only) Graphical methods for finding median and mode. Partition values: Quartiles, deciles, Percentiles, percentile rank (definition and numerical problems). **Measures of Dispersion:** range, mean deviation, quartile deviation (definitions only) standard deviation (Definition and numerical problems only). Relative measures of dispersion- coefficient of variation (definitions only). Skewness: Definition, Pearson's and Bowley's measures of skewness (definitions and simple numerical problems). Kurtosis: definition and measure based on partition values	

REFERENCES
1. Aron A, Aron R &Coups E J (2006). Statistics for Psychology (4[th]ed) : Pearson Education, New Delhi (ISBN:81-317-1464-20).
2. Garret E Henry (2004). Statistics in Psychology and Education (11[th]ed): Paragon International publishers, New Delhi (ISBN:81-89253-00-X).
3. Gravetter,F J & Wallnau L B(2000). Statistics for Behavioural Science(5[th]ed), Wadsworth-Thomson learning Singapore.(ISBN:0-534-35926-4)
4. Gupta, S.C. and Kapoor, V.K. (2002). Fundamentals of Applied Statistics, Sultan Chand & Co. New Delhi.
5. Heiman W Carry (2000). Basic statistics for behavioural Science (3rd ed.), Houghton Mifflin Company, New York.(ISBN:0-395-96251-X).
6. Mangal S K (2000). Statistics in Psychology and Education (2nd ed.): Prentice_Hall Of India Private Limited, New Delhi.(ISBN:978-81-203-8)
7. Minium W Edward, King M Bruce &Bear Gardon (2001), Statistical Reasoning in Psychology and Education(3rd ed), John Wiley & Sons ,Inc, New York(ISBN 9971-51-171-1).
8. Yule Undy G & Kendal M G (1991),An Introduction to Theory of Statistics (14th ed.) Universal Book Stall, New Delhi (ISBN 81-85461-71-6).

Name of the Course: BEHAVIOURAL DATA ANALYTICS-I
Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO1	Understand scope and functions of	PO 1 PSO 1	Understand	F, C	L	

	statistics.					
CO2	Understand different data collection techniques.	PO 2,6 PSO 1,2, 3	Understand	F,C	L	
CO3	Classify and visualize data	PO 1,6 PSO 1,2,3,4	App[y	C,P		
CO4	Carry out some descriptive measures of central tendency and dispersion	PO 2, 6 PSO 1,2,3,4	Apply	C,P	L	
CO5	Understand the concept of skewness and kurtosis	PO 1,2,6 PSO 1,2,3	Understand	F,C	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with POs :

	PS O 1	PS O 2	PS O 3	PS O 4	PS O 5	PS O 6	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO 1	1						1							
CO 2	1	2	2					2				2		
CO 3	1	2	2	2			2					1		
CO 4	1	2	2	1				2				2		
CO 5	2	2	2				1	2				2		

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Examination
- Practical Evaluation
- End Semester Examinations

Mapping of COs to Assessment Rubrics :

	Internal Exam	Quiz / Assignment Discussion / Seminar	Practical Evaluation	End Semester Exam
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

University of Kerala

Discipline	STATISTICS				
Course Code	UK1DSCSTA105				
Course Title	ELEMENTARY STATISTICS				
Type of Course	**DSC**				
Semester	I				
Academic Level	100 – 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-		4
Pre-requisites					

COURSE OUTCOMES

	Up on Completion of the course, students should be able to:	Cognitive level	PSO Addressed
CO1	Explain the significance of Statistics	Understand	PSO -1
CO2	Describe various types of data	Understand	PSO -1
CO3	Describe census and sampling, illustrate different sampling procedures	Understand	PSO -1
CO4	classify and tabulate data	Remember	PSO -1, 5
CO5	Use various data visualization methods (diagrams and graphs)	Apply	PSO -1, 5
CO6	Evaluate various descriptive statistics measures	Evaluate	PSO -1, 2

COURSE CONTENT

Module	Content	Hrs
I	**Introduction to Indian statistical systems**	10
	Introduction-Definition and Significance of Statistics, Introduction to Indian statistical systems, Functions and activities of – MoSPI, NSSO, CSO. Types of Data: primary data and secondary data, Classification of Data, Data Scaling - Nominal, ordinal, interval and ratio scales.	
II	**Methods of data collection**	15
	Methods of data collection: Census and sample surveys, Preparation of Questionnaires and Schedules, Advantages and limitations of sampling, Probability Sampling: simple random sampling with replacement, Stratified sampling and systematic sampling, Non-Probability sampling: Convenience sampling, Quota Sampling (Situations in which each method is used to be specified, no derivations required).	
III	**Data Representation**	10
	Tabulation of data- Frequency tables: Ungrouped, grouped, cumulative Frequency and relative frequency.	

		Diagrams and graphs: Diagrammatic and graphical representation of data, different types of bar diagram, pie-diagram, histogram	
IV		**Descriptive statistics**	25
		Measures of Central Tendency - Arithmetic mean, median and mode (concepts and examples for raw data only, mathematical derivations not required). **Measures of dispersion** - Variance, standard deviation, coefficient of variation and its significance (concepts and examples for raw data only, mathematical derivation not required), skewness and kurtosis (concepts and definitions only).	

REFERENCES:
1. Agarwal, B.L. (2006). Basic Statistics, 4th Edition, New Age International(P) Ltd, New Delhi
2. Gupta, S.C. and Kapoor, V.K. (2002). Fundamentals of Applied Statistics, Sultan Chand & Co. New Delhi
3. Gupta S.C and Kapoor, V.K. (2020). Fundamentals of Mathematical Statistics, Sultan Chand and Sons, New Delhi.
4. Gupta S.P (2004). Statistical Methods, Sultan Chand and Sons, New Delhi.
5. Medhi J (2000) Statistical Methods - An introductory text, New Age International(P), Ltd, New Delhi

Name of the Course: ELEMENTARY STATISTICS
Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)	Practical (P)
CO 1	Explain the significance of Statistics	PSO -1, PO-1	Understand	C	L	
CO 2	Describe various types of data	PSO -1, PO-1	Understand	C	L	
CO 3	Describe census and sampling, illustrate different sampling procedures	PSO -1, PO-1	Understand	C, P	L	
CO 4	classify and tabulate data	PSO -1, PSO -5, PO -1,4	Remember	C	L	
CO 5	Use various data visualization methods (diagrams and graphs)	PSO -1, PSO -5, PO -1,4	Apply	C, P	L	
CO 6	Evaluate various descriptive statistics	PSO -1, PSO -2,	Evaluate	P	L	

measures	PO -1,4			

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO 1	1						1							
CO 2	1						1							
CO 3	1						1							
CO 4	1				2		1			2				
CO 5	1				2		1			2				
CO 6	2	2					2			1				

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Examination
- Practical Evaluation
- End Semester Examinations

Mapping of COs to Assessment Rubrics :

	Internal Exam	Quiz / Assignment Discussion / Seminar	Practical Evaluation	End Semester Exam
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6	✓	✓		✓

University of Kerala

Discipline	STATISTICS				
Course Code	UK1DSCSTA106				
Course Title	ELEMENTS OF STATISTICAL THEORY				
Type of Course	**DSC**				
Semester	I				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites					

COURSE OUTCOMES

	Up on Completion of the course, students should be able to:	Cognitive level	PSO addressed
CO1	Explain application of Statistics in various field of science, various methods of collecting data	Understand	PSO -1, 5
CO2	Use various data visualization methods	Apply	PSO -1, 4, 5
CO3	Calculate various measures of central tendency, dispersion, skewness and kurtosis.	Evaluate	PSO -1, 2, 4, 5
CO4	Analyse bivariate data using scatter diagram, correlation coefficient and simple linear regression.	Apply	PSO -1, 2, 4,5
CO5	Explain the concept of clinical trials and its objectives.	Understand	PSO -1

COURSE CONTENT

Module	Content	Hrs
I	**Introduction to Statistics**	10
	Introduction to Statistics-Origin, Definition. Application of Statistics in various field of science. Collection of data- primary and secondary data. Classification of data- Qualitative, Quantitative, geographical and Chronological classification, Graphical representation of categorical data- Bar diagram and Pie diagram. Tabulation-frequency table, Frequency distribution of data	
II	**Descriptive Statistics**	15
	Descriptive Statistics - Averages - mean, median, mode (for raw data only). Concept of dispersion- range, mean deviation, standard deviation and coefficient of variation (for raw data only). Raw and central moments (first four moments and their inter relations) Skewness and kurtosis (concept and moment measures only).	
III	**Bivariate data**	10

	Bivariate data- scatter diagram, correlation, Direct and inverse correlation, Karl Pearson's coefficient of correlation, concept of dependent and independent variables, simple linear regression, two lines of regression, multiple regression (models and interpreting R^2).		
IV	**Introduction to Biostatistics**	10	
	Biostatistics – basic concepts of clinical trials, main features of study protocol-selection of patients, treatment schedule and evaluation of patient response. Objectives and end points of clinical trials.		
V	**Practicum**	30	
	Practical demonstration of the concepts mentioned in the first, second and third modules using spreadsheet applications		

PRACTICAL/LABWORK
List of Practical worksheet
1. Frequency tables
2. Measures of central tendency
3. Measures of dispersion
4. Skewness and Kurtosis
5. Correlation and simple linear regression

REFERENCES
1. Agarwal, B.L. (2006). Basic Statistics, 4th Edition, New Age International(P) Ltd, New Delhi
2. Gupta, S.C. and Kapoor, V.K. (2002). Fundamentals of Applied Statistics, Sultan Chand & Co. New Delhi
3. Berk, K. N., & Carey, P. (1998). Data Analysis with Microsoft Excel. Pacific Grove, CA: Duxbury Press.
4. Goon A.M., Gupta M.K. and Dasgupta, B. (2016). Fundamentals of Statistics. Vol. I, 8th Ed. The World Press, Kolkata.
5. Gupta, S. C. and Kapoor, V. K. (1994). Fundamentals of Mathematical Statistics. Sultan Chand and Sons, New Delhi.
6. Pocock, S.J. (1983). Clinical Trials. A Practical Approach. Wiley, New York.
7. Wang, D and Bakhai, A (2006). A Practical Guide to Design, Analysis and Reporting.1st Ed.

Name of the Course: ELEMENTS OF STATISTICAL THEORY
 Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)	Practical (P)
CO1	Explain application of Statistics in various field of science, various methods of collecting data	PSO -1, 5, PO -1, 4	Understand	F, C	L	

CO2	Use various data visualization methods	PSO 1, 4,5 PO 1,4,5	Apply	C,P	L	P
CO3	Calculate various measures of central tendency, dispersion, skewness and kurtosis.	PSO -1, 2, 4, 5 PO -1, 4,5,7	Evaluate	C, P	L	P
CO4	Analyse bivariate data using scatter diagram, correlation coefficient and simple linear regression.	PSO -1, 2, 4, 5 PO -1, 5,6,7	Apply	C, P	L	P
CO5	Explain the concept of clinical trials and its objectives.	PSO -1, PO -1	Understand	C	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO 1	1						1							
CO 2	2			2	1		2			2	1			
CO 3	2	1		2	1		2			2	1		2	
CO 4	1	1		2	1		1			2	1	1	2	
CO 5	1						1							

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Examination
- Practical Evaluation
- End Semester Examinations

Mapping of COs to Assessment Rubrics :

	Internal Exam	Quiz / Assignment Discussion / Seminar	Practical Evaluation	End Semester Exam
CO 1	✓	✓		✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓	✓	✓
CO 4	✓	✓	✓	✓
CO 5	✓	✓		✓

University of Kerala

Discipline	STATISTICS				
Course Code	UK1DSCSTA107				
Course Title	BASIC STATISTICS I				
Type of Course	**DSC**				
Semester	I				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites					

COURSE OUTCOMES

	Up on Completion of the course, students should be able to:	Cognitive level	PSO addressed
CO1	Explain the present official statistical system in India and Kerala	Understand	PSO 1
CO2	Inculcate knowledge on visualization of data in the form of tables, diagrams and graphs.	Apply	PSO 1, 2, 4, 5
CO3	Calculate various partition values and moments	Apply	PSO 1, 2, 4, 5
CO4	Describe the concepts of statistical surveys, sampling, and census .	Understand	PSO 1

COURSE CONTENT

Module	Content	Hrs
I	**Introduction to Indian statistical systems**	10
	Introduction to Indian statistical systems: Role, function and activities of central and Kerala State statistical organizations. Role of Ministry of Statistics & Programme Implementation, National Statistical Office. Population Census-Need, Data Collection, Periodicity, Methods of data collection and Agencies involved**.**	
II	**Census and Sample Survey**	10
	Census and Sample Surveys; Methods of sampling (concepts only)- Probability and non-probability sampling, simple random sampling with replacement (SRSWR) & simple random sampling without replacement (SRSWOR), Systematic sampling, Stratified sampling and multi stage sampling (definition and examples only); sampling and non-sampling errors.	
III	**Data Representations**	15
	Classification- Geographical, chronological, qualitative and quantitative classification. Tabulation-frequency table, cumulative frequency table. Diagrams and graphs- line diagram, bar diagrams and pie diagrams, pictograms, cartograms, stem and leaf plot, histograms, frequency curves, histograms, ogives and its uses, Boxplot. Lorenz curve and Gini Index (Definition and Concept). (	
IV	**Partition values and Moments**	10

		Partition values : Quartiles, Deciles and Percentiles (Definition and Problems), Graphical Method to find these values; Moments: Raw moments and central moments for ungrouped and grouped data. Effect of change of origin and scale on central moments, relation between central moments and raw moments (up to 4th order), Sheppard's corrections	
V		**Practicum**	**30**
		Practical demonstration of the concepts mentioned in the third and fourth modules using R	

PRACTICAL/LABWORK
List of Practical worksheet
1. Frequency tables
2. Diagrams and graphs
3. Partition values

REFERENCES
1. Agarwal, B.L. (2006). Basic Statistics. 4th Edition, New Age international (P) Ltd., New Delhi.
2. Gupta S. P. (2004). Statistical Methods. Sultan Chand & Sons, New Delhi.
3. Gupta, S. C., and Kapoor, V. K. (2020). Fundamental of Mathematical Statistics. Sultan Chand & Sons, New Delhi.
4. Kenny J. F (1947). Mathematics of Statistics Part One. 2nd Edition, D. Van Nostard Company, New Delhi-1.
5. Kenny J. F & Keeping E. S (1964). Mathematics of Statistics –Part Two. 2nd Edition, D. Van Nostard Company, New Delhi-1.
6. Ministry of Statistics and Program Implementation. www. mospi.gov.in
7. https://ecostat.kerala.gov.in/

Name of the Course: BASIC STATISTICS I
Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)	Practical (P)
1	Explain the present official statistical system in India and Kerala	PSO 1 PO 1	Understand	F	L	
2	Inculcate knowledge on visualization of data in the form of tables, diagrams and graphs.	PO 1, 7 PSO 1,2, 4, 5	Apply	C, P	L	P
3	Calculate various partition values and moments	PO 1, 7 PSO 1,2, 4,5	Apply	C, P	L	P
4	Describe the concepts of statistical surveys, sampling, and census	PSO 1 PO 1,7	Understand	C,P	L	

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO 1	1						1							
CO 2	2	1		2	1		1						2	
CO 3	1	2		1	2		1						1	
CO 4	1						2						1	

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Examination
- Practical Evaluation
- End Semester Examinations

Mapping of COs to Assessment Rubrics :

	Internal Exam	Quiz / Assignment Discussion / Seminar	Practical Evaluation	End Semester Exam
CO 1	✓	✓		✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓	✓	✓
CO 4	✓	✓		✓

Discipline	STATISTICS				
Course Code	UK1DSCSTA108				
Course Title	FUNDAMENTALS OF STATISTICS				
Type of Course	**DSC**				
Semester	I				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites					

COURSE OUTCOMES

	Up on Completion of the course, students should be able to:	Cognitive level	PSO addressed
CO1	Explain various methods of collecting data and to present data using frequency tables.	Apply	PSO -1,2,4,5
CO2	Calculate various measures of central tendency and dispersion.	Evaluate	PSO-1, 2, 4,5
CO3	Explain sample space, type of events, different approaches to probability and to determine conditional probability	Apply	PSO-1
CO4	Explain the concept of random variable, mathematical expectation, moments and moment generating function.	Understand	PSO-1

COURSE CONTENT

Module	Content	Hrs
I	**Introduction to Statistics**	5
	Introduction to Statistics - Origin, Definition, Uses. Types of data - Primary and Secondary data. Methods of collecting primary data. Frequency distribution. Application of Statistics in Physics.	
II	**Descriptive Statistics**	15
	Central Tendency and its measures-mean, median, mode, geometric mean, harmonic mean (for raw data only). Dispersion and its measures- range, mean deviation, quartile deviation, standard deviation and coefficient of variation (for raw data only). Raw and central Moments(first four moments and their relationship without proof), Skewness and Kurtosis (concept and measures only).	
III	**Introduction to Probability**	12
	Deterministic and random experiment, sample space, events , type of events. Frequency approach, classical approach to probability (simple problems) and Axiomatic approach to probability(definition and basic properties), addition	

	theorem for two events, Conditional probability (concept only), multiplication theorem, Bayes theorem and its application.		
IV	**Random variables and Mathematical Expectation**	**13**	
	Concept of random variable - discrete and continuous. Distribution function, Probability mass function and probability density function (definition and properties). Mathematical Expectation of single random variable and its properties, moment generating function and moments.		
V	**Practicum**	**30**	
	Practical based on Modules I and II to be done using **R package.**		

PRACTICAL/LABWORK
List of Practical worksheet
1. Measures of Central Tendency
2. Measures of Dispersion
3. Moments, Skewness and Kurtosis

REFERENCES
1. Agarwal, B. L. (2006), Basic Statistics, 4th Edition, New Age International (P) Ltd, New Delhi.
2. Goon, A. M., Gupta M.K. and Dasgupta, B. (2016), Fundamentals of Statistics, Vol. I, 8th Ed, The World Press, Kolkata.
3. Gupta, S. C. and Kapoor, V. K. (1994), Fundamentals of Mathematical Statistics, Sultan Chand and Sons, New Delhi.
4. Martin, B.R. (1971), Statistics for Physicists, Academic Press. London
5. Mathai A.M. and Haubold H, J. (2017 ,Probability and Statistics: A Course for Physicists and Engineers, Springer.
6. Kenny J. F (1947). Mathematics of Statistics Part One. 2nd Edition, D. Van Nostard Company, New Delhi-1.

Name of the Course: FUNDAMENTALS OF STATISTICS
Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)	Practical (P)
CO 1	Explain the various methods of collecting data and to present data using frequency tables.	PSO - 1,2,4,5 PO 1,4,7	Apply	C,P	L	
CO 2	Calculate the various measures of central tendency and dispersion.	PSO-1, 2, 4,5 PO 1,4,7	Evaluate	C, P	L	P
CO 3	Explain sample space, type of events, different approaches to probability and to	PSO-1 PO 1	Apply	P, C	L	P

	determine conditional probability				
CO 4	Explain the concept of random variable , mathematical expectation, moments and moment generating function.	PSO-1 PO 1	Understa nd	F,C	L

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	2	3		1	1	1			1			1
CO 2	1	2		1	1	2			1			1
CO 3	2					1						
CO 4	2					1						

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Internal Examination
- Practical Evaluation
- End Semester Examinations

Mapping of COs to Assessment Rubrics :

	Internal Exam	Quiz / Assignment Discussion / Seminar	Practical Evaluation	End Semester Exam
CO 1	✓	✓		✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓	✓	✓
CO 4	✓	✓		✓

University of Kerala

Discipline	STATISTICS				
Course Code	UK1DSCSTA109				
Course Title	DESCRIPTIVE STATISTICS AND PROBABILITY				
Type of Course	**DSC**				
Semester	I				
Academic Level	100 – 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites					

COURSE OUTCOMES

	Up on Completion of the course, students should be able to:	Cognitive level	PSO addressed
CO1	Distinguish between the various data types	Understand	PSO-1, 2
CO2	Explain the concept of scaling and identify their significance in practical situations	Understand	PSO-1,2
CO3	Calculate the measures of Central tendency, dispersion, skewness and kurtosis	Apply	PSO-1,2,3,4
CO4	Explain the concepts of random experiments, sample space and different types of events	Understand	PSO-1,2
CO5	Calculate the probabilities of events using classical, statistical approaches.	Apply	PSO-1,2,3
CO6	Understand Axiomatic approach	Understand	PSO-1,2
CO7	Determine conditional probability and apply concepts of statistical independence and multiplication theorem	Apply	PSO-1,2,3
CO8	Use Bayes' theorem to evaluate posterior probabilities	Apply	PSO-1,2,3
CO9	Explain the concept of random variables	Understand	PSO-1,
CO10	Illustrate random variables and its probability distributions	Analyse	PSO-1,2,3

COURSE CONTENT

Module	Content	Hrs
I	**Descriptive Statistics**	13
	Descriptive Statistics: Data- Definition, types of data, types of scaling - nominal, ordinal, interval and ratio, Central Tendency- Concept and Measures, Dispersion – Concept & Measures of Dispersion, Raw and central Moments(first four moments and their relationship without proof), Skewness and Kurtosis (Concept and definition with problems only).	

II	**Introduction to Probability**	12
	Random experiments - Sample Space, Sample point; Events-algebra of events, equally likely, mutually exclusive and exhaustive events (Concept only). **Probability**: Statistical regularity, frequency definition, classical approaches (numerical problems), Axiomatic approach, theorems in probability (Concepts and statement of results, numerical problems), probability space.	
III	**Conditional probability**	10
	Conditional probability: multiplication theorem, independence of two and three events, compound probability, Bayes' theorem and its applications. (Concepts and statement of results, numerical problems).	
IV	**Random variables**	10
	Random variables – definition, discrete and continuous random variables, probability mass function and probability density function, distribution function. Expectation of random variables and its properties, moments, moment generating function and characteristic function.(No proofs needed)	
V	**Practicum**	30
	Practical based on Modules I to be done using **R package**	

PRACTICAL/LABWORK
List of Practical worksheet
1. Measures of Central tendency.
2. Measures of Dispersion
3. Skewness and Kurtosis

REFERENCES
1. Agarwal, B.L. (2006). Basic Statistics. 4th Edition, New Age international (P) Ltd., New Delhi.
2. Gupta S. P. (2004). Statistical Methods. Sultan Chand & Sons, New Delhi.
3. Gupta, S. C., and Kapoor, V. K. (1994). Fundamental of Mathematical Statistics. Sultan Chand & Sons, New Delhi.
4. Kenny J. F (1947). Mathematics of Statistics Part One. 2nd Edition, D. Van Nostard Company, New Delhi-1.
5. Kenny J. F & Keeping E. S (1964). Mathematics of Statistics –Part Two. 2nd Edition, D. Van Nostard Company, New Delhi-1.
6. Mukhopadhyay, P. (1996). Mathematical Statistics. New Central Book Agency (P) Ltd, Calcutta.
Name of the Course: DESCRIPTIVE STATISTICS AND PROBABILITY
Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)	Practical (P)
CO 1	Distinguish between the various data types	PSO-1, 2 PO 1	Understand	F, C	L	
CO 2	Explain the concept of scaling and identify their significance in practical situations	PSO-1,2 PO 1,2	Understand	F,C	L	

CO 3	Calculate the measures of Central tendency, dispersion, skewness and kurtosis	PSO-1,2,3,4 PO 1,7	Apply	C,P	L	P
CO 4	Explain the concepts of random experiments, sample space and different types of events	PSO-1,2 PO 1,2	Understand	C	L	
CO 5	Calculate the probabilities of events using classical, statistical approaches.	PSO-1,2,3 PO 1,2	Apply	P ,C	L	
CO 6	Understand Axiomatic approach	PSO-1,2 PO 1,2	Understand	F,C	L	
CO 7	Determine conditional probability and apply concepts of statistical independence and multiplication theorem	PSO-1,2,3 PO 1,2	Apply	C,P	L	
CO 8	Use Bayes' theorem to evaluate posterior probabilities	PSO-1,2,3 PO 1,2	Apply	C,P	L	
CO 9	Explain the concept of random variables	PSO-1 PO 1,2	Understand	F,C	L	
CO 10	Illustrate random variables and its probability distributions	PSO-1,2,3 PO 1,2	Analyse	C,P	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO 1	1	2				1							
CO 2	1	2				1	2				2	1	

CO 3	2	1	2	1		2						1	
CO 4	2	2				1	2						
CO 5	2	1	1			1	2						
CO 6	2	1				1	2						
CO 7	3	1	1			1	2						
CO 8	3	1	1			1	2						
CO 9	3					1	2						
CO 10	2	1	1			1	2						

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Examination
- Practical Evaluation
- End Semester Examinations

Mapping of COs to Assessment Rubrics :

	Internal Exam	Quiz / Assignment Discussion / Seminar	Practical Evaluation	End Semester Exam
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓	✓	✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6	✓	✓		✓
CO 7	✓	✓		✓
CO 8	✓	✓		✓
CO 9	✓	✓		✓
CO 10	✓	✓		✓

University of Kerala

Discipline	STATISTICS				
Course Code	UK1DSCSTA110				
Course Title	STATISTICAL METHODS				
Type of Course	**DSC**				
Semester	I				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites					

COURSE OUTCOMES

	Up on Completion of the course, students should be able to:	Cognitive level	PSO addressed
CO1	Explain the basic concept and scope of Statistics and collection, editing, classification and tabulation of data.	Understand	PSO-1,3
CO2	Analyse statistical data using various graphical methods.	Analyse	PSO-1,2,3,4,5
CO3	Calculate measures of central tendency	Apply	PSO-1,2.3,4,.5
CO4	Calculate absolute and relative measures of dispersion, skewness and kurtosis	Apply	PSO-1,2.3,4,.5

COURSE CONTENT

Module	Content	Hrs
I	Origin and meaning of Statistics	10
	Origin and meaning of Statistics: Scope and relation with other disciplines, Limitations and misuses of Statistics, Different scales of measurement, Methods of collection of primary data. Designing of a questionnaire and a schedule. Sources of secondary data. editing of data, Classification and tabulation of data.	
II	Diagrams and Graphs	10
	Diagrammatic presentation- line diagram, bar diagrams, pie diagrams, pictograms and cartograms. Graphical representation of frequency distribution by histogram, frequency polygon, frequency curve and ogives	
III	Measures of central tendency	12
	Measures of central tendency-arithmetic mean, median, mode, geometric mean, harmonic mean. Properties of these averages. Partition values – quartiles, deciles and percentiles	
IV	Measures of dispersion	13

		Measures of dispersion- range, quartile deviation, mean deviation, standard deviation. Properties of these measures. Relative measures of dispersion. Moments - raw and central moments and their interrelationships, Sheppard's corrections for moments for grouped data. Definition and measures of skewness and kurtosis	
V		Practicum	30
		Practical demonstration of topics covered in II, III and IV using R package	

PRACTICAL/LABWORK
List of Practical worksheet
1. Diagrams and graphs
2. Measures of Central tendency.
3. Measures of Dispersion
4. Skewness and Kurtosis

REFERENCES:
1. Anderson, T.W. and Finn, J.D. (2012). *The New Statistical Analysis of Data*. Springer Science & Business Media, New York.
2. Croxton, F.E. and Cowden, D.J. (1973). *Applied General Statistics*. Prentice Hall of India, New Delhi.
3. Gupta S.C. and Kapoor, V.K. (2020). *Fundamentals of Mathematical Statistics*. Sultan Chand & Co., 12th Edn, New Delhi. .
4. Saxena, H.C. (1983). *Elementary Statistics*. S. Chand & Co., New Delhi.
5. Spiegel, M. R. (1961). *Theory and Problems of Statistics*. Schaum's outline series, New York.
6. Gupta S. P. (2004). Statistical Methods. Sultan Chand & Sons, New Delhi.

Name of the Course: Statistical methods
Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)	Practical (P)
1	Explain the basic concept and scope of Statistics and collection, editing, classification and tabulation of data.	PSO-1,3 PO 1	Understand	F	L	
2	Analyse statistical data using various graphical methods.	PSO-1,2,3,4,5 PO-1,4,2,3,7	Apply	C,P	L	P
3	Calculate measures of central tendency	PSO-1,2,3,4,5 PO-1,2,3,4,7	Apply	C P	L	P

| 4 | Calculate absolute and relative measures of dispersion, skewness and kurtosis | PSO-1,2,3,4,5 PO-1, 2,3,4, 7 | Apply | C,P | L | P |

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO 1	3	-	2	-	-	-	1							-
CO 2	3	3	2	2	2	-	2	3	1	1	-		2	-
CO 3	1	3	3	1	3	-	2	3	1	1	-		2	-
CO 4	1	3	3	1	3	-	2	3	1	1	-		2	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Examination
- Practical Evaluation
- End Semester Examinations

Mapping of COs to Assessment Rubrics :

	Internal Exam	Quiz / Assignment Discussion / Seminar	Practical Evaluation	End Semester Exam
CO 1	✓	✓		✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓	✓	✓
CO 4	✓	✓	✓	✓

University of Kerala

Discipline	STATISTICS				
Course Code	UK1DSCSTA111				
Course Title	DESCRIPTIVE STATISTICS WITH R				
Type of Course	**DSC**				
Semester	I				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites					

COURSE OUTCOMES

	Up on Completion of the course, students should be able to:	Cognitive level	PSO addressed
CO1	Explain the concepts of statistical surveys, sampling, census and various sampling methods.	Understand	PSO -1
CO2	Design questionnaires and carry out surveys	Create	PSO -1,3
CO3	Illustrate tabulation data using R	Apply	PSO -1, 2, 4,5
CO4	Present data using graphs and diagrams	Apply	PSO -1, 2, 4,5
CO5	Compute the various descriptive statistics measures using R	Apply	PSO -1, 2, 4,5

COURSE CONTENT

Module	Content	Hrs
I	Collection of Data and Sampling techniques	25
	Population, Sample, observations; qualitative, quantitative, discrete and continuous data; scaling of data - nominal, ordinal, interval, ratio and absolute scale; Collection of data – primary and secondary; Collection of primary data - Preparation of questionnaire, pilot study; Sampling techniques– Simple random sampling (SRSWR, SRSWOR), and stratified random sampling (basic concepts and definitions only). Data Types in R :basics of vector, matrix and data frame, basic functions c( ), sequence( ), scan( ), factor( ).	
II	Data visualization techniques	25
	Classification of data - geographic, chronological, qualitative and quantitative characteristics;	

	Tabulation - Construction of tables with one or more factors of classification, frequency distributions, relative and cumulative frequency distributions; Data visualization techniques–simple bar diagram, multiple bar diagram, deviation bar diagram, pie diagram, histogram, box plot and scatter diagram(basic concepts and definitions only). table(), and cut( ); Data visualization using R – barplot(),pie(), hist(), lines(), plot(), boxplot();	
III	**Descriptive Statistics**	**25**
	Measures of Central Tendency - mean, median, mode, geometric mean, harmonic mean; Measures of dispersion – Absolute measures: Range, Mean Deviation, Quartile Deviation, Standard Deviation, Relative measures: Coefficient of Variation; Moments – raw and central; skewness – moment measure; measure of kurtosis (no mathematical derivations are required in this module) Usage of R functions: sum(), length(), sort(), min(), mean(), median(), IQR(), var(), sd(), sample( )	

PRACTICAL/LABWORK
List of Practical worksheet

1.Classification and Tabulation of data using R
2. Graphical Representation of data using R
3. Descriptive Statistics Measures using R

REFERENCES
1. Dalgaard P. (2008). Introductory Statistics with R, Second Edition, Springer, New York.
2. Purohit, S. G., Deshmukh, S.R., & Gore, S. D. (2008). Statistics using R. Alpha Science
3. International, United Kingdom.
4. Gupta, S. C., & Kapoor, V. K. (2020). Fundamentals of mathematical statistics. Sultan Chand & Sons.
5. Gardener M (2023). An Introduction to R: Data Analysis and Visualization, Pelagic Publishing, UK
6. Heumann C., Schomaker M. and Shalabh (2022). Introduction to Statistics and Data Analysis With Exercises, Solutions and Applications in R, Second Edition, Springer Nature Switzerland
7. Jones E., Harden S., Crawley M.J., (2023). The R Book, Third Edition, John Wiley & Sons Ltd.
8. Taylor R. Brown (2023). An Introduction to R and Python for Data Analysis: A Side-By-Side Approach, CRC Press/Chapman & Hall

Web Resources:
1. https://cran.r-project.org
2.https://cran.r-project.org/manuals.html
3.https://www.r-project.org/other-docs.html
4. https://journal.r-project.org/
5. https://www.r-bloggers.com

Name of the Course: Descriptive Statistics with R

Credits: 2:0:2 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)	Practical (P)
CO 1	Explain the concepts of statistical surveys, sampling, census and various sampling methods.	PSO -1, PO -1	Understand	C	L	P
CO 2	Design questionnaires and carry out surveys	PSO 1, 3 PO -1, PO 2, 3, 6,7	Create	C	L	P
CO 3	Illustrate tabulation data using R	PSO -1, 2, 4, 5 PO -1, 2, 6, 7	Apply	P	L	P
CO 4	Present data using graphs and diagrams	PSO -1, 2, 4, 5 PO -1, 2, 6, 7	Apply	P	L	P
CO 5	Compute the various descriptive statistics measures using R	PSO -1, 2, 3, 4, 5, PO -1, 2, 3, 4, 6, 7	Apply	M		P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO 1	3						1	1						
CO 2	2	2	3				3	3	3			1	1	
CO 3	2	2		3			2	1				1	3	

CO 4	2	2		3			2	1				2	3	
CO 5	2	2	1	3	3		2	2	2	3	2	3	3	

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Practical Evaluation
- Final Exam

	Internal Exam	Assignment	Practical Evaluation	End Semester Examination
CO 1	✓	✓		✓
CO 2	✓	✓	✓	✓
CO 3	✓		✓	✓
CO 4	✓		✓	✓
CO 5	✓		✓	

Discipline	STATISTICS			
Course Code	UK1MDCSTA101			
Course Title	EXPERIMENTAL DESIGNS FOR SCIENCE			
Type of Course	MDC			
Semester	I			
Academic Level	100 - 199			
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	3	2 hours	-	2 hours	4
Pre-requisites				

COURSE OUTCOMES

	Up on Completion of the course, students should be able to:	Cognitive level	PSO addressed
CO1	Explain the need of experimental designs	Understand	PSO 1
CO2	Illustrate various descriptive measures in statistics	Apply	PSO 1,2, 3,4,5, 6
CO3	Demonstrate statistical reasoning in science	Apply	PSO 1,2, 3,4,5, 6
CO4	Perform statistical analyses and interpretation of results	Apply	PSO 1,2, 3,4,5, 6

COURSE CONTENT

Module	Content	Hrs
I	**Experimental designs**	5
	Need of experimental designs in science, Basic principles of designs- randomization, replication and local control, two sample designs, completely randomized design and randomized block design. (Concepts and examples only, derivations not required)	
II	**Descriptive Statistics**	10
	Descriptive Statistics for raw data: Averages (mean, median, mode), Quartiles & percentiles; Measures of Dispersion: range, quartile deviation, standard deviation; Pearson's measure of Skewness and measure of Kurtosis using partition values (Concepts and examples only, derivations not required)	
III	**Introduction to Data Analysis**	10
	Normal curve and its properties, Graphical tools to check normality of the data (box plot, Q-Q plot, histogram), Parameter, Statistic, Sampling distributions - Normal, chi square, t, F (Examples of statistics following these distributions), Statistical hypothesis, type I error, type II error, significance level, power of the	

	test, Z test, T test, Normality test (K-S test, Shapiro-Wilks test) and ANOVA (Concepts and examples only, derivations not required)					
IV	**Practcum**					**20**
	Practical demonstrations of Module II and III using JASP					

REFERENCES

1. Danial W., (2004). Biostatistics : A foundation for Analysis in Health Sciences, John Wiley and Sons Inc
2. Edmondson A. and Druce D.(1996). Advanced Biology Statistics, Oxford University Press
3. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2016). Fundamentals of Statistics, Vol. I, 8th Ed. The World Press, Kolkata.
4. Kothari, C R, (2004). Research Methodology Methods and Techniques, New Age International Publishers, New Delhi
5. Samuels M.L. and Witmer J.A., (2002). Statistics for the life sciences, 3rd Ed, Prentice Hall
6. Whitlock M. C. and Schluter D., (2009). The Analysis of Biological Data, Roberts & Co.
7. JASP - A Fresh Way to Do Statistics (http://jasp-stats.org)

Name of the Course: Experimental Designs for Science
Credits: 2:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial	Practical (P)
CO1	Explain the need of experimental designs	PSO 1 PO 1	F,C	Understand	L	
CO2	Illustrate various descriptive measures in statistics	PSO 1,2, 3,4,5, 6 PO 1 2 4 7	P,M	Apply	L	P
CO3	Demonstrate statistical reasoning in science	PSO 1,2, 3,4,5, 6 PO 1 2 4 7	C P	Apply	L	P
CO4	Perform statistical analyses and interpretation of results	PSO 1,2, 3,4,5, 6 PO 1 2 4 7	C P	Apply	L	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3						1						
CO 2	2	2	1	1	3	1	1	1		2			2
CO 3	2	2	1	1	3	1	1	1		2			2
CO 4	2	2	1	1	3	1	1	1		2			2

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Examination
- Practical Evaluation
- End Semester Examinations

Mapping of COs to Assessment Rubrics :

	Internal Exam	Quiz / Assignment/ Discussion / Seminar	Practical Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓	✓	✓
CO 4	✓	✓	✓	✓

University of Kerala

Discipline	STATISTICS				
Course Code	UK1MDCSTA102				
Course Title	SURVEY DESIGNS AND ANALYSIS FOR SOCIAL SCIENCES				
Type of Course	MDC				
Semester	I				
Academic Level	100 – 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	3	2 hours	-	2 hours	4
Pre-requisites					

COURSE OUTCOMES

	Up on Completion of the course, students should be able to:	Cognitive level	PSO addressed
CO1	Explain scales of measurement and different sampling techniques	Understand	PSO 1
CO2	Calculate the various measures of central tendency, dispersion and measures of skewness and kurtosis	Apply	PSO 1,2,3,4,5
CO3	Perform statistical analyses and interpretation of results	Apply	PSO 1,2, 3,4,5, 6

R-Remember, U-understand , Ap -Apply ,An-Analyse, Ev-Evaluate, C- Create

COURSE CONTENT

Module	Content	Hrs
I	**Data Collection**	5
	Significance of Statistics in Social Sciences, Data scaling - Nominal, ordinal, interval and ratio scales (definitions and examples), Preparation of Questionnaire or schedule, Reliability and Validity, Census and sample surveys, Probability and non-probability sampling, Sampling methods: Simple Random Sampling, Systematic Sampling, Stratified Sampling, Cluster Sampling (Situations in which each method is used to be specified, no derivations required).	
II	**Descriptive Statistics**	10
	Measures of central tendency (for raw data only) - Arithmetic mean, median and mode; Measures of dispersion (for raw data only) – Range, Variance, standard deviation, Coefficient of variation , Quartile Deviation, Skewness and Kurtosis (definition, Pearson measure of skewness and kurtosis measure based on partition values).	
III	**Introduction to Data Analysis tools**	10
	Normal curve and its properties, Graphical tools to check normality of the data (box plot, Q-Q plot, histogram) Parameter, Statistic, Sampling distributions - Normal, chi square, t, F (definition and examples of statistics following these	

	distributions), Statistical hypothesis, type I error, type II error, significance level, power of the test, Z test, t-test, Normality test (K-S test, Shapiro-Wilks test), ANOVA, Chi-Square test of Independence **(Concepts and test procedures only)**	
IV	**Practcum**	**20**
	Practical demonstrations of Module II and III using JASP.	

REFERENCES:
1. Agarwal, B.L. (2006). Basic Statistics, 4th Edition, New Age International(P) Ltd, New Delhi
2. Gupta S.C and Kapoor, V.K. (1990). Fundamentals of Mathematical Statistics, Sultan Chand and Sons, New Delhi.
3. Gupta S.P (2004). Statistical Methods, Sultan Chand and Sons, New Delhi.
4. Medhi J (2000) Statistical Methods - An introductory text, New Age International(P), Ltd, New Delhi
5. JASP - A Fresh Way to Do Statistics (http://jasp-stats.org)

Name of the Course: SURVEY DESIGNS AND ANALYSIS FOR SOCIAL SCIENCES
Credits: 2:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO1	Explain scales of measurement and different sampling techniques	PSO 1 PO 1	U	F, C	L	
CO2	Calculate the various measures of central tendency, dispersion and measures of skewness and kurtosis	PSO 1,2,3,4,5 PO 1,2,4,7	Apply	C,P	L	P
CO3	Perform statistical analyses and interpretation of results	PSO 1,2,3,4,5,6 PO 1,2,4,7	Apply	P,M	L	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO1	3						1							
CO2	2	2	1	2	2		2	1		3			3	
CO3	1	1	2	2	2		2	2		3			3	

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Examination
- Practical Evaluation
- End Semester Examinations

Mapping of COs to Assessment Rubrics :

	Internal Exam	Quiz / Assignment/ Discussion / Seminar	Practical Evaluation	End Semester Examinations
CO1	✓	✓		✓
CO2	✓	✓		✓
CO3	✓	✓	✓	✓
CO4	✓	✓	✓	✓

University of Kerala

Discipline	STATISTICS				
Course Code	UK2DSCSTA101				
Course Title	BUSINESS DATA ANALYTICS-II				
Type of Course	**DSC**				
Semester	2				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites					

COURSE OUTCOMES

	Up on Completion of the course, students should be able to:	Cognitive level	PSO Addressed
CO1	Calculate the degree and nature of relationship between data sets	Apply	PSO -1, PSO-2, PSO-3, PSO-4, PSO-5
CO2	Model real life data sets with regression methods	Apply	PSO -1, PSO-2, PSO-3, PSO-4, PSO-5
CO3	Explain the basic concepts of probability theory and its applications for decision–making	Understand	PSO -1
CO4	Solve problems using probability distributions	Apply	PSO -1, PSO-2 PSO-3, PSO-4

Course Content

Module	Content	Hrs
I	**Correlation and Regression Analysis**	10
	Correlation Analysis: Scatter diagram, Linear Correlation, Direct and inverse correlation, Karl Pearson's coefficient of correlation – formula and problems, properties of correlation coefficient (no derivation), probable error, Spearman's rank correlation including tied ranks (no derivation) – formula and numerical problems	
	Regression Analysis: Simple linear regression, regression coefficients and properties (no derivation), point of intersection two regression lines, identification of two regression lines, angle between two regression lines (formula only), standard error of estimates.	

II	Association of attributes	10
	Association of attributes (dichotomous classification*): Consistency of data, methods of studying association - Yule's coefficient of association, coefficient of colligation, Definitions of partial and illusory association	
III	Probability	10
	Probability: Definition and examples of Random Experiment, sample space, events, simple and composite events, exhaustive, mutually exclusive, equally likely and independent events. Classical definition of probability, elementary properties of probability, addition theorem for two events (statement only), concept of odds in favour of and against an event, concept of conditional probability of two events, independence of two events, simple problems on probability.	
IV	Distribution Theory	15
	Normal distribution – Probability density function, mean and variance (no derivation), important properties of normal curve (no derivation required), simple examples to find probability using standard normal tables. Definition of Statistic, parameter, sampling distribution and standard error, Definition of Chi- square, t and F statistic (pdf not required), examples and usage of statistical tables.	
V	Practicum	30
	Practical Demonstration using spread sheet software	

PRACTICAL/LABWORK
List of Practical worksheet

1. Correlation Analysis.
2. Regression Analysis
3. Normal distribution

REFERENCES

1. Agarwal, B.L. (2017). Basic Statistics, New Age International Publishers, New Delhi
2. Elhance D.N., Veena Elhance and B.M. Agarwal (2018). Fundamentals of Statistics, Kitab Mahal Publications, New Delhi.
3. Goon, Gupta, Das Gupta (2016). Fundamentals of Statistics, The World Press
4. Gupta S.C. and V.K. Kapoor (2021). Fundamentals of Mathematical Statistics, Sultan Chand & Sons, New Delhi
5. Gupta S.P. (2019). Statistical Methods, Sultan Chand & Sons, New Delhi

Name of the Course: BUSINESS ANALYTICS TOOLS-II
Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)

CO 1	Calculate the degree and nature of relationship between data sets	PSO -1, 2,3,4, 5, PO -1, 2, 3,7	Apply	C, P	L	P
CO 2	Model real life data sets with regression methods	PSO -1, 2, 4,5, PO -1, 2, 3, 7	Apply	C, P	L	P
CO 3	Explain the basic concepts of probability theory and its applications for decision– making	PSO -1, PSO-2, PO -1	Understand	C	L	P
CO 4	Solve problems using probability distributions	PSO -1, PSO-2, PO -1, 2, 7	Apply	C, P	L	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PS O1	PS O2	PS O3	PS O4	PS O5	PS O6	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO 1	2	2	1	1	1		1	1	1				2	
CO 2	2	2		1	1		1	1	1				2	
CO 3	1	1					1							
CO 4	1	1					1	1					2	

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Examination

- Practical Evaluation
- End Semester Examinations

Mapping of COs to Assessment Rubrics :

	Internal Exam	Quiz / Assignment/ Discussion / Seminar	Practical Evaluation	End Semester Examinations
CO 1	✓	✓	✓	✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓		✓
CO 4	✓	✓	✓	✓

University of Kerala

Discipline	STATISTICS
Course Code	UK2DSCSTA102
Course Title	QUANTITATIVE DATA ANALYTICS II
Type of Course	**DSC**
Semester	II
Academic Level	100 – 199

Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites					

COURSE OUTCOMES

	Up on Completion of the course, students should be able to:	Cognitive level	PSO addressed
CO1	Calculate the degree and nature of relationship between the economic variables	Apply	PSO 1,2 3,4, 5
CO2	Model real life data sets with regression methods	Apply	PSO 1,2,4,5
CO3	Explain the basic concepts of probability theory and its applications for decision–making	Understand	PSO 1,2
CO4	Solve problems using probability distributions	Apply	PSO 1,2 3,4

Course Content

Module	Content	Hrs
I	**Correlation & Regression Analysis**	12
	Correlation Analysis: Scatter diagram, different types of correlation, Linear Correlation, Karl Pearson's coefficient of correlation – formula and problems, properties of correlation coefficient (no derivation), probable error, Spearman's rank correlation including tied ranks (no derivation) – formula and numerical problems **Regression Analysis**: Simple linear regression, regression coefficients and properties (no derivation), point of intersection two regression lines, identification of two regression lines, angle between two regression lines (formula only), standard error estimates	
II	**Curve fitting**	10

	Curve fitting: Principle of least squares, Fitting of first degree and second degree polynomial, power curves and exponential curves					
III	**Association of attributes**					10
	Association of attributes (dichotomous classification): Consistency of data, methods of studying association - Yule's coefficient of association, coefficient of colligation, Definitions of partial and illusory association					
IV	**Probability**					15
	Probability: definition and examples of Random Experiment, sample space, events, simple and composite events, exhaustive, mutually exclusive, equally likely and independent events. Classical definition of probability, elementary properties of probability, addition theorem for two events (statement only), concept of odds in favour of and against an event, concept of conditional probability of two events, independence of two events simple problems on probability.					
V	**Distribution Theory**					13
	Random variables (definition and example), discrete and continuous random variables definition and examples), probability mass function (definition, properties and simple examples) and probability density function (definition and properties only) **Discrete Probability distributions:** Binomial and Poisson distribution– probability mass function, mean and variance only (no derivations)), uses and applications of binomial and Poisson distributions in economics, simple problems to compute binomial and Poisson probabilities, **Continuous Probability distributions**: Normal distribution – Probability density function, mean and variance (no derivation), important properties of normal distribution (no derivation required), simple examples to find probability using standard normal tables.					

REFERENCES

1. S.P. Gupta (2019). Statistical Methods, Sultan Chand & Sons, New Delhi
2. S.C. Gupta and V.K. Kapoor (2021). Fundamentals of Mathematical Statistics, Sultan Chand & Sons, New Delhi
3. Elhance D.N., Veena Elhance and B.M. Agarwal (2018). Fundamentals of Statistics, Kitab Mahal Publications, New Delhi.
4. Goon, Gupta, Das Gupta (2016). Fundamentals of Statistics, The World Press

Name of the Course: QUANTITATIVE DATA ANALYTICS II

Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO 1	Calculate the degree and nature of relation ship between the economic variables	PSO 1,2 4,5 PO 1, 2 ,4, 7	Apply	C, P	L	P

CO 2	Model real life data sets with regression methods	PSO 1,2,4 5 PO 2, 3, 6 ,7	Apply	C,P	L	P
CO 3	Explain the basic concepts of probability theory and its applications for decision– making other social sciences	PSO 1,2, PO 2, 3 , ,6 7	Understand	C,F	L	P
CO 4	Solve problems using probability distributions	PSO 1,2 3,4 PO 2 3 6 7	Apply	P,M	L	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
C O 1	3	1		1	1		1	1		1			1	
C O 2	2	2		1	2			1	1			1	1	
C O 3	2	2						1	1			1	1	
C O 4	2	1	1	2				1	1			1	1	

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Examination
- Practical Evaluation
- End Semester Examinations

Mapping of COs to Assessment Rubrics :

	Internal Exam	Quiz / Assignment/ Discussion / Seminar	Practical Evaluation	End Semester Examinations
CO 1	✓	✓	✓	✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓		✓
CO 4	✓	✓	✓	✓

University of Kerala

Discipline	STATISTICS				
Course Code	UK2DSCSTA103				
Course Title	GEOSTATISTICS-II				
Type of Course	**DSC**				
Semester	II				
Academic Level	100 – 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites					

COURSE OUTCOMES

Up on Completion of the course, students should be able to:		Cognitive level	PSO Addressed
CO 1	Apply the counting principles in geography.	Apply	PSO 1
CO 2	Describe different types of events	Understand	PSO 1
CO 3	Explain the concepts of probability through classical and frequency approaches and axioms of probability.	Understand	PSO 1
CO 4	Calculate conditional probabilities and posteriori probability using Bayes theorem.	Apply	PSO 1, 3
CO 5	Explain the concept of random variables and their distributions	Understand	PSO 1,
CO 6	Apply binomial, Poisson and normal distributions.	Apply	PSO 1, 2,3,4
CO 7	Explain the concepts of parameter, statistic and sampling distribution.	Understand	PSO 1, 3,4

COURSE CONTENT

Module	Content	Hrs
I	**Introduction to Probability**	10
	Fundamental Principle of Counting, Permutations and Combinations, Random Experiment- Uncertainty in Geographical Phenomena, Sample Space, Events Equally Likely Outcomes, Mutually Exclusive and Exhaustive Events, Definitions of Probability- Classical Approach, Frequency Approach, Axioms of	

		Probability, Addition Theorem for two events (Basic concepts and problems Only; Mathematical derivations are not required), Probability Maps	
II		**Conditional Probability**	10
		Conditional Probability, Multiplication Theorem, Statistical Independence, Bayes' Theorem	
III		**Random Variables and Distributions**	13
		Random Variables: Discrete and Continuous Types, Probability Distribution-for discrete case, Probability Mass Function (Definition, properties and simple problems), Standard Distributions: Binomial, Poisson (Mean, Variance and no derivation is required) and Normal Distribution (definition , properties of normal curve and evaluation of probabilities using standard normal Table).	
IV		**Sampling Distributions**	12
		Sampling Distributions: Parameter, Statistic, Sampling Distribution, Distribution of Sample Mean (no derivation), Chi-Square, Student's t and Snedecor's F Distributions- Definitions and Statistics following these distributions (without Derivations), Uses, Inter-Relationships, Central Limit Theorem (Statement Only)	
V		**Practicum**	30
		Practical demonstration of the concepts mentioned in the first, second and third modules using spreadsheet software	

PRACTICAL/LABWORK
List of Practical worksheet
1. Problems related to Probability mass function and distribution function
2. Problems of Binomial Distribution
3. Problems of Poisson Distribution
4. Problems of Normal Distribution
5. Probabilities evaluation of Chi-Square, Student's t and Snedecor's F Distributions

REFERENCES
1. McGrew Jr, J. C., & Monroe, C. B. (2009). An introduction to statistical problem solving in geography. Waveland Press.
2. Matthews, J. A. (2013). Quantitative and statistical approaches to geography: a practical manual. Elsevier.
3. Acevedo, M. F. (2012). Data analysis and statistics for geography, environmental science, and engineering. Crc Press.
4. Rogerson, P. A. (2019). Statistical methods for geography: A student's guide.
5. Agarwal, B.L. (2006). Basic Statistics, 4th Edition, New Age International(P) Ltd, New Delhi.

Name of the Course: GEOSTATISTICS-II

Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.		CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)

CO 1	Apply the counting principles in geography..	PO-1 PO-1,3	Apply	P	L	P
CO 2	Describe different types of events	PO-1	Understand	F,C	L	
CO 3	Explain the concepts of probability through classical and frequency approaches and axioms of probability.	PO-1	Understand	F, P	L	
CO 4	Calculate conditional probabilities and posteriori probability using Bayes theorem..	PO-1, 2	Apply	F,P	L	
CO 5	Explain the concept of random variables and their distributions	PO-1	Understand	F C	L	P
CO 6	Apply binomial, Poisson and normal distributions	PO-1,2,3,7	Apply	C,P	L	P
CO 7	Explain the concepts of parameter, statistic and sampling distribution	PO-1,2,3	Understand	F,C	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PS O1	PS O2	PS O3	PS O4	PS O5	PS O6	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO 1	3						2		1					
CO 2	3						1							
CO 3	3						1							

CO 4	3		2				2	2						
CO 5	3						1							
CO 6	3	2	1	1			1	2	1			2		
CO 7	3		1	1			1	1				1		

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Examination
- Practical Evaluation
- End Semester Examinations

Mapping of COs to Assessment Rubrics :

	Internal Exam	Quiz / Assignment/ Discussion / Seminar	Practical Evaluation	End Semester Examinations
CO 1	✓	✓	✓	✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6	✓	✓	✓	✓
CO 7	✓	✓		✓

University of Kerala

Discipline	STATISTICS				
Course Code	UK2DSCSTA104				
Course Title	BEHAVIOURAL DATA ANALYTICS-II				
Type of Course	**DSC**				
Semester	II				
Academic Level	100 – 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-		4
Pre-requisites					

COURSE OUTCOMES

	Up on Completion of the course, students should be able to:	Cognitive level	PSO addressed
CO1	Determine correlation and regression	Apply	PSO1,2,3
CO2	Calculate coefficient of association and colligation	Apply	PSO 1,2,3
CO3	Understand the concept of probability	Understand	PSO 1
CO4	Understand Binomial ,Poisson and Normal distributions and their applications.	Understand	PSO 1
CO5	Explain the concept of sampling distributions	Understand	PSO 1

COURSE CONTENT

Module	Content	Hrs
I	**Correlation and Association**	15
	Scatter diagram, Karl Pearson's coefficient of correlation, Direct and inverse correlation, Rank correlation, Simple linear Regression, regression lines, Properties of correlation coefficients and Regression coefficients. Association and Disassociation, Yule's coefficient of association, Coefficient of colligation. Consistency of data (No mathematical derivations required, Numerical illustrations will be based on psychological data).	
II	**Probabilty**	15

	Random experiment, sample space, event, mutually exclusive and exhaustive events. Classical and frequency definition of probability (definitions, properties and simple numerical Problems). Addition theorem (two events), Conditional Probability, Independence of events. Random variable, Discrete and continuous random variable (Definitions and examples) Cumulative distribution function, Probability mass function (Definitions, elementary properties, and simple problems of discrete case only).	
III	**Standard distributions**	**15**
	Standard distributions: Binomial and Poisson distributions(Definitions with examples using psychological data), Mean, Variance (with out derivations), Simple problems. Normal distribution: Normal curve in terms of skewness and kurtosis, Characteristics and applications of normal distribution. Use of the standard normal table . Simple numerical problems. Standard scores : Z-score, T-Score, Stanine score, Converting raw scores into comparable standard normalized scores(based on psychological data).	
IV	**Sampling Distribution**	**15**
	Population, sample, Parameter, Statistic, Sampling distributions, Standard error, Sampling distribution of sample mean from Normal distribution (without proof), Chi-square, Student's-t, F-distributions(definitions only), examples of statistics following each distribution. Inter relationship between chi-square, t and F statistics.	

References:

1. Aron A, Aron R &Coups E J (2006). Statistics for Psychology (4thed):Pearson Education,New Delhi (ISBN:81-317-1464-20).
2. Garret E Henry (2004). Statistics in Psychology and Education (11thed): Paragon International publishers, New Delhi(ISBN:81-89253-00-X).
3. Gravetter,F J &Wallnau L B(2000) Statistics for Behavioral Science(5thed),Wadsworth-Thomson learning Singapore.(ISBN:0-534-35926-4)
4. Heiman W Carry (2000).Basic Statistics for behavioral Science (3rd ed.), Houghton Mifflin Company,New York.(ISBN:0-395-96251-X).
5. Mangal S K (2000). Statistics in Psychology and Education (2nd ed.):Prentice_Hall Of India Private Limited,New Delhi.(ISBN:978-81-203-8)

Name of the Course: BEHAVIOURAL DATA ANALYTICS-II

Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO1	Determine correlation and	PO 1 ,2	Apply	F, C,P	L	

		regression					
CO2	Calculate coefficient of association and colligation	PO 1,2	Understand	F,C,P	L	
CO3	Understand the concept of probability	PO 1	Understand	C,F		
CO4	Understand Binomial ,Poisson and Normal distributions and their applications.	PO 1	Understand	C,F	L	
CO5	Explain the concept of sampling distributions	PO 1	Understand	F,C	L	

Mapping of COs with POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1	2	2				1	1					
CO 2	2	2	2				1	2					
CO 3	1						2						
CO 4	1						1						
CO 5	2						1						

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Examination
- Practical Evaluation
- End Semester Examinations

Mapping of COs to Assessment Rubrics :

	Internal Exam	Quiz / Assignment/ Discussion / Seminar	Practical Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

Discipline	STATISTICS				
Course Code	UK2DSCSTA105				
Course Title	STATISTICAL TOOLS FOR DATA ANALYSIS				
Type of Course	**DSC**				
Semester	II				
Academic Level	100 – 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	4
Pre-requisites					

COURSE OUTCOMES

	Up on Completion of the course, students should be able to:	Cognitive level	PSO addressed
CO1	Explain the concept of Probability	Understand	PSO -1
CO2	Apply Standard Distributions in practical situations.	Apply	PSO -1, PSO -2
CO3	Calculate Pearson's Coefficient of Correlation, Spearman's Rank Correlation Coefficient and interpret the results.	Apply	PSO -1, PSO -2, PSO -4
CO4	Apply regression techniques in real life situations	Apply	PSO -1, PSO -2, PSO -4

COURSE CONTENT

Module	Content	Hrs
I	**Random variables & Distributions**	15
	Random Experiment, sample space, events; Classical definition of probability, simple examples. Random variables- discrete and continuous, binomial, Poisson and normal distributions, mean, variance (No mathematical derivations are required) and real-life applications.	
II	**Bivariate data**	10

	Bivariate data – scatter diagram, correlation, direct and inverse, Karl Pearson's coefficient of correlation, Spearman's Rank correlation coefficient for non-tied ranks (No mathematical derivations are required).	
III	**Analysis of bivariate data**	**10**
	Analysis of bivariate data- simple linear regression, relationship between correlation coefficient and regression coefficient, Coefficient of determination, simple examples (No mathematical derivations are required),	
IV	**Index Numbers**	**10**
	Index Numbers: meaning-classification-construction of index numbers-unweighted index numbers-weighted index numbers-Laspeyre's, Paasche's, Fisher's index numbers. Test on index numbers-factor reversal test, time reversal test; Consumer price index number	
V	**Practicum**	**30**
	Practical demonstration of the concepts mentioned in the second, third and fourth modules using spreadsheet software	

REFERENCES

1. Agarwal, B.L. (2006). Basic Statistics. 4th Edition, New Age international (P) Ltd., New Delhi.
2. Elhance D.N., Veena Elhance and B.M. Agarwal (2018). Fundamentals of Statistics, Kitab Mahal Publications, New Delhi
3. Goon, Gupta, Das Gupta (2016). Fundamentals of Statistics, The World Press
4. Gupta S. P. (2004). Statistical Methods. Sultan Chand & Sons, New Delhi.
5. Gupta, S.C and Kapoor, V.K (2002). Fundamentals of Mathematical Statistics, Sultan Chands.

Name of the Course: Statistical Tools for Data Analysis

Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO1	Explain the concept of Probability	PSO -1, PO -1	Understand	C	L	
CO2	Apply Standard Distributions in practical situations.	PSO -1, PSO -2, PO -1	Apply	C, P	L	P
CO3	Calculate Pearson's Coefficient of Correlation, Spearman's Rank Correlation Coefficient and interpret the results.	PSO -1, PSO -2, PSO -4, PO -1, PO -2, PO -7	Apply	C, P	L	P

		Rank Correlation Coefficient and interpret the results.					
CO4	Apply regression techniques in real life situations	PSO -1, 2, 4, PO -1, 2,7	Apply	C, P	L		P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO 1	1						1							
CO 2	2	1					2						1	
CO 3	2	2		2			2	1					2	
CO 4	2	2		2			2	2					2	

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Examination
- Practical Evaluation
- End Semester Examinations

Mapping of COs to Assessment Rubrics :

	Internal Exam	Quiz / Assignment/ Discussion / Seminar	Practical Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓	✓	✓
CO 4	✓	✓	✓	✓

University of Kerala

Discipline	STATISTICS				
Course Code	UK2DSCSTA106				
Course Title	ELEMENTARY DATA ANALYSIS TECHNIQUES				
Type of Course	**DSC**				
Semester	II				
Academic Level	100 – 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites					

COURSE OUTCOMES

	Up on Completion of the course, students should be able to:	Cognitive level	PSO addressed
CO1	Explain the concept of Probability	Understand	PSO -1
CO2	Explain Standard Distributions and their practical applications.	Apply	PSO -1, PSO -2
CO3	Calculate Pearson's Coefficient of Correlation, Spearman's Rank Correlation Coefficient and interpret the results.	Evaluate	PSO -1, PSO -2, PSO -4
CO4	Describe the regression lines and application of these line in real data	Apply	PSO -1, PSO -2, PSO -4

COURSE CONTENT

Module	Content	Hrs
I	**Probability models for univariate data**	15
	Random Experiment, sample space, events; Classical definition of probability, simple examples. Probability models for univariate data – binomial, Poisson and normal distributions, mean, variance (No mathematical derivations are required) and examples based on application	
II	**Bivariate data Analysis-I**	10
	Bivariate data – scatter diagram, correlation, types of correlation, Karl Pearson's coefficient of correlation, coefficient of determination, Spearman's Rank correlation coefficient (No mathematical derivations are required). Definition and uses of partial and multiple correlation coefficients (three variable case only)	

III	Bivariate data Analysis-II	10
	Analysis of bivariate data- simple linear regression, assumption of normality, relationship among correlation coefficient and regression coefficient, simple examples (No mathematical derivations are required), basic concepts of multiple regression	
IV	Index Numbers	10
	Index Numbers: meaning-classification-construction of index numbers-unweighted index numbers-weighted index numbers-Laspeyre's, Paasche's, Dorbish Bowley's, Fisher's index numbers. Test on index numbers-factor reversal test, time reversal test; Consumer price index number.	
V	Practicum	30
	Practical demonstration of the concepts mentioned in the second, third and fourth modules using R	

PRACTICAL/LABWORK
List of Practical worksheet
1. Problems based on binomial distribution
2. Problems based on Poisson distribution
3. Problems based on normal distribution
4. Problems on Correlation analysis
5. Problems based on Regression equations
6. Problems based on index numbers

REFERENCES
1. Gupta, S.C and Kapoor, V.K (2002). Fundamentals of Mathematical Statistics, Sultan Chands.
2. Agarwal, B.L. (2006). *Basic Statistics*. 4th Edition, New Age international (P) Ltd., New Delhi.
3. Gupta S. P. (2004). *Statistical Methods.* Sultan Chand & Sons, New Delhi.
4. Elhance D.N., Veena Elhance and B.M. Agarwal (2018). Fundamentals of Statistics, Kitab Mahal Publications, New Delhi
5. Goon, Gupta, Das Gupta (2016). Fundamentals of Statistics, The World Press

Name of the Course: Elementary Data Analysis Techniques

Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO1	Explain the concept of Probability	PSO -1, PO -1,2	Understand	C	L	

CO2	Explain Standard Distributions and their practical applications	PSO -1, 2, PO -1, 2,7	Apply	C, P	L	P
CO3	Calculate Pearson's Coefficient of Correlation, Spearman's Rank Correlation Coefficient and interpret the results.	PSO -1, 2, 4, PO -1, 2, 6, 7	Evaluate	C, P	L	P
CO4	Describe the regression lines and application of these line in real data	PSO -1, 2,4, PO -1, 2, 6, 7	Apply	C, P	L	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO1	1						1	1						
CO2	2	1					2	1					1	
CO3	2	2		2			2	1				1	2	
CO4	2	2		2			2	1				2	2	

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Examination
- Practical Evaluation
- End Semester Examinations

Mapping of COs to Assessment Rubrics :

	Internal Exam	Quiz / Assignment/ Discussion / Seminar	Practical Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓	✓	✓
CO 4	✓	✓	✓	✓

Discipline	STATISTICS				
Course Code	UK2DSCSTA107				
Course Title	BASIC STATISTICS II				
Type of Course	**DSC**				
Semester	II				
Academic Level	100- 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites					

COURSE OUTCOMES

	Up on Completion of the course, students should be able to:	Cognitive level	PSO addressed
CO1	Illustrate the association between two qualitative variables	Apply	PSO -1, 2,3
CO2	Compute various index numbers and compute them for data sets.	Apply	PSO -1, 2,3
CO3	Understand the basic concepts and tools in time series analysis and apply it for a time series data.	Analyse	PSO -1, 2,3
CO4	Explain the laws of large numbers	Understand	PSO -1

COURSE CONTENT

Module	Content	Hrs
I	**Association of attributes**	15
	Association of attributes (dichotomous classification): Consistency of data, methods of studying association - Yule's coefficient of association, Coefficient of colligation. Simple numerical problems.	
II	**Index Numbers**	15
	Index Numbers: meaning-classification-construction of index numbers-unweighted index numbers-weighted index numbers- Laspeyre's, Paasche's, Dorbish Bowley's, Fisher's index numbers, Time reversal test, factor reversal test.	
III	**Time Series**	15
	Time Series: concepts of time series, components of time series-additive and multiplicative models, estimation of trend - using graphical, semi-average, moving average methods and method of least squares.	
IV	**Limit Theorems**	15

Moment inequality: Chebychev's inequality, Markov inequality; convergence in probability (definition only), Law of large numbers-BLLN, WLLN; central limit theorem (Lindberg-Levy form) - statement and applications only.						

REFERENCES
1. Gupta, S. C., & Kapoor, V. K. (2020). Fundamentals of Mathematical Statistics, Sultan Chand & Sons, New Delhi
2. Medhi J (2000) Statistical Methods - An introductory text, New Age International(P), Ltd, New Delhi
3. Agarwal, B.L. (2006). Basic Statistics, 4th Edition, New Age International(P) Ltd, New Delhi
4. Mukhopadhyay, P. (2016). Applied statistics. Books and Allied (P) Limited.
5. Gupta, S. C., & Kapoor, V. K. (2007). Fundamentals of applied statistics. Sultan Chand & Sons.

Name of the Course: BASIC STATISTICS II
Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	Illustrate the association between two qualitative variables	PSO -1, 2,3 PO 1 2	Apply	F, C	L	
2	Compute various index numbers and compute them for data sets.	PSO -1, 2,3 PO 1 2	Apply	C,P	L	P
3	Understand the basic concepts and tools in time series analysis and apply it for a time series data.	PSO -1, 2,3 PO 1 2 3	Analyse	C,P	L	P
4	Explain the laws of large numbers	PSO -1 PO 1	Understand	F,C	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	1	2	1				1	1						
CO2	2	1	3				1	1						
CO3	3	1	2				1	2	1					
CO4	2						2							

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Examination
- Practical Evaluation
- End Semester Examinations

Mapping of COs to Assessment Rubrics :

	Internal Exam	Quiz / Assignment/ Discussion / Seminar	Practical Evaluation	End Semester Examinations
CO1	✓	✓		✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓

University of Kerala

Discipline	STATISTICS
Course Code	UK2DSCSTA108
Course Title	INTRODUCTION TO LINEAR MODELS AND COMBINATORIAL ANALYSIS
Type of Course	**DSC**
Semester	II
Academic Level	100 – 199

Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites					

COURSE OUTCOMES

Up on Completion of the course, students should be able to:		Cognitive level	PSO addresed
CO1	Apply principle of least squares for fitting various curves	Apply	PSO 1,2,3,4
CO2	Calculate correlation coefficients for given data sets and interpret	Apply	PSO 1, 2, 3,4
CO3	Analyse regression models	Analyse	PSO 1, 2, 3,4,5
CO4	Explain the concept of combinatorial analysis	Understand	PSO 1

COURSE CONTENT

Module	Content	Hrs
I	**Curve fitting**	12
	Concept of bivariate data, scatter diagram, curve fitting, principle of least squares. Fitting of curves of the forms: $y=ax + b$, $y = ax^2 + bx + c$, $y=ae^{bx}$, $y = ab^x$ and $y = ax^b$. Numerical problems covering these topics.	
II	**Bivariate data analysis**	13
	Linear correlation, Karl Pearson's coefficient of correlation, its invariance property, Spearman's rank correlation coefficient, tied ranks. Regression lines, relation between correlation coefficient and regression coefficients. angle between regression lines Identifying regression lines. Numerical problems covering these topics	
III	**Standard Distributions**	10

		Standard Distributions: binomial, Poisson and normal distributions – definitions and their properties–moments, moment generating function, additive property. Fitting of binomial and Poisson distributions.	
IV	**Combinatorial analysis**		10
	Elements of combinatorial analysis**,** pairs and multipliers**,** ordered samples, sub population and partitiuonsd, Maxwell-Boltzmann statistics, Bose-Einstein statistics and Fermi-Dirac statistic		
V	**Practicum**		30
	Practical based on Modules I, II, III &IV. Practical is to be done using **R package.**		

PRACTICAL/LABWORK
List of Practical worksheet
      1.Problems on Correlation
      2.Problems on Regression lines
      3. Curve fitting
      4. Problems on Binomial and Poisson distributions
      5. Problems on Normal Distribution

REFERENCES
1. Gupta, S. C. & Kapoor, V. K.(2002). Fundamentals of Mathematical Statistics, Sultan Chand, New Delhi.
2. Goon, A. M., Gupta, M. K. & Dasgupta, B. (2016). Fundamentals of Statistics. The World Press.
3. Martin B. R. (2012) . Statistics for Physicists, Academic Press, London.
4. Feller,W.(2008) . An Introduction to Probability Theory and its Applications. Ed-2 Vol II Wiley Eastern Limited (New Delhi).
5. Purohit, S. G., Deshmukh, S.R., & Gore, S. D. (2008). Statistics using R. Alpha Science International, United Kingdom.
6. Nabendu Pal and Sahadeb Sarkar.(2008). Statistics Concepts and Applications. Prentice Hall of India

Name of the Course: INTRODUCTION TO LINEAR MODELS AND COMBINATORIAL ANALYSIS

 Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO1	Apply principle of least squares for fitting various curves	PO 1,2,7 PSO 1,2,3,4	Apply	F, C,P	L	P

			Apply	P	L	P
CO2	Calculate correlation coefficients for given data sets and interpret	PO 1,2,4,7 PSO 1.2, 3,,4	Apply	P	L	P
CO3	Analyse regression models.	PSO 1,2,3,5 4, 7 PSO 1	Apply	C,P	L	P
CO4	Explain the concept of combinatorial analysis	PO 1 PSO 1	Understand	F,C	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PO 1	PO 2	PO 3	PO 4	PO 5	PO6	PO7
CO 1	2	3	1	1		1	1					1
CO 2	3	3	2	1		2	1		1			1
CO 3	2	3	2	1	3	1	3	1	1			1
CO 4	2					1						1

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Examination
- Practical Evaluation
- End Semester Examinations

Mapping of COs to Assessment Rubrics :

	Internal Exam	Quiz / Assignment/ Discussion / Seminar	Practical Evaluation	End Semester Examinations
CO 1	✓	✓	✓	✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓		✓
CO 4	✓	✓	✓	✓

Discipline	STATISTICS				
Course Code	UK2DSCSTA109				
Course Title	STANDARD DISTRIBUTIONS, CORRELATION AND REGRESSION				
Type of Course	**DSC**				
Semester	II				
Academic Level	100 – 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites					

COURSE OUTCOMES

Up on Completion of the course, students should be able to:		Cognitive level	PSO addressed
CO1	Explain Discrete Standard Distributions and apply discrete standard distributions in practical situations	Apply	PSO 1,2,3,4
CO2	Explain Continuous Standard distribution and its practical applications	Apply	PSO 1,2,3,4
CO3	Evaluate Marginal and Continuous distributions of Bivariate Random Variables. Check for the independence of random variables.	Evaluate	PSO 1,2, 3
	Calculate the conditional mean of Bivariate Random Variables.	Evaluate	
CO4	Calculate Pearson's Coefficient of Correlation, Spearman's Rank Correlation Coefficient and interpret the results.	Apply	PSO 1,2,3,4,5

COURSE CONTENT

Module	Content	Hrs
I	**Discrete Standard distributions**	15
	Standard distributions (Discrete) – Uniform, Binomial, Poisson – Moments, moment generating function, characteristic function, problems, additive property	

	(Binomial and Poisson), Recurrence relation for moments (Binomial and Poisson) , Poisson as limiting form of Binomial(statement only), fitting of Binomial and Poisson distribution.		
II	**Normal and Standard Normal distributions**	10
	Normal and Standard Normal distributions– uses, properties, mean, rth central moment, moment generating function, characteristic function, numerical problems, convergence of Binomial and Poisson to Normal	
III	**Bivariate random variables**	10
	Bivariate random variables – Joint Distribution of two random variables, Marginal and Conditional distributions, independence, conditional expectation, Bivariate Moments, Addition and multiplication theorems of Expectation, numerical problems	
IV	**Bivariate data Analysis**	10
	Correlation: Scatter Diagram, Karl Pearson's Coefficient of Correlation, Spearman's Rank Correlation Coefficient. Regression: Definition, Method of Least squares, Fitting of Regression Lines and predictions Fitting of models: $y = ae^{bx}, y = ab^x \ and \ y = ax^b$, Coefficient of Determination	
V	**Practicum**	30
	Practical based on Modules I, II &IV. Practical is to be done using **R package**	

PRACTICAL/LABWORK
List of Practical worksheet

1. Fitting of Binomial and Poisson distribution
2. Problems based on Binomial, Poisson Normal distribution
3. Problems on Correlation
4. Problems on Curve fitting
5. Problems on regression lines

REFERENCES

1. Gupta, S. C., and Kapoor,V. K. (1994). Fundamentals of Mathematical Statistics. Sultan Chand & Sons. New Delhi.
2. Mukhopadhyay, P. (1996). Mathematical Statistics. New Central Book Agency (P) Ltd, Calcutta.
3. Pitman, J. (1993). Probability. Narosa Publishing House, New Delhi.
4. Rohatgi V. K. (1993). An Introduction to Probability Theory and Mathematical Statistics. Wiley Eastern, New Delhi.
5. Purohit, S. G., Deshmukh, S.R., & Gore, S. D. (2008). Statistics using R. Alpha Science International, United Kingdom.

Name of the Course: STANDARD DISTRIBUTIONS, CORRELATION AND REGRESSION

Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO1	Explain Discrete Standard Distributions and apply discrete standard distributions in practical situations	PO1,2,7	Apply	F, C	L	P
CO2	Explain Continuous Standard distribution and its practical applications	PO 1,2,7	Apply	P	L	P
CO3	Evaluate Marginal and Continuous distributions of Bivariate Random Variables. Check for the independence of random variables. Calculate the conditional mean of Bivariate Random Variables..	PO1,2	Evaluate Evaluate		L	
CO4	Calculate Pearson's Coefficient of Correlation, Spearman's Rank Correlation Coefficient and interpret the results.	PO1,2,3,4,7	Apply		L	P

Mapping of COs with PSOs and POs :

	PSO 1	PS O 2	PSO 3	PSO 4	PSO 5	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	1	1	1		2	1					1
CO 2	3	1	1	1		2	1					1
CO 3	3	1	1	1		1	1					
CO 4	1	3	2	1	2	2	1	1	1			2

Assessment Rubrics:
  ▪ Quiz / Assignment/ Discussion / Seminar

- Internal Examination
- Practical Evaluation
- End Semester Examinations

Mapping of COs to Assessment Rubrics :

	Internal Exam	Quiz / Assignment/ Discussion / Seminar	Practical Evaluation	End Semester Examinations
CO 1	✓	✓	✓	✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓		✓
CO 4	✓	✓	✓	✓

University of Kerala

Discipline	STATISTICS				
Course Code	UK2DSCSTA110				
Course Title	STATISTICAL METHODS-II				
Type of Course	**DSC**				
Semester	II				
Academic Level	100 – 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites					

COURSE OUTCOMES

	Up on Completion of the course, students should be able to:	Cognitive level	PSO addressed
CO1	Analyse the different measures of correlation.	Analyse	PSO-1,2,3,4,5
CO2	Apply partial and multiple correlation	Apply	PSO-1,2,3,4,5
CO3	Evaluate regression by OLS method and fit the regression model.	Evaluate	PSO-2,4,5
CO4	Understand the basic concept of random experiment and probability	Understand	PSO-1

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

COURSE CONTENT

Module	Content	Hrs
I	**Correlation Analysis**	10
	Correlation- scatter diagram, Karl Pearson's coefficient of correlation and its properties, correlation ratio. Concept of rank correlation, Spearman's rank correlation coefficient, repeated ranks.	

II	**Curve fitting**	**10**
	Partial and multiple correlation for three variables (without proof). Curve fitting and principle of least squares- fitting of first degree, second degree, power curves and exponential curves.	
III	**Simple regression analysis**	**10**
	Simple regression analysis- regression equations by method of least squares, linear regression coefficients and its properties. Angle between the regression lines. Standard error, probable error, coefficient of determination.	
IV	**Introduction to Probability**	**15**
	Random Experiment, Sample Space, Events, Types of Events, Mathematical and Statistical definitions of Probability, Axiomatic definition, Probability space, Elementary properties of probability, Addition theorem, Conditional Probability, Multiplication theorem, Bayes theorem and its applications.	
V	**Practicum**	**30**
	Practical based on Modules I to III. Practical is to be done using R package	

PRACTICAL/LABWORK
List of Practical worksheet
    1.Find correlation using R
    2.Fitting Regression line using R
    4.Fitting different curves using R
REFERENCES

1. Bhat, B. R., Sri. Venkata Ramana T and Rao Madhava K. S. (1977). *Statistics: A Beginners Text Vol- 2*, New Age International (P) Ltd., New Delhi.
2. Goon A. M., Gupta N.K., Das Gupta B. (1999). *Fundamentals of Statistics. Vol. 2* World Press, Kolkatta.
3. Gupta, S.C. and Kapoor, V.K. (2002). *Fundamentals of Mathematical Statistics,* Sulthan Chand, New Delhi.
4. Hogg, R.V. and Craig, A.T. (1970). Introduction to Mathematical Statistics. Pearson Education Pvt. Ltd, UK.
5. Mukhopadhaya, P. (1996). Mathematical Statistics. New Central Book Agency (P) Ltd., Calcutta.
6. Rohatgi, V. K and Saleh, A.K.MD. (2001). An Introduction to Probability and Statistics. 2nd edition. John Wiley & Sons, Inc., New York.

Name of the Course: STATISTICAL METHODS-II

Credits: 3:0:1(Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	Analyse the different measures of correlation.	PSO-1,2,3,4,5 PO-1,2,3,4,7 6	Analyse	F, C		
2	Apply partial	PSO-	Apply	P		

		1,2,3,4,5 PO-1,2,3,4,7					
	and multiple correlation						
3	Evaluate regression by OLS method and fit the regression model.	PSO-1, 2,4,5 PO-1,2,3,4,7	Evaluate	P			
4	Understand the basic concept of random experiment and probability	PSO-1 PO-1	Understand	P			

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	3	1	1	3	3	1	1	1	-		2	-
CO2	2	3	1	3	3		3	2	2	1	-		2	-
CO3	2	3		2	2		3	2	1	1	-		1	-
CO4		2					3		-	-	-	-	-	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Examination
- Practical Evaluation
- End Semester Examinations

Mapping of COs to Assessment Rubrics :

	Internal Exam	Quiz / Assignment/ Discussion / Seminar	Practical Evaluation	End Semester Examinations
CO 1	✓	✓	✓	✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓		✓
CO 4	✓	✓	✓	✓

University of Kerala

Discipline	STATISTICS				
Course Code	UK2DSCSTA111				
Course Title	DATA ANALYSIS USING R- I				
Type of Course	**DSC**				
Semester	II				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites					

COURSE OUTCOMES

	Up on Completion of the course, students should be able to:	Cognitive level	PSO addressed
CO1	Apply various probability models for univariate data	Apply	PSO -1, PSO -2, PSO-3, PSO -4
CO2	Evaluation of confidence intervals using R	Evaluate	PSO -1, PSO -2, PSO -3, PSO -4
CO3	Evaluate linear relationship between variables using R	Evaluate	PSO -1, PSO -2, PSO -3, PSO -4, PSO -5
CO4	Apply principle of least squares to fit various curves	Apply	PSO -1, PSO -2, PSO -3, PSO -4, PSO -5

COURSE CONTENT

Module	Content	Hrs
I	**Probability models**	15
	Probability models for discrete and continuous data - Standard Distributions - binomial, Poisson and normal distributions, Relation with binomial, Poisson and normal, Fitting of the distributions (No mathematical derivations are required); Usage of R functions: d, p ,q and r to handle the distributions	
II	**Sampling distributions**	15

	Sampling distributions - Parameter and statistic, Statistics following normal, Chi-square, student's t and F distributions, Relations among them, Usage of tables; CLT for iid random variables (No mathematical derivations are required) Usage of R functions: d, p and q to handle the distributions	
III	**Estimation**	**15**
	Point estimation of mean, variance; Interval estimation of mean, difference of means, variance, ratio of variances, proportion and difference of proportions (No mathematical derivations are required) Use R code for estimation	
IV	**Analysis of bivariate data**	**15**
	Analysis of bivariate data - Concepts of correlation, Karl Pearson's correlation, Spearman's correlation, coefficient of determination, assumption of normality and simple linear regression; Fitting of $y = ax^b, y = ab^x, y = ae^{bx}$ and $y = ax^2 + bx + c, a \neq 0$, where a,b,c are real constants using R (No mathematical derivations are required) ; Usage of R functions cov(), cor(), lm() and predict()	

PRACTICAL/LABWORK
List of Practical worksheet
1. Fitting Univariate Probability models
2. Interval Estimation
4. Correlation
5. Simple Linear Regression
6. Curve Fitting

REFERENCES
1.Dalgaard P. (2008). Introductory Statistics with R, Second Edition, Springer, New York.

2.Gardener M (2023). An Introduction to R: Data Analysis and Visualization, Pelagic Publishing, UK

3.Heumann C., Schomaker M. and Shalabh (2022). Introduction to Statistics and Data Analysis With Exercises, Solutions and Applications in R, Second Edition, Springer Nature Switzerland

4.Jones E., Harden S., Crawley M.J., (2023). The R Book, Third Edition, John Wiley & Sons Ltd.

5.Taylor R. Brown (2023). An Introduction to R and Python for Data Analysis: A Side-By-Side Approach, CRC Press/Chapman & Hall

Web Resources:

1. https://cran.r-project.org

2.https://cran.r-project.org/manuals.html

3.https://www.r-project.org/other-docs.html

4. https://journal.r-project.org/

5. https://www.r-bloggers.com

Name of the Course: Data Analysis using R- I

Credits: 2:0:2 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO1	Apply various probability models for univariate data	PSO -1, 2, 4, PO - 12,7	U	F	L	P
CO2	Evaluation of confidence intervals using R	PSO -1, 2, 3, 4, PO - 1, 2, 7	C	P	L	P
CO3	Evaluate linear relationship between variables using R	PSO -1, 2, 3, 4, 5, PO -1, 2, 3, 4, 7	Ap	P	L	P
CO4	Apply principle of least squares to fit various curves	PSO -1, 2, 3, 4, 5, PO -1, 2, 3, 4, 7	E	P	L	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO 1	3	2		1			1	1					2	
CO 2	2	2	1	2			1	2					2	
CO 3	2	2	1	2	2		1	1	1	2			2	
CO 4	2	2	1	2	2		1	1	1	2			2	
CO 5	2	2	1	2	2		1	1	1	2			2	

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Examination
- Practical Evaluation
- End Semester Examinations

Mapping of COs to Assessment Rubrics :

	Internal Exam	Quiz / Assignment/ Discussion / Seminar	Practical Evaluation	End Semester Examinations
CO 1	✓	✓	✓	✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓		✓
CO 4	✓	✓	✓	✓

University of Kerala

Discipline	STATISTICS
Course Code	UK2MDCSTA101
Course Title	BIVARIATE AND CATEGORICAL DATA ANALYSIS
Type of Course	MDC
Semester	II
Academic Level	100 – 199

Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	3	2 hours	-	2 hours	4
Pre-requisites					

COURSE OUTCOMES

	Up on Completion of the course, students should be able to:	Cognitive level	PSO addressed
CO1	Calculate the degree and nature of relationship between variable data sets	Apply	PSO -1, 2, 4, 5
CO2	Describe the classification of data relating to attributes	Understand	PSO 1
CO3	Determine types of association of attributes	Apply	PSO 1 ,2,3,4,5
CO4	Determine the independence of attributes	Apply	PSO1,2,3,4,5

COURSE CONTENT

Module	Content	Hrs
I	**Correlation and Regression Analysis**	10
	Correlation Analysis: Scatter diagram, direct and inverse correlation, Karl Pearson's coefficient of correlation – formula and problems, Spearman's rank correlation including tied ranks (no derivation) – formula and numerical problems **Regression Analysis**: Simple linear regression, regression coefficients and properties (no derivation), point of intersection two regression lines, identification of two regression lines, coefficient of determination and its interpretation	
II	**Association of Attributes**	10
	Attributes, Classification of data relating to attributes, notation and terminology, combination of attributes and class frequencies, consistency of data, Association of attributes, types of association, methods of studying association- Yule's coefficient of association, coefficient of colligation	
III	**Testing of Qualitative variables**	10
	Contingency table, Independence of attributes and criterion of independence, Expected frequencies, Chi-square statistic and Table of Chi-square, Chi-square	

	test for independence (Concept and Simple examples), Relative risk and odds ratios.						
IV	**Practicum**						**20**
	Illustrate module 1,2,3 using spread sheet application						

REFERENCES
1. Agarwal B.L. (2006). Basic Statistics, 4th Edition, New Age International (P) Ltd
2. Gupta S.C. and Kapoor V.K. (1994). Fundamentals of Mathematical Statistics. Sultan Chand & Sons. New Delhi
3. Sharma A.K. (2005). Text Book of Sampling and Attributes, Discovery Publishing House New Delhi
4. www.libreoffice.org
5. Berk, K. N., & Carey, P. (1998). Data Analysis with Microsoft Excel. Pacific Grove, CA: Duxbury Press.

Name of the Course: BIVARIATE AND CATEGORICAL DATA ANALYSIS
Credits: 3:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO1	Calculate the degree and nature of relationship between variable data sets	PSO -1, 2, 4, 5 PO 1, 4,7	Apply	C P	L	P
CO2	Describe the classification of data relating to attributes	PSO 1 PO 1	Understand	FC	L	
CO3	Determine types of association of attributes	PSO 1 ,2,3,4,5 PO 1,4 7	Apply	C P	L	P
CO4	Determine the independence of attributes	PSO1,2,3 ,4,5 PO 1 4 7	Apply	P	L	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO 1	2	2		1	2		1			2			2	
CO 2	2						1							

CO 3	2	2	2	2	2		2			2			2	
CO 4	2	2	2	2	2		2			2			2	

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Quiz / Assignment/ Discussion / Seminar	Practical Evaluation	End Semester Examinations
CO 1	✓	✓	✓	✓
CO 2	✓	✓		✓
CO 3	✓	✓	✓	✓
CO4	✓	✓	✓	✓

University of Kerala

Discipline	STATISTICS				
Course Code	UK2MDCSTA102				
Course Title	DATA INTERPRETATION AND QUANTITATIVE REASONING				
Type of Course	MDC				
Semester	II				
Academic Level	100 – 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	3	3 hours	-		3
Pre-requisites					

COURSE OUTCOMES

	Up on Completion of the course, students should be able to:	Cognitive level	PSO
CO1	Represent data as diagrammatic and graphical forms	Apply	PSO 1, 2
CO2	Learn measures of central tendency and measures of dispersion, describe their properties	Apply	PSO 1 ,2,4
CO3	Describe random experiment, sample space, events, types of events and compute probability	Apply	PSO 1,3
CO4	Describe mathematical reasoning	Apply	PSO 3, 5

COURSE CONTENT

Module	Content	Hrs
I	**Interpretation of Diagrams**	15
	Data Interpretation- Bar Diagrams - Simple, Multiple, Subdivided, Percentage; Pie Chart; Line Graph, Frequency Tables, Case let, Mixed Chart, Histogram and Frequency Polygon - Concepts and examples only.	
II	**Descriptive Statistics and Probability**	15
	Descriptive Statistics – Averages-Mean, Median, Mode, Dispersion-Range, Standard Deviation, Mean Deviation (Concept and Problems for Raw Data only). Probability – Random Experiment, Sample Space, Outcome, Probability Range, Probability concept in Permutation, Combination, Union, Intersection, Complement. Digit Card and Honor Card- (Concepts and simple examples Only)	
III	**Quantitative Reasoning**	15

| | Reasoning- Blood Relation, Seating Arrangement, Puzzle, Alphanumeric Series, Logical Reasoning, Data Sufficiency, Tabulation, Syllogism, Work and Time, Speed and Time. (Numerical examples for Competitive Examinations) | |

REFERENCES

1. Agarwal B.L. (2007). Programmed Statistics (Question-Answers), New age international
2. Aggarwal R.S. (2011). Quantitative Aptitude, Sultan Chand
3. Medhi J. (1992). Statistical Methods: An Introductory Text, New age international
4. Sharma A. (2018). How to Prepare for Quantitative Aptitude for the CAT, McGraw Hill Education

Name of the Course: Data interpretation and reasoning
Credits: 3:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO1	Represent data as diagrammatic and graphical forms	PSO 1, 2 PO 1	Apply	F,C	L	
CO2	Learn measures of central tendency and measures of dispersion, describe their properties	PSO 1 ,2,4 PO 1, 2	Apply	F,C	L	
CO3	Describe random experiment, sample space, events, types of events and compute probability	PSO 1,3 PO 1,2	Apply	F,C ,P	L	
CO4	Describe mathematical reasoning	PSO 3, 5 PO 1,3	Apply	F,C P	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO1	2	3					2							-
CO2	2	2		3			2	2	-	-	-	-		
CO3	2		3				2	2	-	-	-	-		
CO4			2		2		1		2					

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Quiz / Assignment/ Discussion / Seminar	Practical Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO4	✓	✓		✓

Discipline	STATISTICS				
Course Code	UK2MDCSTA103				
Course Title	INTRODUCTION TO MACHINE LEARNING				
Type of Course	MDC				
Semester	II				
Academic Level	100 – 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	3	3 hours	-		3
Pre-requisites					

COURSE OUTCOMES

Up on Completion of the course, students should be able to:		Cognitive level	PSO addressed
CO1	Describe basic concepts of Machine Learning	Understand	PSO 1
CO2	Describe supervised learning and its various methods	Understand	PSO 1,3
CO3	Describe un-supervised learning and it s various methods	Understand	PSO 1, 3

COURSE CONTENT

Module	Content	Hrs
I	**Introduction to Machine Learning**	15
	Machine Learning –importance and applications. Examples of Machine Learning Applications -Association Rules, Classification, pattern recognition, face recognition, medical diagnosis, speech recognition, biometrics, outlier detection (Basic concepts only, Numerical examples are not included)	
II	**Supervised learning**	15
	Supervised learning – regression as supervised learning method, classification using posterior probability, discriminant function, association rule (Basic concepts only, Numerical examples are not included)	
III	**Unsupervised learning**	15
	Unsupervised learning – methods –meaning and applications of Principal Component Analysis, Factor Analysis, nearest neighbourhoods (Basic concepts only, Numerical examples are not included)	

REFERENCES

1. Alpaydın, E (2020). Introduction to machine learning (4th Edn), MIT Press
2. Faul A.C. (2019). A Concise Introduction to Machine Learning, CRC Press
3. Kimani J., Scott J. (2023). Introduction to Machine Learning Professional Level, Finstock Evarsity Publishers, USA
4. Kubat M. (2021). An Introduction to Machine Learning, Springer
5. Rebala G, Ravi A, Churiwala S. (2019). An Introduction to Machine Learning, Springer

Name of the Course: Introduction to Machine Learning
Credits: 3:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO1	Describe basic concepts of Machine Learning	PSO 1 PO 1	Understand	F,C	L	
CO2	Describe supervised learning and its various methods	PSO 1,3 PO 1, 7	Understand	F,C	L	
CO3	Describe un-supervised learning and it s various methods	PSO 1, 3 PO1,7	Understand	F,C	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3						3	3						
CO2	3		1				2						1	
CO3	3		1				1						1	

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Quiz / Assignment/ Discussion / Seminar	Practical Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO4	✓	✓		✓

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University of Kerala

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Discipline	STATISTICS				
Course Code	UK3DSCSTA201				
Course Title	BUSINESS DATA ANALYTICS III				
Type of Course	**DSC**				
Semester	3				
Academic Level	200 – 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites					

COURSE OUTCOMES

	Up on Completion of the course, students should be able to:	Cognitive level	PSO Addressed
CO1	Explain the fundamental concepts of testing of hypothesis.	Understand	PSO -1
CO2	Apply various tests for hypotheses	Apply	PSO –1, 2,3 5,4
CO3	Describe basic concepts of time series analysis	Understand	PSO -1
CO4	Determine trend using different methods	Apply	PSO 1,2,3,4,5
CO5	Compute various index numbers and interpret the results	Apply	PSO -1,2,3,4,5

COURSE CONTENT

Module	Content	Hrs
I	**Testing of Hypotheses**	10
	Testing of Hypotheses: Concepts of statistical hypothesis, Simple and composite hypothesis, Null and alternate hypothesis, One tailed and two-tailed tests, Type I and type II errors, Level of significance and power of tests, p –value, Various steps involved in testing statistical hypothesis Large sample tests: Tests concerning significance of mean, difference between means, significance of proportion, difference between proportions (only applications to numerical problems, no derivations required)	
II	**Small Sample Tests**	10
	Small Sample Tests: Tests concerning significance of mean, difference between means, significance of correlation coefficient and significance of variances (only applications to numerical problems, no derivations required).	
III	**Time Series**	12
	Time Series : Analysis of Time Series-Causes of Variation in Time Series Data - Components of Time Series- Additive and Multiplicative Models-	

		Determination of Trend By Semi Average, Moving Average and Least Square (Linear Second Degree And Exponential) Methods.	
IV		**Index Numbers**	**13**
		Index Numbers: Meaning and Types of Index Numbers-Problems in Construction of Index Numbers- Methods of Construction of Price and Quantity Indices, Errors in Index Numbers- Chain Base Index Numbers- Base Shifting - Splicing -Deflation -Customer Price Index and Its Uses.	
V		**PRACTICUM**	**30**
		Practical demonstration of the concepts mentioned in the second, third and fourth modules using spreadsheet software	

REFERENCES

1. Agarwal, B.L. (2006). Basic Statistics. 4th Edition, New Age international (P) Ltd., New Delhi.
2. Gupta, S.C and Kapoor, V.K (2002). Fundamentals of Mathematical Statistics, Sultan Chand.
3. Medhi J. (2005). Statistical Methods-An Introductory Text. New Age International (P) Ltd, New Delhi.
4. Miah, A. Q. (2016). Applied statistics for social and management sciences. Berlin: Springer.
5. Mukhopadhyay, P. (2016). Applied statistics. Books and Allied (P) Limited.
6. Sharma, J. K. (2012). Business statistics. Pearson Education India..
7. Sah, A. N. (2009). Data analysis using microsoft excel. Excel Books India.
8. https://www.libreoffice.org/calc

Name of the Course: BUSINESS STATISTICS- III
Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)	Practical (P)
CO1	Explain the fundamental concepts of testing of hypothesis.	PSO -1 PO 1	Understand	C	L	
CO2	Apply various tests for hypotheses	PSO –1, 2,3 5,4 PO 1 2 4 7	Apply	C, P	L	P
CO3	Describe basic concepts of time series analysis	PSO -1 PO 1	Understand	C	L	P
CO4	Determine trend using different methods	PSO 1,2,3,4,5 PO 1 2 4 7	Apply	C, P	L	P
CO5	Compute various index numbers and interpret the results	PSO -1,2,3,4,5 PO 1 2 4 7	Apply	C P	L	P

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO 1	2						1							
CO 2	1	2	1	1	2		1	2		1			2	
CO 3	1						1							
CO 4	1	2	1	1	2		1	1		1			2	
CO 5	1	2	1	1	2		1	1		1			2	

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Examinations
- Practical Evaluation
- End Semester Examinations

Mapping of COs to Assessment Rubrics :

	Internal Exam	Quiz / Assignment/ Discussion / Seminar	Practical Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

University of Kerala

Discipline	STATISTICS				
Course Code	UK3DSCSTA202				
Course Title	QUANTITATIVE DATA ANALYTICS -III				
Type of Course	**DSC**				
Semester	III				
Academic Level	200 – 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites					

COURSE OUTCOMES

	Up on Completion of the course, students should be able to:	Cognitive level	PSO addressed
CO1	Explain the fundamental concepts of testing of hypothesis.	Understand	PSO 1
CO2	Apply parametric tests for real life datasets.	Apply	PSO 1, 2, 3,5
CO3	Apply Nonparametric test for real life datasets	Apply	PSO 1, 2, 3, 5

COURSE CONTENT

Module	Content	Hrs
I	**Testing of Hypothesis**	15
	Testing of Hypothesis: Concepts of statistical hypothesis, Simple and composite hypothesis, Null and alternate hypothesis, One tailed and two-tailed tests, Type I and type II errors, Level of significance and power of tests, p – value, Various steps involved in testing statistical hypothesis.	
II	**Large sample tests**	15
	Large sample tests :Tests concerning significance of mean, difference between means, significance of proportion, difference between proportions (only test statistic and applications to numerical problems ,no derivations required)	
III	**Small Sample Tests**	15
	Small Sample Tests: Tests concerning significance of mean, difference between means, significance of correlation coefficient, significance of variances (only test statistic and applications to numerical problems, no derivations required). Confidence interval of mean of normal population (one sample and two sample numerical problems only)	
IV	**Non – parametric tests**	15
	Non – parametric tests - Chi-square test of goodness of fit, Chi-square test of independence of attributes, Sign test, Wilcoxon's signed rank test (One sample	

| | | and paired sample), Mann-Whitney-Wilcoxon test (Two independent samples), Kruskal Wallis test (only test statistic and applications to numerical problems, no derivations required). | |

REFERENCES

1. Gupta, S.C and Kapoor, V.K (2002). Fundamentals of Mathematical Statistics, Sultan Chands.
2. Mukhopadhyay, P. (1996). Mathematical Statistics. New Central Book Agency (P) Ltd, Calcutta
3. Agarwal, B.L. (2006). Basic Statistics. 4th Edition, New Age international (P) Ltd., New Delhi.
4. Medhi J. (2005). Statistical Methods-An Introductory Text. New Age International (P) Ltd, New Delhi.
5.

Name of the Course: QUANTITATIVE DATA ANALYTICS -III
Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO1	Explain the fundamental concepts of testing of hypothesis.	PSO 1 PO 1	Understand	C,P	L	
CO2	Apply parametric tests for real life datasets.	PSO 1, 2, 3,5 PO 1 2 4	Apply	C, P	L	P
CO3	Apply Nonparametric test for real life datasets	PSO 1, 2, 3, 5 PO 1 2 4	Apply	C,P	L	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	1						1							
CO2	1	1	1		1		1	1		1				
CO3	1	2	1		1		1	1		1				

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Internal Examinations
- End Semester Examinations

Mapping of COs to Assessment Rubrics :

	Internal Exam	Quiz / Assignment/ Discussion / Seminar	Practical Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓

University of Kerala

Discipline	STATISTICS				
Course Code	UK3DSCSTA203				
Course Title	GEOSTATISTICS-III				
Type of Course	**DSC**				
Semester	III				
Academic Level	200 – 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites					

COURSE OUTCOMES

	Up on Completion of the course, students should be able to:	Cognitive level	PSO addressed
CO1	Describe the concept of point estimation and explain the desirable properties of a good estimator.	Understand	PSO 1
CO2	Explain the basic concepts of testing of hypotheses	Understand	PSO 1 ,2
CO3	Describe the procedure of the testing of a statistical hypothesis.	Understand	PSO 1 ,2
CO4	Apply the test procedures for testing the hypothesis for real life data	Apply	PSO 1,2, 3 4 5

COURSE CONTENT

Module	Content	Hrs
I	**Estimation**	10
	Estimation: Point Estimation, Estimate, Estimator and Properties of a Good Estimator (Concepts Only). Confidence Interval Estimation for Mean And Proportion (Concepts and Problems, No Mathematical Derivations)	
II	**Testing of Hypothesis**	15
	Basic Idea of Significance Test. Null and Alternative Hypothesis. Type I and Type II Errors, Level of Significance, Concept of p-value. Tests of Hypothesis of Normal Population: One Sample Test for Mean, Test of Equality of Means of Independent Samples, Test of Specified Proportion, Test of Equality of Proportions	
III	**Small Sample Tests**	10
	Small Sample Tests: One Sample Test for Mean, Test of Equality of Means of Independent Samples, Paired T-Test, Chi-Square Test for Specified Variance, F-Test for Equality of Variances, Chi square tests for independence, Illustration Using Geospatial Data.	

IV	**Pattern Analysis**	10
	Point Patterns Study of Spatial Data: Concept of Spatial Data, Random and Systematic Point Patterns, Quadrat Analysis; Area Pattern: Lattice Patterns- Regular and Irregular (Elementary Level), Join Count Analysis (Only For Regular Pattern at Elementary Level), Autocorrelation Structure, Definitions Of Variograms, Semi-Variograms as a Geo Statistics Tool.	
V	**Practicum**	30
	Practical using spread sheet application of the Modules I,II,III.	

PRACTICAL/LABWORK
List of Practical worksheet
1. Testing the significance of the mean and difference of means.
2. Testing the significance of specified proportion and difference of two proportion.
3. Testing if the population variance has a specific value and equality of two population variances.
4. Chi-square test for independence
5. Paired t test.

REFERENCES
1. Agarwal, B.L. (2006). Basic Statistics, 4th Edition, New Age International(P) Ltd, New Delhi
2. McGrew Jr, J. C., & Monroe, C. B. (2009). An introduction to statistical problem solving in geography. Waveland Press.
3. Matthews, J. A. (2013). Quantitative and statistical approaches to geography: a practical manual. Elsevier.
4. Acevedo, M. F. (2012). Data analysis and statistics for geography, environmental science, and engineering. Crc Press.
5. Rogerson, P. A. (2019). Statistical methods for geography: A student's guide.
6. Burt, J. E., Barber, G. M., & Rigby, D. L. (2009). Elementary statistics for geographers. Guilford Press
7. Sah, A. N. (2009). Data analysis using microsoft excel. Excel Books India.
8. https://www.libreoffice.org/calc

Name of the Course: GEOSTATISTICS-III
Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)	Practical (P)
CO1	Describe the concept of point estimation and explain the desirable properties of a good estimator.	PSO 1 PO 1	Understand	F, C	L	
CO2	Explain the basic concepts of testing of hypotheses	PSO 1 ,2 PO 1	Understand	F C	L	

	Describe the procedure of the testing of a statistical hypothesis.	2				
CO3	Apply the test procedures for testing the hypothesis for real life data	PSO 1,2, 3 4 5 PO 1 2 4 7	Apply	P	L	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PO1	PO2	PO3	PO4	PO5	PO6	PO 7
CO 1	3					3						
CO 2	1	2				2	1					
CO 3	1	2	2	1	2		1	2	1			1

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Examinations
- Practical Evaluation
- End Semester Examinations

Mapping of COs to Assessment Rubrics :

	Internal Exam	Quiz / Assignment/ Discussion / Seminar	Practical Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓	✓	✓

Discipline	STATISTICS				
Course Code	UK3DSCSTA204				
Course Title	BEHAVIOURAL DATA ANALYTICS-III				
Type of Course	**DSC**				
Semester	III				
Academic Level	200 – 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites					

COURSE OUTCOMES

	On completion of the course, the students should be able to:	Cognitive level	PSO addressed
CO1	Explain the concepts of point estimation and interval estimation	Understand	PSO1
CO2	Calculate interval estimators for means , difference of means	Apply	PSO1,2,3
CO3	Illustrate some parametric tests of hypotheses.	Apply	PSO1,2,3
CO4	Illustrate some non-parametric tests of hypotheses	Apply	PSO1,2,3

COURSE CONTENT

Module	Content	Hrs
I	**Estimation theory**	15
	Estimation theory-point and interval estimation (basic concepts, definition only), interval estimation problems based on Normal and t distributions. Testing of hypothesis: Procedure of testing of hypothesis, Null and alternative hypothesis, Two types of errors, Two tailed and one tailed tests of significance, significance level, power of test, p-value (Definition only).	
II	**Large sample tests**	15
	Large sample tests: testing the significance of mean, testing the significance of difference between two means, testing significance of proportion, testing significance of difference between two proportions. Chi-square tests: testing independence of attributes, testing of goodness of fit (No derivation of test statistics).	
III	**Small sample tests**	15
	Small sample tests: testing the significance of mean of normal distribution, testing the significance of difference between means of two normal populations, paired-t	

		tests, testing significance of correlation coefficient (No derivation of test statistics).	
IV		**Non- parametric tests**	**15**
		Non- parametric tests: Importance of non- parametric tests in psychology. Sign test, Wilcoxon's matched pair signed rank test, Wald-Wolfowitz Run test, Mc-Nemer test, Simple problems based on psychological data (for problems table value to be provided in the question paper).	

REFERENCES:

1. Garret E.Henry (2004), Statistics in psychology and education (11th ed): Paragon international publishers New Delhi
2. Gravetter, F.J&Wollnau, L.B(2000), Statistics for behavioral science (5th ed): Wadsworth Thomson learning, Singapore
3. Aron.A, Aron.R &Coups E.J(2006), Statistics for psychology (4th ed): Pearson education, New Delhi
4. Heyman W.Carry (200), Basic statistics for behavioral science (3rd ed): Houghton Mifflin company, New York
5. Mangal S.K (2000)-Statistics in psychology and education (2nd ed): Prentice Hall of India private limited, New Delhi
6. Minium .W.Edward, King M.Bruce & Bear Gordon (2001)-Statistical reasoning in psychology and education (3 rd ed): John Wiley and sons, Inc, New York

Name of the Course: BEHAVIOURAL DATA ANALYTICS-III
Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO1	Explain the concepts of point estimation and interval estimation	PSO1 PO 1	Understand	F, C	L	
CO2	Calculate interval estimators for means , difference of means	PSO1,2,3 PO1 2	Apply	F,C	L	
CO3	Illustrate some parametric tests of hypotheses.	PSO1,2,3 PO 1 2	Apply	C,P	L	
CO4	Illustrate some non-parametric tests of hypotheses	PSO1,2,3 PO 1 2	Apply	C,P	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	2						1						1
CO 2	2	2	2					2				2	1
CO 3	2	2	3	2			2					1	1
CO 4	2	2	3	2				2				2	1

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Examinations
- End Semester Examinations

Mapping of COs to Assessment Rubrics :

	Internal Exam	Quiz / Assignment/ Discussion / Seminar	Practical Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO4	✓	✓		✓

University of Kerala

Discipline	STATISTICS				
Course Code	UK3DSCSTA205				
Course Title	STATISTICAL TOOLS FOR DATA ANALYSIS-II				
Type of Course	**DSC**				
Semester	III				
Academic Level	200 – 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites					

COURSE OUTCOMES

	Up on Completion of the course, students should be able to:	Cognitive level	PSO Addressed
CO1	Describe the fundamental concepts of testing of hypothesis	Understand	PSO -1
CO2	Illustrate tests for hypothesis about the mean and variance.	Apply	PSO -1, 2, 3, 4,5
CO3	Illustrate one way and two way ANOVA	Apply	PSO -1, 2, 3, 4,5
CO4	Illustrate non-parametric test	Apply	PSO -1, 2, 3, 4,5
CO5	Practical: Use software to solve numerical problems on modules II, III & IV	Apply	PSO - 2, 3, 4,5

COURSE CONTENT

Module	Content	Hrs
I	**Testing of Hypothesis**	**10**
	Testing of Hypothesis: statistical hypotheses, simple and composite hypotheses, two types of errors, significance level, p-value, power of a test (Concepts and definitions only) Large sample tests (Concepts, test statistics and numerical problems) - testing mean and proportion - one and two sample cases.	
II	**Small sample tests**	**10**
	Small sample tests (Concepts, test statistics and numerical problems)- test for mean - one and two sample cases, t-test for independent samples and paired samples, chi-square test for variance, F-test for equality of variances**.**	
III	**Analysis of Variance**	**12**
	Testing of equality of multiple means - Analysis of Variance (ANOVA) of one way and two way (single observation) classified data (No derivations required).	
IV	**Non-parametric tests**	**13**

	Non-parametric tests (Concepts and definitions only)- Wilcoxon Sign rank test, Mann–Whitney U test, chi-square test of goodness of fit (only for given class proportions), independence and homogeneity , The Kruskal–Wallis H-Test for One-way Analysis of Variance (ANOVA) by Ranks.	
V	**Practicum**	**30**
	Practical demonstration of the concepts mentioned in the first, second and third modules using spreadsheet software	

PRACTICAL/LABWORK
List of Practical worksheet
1. Testing hypothesis: z-test
2. Testing hypothesis: t-test and F-test
3. Testing hypothesis: chi square-test
4. ANOVA

REFERENCES
1. Agarwal, B.L. (2006). Basic Statistics. 4th Edition, New Age international (P) Ltd., New Delhi.
2. Elhance D.N., Veena Elhance and B.M. Agarwal (2018). Fundamentals of Statistics, Kitab Mahal Publications, New Delhi
3. Goon, Gupta, Das Gupta (2016). Fundamentals of Statistics, The World Press
4. Gupta S. P. (2004). Statistical Methods. Sultan Chand & Sons, New Delhi.
5. Gupta, S.C and Kapoor, V.K (2002). Fundamentals of Mathematical Statistics, Sultan Chands.

Name of the Course: STATISTICAL TOOLS FOR DATA ANALYSIS-II
Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO1	Describe the fundamental concepts of testing of hypothesis	PSO -1, PO -1	Understand	F, C	L	
CO2	Illustrate tests for hypothesis about the mean and variance.	PSO -1, 2, 34 5 PO - 1, 2,4,7	Apply	C	L	P
CO3	Illustrate one way and two way ANOVA	PSO -1, 2, 3, 4 5 PO - 1, 2,4,7	Apply	C, P	L	P
CO4	Illustrate non-parametric test	PSO -1, 2,3 4 5 PO -1, 2, 4, 7	Apply	C, P	L	P

CO5	Practical: Use software to solve numerical problems on modules II, III & IV	PSO -2, 3, 4, 5, PO - 1, 2, 4, 7	Apply	C, P	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO 5	PSO 6	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO 1	2						2							
CO 2	2	3	1	1	1		2	1		1			1	
CO 3	2	3	1	1	1		2	1		1			1	
CO 4	2	3	1	1	1		2	1		1			1	
CO 5		3	3	1	1		1	1		1			3	

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Examinations
- Practical Evaluation
- End Semester Examinations

Mapping of COs to Assessment Rubrics :

	Internal Exam	Quiz / Assignment/ Discussion / Seminar	Practical Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓	✓	✓
CO4	✓	✓	✓	✓

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University of Kerala

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Discipline	STATISTICS
Course Code	UK3DSCSTA206
Course Title	BASIC STATISTICS-III
Type of Course	**DSC**
Semester	III
Academic Level	100 – 199

Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites					

COURSE OUTCOMES

	Up on Completion of the course, students should be able to:	Cognitive level	PSO addressed
CO1	Understand the Properties and use of Generating functions	Understand	PSO 1
CO2	Define various discrete standard distributions and explain their theoretical properties.	Understand	PSO 1
CO3	Define various continuous standard distributions and explain their theoretical properties.	Understand	PSO 1
CO4	Carry out and interpret ANOVA.	Evaluate	PSO 1,2,3

COURSE CONTENT

Module	Content	Hrs
I	**Generating functions**	10
	Generating functions: Probability generating functions, properties and examples, Characteristic functions - properties and examples	
II	**Standard Distributions I**	10
	Standard Distributions : geometric- moments, moment generating function, problems, memoryless property of geometric distribution, hypergeometric distribution (definition, mean and variance only)	
III	**Standard Distributions II**	10

		Standard Distributions (continuous); exponential and gamma - moment generating function, ; memoryless property of exponential distribution; additive property of gamma distribution; beta distribution (I and II kinds)- momentS	
IV	**Design of Experiments**		**15**
	Design of Experiments- assumptions and principles, CRD, RBD- single observation per cell. Analysis of Variance (ANOVA) of one way and two way classified data (Derivation not required).		
V	**PRACTICUM**		**30**
	Practical demonstration of the concepts mentioned in the second, third and fourth modules using spread sheet software		

REFERENCES

1. S.C.Gupta and V.K.Kapoor (2021). Fundamentals of Mathematical Statistics,   Sultan Chand & Sons, New Delhi
2. Medhi J (2000) Statistical Methods - An introductory text, New Age International(P), Ltd, New Delhi
3. Agarwal, B.L. (2006). Basic Statistics, 4th Edition, New Age International(P) Ltd,   New Delhi
4. Rohatgi V. K. (1993). An Introduction to Probability Theory & Mathematical Statistics. Wiley Eastern, New Delhi.
5. Das M. N., Giri N. C. (2003). Design and analysis of experiments. New Age International (P) Ltd, New Delhi.

Name of the Course: BASIC STATISTICS-III
Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO1	Understand the Properties and use of Generating functions	PSO 1 PO 1	Understand	F, C	L	
CO2	Define various discrete standard distributions and explain their theoretical properties.	PSO 1 PO1	Understand	P,C	L	P
CO3	Define various continuous standard distributions and explain their theoretical properties.	PSO 1 PO 1	Understand	C, P	L	P
CO4	Carry out and interpret ANOVA.	PSO 1,2,3 PO 1,2,3	Evaluate	M,P C	L	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

A	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	1	1					1	1				
CO 2	2	2	1				2	2	1			
CO 3	2	2	1				2	2	1			
CO 4	3	3	3			1	3	3	3			1

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Practical Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓	✓	✓
CO 4	✓	✓	✓	✓

University of Kerala

Discipline	STATISTICS				
Course Code	UK3DSCSTA207				
Course Title	STATISTICAL INFERENCE AND RANDOM PROCESSES				
Type of Course	**DSC**				
Semester	III				
Academic Level	200 – 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites					

COURSE OUTCOMES

	Up on Completion of the course, students should be able to:	Cognitive level	PSO addressed
CO1	Explain the concepts of statistic, parameter and sampling distribution	Understand	PSO 1
CO2	Explain the properties of estimators	Understand	PSO 1
CO3	Analyse the methods of estimation and confidence interval.	Analyse	PSO 1,2,3,4,5
CO4	Explain the fundamental concepts of testing of hypothesis.	Understand	PSO 1
CO5	Apply tests for hypothesis for real life data sets	Apply	PSO 1,2,3,4,5
CO 6	Explain the concepts of Stochastic process Markov processes, Markov chains, random walks and Brownian motion.	Understand	PSO 1

COURSE CONTENT

Module	Content	Hrs
I	**Sampling distributions**	5
	Sampling distributions: Parameter and statistic, Sampling distributions- Central limit Theorem (Statement only). Distribution of mean of a sample taken from a normal population; chi-square, t and F distributions (definitions only, without derivation).	
II	**Estimation Theory**	10
	Point estimation: Desirable properties of estimators – unbiasedness, consistency, efficiency (definitions and simple problems) and sufficiency (definition only); Methods of estimation –Maximum likelihood and method of moments. **Interval Estimation:** Confidence Interval-Concept, Interval estimation of mean, variance and differences of means	

III	Testing of Hypothesis	15
	Testing of Hypothesis: Statistical hypotheses, null and alternative hypotheses, simple and composite hypotheses, two types of errors, significance level, p-value, power of a test. Large sample tests concerning mean, equality of means, proportion and equality of proportions. Test based on Chi-square distribution for testing goodness of fit and independence of attributes. **Small sample tests**: Testing the hypotheses of mean and equality of means for normal population, paired t-test, testing the hypotheses of variance and equality of variance for normal population.	
IV	Stochastic Processes	15
	Stochastic Processes: Introduction, time and state space, classification of stochastic processes, process with stationary independent increments (definition only). Basic concepts and examples of Markov Process, Markov chain, transition probability matrix – up to two steps probability only, initial probability vector. Definitions of random walk and Brownian motion and their examples.	
V	Practicum	30
	Practical based on Modules I, II and III . Practical is to be done using **R package.**	

PRACTICAL/LABWORK
List of Practical worksheet
1. Confidence interval.
2. Z-test
3. T-test
4. Chi-square test of goodness of fit
5. F- test for equality of variances

REFERENCES

1. Biswal P.C. (2007) Probability and Statistics. Prentice Hall of India.
2. Gupta, S. C. and Kapoor, V.K. (2002) Fundamentals of Mathematical Statistics. Sultan Chand and Co. New Delhi. 10
3. Gupta, S. C. and Kapoor, V.K.(2020) Applied Statistics. Sultan Chand and Co. New Delhi.
4. Agarwal, B.L. (2006). Basic Statistics. 4th Edition, New Age international (P) Ltd., New Delhi.
5. Mathai, A. M., & Haubold, H. J. (2017). Probability and Statistics: A Course for Physicists and Engineers (p. 582). De Gruyter.
6. Kerns G. J. (2010) Introduction to Probability and Statistics using R, Springer.
7. Lander J. P. (2017). R for everyone 2/e. Addison-Wesley Professional, U. S.
8. Purohit, S. G., Deshmukh, S.R., & Gore, S. D. (2008). Statistics using R. Alpha Science International, United Kingdom.
9. Medhi, J. (2009). Stochastic Processes, New Age International Publishers, New Delhi

Name of the Course: STATISTICAL INFERENCE AND RANDOM PROCESS
Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO1	Explain the concepts of statistic, parameter and sampling distribution	PSO 1 PO 1	Understand	F, C	L	
CO2	Explain the properties of estimators	PSO 1 PO1	Understand,	C	L	
CO3	Analyse the methods of estimation and confidence interval.	PSO 1,2,3,4,5 PO 1,2,4,7	Analyse	C, P	L	P
CO4	Explain the fundamental concepts of testing of hypothesis .	PSO 1 PO1	Understand	C	L	
CO5	Apply tests for hypothesis for real life data sets	PSO 1,2,3,4,5 PO 1,2,4,7	Apply	P C	L	P
CO 6	Explain the concepts of Stochastic process Markov processes, Markov chains, random walks and Brownian motion.	PSO 1 PO 1	Understand	C	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO 7
CO 1	2						3						
CO 2	3						3						

CO 3	2	2	3	3	2		2	2		2			2
CO 4	3						1						
CO5	2	2	3	3	2		2	2		2			2
CO 6	1						1						

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Examinations
- Practical Evaluation
- End Semester Examinations

Mapping of COs to Assessment Rubrics :

	Internal Exam	Quiz / Assignment/ Discussion / Seminar	Practical Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓	✓	✓
CO4	✓	✓		✓
CO5	✓	✓	✓	✓
CO6	✓	✓		✓

University of Kerala

Discipline	STATISTICS				
Course Code	UK3DSCSTA208				
Course Title	STATISTICAL INFERENCE				
Type of Course	**DSC**				
Semester	III				
Academic Level	200 – 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites					

COURSE OUTCOMES

Up on Completion of the course, students should be able to:		Cognitive level	PSO addressed
CO1	Define the concept of sampling distributions.	Understand	PSO 1
CO 2	Explain the properties of estimators	Understand	PSO 1
CO3	Solve numerical problems for the point and interval estimators of the parameters.	Apply	PSO 1,2,3,4,5
CO4	Explain the fundamental concepts of testing of hypothesis.	Understand	PSO 1
CO5	Apply tests for hypothesis	Apply	PSO 1,2,3,4,5,6

COURSE CONTENT

Module	Content	Hrs
I	**Sampling distributions**	10
	Sampling distributions - Parameter and statistic, Sampling distributions- Central limit Theorem (Statement only). Distribution of mean of a sample taken from a normal population; chi-square, t and F distributions (definitions only) and statistics following these distributions, relation between normal, chi-square, t and F distributions (No derivations required).	
II	**Estimation Theory**	10
	Point estimation, desirable properties of estimators – unbiasedness, consistency, efficiency (definitions and simple problems) and sufficiency (definition only); Confidence Interval of mean, variance and difference of means (No derivations required). Methods of estimation –Maximum likelihood and method of moments	
III	**Testing of Hypothesis**	15

	Testing of Hypothesis: statistical hypotheses, null and alternative hypotheses, simple and composite hypotheses, two types of errors, significance level, p-value, power of a test. Z test- testing mean and proportion (one and two sample cases). Chi-square test of goodness of fit, independence/homogeneity.	
IV	**Small sample tests**	**10**
	Small sample tests: t- test for one sample, independent samples and paired samples, Chi-square test for variance, F- test for equality of variances.	
V	**Practicum**	**30**
	Practical based on Modules II, III &IV. Practical is to be done using **R package.**	

PRACTICAL/LABWORK
List of Practical worksheet
1. Confidence interval.
2. Z-test
3. T-test
4. Chi-square test
5. F- test for equality of variances

REFERENCES
1. Gupta, S.C and Kapoor, V.K (2020). Fundamentals of Mathematical Statistics, Sultan Chands.
2. Mukhopadhyay, P. (1996). Mathematical Statistics. New Central Book Agency (P) Ltd, Calcutta
3. Agarwal, B.L. (2006). Basic Statistics. 4th Edition, New Age international (P) Ltd., New Delhi.
4. Dalgaard, P. (2008). Introductory Statistics with R, Springer, New York.
5. Purohit, S. G., Deshmukh, S.R., & Gore, S. D. (2008). Statistics using R. Alpha Science International, United Kingdom.

Name of the Course: STATISTICAL INFERENCE
 Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial	Practical (P)
1	Define the concept of sampling distributions.	PSO 1 PO 1	Understand	F, C	L	
2	Explain the properties of estimators	PSO 1 PO 1	Understand	F, C	L	
3	Solve numerical problems for the point and interval estimators of the parameters	PSO 1,2,3,4,5 PO 1,2,4,7	Apply	P	L	P

4	Explain the fundamental concepts of testing of hypothesis	PSO 1 PO 1	Understand	F, C	L	
5	Apply large tests of hypothesis.	PSO 1,2,3,4,5,6 PO 1,2,4,7	Apply	P, M	L	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

	PS O 1	PS O 2	PS O 3	PS O 4	PS O 5	PS O 6	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO 1	2						2							
CO 2	3						2							
CO 3	3	2	1	1	2		2	1		2			2	
CO 4	1						1							
CO 5	3	2	1	1	2		2	1		2			2	

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Examinations
- Practical Evaluation
- End Semester Examinations

Mapping of COs to Assessment Rubrics :

	Internal Exam	Quiz / Assignment/ Discussion / Seminar	Practical Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓	✓	✓
CO4	✓	✓		✓
CO5	✓	✓	✓	✓
CO6	✓	✓		✓

Discipline	STATISTICS				
Course Code	UK3DSCSTA209				
Course Title	PROBABILITY AND DISTRIBUTIONS - I				
Type of Course	**DSC**				
Semester	III				
Academic Level	200 – 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites					

COURSE OUTCOMES

	Up on Completion of the course, students should be able to:	Cognitive level	PSO addressed
CO1	Illustrate random variables and their probability distributions	Analyse	PSO-1,2,3,4
CO2	Calculate moments of random variables	Apply	PSO-1,2,3,4
CO3	Determine generating functions of random variables	Apply	PSO-1,2,3
CO4	Demonstrate bivariate random variables and their distributions	Analyse	PSO-1,2,3,4

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

COURSE CONTENT

Module	Content	Hrs
I	**Random variable**	13
	Random variable, Distribution function of a random variable - properties, Discrete and Continuous random variables, probability mass function and probability density function, their properties, functions of random variables, transformation of random variables.	
II	**Bivariate random variable**	12
	Bivariate random variable, joint distribution function and its properties, joint probability mass function and joint probability density function and their properties, marginal and conditional distributions, independence of random variables, transformations of bivariate random variable.	
III	**Mathematical expectation**	10
	Mathematical expectation, properties, addition and multiplication theorem on expectation, expectation of function of random variables, moments-univariate and bivariate, Cauchy – Schwartz inequality, correlation coefficient, conditional expectation (regression function), conditional variance.	
IV	**Generating functions**	10

	Generating functions– probability generating function, moment generating function, characteristic function, cumulant generating function, their properties, derivation of moments from generating functions, bivariate moment generating function.	
V	**Practicum**	**30**
	Practical based on Modules I to IV. Practical is to be done using R package	

PRACTICAL/LABWORK
List of Practical worksheet
1. Compute and plot probability mass functions, probability density functions and distribution function for the generated random variables in R
2. Compute moments and correlation coefficient using R

REFERENCES
1. Gupta, S.C. and Kapoor, V.K. (2020). Fundamentals of Mathematical Statistics, Sultan Chand, New Delhi.
2. F. M. Dekkingetal. (2005). A Modern Introduction to Probability and Statistics. Springer Verlag, New York. 9 .
3. Goon A. M., Gupta N.K., Das Gupta B. (1999). Fundamentals of Statistics. Vol. 2 World Press, Kolkata.
4. Hogg, R.V. and Craig, A.T. (1970). Introduction to Mathematical Statistics. Pearson Education Pvt. Ltd, UK.
5. Mukhopadhaya, P. (1996). Mathematical Statistics. New Central Book Agency (P) Ltd., Calcutta.
6. Rohatgi, V. K and Saleh, A.K.MD. (2001). An Introduction to Probability and Statistics. 2nd edition. John Wiley & Sons, Inc., New York.
7. Dalgaard, P.(2008). Introductory Statistics with R, Springer, New York
8. Purohit, S. G., Deshmukh, S.R., & Gore, S. D. (2008). Statistics using R. Alpha Science International, United Kingdom.

Name of the Course: PROBABILITY AND DISTRIBUTIONS – I
 Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO1	Illustrate random variables and their probability distributions	PSO-1,2,3,4 PO 1,2,7	Analyse	C,P	L	P
CO2	Calculate moments of random variables	PSO-1,2,3,4 PO 1,2,7	Apply	C,P	L	P
CO3	Determine generating functions	PSO-1,2,3	Apply	C,P	L	P

	of random variables	PO 1, 2			
CO4	Demonstrate bivariate random variables and their distributions	PSO-1,2,3,4 PO 1,2,7	Analyse	C,P	L	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	1	1	1			1	1					2	-
CO2	3	1	1	1			1	1					2	-
CO3	3	2	2				1	1						-
CO4	3	2	1	1			1	1					2	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Examinations
- Practical Evaluation
- End Semester Examinations

Mapping of COs to Assessment Rubrics :

	Internal Exam	Quiz / Assignment/ Discussion / Seminar	Practical Evaluation	End Semester Examinations
CO1	✓	✓	✓	✓
CO2	✓	✓	✓	✓
CO3	✓	✓	✓	✓
CO4	✓	✓	✓	✓

University of Kerala

Discipline	STATISTICS				
Course Code	UK3DSCSTA210				
Course Title	DATA ANALYSIS USING R- II				
Type of Course	**DSC**				
Semester	III				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites					

COURSE OUTCOMES

	Up on Completion of the course, students should be able to:	Cognitive level	PSO addressed
CO1	Explain the concept of testing statistical hypotheses.	Understand	PSO -1
CO2	Illustrate various Parametric tests using R	Analyse	PSO -1, 2,3,4,5
CO3	Illustrate various non-parametric tests using R	Analyse	PSO -1, 2,3,4,5

COURSE CONTENT

Module	Content	Hrs
I	**Testing of Hypothesis**	25
	Testing of Hypothesis: statistical hypotheses, simple and composite hypotheses, two types of errors, significance level, p-value, power of a test; Testing mean and proportion - one and two sample cases- independent and paired samples (No mathematical derivations are required) ; Usage of R functions: z.test(),t.test(), and prop.test() to perform the tests. Chi-square test for variance, F-test for equality of variances (No mathematical derivations are required) .Usage of R functions: chisq.test() and var.test() to perform the tests.	
II	**Analysis of Variance**	25
	Testing of equality of several means - Analysis of Variance (ANOVA) of one way and two way classified data with out replication (No mathematical derivations are required). Usage of R function: aov() and summary() to perform the tests	
III	**Non-parametric tests**	25
	Non-parametric tests -Wilcoxon Signed rank test, Mann–Whitney U test, chi-square test of goodness of fit, independence and homogeneity , The Kruskal–Wallis H-Test for Oneway Analysis of Variance (ANOVA) by Ranks (No mathematical derivations are required). Usage of R functions: binom.test(), wilcox.test() and kruskal.test() to perform the tests.(	

PRACTICAL/LABWORK

List of Practical worksheet

1. Various parametric one sample tests
2. Various parametric two sample tests
3. ANOVA
4. Non-Parametric Statistical Tests

REFERENCES

1. Dalgaard P. (2008). Introductory Statistics with R, Second Edition, Springer, New York.
2. Gupta, S. C., & Kapoor, V. K. (2020). Fundamentals of mathematical statistics. Sultan Chand & Sons.
3. Purohit, S. G., Deshmukh, S.R., & Gore, S. D. (2008). Statistics using R. Alpha Science
International, United Kingdom.
2. Gardener M (2023). An Introduction to R: Data Analysis and Visualization, Pelagic Publishing, UK
3. Heumann C., Schomaker M. and Shalabh (2022). Introduction to Statistics and Data Analysis With Exercises, Solutions and Applications in R, Second Edition, Springer Nature Switzerland
4. Jones E., Harden S., Crawley M.J., (2023). The R Book, Third Edition, John Wiley & Sons Ltd.
5. Taylor R. Brown (2023). An Introduction to R and Python for Data Analysis: A Side-By-Side Approach, CRC Press/Chapman & Hall
6. Kloke J., McKean J.W., (2015). Nonparametric Statistical Methods Using R, CRC press
7. Thomas W.M, Yates J.M. (2016). Introduction to Nonparametric Statistics for the Biological Sciences Using R, Springer

Web Resources:

1. https://cran.r-project.org
2. https://cran.r-project.org/manuals.html
3. https://www.r-project.org/other-docs.html
4. https://journal.r-project.org/
5. https://www.r-bloggers.com

Name of the Course: Data Analysis using R- II
Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial	Practical (P)
CO1	Explain the concept of testing statistical hypotheses.	PSO -1 PO 1	Understand	C	L	

| CO2 | Illustrate various Parametric tests using R | PSO -1, 2,3,4,5 PO 1, 2, 4,7 | Analyse | P,M | L | P |
| CO3 | Illustrate various non-parametric tests using R | PSO -1, 2,3,4,5 PO 1, 2, 4,7 | Analyse | P,M | L | P |

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3						1							
CO2	3	3	2	2	1		1	2		2			3	
CO3	3	3	2	2	1		1	2		2			3	

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Practical Evaluation
- Final Exam

	Internal Exam	Quiz / Assignment Discussion / Seminar	Practical Evaluation	End Semester Examination
CO 1	✓	✓		✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓	✓	✓

University of Kerala

Discipline	STATISTICS
Course Code	UK3DSESTA201
Course Title	APPLIED STATISTICS
Type of Course	**DSE**
Semester	III
Academic Level	200 - 299

Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites					

COURSE OUTCOMES

	Up on Completion of the course, students should be able to:	Cognitive level	PSO addressed
CO1	Calculate various index numbers	Apply	PSO 1,2,5
CO2	Apply the concepts of base shifting, splicing and deflation of index numbers	Apply	PSO 1,2,5
CO3	Calculate consumer price index number.	Apply	PSO 1, 2, 5
CO4	Determine the component of time series and Calculate trend and seasonal values.	Apply	PSO 1,2,5

COURSE CONTENT

Module	Content	Hrs
I	**Index Numbers**	20
	Index Numbers: meaning-classification-construction of index numbers-unweighted index numbers-weighted index numbers- Laspeyres's, Paasche's, Dorbish Bowley's, Fisher's, Marshall-Edgeworth's and Kelly's Methods. Practical based on this module using R	
II	**Tests on index numbers**	20
	Test on index numbers-factor reversal test, time reversal test, circular test, chain Index numbers-base shifting, splicing and deflating of index numbers. Consumer price index number. Practical based on this module using R	
III	**Time Series**	20
	Time Series: concepts of time series, components of time series-additive and multiplicative models, estimation of components-measurement of trend using graphical, semi-average and moving average methods, method of least squares. Practical based on this module using R	

IV	Measurement of seasonal variation	15
	Measurement of seasonal variation using method of simple averages- ratio to trend method, ratio to moving average method, method of link relatives. Practical based on this module using R	

PRACTICAL WORKSHEET
1. Index numbers
2. Time series

REFERENCES

1. Gupta, S.C and Kapoor V. K. (2002)- Fundamentals of Applied Statistics. Sultan Chand & Co. New Delhi.
2. Mukhopadhyay ,P. (2005). Applied Statistics. Arunabha Sen Books and Allied Ltd. Kolkata.
3. Croxton, Frederick E, Cowden, Dudley J. and Klein, S. (1973): Applied General Statistics, 3rd edition, Prentice Hall of India Pvt. Ltd.
4. Mudgett B.D. (1951): Index Numbers, John Wiley & Sons, New York.

Name of the Course:Applied Statistics
Credits: 3:0:1 (Lecture: Tutorial: Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO1	Calculate various index numbers	PSO 1,2,5 PO1,2,4	Apply	C, P	L	-
CO2	Apply the concepts of base shifting, splicing and deflation of index numbers	PSO 1,2,5 PO1,2,4	Apply	P	L	-
CO3	Calculate consumer price index number.	PSO 1, 2, 5 PO1,2,4	Apply	C, P	L	-
CO4	Determine the component of time series and Calculate trend and seasonal values.	PSO 1,2,5 PO1,2,4	Apply	M	L	-

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

Correlation Levels:

	PSO 1	PSO 2	PSO 3	PSO4	PSO 5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO 7	PO 8
CO 1	3	2			2		3	2		1	-			-
CO 2	3	2			2		3	2		1	-	2	1	-
CO 3	3	2			2		3	2		1	-	3	2	1
CO 4	3	2			2		3	2		1	-	3	2	-

Level	**Correlation**
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High
3	Substantial / High

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Examination
- Practical Evaluation
- End Semester Examinations

Mapping of COs to Assessment Rubrics :

	Internal Exam	Quiz / Assignment/ Discussion / Seminar	Practical Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓	✓	✓
CO 5	✓	✓	✓	✓

Discipline	STATISTICS				
Course Code	UK3DSESTA202				
Course Title	INTRODUCTION TO DATA ANALYSIS SOFTWARES				
Type of Course	**DSE**				
Semester	III				
Academic Level	200 – 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites					

COURSE OUTCOMES

	Up on Completion of the course, students should be able to:	Cognitive level	PSO addressed
CO1	Explain Excel features and functions for data analysis and manipulation.	Understand	PSO 1, 2,4, 5
CO2	Describe effective visualizations using Tableau for presenting data insights and trends.	Understand	PSO 1, 2,4, 5
CO3	Explain the features in SPSS for importing, coding, decoding, scaling, and visualizing data, as well as performing descriptive statistics.	Understand	PSO 1, 2,4, 5
CO4	Describe the features of SAS for data management, including reading, manipulating, combining, sorting, merging, formatting, and conducting basic statistical analyses.	Understand	PSO 1, 2,4, 5

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

COURSE CONTENT

Module	Content	Hrs
I	**Advanced Excel**	20
	An Overview of basic Spread sheet Concepts, Various Selection Techniques, Shortcut Key; Mathematical Functions- Sum, Average, Max, Min, Count, Counta, SumIf, CountIf. Format - Currency, Number, Font, Alignment and Borders; Text Function- Upper, Lower, Proper, Left, Mid, Right, Trim, Len, Exact.	
II	**Tableau**	20

	Introduction to Tableau interface, connecting to data sources, Excel Files, Text Files, Data Labels, Create Folder, Sorting Data, Visualizations: charts and graphs		
III	**SPSS**		20
	Introduction, Import Data- Data View and Variable View, coding and Decoding of variable, Scaling of Variable, Visualisation of Data, Descriptive Statistics.		
IV	**Statistical Analysis System (SAS)**		15
	Introduction to SAS environment, Data step programming: reading, manipulating, and combining data, Data management techniques: sorting, merging, and formatting data, Basic statistical analysis: descriptive statistics		

REFERENCES

1. Brace, Nicola. (2006) SPSS for psychologists 5th ed. BF39.B73 2013.
2. Argyrous, D. G. (2011). Statistics for Research: With a Guide to SPSS. United Kingdom: SAGE Publications.
3. Remenyi, D., English, J., Onofrei, G. (2022). An Introduction to Statistics using Microsoft Excel. South Africa: University Press of University of Johannesburg.
4. Bennett, K., Heritage, B., Allen, P. (2022). SPSS Statistics: A Practical Guide 5e. Australia: Cengage Learning Australia.
5. Cody, R. (2021). A Gentle Introduction to Statistics Using SAS Studio in the Cloud. United States: SAS Institute.
6. https://www.ibm.com/docs/SSLVMB_29.0.0/pdf/IBM_SPSS_Statistics_Core_System_User_Guide.pdf
7. https://cedar.princeton.edu/sites/g/files/toruqf1076/files/media/introduction_to_tableau_training_0.pdf

Name of the Course: INTRODUCTION TO DATA ANALYSIS SOFTWARES
Credits: 3:0:1 (Lecture: Tutorial: Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO1	Explain Excel features and functions for data analysis and manipulation.	PSO 1, 2,4, 5 PO 1,4,7	R, U	F, C	L	
CO2	Describe effective visualizations using Tableau for presenting data insights and trends.	PSO 1, 2,4, 5 PO 1,4,7	R, U, C	P	L	
CO3	Explain the features in SPSS for importing, coding, decoding, scaling, and visualizing data, as well as performing descriptive statistics.	PSO 1, 2,4, 5 PO 1,4,7	R, U, Ap	C, P	L	

| CO4 | Describe the features of SAS for data management, including reading, manipulating, combining, sorting, merging, formatting, and conducting basic statistical analyses. | PSO 1, 2,4, 5 PO 1,4,7 | R, U, Ap | C, P | L | |

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO 1	3	2		2	1		3			1	-		3	
CO 2	3	2		2	1		3			1	-		3	
CO 3	3	2		2	1		3			1	-		3	
CO 4	3	2		2	1		3			1	-		3	

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High
3	Substantial / High

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Examination
- Practical Evaluation
- End Semester Examinations

Mapping of COs to Assessment Rubrics :

	Internal Exam	Quiz / Assignment/ Discussion / Seminar	Practical Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓	✓	✓
CO 5	✓	✓	✓	✓

University of Kerala

Discipline	STATISTICS (Specialization in Operations Research)				
Course Code	UK3DSESTA203				
Course Title	**INTRODUCTION TO OPERATIONAL RESEARCH AND LINEAR PROGRAMMING**				
Type of Course	**DSE**				
Semester	III				
Academic Level	200 – 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites					

COURSE OUTCOMES

	Up on completion of the course, students should be able to	Cognitive level	PSO Addressed
CO1	Explain the need of Operations Research in real life situations	Understand	PSO 1
CO2	Describe the different phases of Operations Research	Understand	POS 1
CO3	Demonstrate the mathematical formulation of LPP	Apply	PSO 2
CO4	Apply various methods for solving a LPP	Apply	PSO 3

COURSE CONTENT

Module	Content	Hrs
I	**Matrix Theory**	15
	Algebra of matrices, Types of matrices, Elementary row operations on a matrix, Echelon form of a matrix, Rank of a matrix, Inverse of a matrix, Solution of System of Homogeneous & Non-Homogeneous Equations, Vector Spaces, Sub-spaces, Linear Combinations, Linear Span, Basis & Dimension, Linear Transformation, Linear transformation on finite dimensional vector spaces, Characteristic Polynomial, EigenValues, Eigen Vectors.	
II	**Basics of Operational Research**	15
	Basics of Operational Research: Origin & Development of Operational Research, Definition and Meaning of Operational Research, Different Phases of an Operational Research Study, Scope and Limitations of Operational Research, Mathematical Modelling of Real-Life Problems.	

III	**Linear Programming Problem**	15
	Linear Programming Problem (LPP), Formulation of LPP, solving the LPP by graphical method, Concept of Basic solution, Basic Feasible solution, convex sets. Extreme points, Hyperplanes and Half spaces, convex cones, Polyhedral sets and cones.	
IV	**Solution of LPP**	15
	Fundamental properties of solutions, simplex method-various cases-unbounded solution, infeasible solution, alternative optimum, need for artificial variables, two phase simplex method, Big-M method, degenerate basic feasible solution, duality in LPP, formation of dual, fundamental theorem of duality, dual simplex method.	

REFERENCES

1. Kanti Swarup, Gupta, P. K and Manmohan. (1993). *Operations Research*. Sulthan Chand & Sons
2. Ravindran, A., Philips, D.T. and Solberg, J. (2007). Operations Research: Principles and Practice, John Wiley & Sons, New York.
3. Sharma, J.K. (2009). Operations Research Theory and Applications, Macmillan India Limited
4. Taha, H. A. (2010). Operations Research, Macmillan India Limited

Name of the Course: INTRODUCTION TO OPERATIONAL RESEARCH AND LINEAR PROGRAMMING
Credits: 4:0:0 (Lecture: Tutorial: Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	Explain the need of Operations Research in real life situations.	PO1,2 PSO1	Understand	F, C	L	
2	Describe the different phases of Operations Research	PO 1,2 PSO 1	Understand,	P	L	
3	Demonstrate the mathematical formulation of LPP	PO1,2 7 PSO 2	Apply	F, C	L	
4	Apply various methods for solving a LPP	PO 1,2,7 PSO 3	Apply	P, M	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	1						3	3					-	-

CO 2	1						3	3					-	-
CO 3		3					3	3					1	-
CO 4			2				3	3					1	-

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Examination
- Practical Evaluation
- End Semester Examinations

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Practical Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓

University of Kerala

Discipline	STATISTICS				
Course Code	UK3VACSTA201				
Course Title	DATA VISUALIZATION AND INTERPRETATION				
Type of Course	VAC				
Semester	III				
Academic Level	200 – 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	3	2hours	-	2hours	4
Pre-requisites					

COURSE OUTCOMES

	Up on Completion of the course, students should be able to:	Cognitive level	PSO addressed
CO1	Explain basic concepts data	Understand	PSO-1 PO 1
CO2	Present data using diagrams and graphs	Apply	PSO-1,2,4,5 PO 1, 4, 7
CO3	Calculate the measures of central tendency and dispersion of a given data	Apply	PSO-1,2,4,5 PO 1, 4, 7
CO4	Use Spread sheet applications for statistical data analysis.	Apply	PSO-1,2,4,5 PO 1, 4, 7

COURSE CONTENT

Module	Content	Hrs
I	**Data types and Scaling techniques**	**10**
	Concepts of population and sample, quantitative and qualitative data, cross-sectional and time-series data, discrete and continuous data. Different types of scales: Nominal, ordinal, interval and ratio.	
II	**Sample and census surveys**	**10**
	Sample and census surveys-meaning and comparison. Primary data. Secondary data – its major sources. Diagrammatic presentation- line diagram, bar diagrams and pie diagrams, pictograms, cartograms and box-plot. Frequency tables, frequency polygon, frequency curve, ogives and histogram	
III	**Descriptive measures**	**10**
	Descriptive measures (concept and application only): Central tendency- Mean, median and mode. Dispersion- standard deviation, mean deviation. Relative measure of dispersion- Coefficient of variation.	
IV	**Data analysis**	**30**

	Practical based on Module 2 and 3 using Spread sheet applications like Libre office calc. Data analysis: presentation of data –Charts and Diagrams, Frequency table, Histogram, calculation of descriptive statistics.	

PRACTICAL/LABWORK
List of Practical worksheet
1. Diagrams and Graphs
2. Frequency table and Histogram
3. Measures of Central Tendency
4. Measures of Dispersion
(Practical record not required)

REFERENCES

1. Gupta, S.C and Kapoor, V.K (2002). Fundamentals of Mathematical Statistics, Sultan Chands.
2. Kenny J. F (1947). *Mathematics of Statistics Part One*. 2nd Edition, D. Van Nostard Company, New Delhi-1.
3. Agarwal, B.L. (2006). *Basic Statistics*. 4th Edition, New Age international (P) Ltd., New Delhi.
4. Gupta S. P. (2004). *Statistical Methods.* Sultan Chand & Sons, New Delhi.
5. Dan Remenyi, George Onofrei, Joe English (2010). An Introduction to Statistics Using Microsoft Excel. Academic Publishing Ltd., UK
6. Neil J Salkind (2010). Excel Statistics, A Quick Guide. SAGE Publication Inc. New Delhi
7. Vijai Gupta (2002). Statistical Analysis with Excel. VJ Books Inc. Canada

Name of the Course: DATA VISUALIZATION AND INTERPRETATION
Credits: 2:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO1	Explain basic concepts data	PO-1 PSO-1	Understand	F,C	L	
CO2	Present data using diagrams and graphs	PO-1,4,7 PSO-1,2,4,5	Apply	C,P	L	
CO3	Calculate the measures of central tendency and dispersion of a given data	PO-1,4,7 PSO-1,2,4,5	Apply	C,P	L	
CO4	Use Spread sheet applications for	PSO-1,2,4,5 PO 1,	Apply	P,F		P

		statistical data analysis.	4,7				

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive
Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PS O6	PO1	PO2	PO3	PO4	PO5	PO 6	P07	PO 8
CO 1	3					-	3							-
CO 2	1	3		2	2	-	2			1	-		2-	-
CO 3	1	3		2	2	-	2			1	-		2-	-
CO 4	1	3		2	2	-	2			1	-		2-	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Examination
- Practical Evaluation
- End Semester Examinations

Mapping of COs to Assessment Rubrics :

	Internal Exam	Quiz / Assignment/ Discussion / Seminar	Practical Evaluation	End Semester Examinations
CO 1	✓	✓	✓	✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓	✓	✓
CO 4	✓	✓	✓	✓

University of Kerala

Discipline	STATISTICS				
Course Code	UK3VACSTA202				
Course Title	AN INTRODUCTION TO R				
Type of Course	VAC				
Semester	III				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	3	2hours	-	2hours	4
Pre-requisites					

COURSE OUTCOMES

	Up on Completion of the course, students should be able to:	Cognitive level	PSO addressed
CO1	Illustrate the operators and functions in R	Apply	PSO-1, 2,4,5 PO-1,4,7
CO2	Calculate various measures of central tendency and dispersion using R	Apply	PSO-1, 2,4,5 PO-1,4,7
CO3	Present data using the basic plotting tools in R	Apply	PSO-1, 2,4,5 PO-1,4,7

COURSE CONTENT

Module	Content	Hrs
I	**Introduction to R software**	20
	Introduction to R software. Source and installation. Importance of R. Basic object – vectors. Basic arithmetic and logical operations, extraction operator. Numeric and character vectors. Basic operations on vectors. c(), seq(), scan(), rep() functions and their uses. Matrices in R: matrix(), dim(), t(),Concept of data frames, its indexing, conditional selection, attach() and detach() functions.	
II	**Descriptive measures in R**	20
	Descriptive measures: sum(), sort(), min(), max(), length(), mean(), median(), mode (using sort and table), quantile(). Range, mean deviation, IQR(), quartile deviation, sd(), var(), coefficient of variation, quantile, summary().	
III	**Basic Plots in R**	20
	Basic Plots: Simple bar plot, multiple bar plot (side by side and subdivided), pie chart, histogram, scatter plot, plot function and lines function. Bivariate data analysis using cov(), Pearson's and Spearman's correlation coefficient using cor().	

PRACTICAL/LABWORK
List of Practical worksheet
1. Data types in R
2. Measures of Central tendency
3. Measures of dispersion
4. Graphical methods
5. Correlation

REFERENCES

1. Dalgaard, P.(2008). *Introductory Statistics with R*, Springer, New York.
2. Kerns, G J. (2010). *Introduction to Probability and Statistics using R.* ISBN-10 : 0557249791
3. Lander J. P. (2017). *R for everyone* 2/e. Addison-Wesley Professional, U. S.
4. Michael J. Crawley (2013*). The R Book*, 2/e, Wiley, New York.
5. Purohit, S. G., Deshmukh, S.R., & Gore, S. D. (2008). *Statistics using R*. Alpha Science International, United Kingdom.

Name of the Course: AN INTRODUCTION TO R
Credits: 2:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO1	Illustrate the operators and functions in R	PSO-1, 2,4,5 PO-1,4,7	Apply	F, C,P	L	P
CO2	Calculate various measures of central tendency and dispersion using R	PSO-1, 2,4,5 PO-1,4,7	Apply	F, C,P	L	P
CO3	Present data using the basic plotting tools in R	PSO-1, 2,4,5 PO-1,4,7	Apply	F, C,P	L	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive
Assessment: Assignments, Practical Examinations, End semester Examinations
Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PSO5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO 6	PO 7	PO 8
CO 1	1	2		3	2	-	1	-	-	2	-		3	
CO 2	1	2		3	2	-	1	-	-	2	-		3	

CO 3	1	2		3	2	-	1	-	-	2	-		3	

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Examination
- Practical Evaluation
- End Semester Examinations

Mapping of COs to Assessment Rubrics :

	Internal Exam	Quiz / Assignment/ Discussion / Seminar	Practical Evaluation	End Semester Examinations
CO 1	✓	✓	✓	✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓	✓	✓

-

University of Kerala

Discipline	STATISTICS				
Course Code	UK4DSCSTA201				
Course Title	PROBABILITY AND DISTRIBUTIONS - II				
Type of Course	**DSC**				
Semester	IV				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites					

COURSE OUTCOMES

	Up on Completion of the course, students should be able to:	Cognitive level	PSO addressed
CO1	Analyse real life situations with the help of univariate discrete distributions	Analyse	PSO 1,2,3,4,5
CO2	Analyse real life situations with the help of the univariate continuous distributions	Analyse	PSO 1,2,3,4,5
CO3	Illustrate the concepts and applications of Normal and standard normal distributions.	Analyse	PSO 1,2,3,4,5

COURSE CONTENT

Module	Content	Hrs
I	**Discrete probability distributions I**	13
	Discrete probability distributions I: Degenerate distribution-mean, variance and mgf; Uniform distribution on n points-mean, variance and mgf; Bernoulli distribution – mean, variance and mgf; Binomial distribution, Poisson distribution – Poisson distribution as limiting case of binomial distribution, first four raw moments and central moments, mgf and probability generating function, recurrence relations for the moments, mode, additive property, other simple distributional properties and fitting of both binomial and Poisson.	
II	**Discrete probability distributions II**	10
	Discrete probability distributions II: Negative binomial distribution – mean and variance, mgf, additive property, Geometric distribution – mean and variance, mgf and probability generating function, Lack of memory property; Hypergeometric distribution – mean and variance	
III	**Continuous probability distributions I**	10
	Continuous probability distributions I - Uniform distribution-mean, variance and mgf, Probability integral transformation; Triangular distribution-mean, variance	

		and mgf; Gamma distribution-mean and variance, mgf, additive property; Beta distribution-two types, means and variance of both types, Exponential distribution – mean, variance and mgf, Lack of memory property.	
IV		**Continuous probability distributions II**	12
		Continuous probability distributions II - Normal distribution – raw moments and central moments, mgf and characteristic function, mode and median, linear combination of independent normal variates, Standard normal distribution - properties and use of standard normal tables, fitting of normal distribution.	
V		**Practicum**	30
		Practical based on Modules I, II, III &IV. Practical is to be done using **R package**	

PRACTICAL/LABWORK
List of Practical worksheet

1. Fitting of Binomial distributions.
2. Fitting of Poisson distribution.
3. Computing probabilities of binomial and Poisson distribution.
4. Problems based on area property of normal distribution.

REFERENCES

1. Gupta, S. C.and Kapoor,V.K.(2020).Fundamentals of Mathematical Statistics, 11th Edition Sultan Chand and Sons, New Delhi.
2. Mukhopadhyay, P. (2012). An introduction to the theory of probability. World Scientific.
3. Rohatgi V. K. and Saleh, A.K. Md. E. (2009): An Introduction to Probability and Statistics. 2nd Edn. (Reprint) John Wiley and Sons.
4. Mood, A.M., Graybill, F.A. and Boes, D.C. (2007): Introduction to the Theory of Statistics, 3rd Edn. (Reprint).Tata McGraw-Hill Pub. Co. Ltd.
5. Purohit, S. G., Deshmukh, S.R., & Gore, S. D. (2008). Statistics using R. Alpha Science International, United Kingdom.

Name of the Course: PROBABILITY AND DISTRIBUTIONS - II
Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO 1	Analyse real life situations with the help of univariate discrete distributions	PSO 1,2,3,4,5 PO 1 2 3 4 6 7	Analyse	C, P	L	P

CO 2	Analyse real life situations with the help of the univariate continuous distributions	PSO 1,2,3,4,5 PO 1 2 3 4 6 7	Analyse	P,C	L	P
CO 3	Illustrate the concepts and applications of Normal and standard normal distributions.	PSO 1,2,3,4,5 PO 1 2 3 4 6 7	Analyse	C, P	L	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

	PS O1	PS O2	PS O3	PS O4	PS O5	PS O6	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO 1	2	3	1	3	-	-	2	3	3	1	-	2	3	
CO 2	2	3	2	3	1	-	1	3	1	1	-	3	3	
CO 4	3	2	3	3	2		2	3	2	1	-	3	3	

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Practical Evaluation
- Final Exam

Mapping of COs to Assessment Rubrics:

	Internal Exam	Quiz / Assignment Discussion / Seminar	practical	End Semester Examinations
CO 1	✓	✓	✓	✓
CO 2	✓	√	√	✓
CO 3	✓	√	√	✓

University of Kerala

Discipline	STATISTICS				
Course Code	UK4DSCSTA202				
Course Title	LIMIT THEOREMS AND SAMPLING DISTRIBUTIONS				
Type of Course	**DSC**				
Semester	IV				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites					

COURSE OUTCOMES

	Up on Completion of the course, students should be able to:	Cognitive level	PSO addressed
CO1	Explain the convergence of a sequence of events.	Understand	PSO-1
CO2	Explain the Laws of convergence, their inter relations and applications, WLLN, Central Limit Theorem and its applications.	Understand	PSO-1
CO3	Explain the concept of sampling distributions	Understand	PSO-1
CO4	Apply sampling distributions in analysing real life data	Apply	PSO-1,2,3

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

COURSE CONTENT

Module	Content	Hrs
I	**Probability measure**	13
	Sequence of real numbers, limit of sequence, bounded sequence (Definition and Concepts only). Introduction to probability measure: Sequence of events, limit of events – limit supremum, limit infimum, monotone and continuity property of probability measure, independence of finite number and sequence of events.	
II	**Limit Theorems**	12
	Chebyshev's inequality, convergence in probability, convergence in law, Bernoulli Law of large numbers, Chebyshev's weak law of large numbers, concept of central limit theorem, Lindberg-Levy Central Limit theorem, application of central limit theorem	

III	Sampling distributions I	10
	Sampling distributions: Concept of random sample and statistic, definition of sampling distribution, standard error; sampling distribution of the mean and variance of a sample arising from a normal distribution; Chi square distribution- mean and variance, mgf, additive property and use of χ^2 tables. Non-central Chi square statistic (definition only).	
IV	Sampling distributions II	10
	Student's t distribution- mean and variance; use of t tables; F-distribution – mean and variance, use of F tables, definition of F distribution; inter-relationships between the standard normal, χ^2, t and F distributions. Non– central t and non-central F statistics(definition only).	
V	Practicum	30
	Practical based on Modules II to IV. Practical is to be done using R package	

PRACTICAL/LABWORK
List of Practical worksheet

　　1. Plot normal distribution in R
　　2. Simulate random samples from normal distributions and compute sampling distributions of the mean and variance in R
　　3. Utilize R to compute and visualize Student's t distribution and F-distribution with different degrees of freedom.
　　4. Computing quantile values of normal, chi-square, t and F distribution using R

REFERENCES

1. Bhat, B.R.(2007).Modern Probability Theory-An Introductory Text Book, New Age International Publishers, New Delhi.
2. Bartle, R.G and Sherbert D. R. (2020): Introduction to Real Analysis, Fourth Edition, John Wiley & Sons, Limited
3. Gupta, S C and Kapoor V K (2002).Fundamentals of Mathematical Statistics, 11th Edition Sultan Chand and Sons, New Delhi.
4. Rohatgi V. K. and Saleh, A.K. Md. E. (2009): An Introduction to Probability and Statistics. 2nd Edn. (Reprint) John Wiley and Sons.
5. Dalgaard, P.(2008). Introductory Statistics with R, Springer, New York
6. Purohit, S. G., Deshmukh, S.R., & Gore, S. D. (2008). Statistics using R. Alpha Science International, United Kingdom.

Name of the Course: Limit Theorems and Sampling Distributions
Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)	Practical (P)
CO1	Explain the convergence of a sequence of events.	PSO-1 PO 1	Understand	F, C	L	
CO2	Explain the Laws of convergence, their inter relations and	PSO-1 PO-1	Understand	P,C	L	

	applications, WLLN, Central Limit Theorem and its applications.				
CO3	Explain the concept of sampling distributions	PSO-1 PO-1	Understand	P,C	L
CO4	Apply sampling distributions in analysing real life data	PSO-1,2,3 PO 1 2 4 7	Apply	C,P	L	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3			-	-	-	1	-		-	-		-	-
CO2	2			-	-	-	2							-
CO3	2					-	2						-	-
CO4	2	2	3			-	2	1		1	-		3	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Exam
- Practical Evaluation
- Final Exam

Mapping of COs to Assessment Rubrics:

	Internal Exam	Quiz / Assignment/ Discussion / Seminar	Practical Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓	✓	✓

University of Kerala

Discipline	STATISTICS				
Course Code	UK4DSESTA201				
Course Title	OFFICIAL STATISTICS				
Type of Course	**DSE**				
Semester	III				
Academic Level	200 – 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites					

COURSE OUTCOMES

	Upon Completion of the course, students should be able to:	Cognitive level	PSO addressed
CO1	Describe various measures of Vital statistics	Understand	PSO-1,5
CO2	Explain the present official statistical system in India.	Understand	PSO-1,5
CO3	Explain national income statistics.	Understand	PSO-1,5

R-Remember, U-Understand , Ap-Apply, An-Analyse, E-Evaluate , C-Create
COURSE CONTENT

Module	Content	Hrs
I	**Demography**	15
	Demography, sources of collecting data on vital statistics-census, registration, adhoc surveys, measurement of mortality, crude death rate, age specific death rate, infant mortality rate, standardized death rate, life table and its main features.	
II	**Measurement of fertility**	15
	Measurement of fertility :- crude birth rate, general fertility rate, age specific birth rate, total fertility rate, gross reproduction rate and net reproduction rate.	
III	**Income Statistics**	15
	Population census- De Facto and De Jure method-economic census- agricultural statistics-world agricultural census-live stock and poultry statistics, forest statistics, fisheries statistics, mining and quarrying statistics, labour statistics, national income statistics, methods of national income estimation, financial statistics.	
IV	**National official statistical system**	15
	National official statistical system- Role of Ministry of Statistics and Programme Implementation (MoSPI), Central Statistical Organization (CSO), National	

| | | Sample Survey Organization (NSSO)-roles and responsibilities, Important activities, Publications etc. National Statistical Commission: Need, Constitution, its role, functions etc. | |

REFERENCES

1. Mukhopadyay. P (2005). Applied Statistics. Arunabha Sen Books and Allied Ltd. Kolkata.
2. Gupta, S. C., & Kapoor, V. K. (2007). Fundamentals of applied statistics. Sultan Chand & Sons.
3. Saluja, M.R (1972): Indian official statistical systems: Statistical publishing society, Calcutta and The Indian Econometric Society, Hyderabad.
4. Central Statistical Organisation (1995), Statistical System in India, Ministry of Statistics and Programme Implementation, India.
5. Central Statistical Organisation (1999), Guide to Official Statistics, Ministry of Statistics and Programme Implementation, India.
6. https://mospi.gov.in/

Name of the Course: Official Statistics
Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO1	Describe various measures of Vital statistics	PSO-1,5 PO 1, 4	Understand	F	L	
CO2	Explain the present official statistical system in India.	PSO-1,5 PO 1,4	Understand	F	L	
CO3	Explain national income statistics.	PSO-1,5 PO-1,4	Understand	F	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PS O1	PS O2	PS O3	PS O4	PS O5	PS O6	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO 1	3	-	--	-	1		2	-	-	1	-	-	-	

CO 2	3	-	--	-	1		2	-	-	1	-	-	-	
CO 3	3	-	--	-	1		2	-	-	1	-	-	-	
CO 4	3	-	--	-	1		2	-	-	1	-	-	-	

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High
3	Substantial / High

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Examination
- Practical Evaluation
- End Semester Examinations

Mapping of COs to Assessment Rubrics :

	Internal Exam	Quiz / Assignment/ Discussion / Seminar	Practical Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

University of Kerala

Discipline	STATISTICS				
Course Code	UK4DSESTA202				
Course Title	ACTUARIAL SCIENCE				
Type of Course	**DSE**				
Semester	IV				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites					

COURSE OUTCOMES

Up on Completion of the course, students should be able to:		Cognitive level	PSO addressed
CO1	Discuss about application of Actuarial Science and Agricultural Insurance in India.	Understand	PSO-1
CO2	Explain various Financial Risk and Management	Understand	PSO-1
CO3	Explain basic statistical tools for analysing insurance data	Understand	PSO-1
CO4	Explain the modelling in actuarial science	Understand	PSO-1

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

COURSE CONTENT

Module	Content	Hrs
I	**Introduction to Actuarial Science and Insurance**	15
	Actuarial Science-Introduction and its application, Concept of insurance, and its classification, Role of Actuaries in Insurance and other sectors; Agricultural Insurance in India-Types of Agricultural Insurance schemes available.	
II	**Risk Theory**	15
	Risk Concept, Classification, Costs, Risk Management-Scope and Objectives, Definition, basic components- Important measures of Risk Management and Decision Making.	
III	**Variables and Probability**	15
	Types of Variables, frequency distribution, Measure of Central tendency and Dispersion; Probability- Meaning basic Concept, a prior probability- Addition and Multiplicative Theorems, Conditional Probability. (Definitions only)	

IV	Modelling in Actuarial Science	15
	Time Value of Money: Interest Rates, Present Value, Future Value, Loans, Bonds, Cash Flows, Annuities and Pension Plans: Accumulation, Valuation, and Funding	

REFERENCES:

1. S. David Promislow (2015): Fundamentals of Actuarial Mathematics, Third Edition, Willey
2. Rao.K.N(2010),'Agricultural Insurance' Insurance Institute of India, Mumbai.
3. Trieschmann, J. S., Gustavson, S. G., Hoyt, R. E. (2001). Risk Management and Insurance. United States: South-Western College Pub.
4. Dorfman, M. S. (2002). Introduction to Risk Management and Insurance. United Kingdom: Prentice Hall..
5. Dekking, F.M., Kraaikamp, C., Lopuhaa, H.P., Meester, L.E., (2005)A Modern Introduction to Probability and Statistics, Springer Text Series, 2nd Edition.
6. S.C Gupta, V.K Kapoor,(2020) "Fundamentals of Mathematical Statistics", Sultan Chand and Sons, New Delhi.

Name of the Course: Actuarial Science
Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO1	Discuss about application of Actuarial Science and Agricultural Insurance in India.	PSO-1 PO-1	Understand	F	L	
CO2	Explain various Financial Risk and Management	PSO-1 PO-1	Understand	C	L	
CO3	Explain basic statistical tools for analysing insurance data	PSO-1 PO-1	Understand	C	L	
CO4	Explain the modelling in actuarial science	PSO-1 PO-1	Understand	C, P	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitiv

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8

CO 1	2						2								
CO 2	2						2								
CO 3	2						2								
CO 4	2						2								

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High
3	Substantial / High

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Examination
- Practical Evaluation
- End Semester Examinations

Mapping of COs to Assessment Rubrics :

	Internal Exam	Quiz / Assignment/ Discussion / Seminar	Practical Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

University of Kerala

Discipline	STATISTICS				
Course Code	UK4DSESTA203				
Course Title	**ADVANCED LINEAR PROGRAMMING**				
Type of Course	**DSE**				
Semester	IV				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites					

COURSE OUTCOMES

Up on completion of the course, students should be able to		Cognitive level	PSO Addressed
CO1	Apply the advanced techniques for solving an LPP	Apply	PSO 3,4
CO2	Describe the different methods for solving TP and Assignment problems	Apply	PSO 3,4
CO3	Understand the mathematical formulation of integer programming problem	Understand	PSO 1
CO4	Apply various methods for solving a LGPP	Apply	PSO 3,4

COURSE CONTENT

Module	Content	Hrs
I	**Types of LPP**	15
	Revised Simplex Method, Bounded Variable linear programming problem, Interior point algorithm for linear programming problem. Parametric linear programming problem.	
II	**Transportation and Assignment problems**	15
	Transportation problem (TP), formulation of TP. Basic feasible solution of TP, north- west corner method, least-cost method, Vogal's approximation method, test for optimality. Degenerate solutions, formulation of Assignment problems, Hungarian method of assignment problem, travelling salesman problem.	
III	**Linear integer programming problem**	15
	Introduction to linear integer programming problem, Branch and Bound Technique, Gomory's CuttingPlane Algorithm for pure and mixed linear integer programming problem, Algorithm for 0-1 programming problem, Real life applications of linear Integer Programming Problem	

IV	Linear Goal Programming Problem	15
	Linear Goal Programming Problem (LGPP): formulation of LGPP, solution of LGPP by graphical goal attainment method, simplex method.	

REFERENCES

1. Kanti Swarup, Gupta, P. K and Manmohan. (1993). *Operations Research*. Sulthan Chand & Sons
2. Ravindran, A., Philips, D.T. and Solberg, J. (2007). Operations Research: Principles and Practice, John Wiley & Sons, New York.
3. Sharma, J.K. (2009). Operations Research Theory and Applications, Macmillan India Limited
4. Taha, H. A. (2010). Operations Research, Macmillan India Limited

Name of the Course: ADVANCED LINEAR PROGRAMMING
 Credits: 4:0:0 (Lecture: Tutorial: Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	Apply the advanced techniques for solving an LPP	PO 2,3,6,7 PSO 3,4.	Apply		L	
2	Describe the different methods for solving TP and Assignment problems	PO 2,3,6,7 PSO 3,4.	Apply		L	
3	Understand the mathematical formulation of integer programming problem	PO1,2, 7 PSO 1	Apply		L	
4	Apply various methods for solving a LGPP	PO 2,3,6,7 PSO 3,4.	Apply		L	

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO 1			2	2				1	1			1	1	
CO 2			2	2				1	1			1	1	-
CO 3	3						1	1					1	-
CO 4			2	2				1	1			1	1	-

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar

- Internal Examination
- Practical Evaluation
- End Semester Examinations

	Internal Exam	Assignment	Practical Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓

University of Kerala

Discipline	STATISTICS				
Course Code	UK4SECSTA201				
Course Title	STATISTICAL ANALYSIS USING PYTHON				
Type of Course	SEC				
Semester	IV				
Academic Level	200 – 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	3	2 hours	-	2 hours	4
Pre-requisites					

COURSE OUTCOMES

	Up on Completion of the course, students should be able to:	Cognitive level	PSO addressed
CO1	Describe basic concepts of python.	Understand	**PSO 2,4**
CO2	Describe basic Operations with python objects	Apply	**PSO1, 2, 4**
CO3	Demonstrate Data Analysis using Pandas	Apply	**PSO1 ,2, 3, 4**
CO4	Illustrate data Visualization using Matplotlib and Seaborn libraries	Apply	**PSO1, 2, 3, 4,5**

R-Remember, U-Understand, Ap -Apply, An-Analyse, E-Evaluate, C-Create

COURSE CONTENT

Module	Content	Hrs
I	**Introduction to Python**	**20**
	Source and installation. History of python. Importance of Python in data analysis. Python editors, identifiers, lines and indentation, declaring variables, assigning values, data types numbers and strings (definition, meaning, syntax and uses only)	
II	**Basic Tools in Python**	**20**
	Variable names, keywords, basic operations: arithmetic, relational, assignment, logical. Data structures: Lists, tuples, sets, dictionaries (only fundamental concepts), Pandas library: creation and uses of series, data frames	
III	**Data Analysis with data frame object**	**20**
	Data Analysis with data frame object: (syntax, example and usage only) df.describe(), df.mean(), df.corr(), df.count(), df.min(), df.max(), df.median(), df.std(), data grouping, aggregation transformation, filtration, Direct plotting methods using Pandas series. Data visualization libraries – matplotlib and	

seaborn; Basic syntax and usages of scatter plot, barplot, pieplot, histogram and boxplot.	

REFERENCES

1. Embarak, O. Data Analysis and Visualization Using Python, 2018 Apress.

2. Henley, A. J. and Wolf, D. 2018 Learn Data Analysis with Python Apress

3. Hunt, J. A Beginners Guide to Python 3 Programming, Springer.

Name of the Course: STATISTICAL ANALYSIS USING PYTHON
 Credits: 2:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO1	Describe basic concepts of python.	**PSO 2,4 PO 7**	Understand	C	L	
CO2	Describe basic Operations with python objects	**PSO1, 2, 4 PO1,7**	Apply	C, P	L	
CO3	Demonstrate Data Analysis using Pandas	**PSO1 ,2, 3, 4 PO1,3,4, 7**	Apply	P, C	L	P
CO4	Illustrate data Visualization using Matplotlib and Seaborn libraries	**PSO1, 2, 3, 4,5 PO 1,3,4,7**	Apply	P, C	L	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO 1		2		3									2	

CO 2	2	3		3			2						3	
CO 3	2	2	2	2	2		3		2	1			3	
CO 4	2	3	2	3	2		2		2	2			3	

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Examination
- Practical Evaluation
- End Semester Examinations

Mapping of COs to Assessment Rubrics :

	Internal Exam	Quiz / Assignment/ Discussion / Seminar	Practical Evaluation	End Semester Examinations
CO 1	✓	✓	✓	✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓	✓	✓
CO 4	✓	✓	✓	✓

University of Kerala

Discipline	STATISTICS				
Course Code	UK4SECSTA202				
Course Title	STATISTICAL ANALYSIS USING R				
Type of Course	SEC				
Semester	IV				
Academic Level	200 – 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	3	2 hours	-	2 hours	4
Pre-requisites					

COURSE OUTCOMES

	Up on Completion of the course, students should be able to:	Cognitive level	PSO addressed
CO1	Explain the basic concepts of R software	Understand	**PSO2**
CO2	Use R tools for descriptive statistical analysis	Apply	**PSO1**
CO3	Illustrate data Visualization using R	Analyse	**PSO5**
CO4	Evaluation of statistical relationships using R tools	Evaluate	**PSO2, PSO4**

R-Remember, U-Understand, Ap -Apply, An-Analyse, E-Evaluate, C-Create

COURSE CONTENT

Module	Content	Hrs
I	**Introduction to R software**	20
	Source and installation. Importance of R. Basic object – vectors. Basic arithmetic and logical operations, extraction operator. Numeric and character vectors. Basic operations on vectors. c(), seq(), scan(), rep(), cat(), cut(), factor(), table() functions and their uses. Matrices in R: matrix(), dim(), t(), Arrays, lists in R, Concept of data frames, its indexing, conditional selection, attach() and detach() functions.	
II	**Sampling and Descriptive measures**	20
	Forming ungrouped and grouped frequency tables with raw data using table and cut functions. SRSWR and SRSWOR with sample( ) Descriptive measures: sum(), sort(), min(), max(), length(), mean(), median(), mode (using sort and table), quantile(). Range, mean deviation, IQR(), quartile deviation, sd(), var(), coefficient of variation, quantile, summary().	

III	Basic Plots	20
	Simple bar plot, multiple bar plot (side by side and subdivided), pie chart, histogram, scatter plot, plot function and lines function. Basic Distributions: Binomial, Poisson, normal, chi-square, t and F distributions – The **d**, **p, q** and **r** functions, the scale function, evaluation of probabilities using these functions. Bivariate data analysis using cov(), Pearson's and Spearman's correlation coefficient using cor(). Linear regression models: fitting using lm(), prediction from fitted model	

REFERENCES

1. Dalgaard, P.(2008). *Introductory Statistics with R*, Springer, New York.
2. Kerns, G J. (2010). *Introduction to Probability and Statistics using R.* ISBN-10 : 0557249791
3. Lander J. P. (2017). *R for everyone* 2/e. Addison-Wesley Professional, U. S.
4. Michael J. Crawley (2013*). The R Book*, 2/e, Wiley, New York.
5. Purohit, S. G., Deshmukh, S.R., & Gore, S. D. (2008). *Statistics using R*. Alpha Science International, United Kingdom.

Web Resources:

1. https://cran.r-project.org
2. https://cran.r-project.org/manuals.html
3. https://www.r-project.org/other-docs.html
4. https://journal.r-project.org/
5. https://www.r-bloggers.com

Name of the Course: STATISTICAL ANALYSIS USING R
Credits: 2:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO1	Explain the basic concepts of R software	**PSO 2, 5 PO 7**	U, Ap	P	L	
CO2	Use R tools for descriptive statistical analysis	**PSO 2,3 4,5 PO 1,2,4,7**	Ap, An	P	L	
CO3	Illustrate data Visualization using R	**PSO 2 PO 4**	Ap, U	P, C	L	P
CO4	Evaluation of statistical relationships using R tools	**PSO2, PSO4, PO2, PO7**	Ap, E	C		P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	3	2	2	1	1	2	2	2	1	1	2	3	1
CO2	3	2	2	2	2	1	3	2	2	2	1	2	2	1
CO3	2	2	2	2	3	2	2	2	2	3	2	2	2	1
CO4	2	3	2	3	2	2	2	3	2	2	2	2	3	1

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Examination
- Practical Evaluation
- End Semester Examinations

Mapping of COs to Assessment Rubrics :

	Internal Exam	Quiz / Assignment/ Discussion / Seminar	Practical Evaluation	End Semester Examinations
CO1	✓	✓	✓	✓
CO2	✓	✓	✓	✓
CO3	✓	✓	✓	✓
CO4	✓	✓	✓	✓

University of Kerala

Discipline	STATISTICS				
Course Code	UK4VACSTA201				
Course Title	BIG DATA ANALYSIS				
Type of Course	VAC				
Semester	IV				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	3	3 hours	-		3
Pre-requisites					

COURSE OUTCOMES

	Up on Completion of the course, students should be able to:	Cognitive level	PSO addressed
CO1	Describe the Big Data Platform	Understand	PSO-1, 4 PO 1,6,7
CO2	Describe the big data concepts through practical implications	Understand	PSO-1,4
CO3	Summarise the important software tools for big data analysis	Understand	PSO-1,4
CO4	Discuss the basics of artificial intelligence	Understand	PSO- 1 4

COURSE CONTENT

Module	Content	Hrs
I	**Introduction to Big data**	**10**
	Introduction to Big data. Meaning of big data, its sources. Historical development of big data. Structured and unstructured data, semi structured data. Elements of Big data- Volume, Velocity, Variety, Veracity and Value	
II	**Basic concepts of Big data analytics**	**15**
	Basic concepts of Big data analytics: Main types of Business analytics: Descriptive, diagnostic, predictive and prescriptive, machine learning, natural language processing, graph analytics, distributed computing, data mining. advantage of big data analytics, fields of application of big data analytics and their uses.	
III	**Important software tools for big data analysis**	**15**
	Important software tools for big data analysis: Apache Hadoop, Apache Spark, Hortonworks Data Platform (HDP) / Cloudera Data Platform (CDP), AWS EMR, Google cloud Dataproc, Microsoft Azure HDInsight, Databricks, Tableau	

		(an overview only for all these tools, without any technical details). Uses of big data analysis in industry	
IV		**Artificial intelligence**	**5**
		Artificial intelligence – meaning and scope. Importance of AI in modern world. History of artificial intelligence. Areas of application in real life	

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1. Berson, Alex, and Stephen J. Smith. Data warehousing, data mining, and OLAP. McGraw-Hill, Inc., 1997.
2. Leo Breiman, Jerome H. Friedman, Richard A. Olshen, and Charles J. Stone. "Classification and regression trees". Brooks. 1984.
3. Jiawei, Han, and Kamber Micheline. Data mining: concepts and techniques. Morgan kaufmann, 2006.
4. Acharjya, D. P. , Sachidananda, D. , Sugata, S. Computational intelligence for big data analysis: Frontier Advances and Applications. Springer.
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6. Flach, Peter. Machine learning: the art and science of algorithms that make sense of data. Cambridge university press, 2012.
7. Kaur, J., & Gill, N. S. . Artificial Intelligence and deep learning for decision makers: a growth hacker's guide to cutting edge technologies. BPB Publications. 2019.
8. Seema Acharya, Subhasini Chellappan, "Big Data Analytics" Wiley 2015.
9. Michael Berthold, David J. Hand, "Intelligent Data Analysis", Springer, 2007.
10. Jay Liebowitz, "Big Data and Business Analytics" Auerbach Publications, CRC press (2013)
11. Anand Rajaraman and Jef rey David Ulman, "Mining of Massive Datasets", Cambridge University Press, 2012.
12. Michael Mineli, Michele Chambers, Ambiga Dhiraj, "Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses", Wiley Publications, 2013.

Name of the Course: BIG DATA ANALYSIS
Credits: 3:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO1	Describe the Big Data Platform	PSO-1, 4 PO 1,6,7	Understand	F, C	L	
CO2	Describe the big data concepts through practical implications	PSO-1,4	Understand	C,P	L	
CO3	Summarise the important	PSO-1,4	Understand	C,P	L	

	software tools for big data analysis					
CO4	Discuss the basics of artificial intelligence	PSO- 1 4	Understand	F,C,P	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive
Assessment: Assignments, Practical Examinations, End semester Examinations
Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO 5	PO6	PO 7	PO 8
CO 1	2		-	2			2	1		-	-	2	3	-
CO 2	2		-	2			2	1		-	-	2	3	
CO 3	2		-	2			2	1		-	-	2	3	
CO 4	2		-	2			2	1		-	-	2	3	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Examination
- Practical Evaluation
- End Semester Examinations

Mapping of COs to Assessment Rubrics :

	Internal Exam	Quiz / Assignment/ Discussion / Seminar	Practical Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓

University of Kerala

Discipline	STATISTICS				
Course Code	UK4VACSTA202				
Course Title	STUDY DESIGN IN RESEARCH				
Type of Course	VAC				
Semester	IV				
Academic Level	200 – 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	3	3 hours	-		3
Pre-requisites					

COURSE OUTCOMES

	Up on Completion of the course, students should be able to:	Cognitive level	PSO addressed
CO1	Understand the fundamentals of study design	Understand	PSO-1, 2,4,6 PO 1, 4
CO2	Describe basic inferential techniques	Apply	PSO-1,2,4,5,6 PO 1, 4,7
CO3	Describe inferential techniques of parametric and non-parametric data	Apply	PSO-1, 2,4,5,6 PO 1, 4,7

COURSE CONTENT

Module	Content	Hrs
I	**Fundamentals of study design**	15
	Introduction to study design, main classes: observational studies and intervention studies. Cohort studies, cross-sectional studies and case control studies. Types of variables (Qualitative, Quantitative and hierarchy type), Tables and charts (Tables in charts, Diagrams in reports). Data Analysis (includes basic problems on identification of study type and conclusion), develop situations where each case study arises.	
II	**Basic Inferential Techniques**	15
	Descriptive techniques for quantitative variables (The five number summary, Quantiles, The two number summary, summary statistics of spread, assessing symmetry, investigating shape).Inferential technique for categorical variables (contingency tables, binary variables: proportion and percentages, comparing two proportions or percentages).	
III	**Inferential techniques of parametric and non- parametric data**	15

	Inference about mean (checking normality, inference for a single mean, comparing two means, paired data), Basic Inferential techniques for non-normal data(Transformations, nonparametric tests, confidence interval for medians).				

REFERENCES

1. Aggarwal N(2010),   Essentials of Bio Statistics, Peepee publishers and distributors(P) Ltd, Delhi, 1st edition .
2. Kothari C R(2004),   Research Methodology: Methods and Techniques, New Age International Publishers, 2nd edition.
3. Mahajan B K , Methods in Bio Statistics, Jaypee Brothers Medical Publishers (P) Ltd, sixth edition, 1997.
4. Woodward, M (2000), Epidemiology: Study design and data analysis, Chapman & Hall , second edition.

Name of the Course: STUDY DESIGN IN RESEARCH
Credits: 3:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO1	Understand the fundamentals of study design	PSO-1, 2,4,6 PO 1, 4	Understand	F, C, P	L	
CO2	Describe basic inferential techniques	PSO-1,2,4,5,6 PO 1, 4,7	Apply	C, P	L	
CO3	Describe inferential techniques of parametric and non-parametric data	PSO-1, 2,4,5,6 PO 1, 4,7	Apply	C, P	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PS O1	PS O2	PS O3	PS O4	PS O5	PS O6	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO 1	2	3		1	1	2	2	-		1	-		3	
CO 2	2	3		1	1	2	2	-		1	-		3	
CO 3	2	3		1	1	2	2	-		1	-		3	

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Examination
- Practical Evaluation
- End Semester Examinations

Mapping of COs to Assessment Rubrics :

	Internal Exam	Quiz / Assignment/ Discussion / Seminar	Practical Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓

University of Kerala

Discipline	STATISTICS				
Course Code	UK4VACSTA203				
Course Title	DATA ANALYSIS USING SPREADSHEETS				
Type of Course	VAC				
Semester	IV				
Academic Level	200 – 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	3	2hours	-	2hours	4
Pre-requisites					

COURSE OUTCOMES

	Upon completion of the course, students should be able to:	Cognitive level	PSO addressed
CO1	Explain the significance of spreadsheet applications	Understand	PSO-2,4,5 PO -1,3 4 7
CO2	Demonstrate the predefined and conditional functions in spreadsheets.	Apply	PSO-2,3,4,5 PO -1,3 4 7
CO3	Illustrate the basic plotting tools in spreadsheets.	Apply	PSO-2,3,4,5,6 PO -1,3 4 7

COURSE CONTENT

Module	Content	Hrs
I	**Introduction to Spreadsheets**	**20**
	Overview and significance of Spreadsheet Applications like LibreOffice Calc; Key components of a spreadsheet interface such as cells, rows, columns, and sheets; Ribbon toolbar/menu options for accessing different functionalities.	
II	**Pre-defined and Conditional functions in spreadsheets**	**20**
	Pre-defined functions -Uses of Mathematical functions to calculate sum, minimum, maximum, square root logarithmic and trigonometric functions; Statistical functions for univariate and bivariate analysis; Conditional functions	
III	**Data Visualization and interpretation**	**20**
	Importance of Data Visualization in data analysis, creating different types of charts and graphs such as bar charts, line graphs, pie charts, histograms and scatter plots, Adding labels, titles and legends. Interpretation of charts and Graphs	

PRACTICAL/LABWORK
List of Practical Worksheets
1. Problems using mathematical functions
2. Problems using statistical functions

3. Graphical Methods

REFERENCES

1. Manohar, H.L. (2017). *Data Analysis and Business Modelling Using Microsoft Excel.* Prentice Hall of India, New Delhi.
2. Dan Remenyi, George Onofrei, Joe English (2010). An Introduction to Statistics Using Microsoft Excel. Academic Publishing Ltd., UK
3. Neil J Salkind (2010). Excel Statistics, A Quick Guide. SAGE Publication Inc. New Delhi
4. Vijai Gupta (2002). Statistical Analysis with Excel. VJ Books Inc. Canada

Name of the Course: DATA ANALYSIS USING SPREADSHEETS
Credits: 2:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO1	Explain the significance of spreadsheet applications	PSO-2,4,5 PO -1,3 4 7	Understand	F, C, P	L	P
CO2	Demonstrate the predefined and conditional functions in spreadsheets.	PSO-2,3,4,5 PO -1,3 4 7	Apply	F, C, P	L	P
CO3	Illustrate the basic plotting tools in spreadsheets.	PSO-2,3,4,5,6 PO -1,3 4 7	Apply	C, P	L	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive
Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PSO5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1		3	-	2	2	-	2		1	1	-	-	3	-
CO2	-	2	2	3	2	-	2		1	1	-	-	3	
CO3	-	2	3	3	3	1	2		1	1	-	-	3	

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Examination
- Practical Evaluation
- End Semester Examinations

Mapping of COs to Assessment Rubrics :

	Internal Exam	Quiz / Assignment/ Discussion / Seminar	Practical Evaluation	End Semester Examinations
CO 1	✓	✓	✓	✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓	✓	✓

University of Kerala

Discipline	STATISTICS				
Course Code	UK5DSCSTA301				
Course Title	THEORY OF ESTIMATION				
Type of Course	**DSC**				
Semester	V				
Academic Level	300 – 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	2 hours	-	4 hours	6
Pre-requisites					

COURSE OUTCOMES

	Up on Completion of the course, students should be able to:	Cognitive level	PSO addressed
CO1	Define the desirable properties of a good estimator.	Understand	**PSO1**
CO2	Illustrate whether an estimator satisfy any of the desirable properties or not.	Apply	**PSO 1,2,3**
CO3	Calculate confidence intervals for mean, variance, proportion in a population and difference between means and difference between proportions	Apply	**PSO1,2,3,4,5**
CO4	Determine estimate for parameters using estimation techniques	Apply	**PSO 1,2,3,4,5**

R-Remember, U-Understand, Ap -Apply, An-Analyse, E-Evaluate, C-Create

COURSE CONTENT

Module	Content	Hrs
I	**Point estimation I**	15
	Point estimation: estimator and estimate; Unbiasedness, Consistency, sufficient condition for consistency and its use.	
II	**Point estimation II**	15
	Sufficiency Factorization theorem (statement only) and its application; Efficiency; Minimum variance unbiased estimator, Cramer –Rao inequality (statement only) and its application; Minimum variance bound estimator.	
III	**Methods of estimation**	30

	Methods of estimation: Method of moments, Properties of moment estimator (without proof); Method of maximum likelihood, properties of maximum likelihood estimator (without proof), Method of least squares.	
IV	**Interval Estimation**	**30**
	Interval Estimation: Problem of Interval estimation; Concepts of confidence interval and confidence coefficient; Constructing confidence intervals for each of the mean, variance and proportion of a population and for each of the difference of means and the difference of proportions of two populations. Practical of these module in R	

PRACTICAL/LABWORK
List of Practical worksheet
1. Construct confidence intervals for the mean, proportion and variance.
2. Confidence intervals for the difference of means between two populations.
3. Confidence intervals for the difference of proportions between two populations.

REFERENCES

1. Gupta, S.C. and Kapoor, V.K. (2002). Fundamentals of Mathematical Statistics, Sultan Chand & Sons, New Delhi
2. Hogg, R.V. and Craig, A.T. (1970). Introduction to Mathematical Statistics, Amerind Publishing Co. Pvt. Ltd.
3. Mukhopadhaya P. (1996). Mathematical Statistics, New Central Book Agency(P) Ltd., Calcutta.
4. Rohatgi, V. K. (2013). Statistical inference. Courier Corporation.
5. Rohatgi, V. K., & Saleh, A. M. E. (2015). An introduction to probability and statistics. John Wiley & Sons.
6. Casella, G., & Berger, R. L. (2002). Statistical lnference. Duxbury press.
7. Kale, B. K. (2005). A first course on parametric inference. Alpha Science Int'l Ltd..
8. Dalgaard, P.(2008). Introductory Statistics with R, Springer, New York
9. Purohit, S. G., Deshmukh, S.R., & Gore, S. D. (2008). Statistics using R. Alpha Science International, United Kingdom.

Name of the Course: THEORY OF ESTIMATION
Credits: 2:0:2 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO1	Define the desirable properties of a good estimator.	PSO1 PO 1	Understand	C	L	
CO2	Illustrate whether an estimator satisfy any of the desirable	PSO 1,2,3 PO 1,2,3,6	Apply	C,P	L	P

	properties or not.					
CO3	Calculate confidence intervals for mean, variance, proportion in a population and difference between means and difference between proportions	**PSO1,2, 3,4,5 PO 1,2,3,7**	Apply	P	L	P
CO4	Determine estimate for parameters using estimation techniques	**PSO1,2, 3,4,5 PO 1,2,3,7**	Apply	P	L	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3						1							–
CO2	2	2	3	–			2	2	2			1	–	
CO3	2	3	2	2	2		2	3	2				1	
CO4	2	3	2	3	3		2	2	2				3	

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Exam

- Practical Evaluation
- Final Exam
-

Mapping of COs to Assessment Rubrics:

	Internal Exam	Quiz / Assignment/ Discussion /Seminar	Practical Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓	✓	✓
CO 4	✓	✓	✓	✓

University of Kerala

Discipline	STATISTICS				
Course Code	UK5DSCSTA302				
Course Title	TESTING OF HYPOTHESIS				
Type of Course	**DSC**				
Semester	V				
Academic Level	300 – 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	2 hours	-	4 hours	6
Pre-requisites					

COURSE OUTCOMES

	Up on Completion of the course, students should be able to:	Cognitive level	PSO addressed
CO1	Explain Hypothesis Testing	Understand	PSO-1
CO2	Apply Neymann-Pearson Lemma	Apply	PSO-1,2,3
CO3	Analyse real life situations using various statistical tests	Analyse	PSO-1,2,3,4,5

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

COURSE CONTENT

Module	Content	Hrs
I	**Statistical Hypothesis**	15
	Statistical hypothesis– simple and composite, null and alternative hypothesis, test of hypothesis, two types of errors, level of significance, size and power of a test, critical region, p value	
II	**Neymann– Pearson's approach**	15
	Neymann– Pearson's approach of test of hypothesis, Neymann– Pearson lemma (Without proof), most powerful test, uniformly most powerful test, derivation of critical region using Neyman Pearson lemma for mean and variance of a normal population, the mean of binomial and Poisson distribution, likelihood ratio test and its properties (statement only)	
III	**Large sample tests**	30
	Large sample tests- testing the significance of a mean, testing the significance of a proportion, testing the equality of two proportions, testing the equality of two means, testing the significance of correlation coefficient, testing the significance of difference between two correlation coefficients. Tests based on chi– square distribution – testing the goodness of fit, testing the independence of attributes, testing the significance of standard deviation of a normal population.	

		Practical based on these Module to be done using R package					
IV		**Small sample tests**				**30**	
		Small sample tests: test based on student 't' distribution– test of significance of mean from a normal population, testing the equality of means of two normal population, testing the significance of correlation coefficient, paired 't' test. Test based on F distribution– testing the equality of variances of two normal populations. Practical based on these Module to be done using R package					

PRACTICAL/LABWORK
List of Practical worksheet
1. Tests for Proportion(s).
2. Tests for mean(s)
3. Tests for correlation coefficient.
4. $\chi 2$ test for Goodness of fit and Independence of Attributes
5. testing the significance of standard deviation of a normal population.
6. F test for testing the equality of variances of two normal populations.

REFERENCES
1. Goon, A.M, Gupta, M.K and Das Gupta (1994). An outline of statistical theory Vol-I, World Press Calcutta.
2. Gupta, S.C and Kapoor, V.K (2002). Fundamentals of Mathematical Statistics, Sultan Chands.
3. Hogg, R.V., Craig, A.J. (2011). Introduction to Mathematical Statistics, 4thedition, Collier McMillan.
4. Mood, A.M, Graybill, F.A. and Bose, D.P. (1972). Introduction to theory of statistics, 3rdedition–Mc Graw Hill.
5. Rohatgi, V.K and Saleh, A.K. MD. (2001). An Introduction to Probability and Statistics, 2ndedition. John Wiley & Sons, Inc., New York. Wilks, S.S(1962). Mathematical Statistics, John Wiley, New York.
6. Dalgaard, P.(2008). Introductory Statistics with R, Springer, New York
7. Purohit, S. G., Deshmukh, S.R., & Gore, S. D. (2008). Statistics using R. Alpha Science International, United Kingdom.

Name of the Course: TESTING OF HYPOTHESIS
Credits: 2:0:2 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)	Practical (P)
CO1	Explain Hypothesis Testing	PSO-1 PO1	Understand	C	L	
CO2	Apply Neymann-Pearson Lemma	PSO-1,2,3 PO1,2	Apply	C	L	

CO3	Analyse real life situations using various statistical tests	PSO-1,2,3,4,5 PO 1,2,3,4,7	Analyse	P		L		P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PS O1	PS O2	PS O3	PS O4	PS O5	PS O6	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO 1	3				-	-	1						-	-
CO 2	3	2	1			-	1	1		-	-	-	-	-
CO 3	2	3	3	2	1		3	3	3	1	-		1	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Practical Evaluation
- Final Exam

Mapping of COs to Assessment Rubrics:

	Internal Exam	Quiz / Assignment/ Discussion / Seminar	Practical Evaluation	End Semester Examinations
CO 1	✓	√		✓
CO 2	✓	√		✓
CO 3	✓	✓	✓	✓

University of Kerala

Discipline	STATISTICS				
Course Code	UK5DSCSTA303				
Course Title	SAMPLE SURVEY METHODS				
Type of Course	**DSC**				
Semester	V				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	2 hours	-	4 hours	6
Pre-requisites					

COURSE OUTCOMES

	Up on Completion of the course, students should be able to:	Cognitive level	PSO addressed
CO1	Explain the basic concept of sample survey.	Understand	PSO- 1
CO2	Discuss the differences between sample survey and census survey	Understand	PSO-1
CO3	Apply various sampling schemes like simple random sampling, Stratified sampling and Systematic sampling	Apply	PSO-1,2,3,4
CO4	Illustrate the efficiencies of estimates obtained using different sampling techniques	Apply	PSO-1,2,3,4
CO5	Describe the merits and demerits of different sampling techniques.	Understand	PSO-1,2

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

COURSE CONTENT

Module	Content	Hrs
I	**Introduction**	15
	Concepts of population and sample, sampling frame, sampling design, need for sampling, principle steps in sample survey, advantages of sample survey over census survey, probability sampling and non-probability sampling, sampling and non – sampling errors	
II	**Simple random sampling**	25

		Simple random sampling (SRS) with and without replacement, estimation of population mean and variance, unbiasedness and standard error of estimators, unbiased estimators of variances of these estimators, SRS for attributes, estimation of sample size based on desired accuracy for variables and attributes. Practical based on these Module to be done using R package	
III	**Stratified sampling**		25
	Stratified sampling: concepts, need and importance of stratified sampling, and stratified sample estimation of population mean and total, mean and variance of estimator of population mean assuming SRSWOR with in strata, proportional allocation, Optimum allocation with and without varying costs, comparison of simple random sampling with proportional and optimum allocation. Practical based on these Module to be done using R package		
IV	**Systematic sampling**		25
	Systematic sampling: concepts, need and importance of systematic sampling, estimation of population mean and total, expectation and variance of estimators, circular systematic sampling, Population with linear trend. Practical based on these Module to be done using R package		

PRACTICAL/LABWORK
List of Practical worksheet using R
1. To select a SRS with and without replacement.
2. Estimate population mean, population mean square and population variance , possible samples of size n by WR and WOR and establish all properties relative to SRS.
3. For SRS, estimate mean, standard error, the sample size
4. Stratified Sampling: allocation of sample to strata by proportional and Neyman's methods Compare the efficiencies of above two methods relative to SRS

REFERENCES

1. Gupta, S.C. and Kapoor, V.K. (2002). Fundamentals of Applied Statistics, SultanChand & Co. New Delhi.

2. Cochran, W.G. (1977). Sampling Techniques. Wiley Eastern Ltd., New Delhi.
3. Mukhopadyaya.P (2009). Theory and Methods of Survey Sampling. PHI Learning Pvt Ltd. New Delhi.
4. Sambath. (2001). Sampling Theory and Methods. Narosa Publishing House. NewDelhi, Chennai, Mumbai, Calcutta.
5. Murthy, M.N. (1967). Sampling theory and Methods. Statistical Publishing Society,Calcutta.
6. Bansal, A. (2017). Survey Sampling. United Kingdom: Alpha Science International, Limited.

Name of the Course: SAMPLE SURVEY METHODS
 Credits: 2:0:2 (Lecture:Tutorial:Practical)

CO	CO	PO/PSO	Cognitive	Kno	Lecture	Practical

No.			Level	wledge Category	(L)/Tutorial (T)	(P)
CO1	Explain the basic concept of sample survey.	PSO-1 PO 1	Understand	F, C	L	
CO2	Discuss the differences between sample survey and census survey	PSO-1 PO 1	Understand	C	L	
CO3	Apply various sampling schemes like simple random sampling, Stratified sampling and Systematic sampling	PSO-1,2,3,4 PO 1, 2,4, 7	Apply	C,P	L	P
CO4	Illustrate the efficiencies of estimates obtained using different sampling techniques	PSO-1,2 PO 1,2,4,7	Apply	C,P	L	P
CO5	Describe the merits and demerits of different sampling techniques.	PSO-1 PO 1	Understand	F,C	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Assessment:

Internal Examination/External Examination/Practical Examination/Assignment

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO 11	1						1							
CO2	2	-	-				2		-		-	-	-	-
CO3	2	1	3	1		-	2	1		1	-		2	

CO 4	1	1	1	2		-	2	1		1	-		2	
CO 5	2	-				2								-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Examination
- Practical Evaluation
- End Semester Examinations

Mapping of COs to Assessment Rubrics:

	Internal Exam	Quiz / Assignment/ Discussion / Seminar	Practical Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓	✓	✓
CO 4	✓	✓	✓	✓
CO 5	✓	✓		✓

University of Kerala

Discipline	STATISTICS				
Course Code	UK5DSESTA301				
Course Title	STATISTICAL QUALITY CONTROL				
Type of Course	**DSE**				
Semester	V				
Academic Level	300 – 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites					

COURSE OUTCOMES

	Up on Completion of the course, students should be able to:	Cognitive level	PSO addressed
CO1	Explain the techniques and approach of SQC being used in industry	Understand	PSO-1,5,6
CO2	Apply the statistical process control tools for variables	Apply	PSO-1,2,3, 4,5
CO3	Apply the statistical process control tools for attributes	Apply	PSO-1,2,3, 4,5
CO4	Apply the statistical product control tools.	Apply	PSO-1,2,3, 4,5

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

COURSE CONTENT

Module	Content	Hrs
I	**Statistical Quality Control**	15
	Quality: Definition, dimensions of quality, historical perspective of quality control and improvements starting from World War II. Quality system and standards: Introduction to ISO quality standards, Quality registration. Statistical Process Control - Seven tools of SPC, chance and assignable causes of quality variation. Statistical Control Charts- Construction and Statistical basis of 3-σ Control charts, uses of control chart, specification and tolerance limits- 3sigma limits, warning limits. Rational Sub-grouping.	
II	**Control charts for variables**	22
	Control charts for variables- $\bar{X}$ chart, R chart -purpose of the charts-basis of sub grouping-plotting $\bar{X}$ bar and R results, determining the trial control limits, interpretation of control charts. Criterion for detecting lack of control in $\bar{X}$ bar and R Chart , Practical in R	
III	**Control chart for attributes**	23

		Control chart for attributes, purpose of the chart - p chart-np chart, construction of p and np charts; Construction of c-chart and u-chart, Practical in R	
IV		**Acceptance sampling plan**	15
		Acceptance sampling plan: Principle of acceptance sampling plans. Single and Double sampling plans, their Operating Characteristic (OC), Acceptance Quality Level (AQL), Lot Tolerance Percent Defective (LTPD), Average Outgoing Quality (AOQ), Average Outgoing Quality Limit (AOQL), Average Sample Number (ASN), and Average Total Inspection (ATI) functions with graphical interpretation, use, and interpretation of Dodge and Romig's sampling inspection plan tables	

Practical sheets
1. Control charts for variables
2. Control charts for attributes

REFERENCES
1. Montogomery, D. C. (2009): Introduction to Statistical Quality Control, 6th Edition, Wiley India Pvt. Ltd.
2. Goon A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. I & II, 8th Edn. The World Press, Kolkata.
3. Mukhopadhyay, P (2011):Applied Statistics, 2nd edition revised reprint, Books and Allied (P) Ltd.
4. Montogomery, D. C. and Runger, G.C. (2008): Applied Statistics and Probability for Engineers, 3rd Edition reprint, Wiley India Pvt. Ltd.
5. Gupta S.C. and Kapoor V.K. (2007): Fundamentals of Applied Statistics, Sultan Chand and Sons, New Delhi.

Name of the Course: STATISTICAL QUALITY CONTROL
Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO1	Explain the techniques and approach of SQC being used in industry Understand the concept of quality	PSO-1,5,6 PO 1	Understand	F, C	L	
CO2	Apply the statistical process control tools for variables	PSO-1,2,3,4,5 PO 1,2,4,6,7	Apply	P	L	P
CO3	Apply the statistical process control tools for attributes	PSO-1,2,3,4,5 PO 1,2,4,6,7	Apply	P	L	P

CO4	Apply the statistical product control tools.	PSO-1,2,3, 4,5 PO 1,2,4,6,7	Appl y	P		L		

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO 1	3		-	-	2	3	3	-	-	-	-	-		
CO 2	3	3	3	1	2	-	3	1		1	-	3	1	-
CO 3	3	3	3	1	2	-	3	1		1	-	3	1	-
CO 4	3	3	3	1	2	-	3	1		1	-	3	1	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High
3	Substantial / High

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Examination
- Practical Evaluation
- End Semester Examinations

Mapping of COs to Assessment Rubrics :

	Internal Exam	Quiz / Assignment/ Discussion / Seminar	Practical Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓	✓	✓
CO 4	✓	✓		✓

University of Kerala

Discipline	STATISTICS				
Course Code	UK5DSESTA302				
Course Title	ECONOMETRICS				
Type of Course	**DSE**				
Semester	V				
Academic Level	300 – 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites					

COURSE OUTCOMES

Up on Completion of the course, students should be able to:		Cognitive level	PSO addressed
CO1	Explain the concept of Econometrics	Understand	PSO-1
CO2	Explain simple linear regression model	Understand	PSO-1
CO3	Apply least square method to estimate the parameters of a linear model	Apply	PSO-1,2
CO4	Analyse the problems of multicollinearity and heteroscedasticity	Analyse	PSO-1,2,3

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

COURSE CONTENT

Module	Content	Hrs
I	**Relationship between variables**	10
	Relationship between variables, endogenous and exogenous variables, Definition of econometrics-Economic theory and Mathematical economics, economic models, role of econometrics. Methodology of econometric analysis.	
II	**Simple linear model**	15
	Simple linear model: Assumptions, Estimation of Parameters-OLS, Properties of Estimators, Gauss-Markov theorem	
III	**General linear models**	15
	General linear models- Assumptions, Estimation and properties of estimator: significance test and confidence intervals of estimates- Generalized least square estimation (GLS)-Aitken Estimator, Auto correlation- concept, consequences, detection and solution, Tests for autocorrelation – Durbin Watson test- Dummy variables and lagged variable –Nature and Use.	

IV	**Multicollinearity & Heteroscedasticity**	**20**
	Multicollinearity: Nature and consequences, detection of Multicollinearity-Variance Inflation Vector (VIF) only and remedial measures -Problems. Heteroscedasticity: Nature and consequences, detection of Heteroscedasticity-Graphical Method only-Problems.	

Reference:
1. Gujarati D.N. (1979). Basic Econometrics. McGraw Hill.
2. Johnston, J. (1984): Econometric Models, Third edition, McGraw Hill.
3. Hill R.C., Griffiths W.E. and Lim G.C. (2011). Principles of Econometrics, Fourth Edition, John Wiley & Son
4. Koutsoyiannis A. (1979). Theory of Econometrics. Mac million Press.
5. Madnani G. M. K. (2005). Introduction to Econometrics Principles and Applications, 7th edition. Oxford and IBH Publishing Co. Pvt. Ltd.

Name of the Course: ECONOMETRICS
Credits: 4:0:0 (Lecture: Tutorial: Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO1	Explain the concept of Econometrics	PSO-1 PO-1	Understand	C	L	
CO2	Explain simple linear regression model	PSO-1 PO-1	Understand	C,P	L	
CO3	Apply least square method to estimate the parameters of a linear model	PSO-1,2 PO 1,2,7	Apply	P	L	
CO4	Analyse the problems of multicollinearity and heteroscedasticity	PSO-1,2,3 PO 1,2,7	Analyse	P	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO 1	3	-	-			-	2	-	-	-				-
CO 2	3	-	-			-	2							-
CO 3	2	2					2	1					1	-
CO 4	2	2	3				2	3					1	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Examination
- Practical Evaluation
- End Semester Examinations

Mapping of COs to Assessment Rubrics :

	Internal Exam	Quiz / Assignment/ Discussion / Seminar	Practical Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓

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University of Kerala

Discipline	STATISTICS				
Course Code	UK5DSESTA303				
Course Title	MEDICAL STATISTICS				
Type of Course	**DSE**				
Semester	V				
Academic Level	300 – 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites					

COURSE OUTCOMES

	Up on Completion of the course, students should be able to:	Cognitive level	PSO addressed
CO1	Explain clinical trial fundamentals	Understand	PSO – 1, 2, 3
CO2	Analyse advanced clinical trial designs, data analysis methods,	Apply	PSO – 1, 2, 3
CO3	Apply survival analysis concepts and non-parametric methods	Apply	PSO – 1, 2, 3

COURSE CONTENT

Module	Content	Hrs
I	**Fundamentals of Clinical Trials**	15
	Controlled vs. Uncontrolled Clinical Trials, historical Controls and their Limitations, Clinical Trial Protocols and their Components, Randomization, Blinding (Single & Double-Blind), and Placebo Controls, Ethical Considerations in Clinical Research, Sample Size Determination and Power Analysis	
II	**Advanced Clinical Trial Designs, Epidemiology and Data Analysis**	15
	Interim Analysis, Multi-Centre Trials, Combining Trials, Crossover Trials and their Applications, Analysing Binary Response Data: Logistic Regression Modelling, McNemar's Test for Paired Data.	
III	**Introduction to Survival Analysis**	15
	Concepts of survival and hazard functions, Censoring and life tables, Non-Parametric Methods: Kaplan-Meier survival curve, Log-rank test for comparing survival curves, Regression Models in Survival Analysis, Inclusion of covariate in survival models, Cox's proportional hazards model.	
IV	**Parametric Survival Models**	15

| | Introduction to parametric models- life time,distributions (Exponential, Weibull, Gamma, Log-normal, Loglogistic), comparing survival distributions using parametric methods, hazards functions for parametric models, inter- relation between survival function, density function and hazard function; Accelerated failure time (AFT) model. | |

REFERENCES

1. Altman, D. G. (1999). Practical Statistics for Medical Research. Chapman &Hall.
2. Atkinson, A. C and Donev, A. N. (1992). Optimum Experimental Designs. Oxford University Press.
3. Barnett, V. (1991). Sample Survey-Principles and Methods. 2nd Ed., Edward Arnold.
4. Box, G. E. P and Draper, N. R. (1987). Empirical Model Building and Response Surface. Wiley, New York. 22
5. Campbell, M. J. (2001). Statistics at Square Two, BMJ.
6. Collectt, D. (2003). Modelling Survival data in Medical Research, 2nd Ed., Chapman and Hall. 7. Cornell, J. A. (1990). Experiments with Mixtures,3rd Ed., Wiley New York.
7. Cox, D. R and Reid, N. (2000). The Theory of the Design of Experiments. Chapman and Hall, CRC London.
8. Everitt, B. S and Rabe-Heskith, S. (2001). Analysing Medical Data Using S-Plus. Springer.
9. Mathews, J. N. S. (2000). An Introduction to Randomized Controlled Clinical Trials. Hodder Arnold.
10. Pocock, S. J. (1983). Clinical trials. A Practical Approach. Wiley, New York.
11. Senn, S. (2003). Dicing with Death: Chance, Risk and Health. CUP.
12. Wayne W. Daniel, Chad L. Cross (2018). Biostatistics: A Foundation for Analysis in the Health Sciences, 11th Edition. John Wiley & Sons, Inc., New York.
13. David G. Kleinbaum , Mitchel Klein (2005). Survival Analysis: A Self Learning Text. 3rd Edition. Springer, New York, USA.

Name of the Course: MEDICAL STATISTICS
Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO1	Explain clinical trial fundamentals	PSO – 1, 2, 3 PO 1 2,3	Understand	C	L	
CO2	Analyse advanced clinical trial designs, data analysis methods,	PSO – 1, 2, 3 PO 1 2,3	Apply	C	L	

| CO3 | Apply survival analysis concepts and non-parametric methods | PSO – 1, 2, 3 PO 1 2,3 | Apply | P | L | |

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	3	2	2				3	2	1			
CO 2	2	3	3				3	3	2			
CO 3	2	3	2				3	3	1			

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High
3	Substantial / High

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Examination
- Practical Evaluation
- End Semester Examinations

Mapping of COs to Assessment Rubrics :

	Internal Exam	Quiz / Assignment/ Discussion / Seminar	Practical Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓

University of Kerala

Discipline	STATISTICS				
Course Code	UK5DSESTA304				
Course Title	OPERATIONS RESEARCH				
Type of Course	**DSE**				
Semester	V				
Academic Level	300 – 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites					

COURSE OUTCOMES

	Up on Completion of the course, students should be able to:	Cognitive level	PSO addressed
CO1	Describe the concept of OR	Understand	PSO 1
CO2	Solve LPP using graphical method and simplex method	Apply	PSO 1, 3
CO3	Solve LPP using Duality Method	Apply	PSO 1, 3
CO4	Solve Transportation and Assignment problem	Apply	PSO 1,3

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create
COURSE CONTENT

Module	Content	Hrs
I	**Operations Research**	15
	Introduction to Operations Research (OR)-Linear programming problem (LPP). Mathematical Formulation of LPP ,Canonical and Standard form of LPP ,	
II	**LPP**	15
	Solving the LPP by Graphical Method, Basic solution, Optimum solution, Bounded and Unbounded solution, Infeasible solution, Alternative optimum with examples, Simplex method-various cases.	
III	**Solution of LPP**	15
	Need for Artificial variables -Big M method , Two Phase method, Duality in Linear Programming, Duality Theorem	
IV	**Transportation Problem & Assignment Problem**	15

Transportation Problem, General Transportation Problem, Solution of Transportation Problem-North West Corner Method(NWCM), Lowest Cost Method(LCM), Vogal's Approximation Method, Degeneracy in Transportation Problem, Transportation Algorithm (MODI Method), Assignment Problem, Test for Optimality by Hungarian Method, Maximization in Assignment Problem

REFERENCES

1. Frederick, S. Hiller and Gerald, J. Lieberman. (1987). Operations Research. CBS Publishers & Distributors, Delhi.
2. Kanti Swarup, Gupta, P. K and Manmohan. (1993). Operations Research. Sultan Chand Publishers, New Delhi.
3. Goel and Mittal (1982). Operations Research. Pragathi Prakashan, Meerut.
4. Sharma, J.K. (2009). Operations Research Theory and Applications, Macmillan India

Name of the Course: OPERATIONS RESEARCH
Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO1	Describe the concept of OR	PSO 1 PO 1	Understand	F	L	
CO2	Solve LPP using graphical method and simplex method	PSO 1, 3 PO 1,2	Apply	C P	L	
CO3	Solve LPP using Duality Method	PSO 1, 3 PO 1,2	Apply	C P	L	
CO4	Solve Transportation and Assignment problem	PSO 1, 3 PO 1,2	Apply	C P	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO 1	1						1							
CO 2	2		2				2	3						

CO 3	2		2				2	3					
CO 4	2		2				2	3					

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High
3	Substantial / High

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Examination
- Practical Evaluation
- End Semester Examinations

Mapping of COs to Assessment Rubrics :

	Internal Exam	Quiz / Assignment/ Discussion / Seminar	Practical Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓

University of Kerala

Discipline	STATISTICS (Specialisation in OR)				
Course Code	UK5DSESTA305				
Course Title	**OPTIMIZATION TECHNIQUES**				
Type of Course	**DSE**				
Semester	V				
Academic Level	300 – 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites					

COURSE OUTCOMES

Up on completion of the course, students should be able to		Cognitive level	PSO Addressed
CO1	Explain the concept of NLPP	Understand	PSO 1
CO2	Describe the different methods for solving Dynamic Programming	Apply	PSO 3,4
CO3	Describe the different methods for solving geometric Programming	Apply	PSO 3,4
CO4	Apply various methods for solving a FPP	Apply	PSO 3,4

COURSE CONTENT

Module	Content	Hrs
I	**Non linear Programming Problem**	15
	Unconstrained and constrained optimization problems. Kuhn-Tucker optimality conditions. Quadratic Programming: Wolfe's and Beale's method. Applications of Quadratic programming.	
II	**Dynamic Programming Problem**	15
	Introduction to Dynamic Programming. Characteristics of Dynamic Programming, Developing Optimal decision Policy, Additive and Multiplicative Separable returns for objective as well as constraints functions. Dynamic Programming Approach for solving Linear ProgrammingProblem. Applications of Dynamic programming.	
III	**Geometric Programming Problem**	15
	Geometric Programming Problem (GPP): Formulation of the problem, constrained and unconstrained type, conditions for optimality, complementary geometric programming problems, complementary algorithm, equality and inequality constraints, advantage of GPP.	

IV	**Fractional Programming Problem**	15
	Fractional Programming Problem (FPP): Formulation of FPP, Linear FPP, Computational procedure of FPP.	

REFERENCES.

1. Kanti Swarup, Gupta, P. K and Manmohan. (1993). *Operations Research*. Sulthan Chand & Sons
2. Mittal, K.V. and Mohan, C. (1996). Optimization Methods in Operations Research and System Analysis, New Age Publishers.
3. Sharma, J.K. (2009). Operations Research Theory and Applications, Macmillan India Limited

Name of the Course: OPTIMIZATION TECHNIQUES
Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	Explain the concept of NLPP	PO1, 2 PSO 1.	Uderstand		L	
2	Describe the different methods for solving Dynamic Programming	PO 2,3,6,7 PSO 3,4.	Apply		L	
3	Describe the different methods for solving geometric Programming	PO1,2, 7 PSO 1	Apply		L	
4	Apply various methods for solving a FPP	PO 2,3,6,7 PSO 3,4.	Apply		L	

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO 1	1						1	1						
CO 2			2	1				3	1			1	1	
CO 3			2	1			2	3					1	

CO 4			2	1				3	1			1	1	

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Examination
- Practical Evaluation
- End Semester Examinations

	Internal Exam	Assignment	Practical Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓

University of Kerala

Discipline	STATISTICS				
Course Code	UK5DSESTA306				
Course Title	BIOSTATISTICS				
Type of Course	**DSE**				
Semester	V				
Academic Level	300 – 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites					

COURSE OUTCOMES

	Up on Completion of the course, students should be able to:	Cognitive level	PSO addressed
CO1	Explain the statistical methods in medicine, public health, and biology to measure disease occurrence and evaluate study designs for sample size estimation.	Understand	PSO 1
CO2	Perform validity and reliability of diagnostic tests	Analyse	PSO 1 ,3
CO3	Analyse ROC curves for biomedical applications.	Analyse	PSO 1, 3
CO4	Analyse risk estimation techniques and illustrate logistic regression models for causal inference in research studies.	Analyse	PSO 1, 3
CO5	Analyse survival distributions for biomedical research applications.	Analyse	PSO 1, 3

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create
COURSE CONTENT

Module	Content	Hrs
I	**Introduction of Biostatistics**	15
	Concepts of Biostatistics: Need for statistical methods in medicine, Public health and Biology. Measuring the occurrence of disease, Measures of morbidity - prevalence and incidence rate, association between prevalence and incidence, uses of prevalence and incidence, problems with incidence and prevalence measurements; Clinical agreement: kappa statistics, Mantel-Haenszel test; intra-class correlation. Study designs- cross sectional, case- control and cohort. Estimation of sample size in different study designs	
II	**Assessing variability & Reliability**	15

		Assessing the validity and reliability of diagnostic and screening test: Validity of screening test – sensitivity, specificity, positive predictive value and negative predictive value; Reliability; Relationship between validity and reliability; ROC curve and its applications.	
III	**Basic Epidemiology**		**15**
	Epidemiology concepts: Association; causation; causal inference; Errors and bias; Confounding; Controlling confounding; Measurement of interactions; Estimating risk: Estimating association –absolute risk, relative risk, The Logistic Regression Model, The Logistic Function, Odds Ratio, The Logit of P, Logit Regression Coefficient as measures of effect on Logit P		
IV	**Survival Distributions**		**15**
	Survival distributions and their applications viz. Exponential, Gamma, Weibull, Rayleigh, Lognormal, death density function for a distribution having bathtub shape hazard function. Tests of goodness of fit for survival distributions. Hazard rate and hazard function for life time distributions.		

REFERENCES:

1. P. Armitage, G. Berry & J. N. S. Matthews; (2002); Statistical Methods inMedical Research: 4th Ed., Blackwell science.
2. Martin Bland, (2000) An introduction to medical statistics, Oxford university press.
3. Gross and Clark (1999) Survival distributions: Reliability applications in the Biomedicalscience: John Wiley & Sons
4. Mark Woodward (2013) Epidemiology- Study, Design & Analysis:. Chapman & Hall (CRCSeries).
5. Wayne W. Daniel, Chad L. Cross (2018). Biostatistics: A Foundation for Analysis in the Health Sciences, 11th Edition. John Wiley & Sons, Inc., New York.
6. David G. Kleinbaum , Mitchel Klein (2005). Survival Analysis: A Self Learning Text. 3rd Edition. Springer, New York, USA.

Name of the Course: BIOSTATISTICS
Credits: 4:0:0 (Lecture: Tutorial: Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO1	Explain the statistical methods in medicine, public health, and biology to measure disease	PSO 1 PO 1	Understand	C	L	

		occurrence and evaluate study designs for sample size estimation.				
CO2	Perform validity and reliability of diagnostic tests	PSO 1 ,3 PO 1, 2, 4	Analyse	P	L	
CO3	Analyse ROC curves for biomedical applications.	PSO 1, 3 PO 1, 2, 4	Analyse	C	L	
CO4	Analyse risk estimation techniques and illustrate logistic regression models for causal inference in research studies.	PSO 1, 3 PO 1, 2, 4	Analyse	P	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO 1	3						2							
CO 2	1		3				2	1		1	-			
CO 3	1		3				2	1		1	-			
CO 4	1		3				2	1		1	-			

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High
3	Substantial / High

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Examination
- Practical Evaluation

- End Semester Examinations

Mapping of COs to Assessment Rubrics :

	Internal Exam	Quiz / Assignment/ Discussion / Seminar	Practical Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓

University of Kerala

Discipline	STATISTICS				
Course Code	UK5SECSTA301				
Course Title	DATA ANALYSIS WITH R				
Type of Course	SEC				
Semester	V				
Academic Level	300 – 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	3	2 hours	-	2 hours	4
Pre-requisites					

COURSE OUTCOMES

Up on Completion of the course, students should be able to:		Cognitive level	PSO addressed
CO1	Evaluate correlation structure, normality assumption, and regression modelling in R	Evaluate	PSO 1, 2, 3, 4, 5
CO2	Evaluate hypotheses in large sample cases	Evaluate	PSO 1, 2, 3, 4, 5
CO3	Evaluate hypotheses in small sample cases	Evaluate	PSO 1, 2, 3, 4, 5

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

COURSE CONTENT

Module	Content	Hrs
I	**Correlation and Regression**	15
	Correlation (Karl Pearson and Spearman) with test of significance, Normality Checking – graphical and test procedures, Regression modelling using lm(), Interpretation of model parameters, R^2 , predict()	
II	**Large Sample tests in R**	15
	Testing specified mean using R, Testing equality of mean using R, One-sample proportion test in R, Two-sample proportion test in R, Testing of Independence using R, Implementation and interpretation of large sample tests in R	
III	**Small Sample tests in R**	15
	t test in R, Testing specified mean, Equality of mean, equality of mean between Paired observation , Testing specified variance and equality of variance	

PRACTICAL/LABWORK
List of Practical worksheet
1. Pearson and Spearman correlation coefficients.
2. Graphical methods for checking normality, such as histograms and Q-Q plots.
3. Build linear regression models in R
4. Large Sample tests for Proportion(s).
5. Large Sample tests for mean(s)
6. $\chi 2$ test for Independence of Attributes.
7. $\chi 2$ test for testing the significance of standard deviation of a normal population.
8. Small Sample tests for test the significance of mean from a normal population.
9. Paired 't' test
10. F test for testing the equality of variances of two normal populations.

REFERENCES:
1. Dalgaard, P.(2008). *Introductory Statistics with R*, Springer, New York.
2. Kerns, G J. (2010). *Introduction to Probability and Statistics using R.* ISBN-10 : 0557249791
3. Lander J. P. (2017). *R for everyone* 2/e. Addison-Wesley Professional, U. S.
4. Michael J. Crawley (2013*). The R Book*, 2/e, Wiley, New York.
5. Purohit, S. G., Deshmukh, S.R., & Gore, S. D. (2008). *Statistics using R*. Alpha Science International, United Kingdom.

Name of the Course: DATA ANALYSIS WITH R
Credits: 2:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	CO1	PSO 1, 2, 3, 4, 5 PO 1, 2,4,7	Evaluate	F, C, P	L	P
2	CO2	PSO 1, 2, 3, 4, 5 PO 1, 2,4,7	Evaluate	F, C, P	L	P
3	CO3	PSO 1, 2, 3, 4, 5 PO 1, 2,4,7	Evaluate	F, C, P	L	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO 1	3	3	2	3	2	-	3	2	-	2	-	-	3	-
CO 2	3	3	2	3	2	-	3	2	-	2	-	-	3	-
CO 3	3	3	2	3	2	-	3	2	-	2	-	-	3	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:
Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Examination
- Practical Evaluation
- End Semester Examinations

Mapping of COs to Assessment Rubrics :

	Internal Exam	Quiz / Assignment/ Discussion / Seminar	Practical Evaluation	End Semester Examinations
CO 1	✓	✓	✓	✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓	✓	✓

University of Kerala

Discipline	STATISTICS				
Course Code	UK5SECSTA302				
Course Title	**REPORT WRITNG USING LATEX**				
Type of Course	SEC				
Semester	V				
Academic Level	300 – 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	3	2 hours	-	2 hours	4
Pre-requisites					

COURSE OUTCOMES

Up on Completion of the course, students should be able to:		Cognitive level	PSO addressed
CO1	Use LaTeX basics tools for typesetting a scientific article	Apply	PSO 5
CO2	Demonstrate advanced LaTeX skills in document layout, page styles, box usage, document division, cross-referencing, footnotes, and nested lists formatting.	Apply	PSO 5
CO3	Apply LaTeX techniques for including graphics (JPG, PNG), managing figure placement, adding captions, typesetting equations (single and group), managing references, and using hyperlinks with hyperref package.	Apply	PSO 5

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create
COURSE CONTENT

Module	Content	Hrs
I	**Introduction to LaTeX**	20
	Introduction to LaTeX, Basics of typesetting, changing font size, various fonts, Spacing: changing line spacing, controlling horizontal, vertical spacing. Typesetting basic tables, Merge cells using \multicolumn	
II	**Document layout**	20
	Document layout: page styles, breaking line and page, using boxes (like, mbox) to keep text unbroken across lines, dividing document in to parts like front matter, mainmatter, backmatter, chapters, sections, etc, cross referencing with and without page number, adding footnotes, Nested lists-Nested enumerate lists: number format, Nested itemize lists: bullet style	
III	**Figure in Latex**	20

	Figures: Including JPG, PNG graphics with graphicx package, controlling width, height etc, floating figures, adding captions, the wrap g package. Single Equations (equation, equation*, split) Group of Equations (gather, gather*, align, align*, cases). Putting one over another (frac, dfrac, int, lim, sum, prod). Adding references/bibliogrpahy and citing them, using the package hyperref to add and control hypertext links.	

Reference:
1. The LaTeX Tutorial: A Primer, by The Tutorial Team, Indian TEX Users Group, Sayahna Foundation, http://www.sayahna.org, 2020
2. Donald Binder and Martin Erickson, A student's guide to the study, practice and tools of modern mathematics, CRC Press, 2010
3. Tobias Oetiker, Hubert Partl, Irene Hyna and Elisabeth Schlegl. The (Not So) Short Introduction to LaTeX, Samurai Media Limited
4. Learn LaTeX: Lists - Overleaf, Online LaTeX Editor

PRACTICAL/LABWORK
List of Practical worksheet
1. LaTeX Basics: Font Size and Styles
2. Line and Spacing Control in LaTeX
3. Typesetting Basic Tables and Utilizing \multicolumn for Cell Merging
4. Document Layout: Page Styles and Line/Page Breaks
5. Using Boxes to Maintain Text Integrity
6. Organizing Document Parts: Front Matter, Main Matter, Back Matter
7. Cross Referencing and Footnotes implementation.
8. Nested Lists : Enumerate and itemize formatting
9. Graphics Inclusion: JPG and PNG with graphicx Package, Captioning, and Floating Figures
10. Equations and References in LaTeX

Name of the Course: REPORT WRITNG USING LATEX
Credits: 2:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	CO1	PSO 5	Apply	C	L	P
2	CO2	PSO 5	Apply	M	L	P
3	CO3	PSO 5	Apply	P	L	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PSO5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO 1					3								3	
CO 2					3								3	
CO 3					3								3	

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Examination
- Practical Evaluation
- End Semester Examinations

Mapping of COs to Assessment Rubrics :

	Internal Exam	Quiz / Assignment/ Discussion / Seminar	Practical Evaluation	End Semester Examinations
CO 1	✓	✓	✓	✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓	✓	✓

University of Kerala

Discipline	STATISTICS				
Course Code	UK6DSCSTA301				
Course Title	MACHINE LEARNING				
Type of Course	**DSC**				
Semester	VI				
Academic Level	300 – 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites					

COURSE OUTCOMES

	Up on Completion of the course, students should be able to:	Cognitive level	PSO addressed
CO1	Discuss the fundamental concepts of machine learning	Understand	PSO 1
CO2	Explain Regression and Classification techniques in machine learning	Understand	PSO 1
CO3	Explain the programming concepts in python programming	Understand	PSO 4,5
CO4	Perform python programming	Apply	PSO 4,5

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

COURSE CONTENT

Module	Content	Hrs
I	**Machine Learning**	15
	Machine Learning-Definition, needs, features, advantages, disadvantages and applications. Machine learning paradigms-supervised, semi-supervised, unsupervised, reinforcement learning-elementary concepts only	
II	**Introduction to Data mining**	15
	Introduction to Data mining and data warehousing; Data mining and OLAP; Data Description for data mining (Summaries and Visualization, Clustering, Link Analysis) Predictive data mining: Types of predictions (Classification, Regressions and Time series)	
III	**Machine learning algorithms**	15
	Machine learning algorithms-Regression - Linear regression with one	

	variable, linear regression with multiple variables-concepts only (no need of examples). Linear Methods for Classification- Logistic regression, Naive Bayes, and Decision tree algorithm, over fitting and under fitting (definitions), **K**-means clustering ,kNN (k-nearest neighbours)-(no need of derivations).	
IV	**Python**	**15**
	Installing Python and running Python scripts using IDEs. Variables, operators, conditional statements, loops- for, if else, while, do while. Data structures: Basics of lists, tuples, sets and dictionaries.	

REFERENCES:

1. Alpaydin, E. (2010). Introduction to Machine Learning. MIT press.

2. Eibe Frank and Mark Hall(2011). Data mining : Practical machine learning tools and Techniques. 3rd Edition. Elsevier India.
3. Chun, W. (2006) . Core Python Programming. Prentice Hall Professional.
4. Embarak, O. (2018). Data Analysis and Visualization Using Python: Analyze Data to Create Visualizations for BI Systems. Apress.
5. Lambert, K. A. (2011). Fundamentals of Python: First Programs. Cengage Learning.
6. Kenneth A Lambert., Fundamentals of Python : First Programs, 2/e, Cengage Publishing, 2016

Name of the Course: MACHINE LEARNING Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO1	Discuss the fundamental concepts of machine learning	PSO 1 PO 1	Understand	C	L	-
CO2	Explain Regression and Classification techniques in machine learning	PSO 1 PO 1	Understand	C	L	-
CO3	Explain the programming concepts in python programming	PSO 4,5 PO 1 3 4 7	Understand	C, P	L	-

CO4	Perform python programming	PSO 4,5 PO 1 3 4 7	Apply	C, P	L	-

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO 1	1						1							
CO 2	1						1							
CO 3				3	2		1		2	2			2	
CO 4				3	2		1		2	2			2	

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Examination
- Practical Evaluation
- End Semester Examination

Mapping of COs to Assessment Rubrics :

	Internal Exam	Quiz / Assignment Discussion / Seminar	Practical Evaluation	End Semester Examination
CO 1	✓			✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓

University of Kerala

Discipline	STATISTICS
Course Code	UK6DSCSTA302
Course Title	DESIGN OF EXPERIMENTS
Type of Course	**DSC**
Semester	VI
Academic Level	300 – 399

Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	2 hours	-	4 hours	6
Pre-requisites					

COURSE OUTCOMES

	Up on Completion of the course, students should be able to:	Cognitive level	PSO addressed
CO1	Analyse data using the technique of One way and two way anova	Analyse	PSO 1,2,3,4,5
CO2	Analyse CRD,RBD,LSD	Analyse	PSO 1,2,3,4,5
CO3	Explain the concept of BIBD	Understand	PSO1, 5
CO4	Explain factorial experiment	Understand	PSO1, 5

COURSE CONTENT

Module	Content	Hrs
I	**Analysis of variance**	30
	Analysis of variance- Meaning and assumptions; fixed effect models. Analysis of variance for one way classified data , two-way classified data with and without interaction effects - layout and analysis, Practical based on these Module to be done using R package	
II	**Basic designs**	30
	Principles of design of experiments - randomisation, replication and local control. Basic designs - CRD, RBD (one observation per cell), LSD- layout and analysis, missing plot technique for one or two missing observations, efficiency of RBD over CRD, LSD over RBD and LSD over CRD. Practical based on these Module to be done using R package	
III	**Incomplete Block Designs**	15
	Incomplete Block Designs: Balanced Incomplete Block Design (BIBD) – incidence matrix ,parameters, relationships among its parameters , Symmetric BIBD (concept only)	
IV	**Factorial Experiments**	15

| | Factorial Experiments: Basic concepts, main effects, interaction effects ,contrast, orthogonal contrasts in 2^2 and 2^3 factorial experiments, design and analysis, Yates method of computing factorial effect totals. Confounding- complete and partial confounding (Definition and example Only) | |

Reference:
1. Das., M.N. and Giri, N.C. (1986): Design and Analysis of Experiments. Wiley Eastern.
2. Montgomery, D. C. (2008): Design and Analysis of Experiments. John Wiley.
3. Cochran, W.G. and Cox, G.M. (1959): Experimental Design. Asia Publishing House.
4. Gupta, S.C. and Kapoor, V.K. (2002). Fundamentals of Applied Statistics. Sultan Chand & Co. New Delhi.

PRACTICAL/LABWORK
List of Practical worksheet
1. Analysis of one way classification using R
2. Analysis of two way classification using R
3. Analysis of CRD using R
4. Analysis of RBD using R, Missing plot Analysis of RBD using R
5. Analysis of LSD using R, Missing plot Analysis of LSD using R

REFERENCES
Name of the Course: DESIGN OF EXPERIMENTS
 Credits: 2:0:2 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO1	Analyse data using the technique of One way and two way anova	PSO 1,2,3,4,5 PO 1,2,4,7	Analyse	C, P	L	P
CO2	Analyse CRD,RBD,LSD	PSO 1,2,3,4,5 PO 1,2,4,7	Analyse	C, P	L	P
CO3	Explain the concept of BIBD	PSO1, 5 PO 1	Understand	C	L	
CO4	Explain factorial experiment	PSO1, 5 PO 1	Understand	C	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

	PS O1	PS O2	PS O3	PS O4	PS O5	PS O6	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO 1	3	3	3	3	3		3	2		3			3	
CO 2	3	3	3	3	3		3	2		3			3	
CO 3	2				3		3							
CO 4	2				3		3							

Mapping of COs with PSOs and POs :

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Exam
- Practical Evaluation
- End Semester Examination

Mapping of COs to Assessment Rubrics :

	Internal Exam	Quiz / Assignment/ Discussion / Seminar	Practical Evaluation	End Semester Examination
CO 1	✓	✓	✓	✓
CO 2	✓	✓	✓	✓
CO 3	✓			✓
CO 4	✓	✓		✓

University of Kerala

Discipline	STATISTICS				
Course Code	UK6DSCSTA303				
Course Title	BASICS OF MULTIVARIATE ANALYSIS				
Type of Course	**DSC**				
Semester	VI				
Academic Level	300 – 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3hours	-	2 hours	5
Pre-requisites					

COURSE OUTCOMES

	Up on Completion of the course, students should be able to:	Cognitive level	PSO addressed
CO1	Describe Main operations in matrices and Different types of matrices	Understand	PSO1
CO2	Perform diagonalisation of Square Matrices	Apply	PSO 1, 4
CO3	Calculate eigen values and eigen vectors	Apply	PSO1,2, 4
CO4	Demonstrate bivariate normal distribution	Apply	PSO 1,2
CO5	determine marginal and conditional distributions of BVN	Apply	PSO 1,2
CO6	Demonstrate multivariate normal distribution	Apply	PSO 1,2
CO7	determine marginal and conditional distributions of multivariate normal distribution	Apply	PSO 1,2

COURSE CONTENT

Module	Content	Hrs
I	**Matrix Theory-I**	30
	Algebra of matrices, Transpose, Trace, Determinant. Different types of Matrices -Square matrix, Identity matrix, Idempotent matrix, Triangular matrix - Upper & Lower, Diagonal matrix, Singular and non-singular matrix, Orthogonal matrix, Nilpotent matrix, stochastics matrix with examples , Rank, Determination of Rank ,Invertible Matrices- Inverse of a Matrix, Practical based on these Module to be done using R package	

II	Matrix Theory-II	15
	Solving system of Linear Equation (Up to 3 unknowns). Eigen values and Eigen Vectors, Diagonalisation of Matrix, Quadratic forms, Matrix Representation of Quadratic Forms ,Definiteness of Quadratic Forms, Relation between Definiteness and Eigen values, Practical based on these Module to be done using R package	
III	Bivariate Normal Distribution	15
	Bivariate Normal Distribution - Joint probability density function, Marginal density function, Conditional Density function, Conditional Expectation and Conditional Variance	
IV	Multivariate Normal Distribution	15
	Random vector- Mean vector, variance-covariance matrix, Multivariate Normal Distribution, basic properties, Characteristic function, Marginal and Conditional Distributions.	

PRACTICAL/LABWORK
1 . Matrix entry and basic operations using R
2. Inverse of Matrix using R
3. Determine Eigen values Eigen vectors using R
4. Solving System of Linear Equations using R
5. Plotting Bivariate Normal Data using R

REFERENCES
1 . David C. Lay (2007)Linear Algebra, Thompson Publications.
2. T S Blyth, E F Robertson: Linear Algebra, Springer, Second Edition. Ref.
3. Biswas, S. (2012). Textbook of Matrix Algebra. PHI Learning Pvt. Ltd..
4. Johnson, R.A. and Wichern, D.W. (1992). Applied Multivariate Statistical Analysis, 3 rd edn., Prentice- Hall, London.
5. Rohatji, V.K. and Saleh, A.K.M.E. (2003). An Introduction to Probability Theory and Mathematical Statistics, 2nd edn., John Wiley & Sons, New York.
6. Narayan, S., & Mittal, P. K. (2010). A textbook of matrices. S. Chand Publishing.
7. Dalgaard, P.(2008). Introductory Statistics with R, Springer, New York

8. Purohit, S. G., Deshmukh, S.R., & Gore, S. D. (2008). Statistics using R. Alpha Science International, United Kingdom.

Name of the Course: BASICS OF MULTIVARIATE ANALYSIS
 Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)	Practical (P)
CO1	Describe Main operations in matrices	PSO1 PO1	Understand	F, C ,P	L	P

CO		PSO/PO			
	and Different types of matrices				
CO2	Perform diagonalisation of Square Matrices	PSO 1, 4 PO 1,7	Apply	C ,P	L	P
CO3	Calculate eigen values and eigen vectors	PSO1,2, 4 PO 1,2	Apply	C	L	-
CO4	Demonstrate bivariate normal distribution	PSO 1,2 PO 1,2	Apply	C ,P	L	P
CO5	determine marginal and conditional distributions of BVN	PSO 1,2 PO 1,2	Apply	C,P	L	
CO6	Demonstrate multivariate normal distribution	PSO 1,2 PO 1,2	Apply	C,P	L	
CO7	determine marginal and conditional distributions of multivariate normal distribution	PSO 1,2 PO 1,2	Apply	C,P	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2						2							
CO2	2			2			2						2	
CO3	2	1		1			2	2						
CO4	2	1					1	1						
CO5	2	1					1	1						

213

CO6	2	1					1	1						
CO7	2	1					1	1						

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Exam
- Practical Evaluation
- End Semester Examination

Mapping of COs to Assessment Rubrics :

	Internal Exam	Quiz / Assignment/ Discussion / Seminar	Practical Evaluation	End Semester Examination
CO 1	✓	✓	✓	✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓		✓
CO 4	✓	✓	✓	✓

University of Kerala

Discipline	STATISTICS				
Course Code	UK6DSESTA301				
Course Title	NONPARAMETRIC METHODS				
Type of Course	**DSE**				
Semester	VI				
Academic Level	300 – 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites					

COURSE OUTCOMES

	Up on Completion of the course, students should be able to:	Cognitive level	PSO addressed
CO1	Explain non-parametric methods	Understand	PSO-1
CO2	Perform non parametric tools	Apply	PSO-1,2,4,5
CO3	Analyse association between categorical variables	Analyse	PSO-1,2,4,5

R-Remember, U-Understand, Ap -Apply, An-Analyse, E-Evaluate, C-Create

COURSE CONTENT

Module	Content	Hrs
I	**Non-parametric methods**	15
	Definition and scope of non-parametric methods, comparison with parametric methods. Definition and properties of estimable parameters. Concept of kernel density estimation. Definition and properties of empirical distribution function. Definition and properties of U-statistics.	
II	**Non parametric Tests-I**	15
	Kolmogorov-Smirnov one-sample test, sign test, run test, median test, Wilcoxon signed rank test. Mann-Whitney-Wilcoxon Test (Wilcoxon Rank-Sum Test), Kolmogorov-Smirnov Two-Sample- use, assumptions ,test statistic and critical values.	
III	**Non parametric Tests-II**	15
	Chi-square Test for Independence, Kruskal-Wallis Test for Comparing Multiple Independent Samples , Friedmann test- Use, assumptions , test statistic and critical values. Tests of association with Kendall's tau.	
IV	**Practicum**	30
	Practical based on Modules I to IV. Practical is to be done using R package	

PRACTIAL SHEETS

1. One sample non parametric test in R
2. Two sample non-parametric test in R
3. Kruskal Walliis test and Friedman test in R
4. Chi Square test for independence

REFERENCES:
1. S.P. Gupta (2019). Statistical Methods, Sultan Chand & Sons, New Delhi
2. S.C.Gupta and V.K.Kapoor (2021). Fundamentals of Mathematical Statistics, Sultan Chand & Sons, New Delhi.
3. Rohatgi, V.K and Saleh, A.K. MD. (2001). An Introduction to Probability and Statistics, 2ndedition. John Wiley & Sons, Inc., New York.
4. Hogg R.V.and Craig, A.T. (1972): Introduction to mathematical statistics, 3rd edition, Academic Press, USA.

Name of the Course: NONPARAMETRIC METHODS
Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO1	Explain non-parametric methods	PSO-1 PO 1	Understand	C,M	L	
CO2	Perform non parametric tools	PSO-1,2,4,5 PO 1,2,4,7	Apply	C,P,M	L	P
CO3	Analyse association between categorical variables	PSO-1,2,4,5 PO 1,2,4,7	Analyse	C,M	L	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PSO5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO 1	3						3							
CO 2	2	1		1	1		3	3		1	0		1	0
CO 3	2	1		1	1		3	3		1	0		1	0

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High
3	Substantial / High

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Examination
- Practical Evaluation
- End Semester Examinations

Mapping of COs to Assessment Rubrics :

	Internal Exam	Quiz / Assignment/ Discussion / Seminar	Practical Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓

University of Kerala

Discipline	STATISTICS
Course Code	UK6DSESTA302
Course Title	QUEUING THEORY
Type of Course	**DSE**
Semester	VI
Academic Level	300 – 399

Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites					

COURSE OUTCOMES

	Up on Completion of the course, students should be able to:	Cognitive level	PSO addressed
CO1	Describe the fundamentals of Queuing Theory	Understand	PSO-1
CO2	Illustrate MM1and MMS queuing models	Apply	PSO -1,3
CO3	Explain non Poisson Queuing Models	Understand	PSO-1,3

R-Remember, U-Understand, Ap -Apply, An-Analyse, E-Evaluate, C-Create

COURSE CONTENT

Module	Content	Hrs
I	**Queuing theory**	15
	Introduction to queuing theory, elements of a queuing system, operating characteristics, pure birth and death models, classification of queuing models, transient and steady state, Little's formula, Kolmogorov difference differential Equation	
II	**Markovian queuing model**	15
	Markovian queuing model- M|M|1 with infinite and finite channel capacity, expected system length, steady state probability, expected queue length, waiting time distribution in the queue and system.	
III	**M|M|S queue**	15
	M|M|S queue with infinite and finite channel capacity - steady state probability, Expected system length, Expected queue length, waiting time distribution in queue.	
IV	**Non-Poisson queuing system**	15
	Non-Poisson queuing system, Erlangian models, models with general arrival pattern - M|G|1 queuing model, Erlangian service time distribution with k phases,	

	embedded Markov chain, M|E$_k$|1 model, Erlang's formula and cost models in queuing.	

REFERENCES

1. Gross, D. and Hariss, C.M. (2009). Fundamentals of Queuing Theory, John Wiley & Sons.
2. Kanthi Swarup, Gupta, P.K, and Man Mohan (2012). Operations Research, Sulthan Chand & Sons.
3. Sharma, J.K. (2009). Operations Research Theory and Applications, Macmillan India Limited.
4. Medhi J (2014) Introduction to Queuing Systems and Applications, New Age International Publishers.
5. Mittal, K.V. and Mohan, C. (1996). Optimization Methods in Operations Research and System Analysis, New Age Publishers.
6. Paneerselvam, R. (2006). Operations Research, Prentice Hall of India.
7. Mustafi, C.K. (1996). Operations Research Methods and Practices. New Age International Publishers, New Delhi.

Name of the Course: QUEUING THEORY
Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO1	Describe the fundamentals of Queuing Theory	PSO-1 PO 1	Understand	F, C	L	
CO2	Illustrate MM1and MMS queuing models	PSO -1,3 PO 1,2	Apply	P	L	
CO3	Explain non Poisson Queuing Models	PSO-1,3 PO 1,2	Understand	P	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PSO5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	3						3					
CO 2	3		3				3	2				
CO 3	3		3				3	2				

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High
3	Substantial / High

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Examination
- Practical Evaluation
- End Semester Examinations

Mapping of COs to Assessment Rubrics :

	Internal Exam	Quiz / Assignment/ Discussion / Seminar	Practical Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓

<p align="center">**University of Kerala**</p>

Discipline	STATISTICS				
Course Code	UK6DSESTA303				
Course Title	RELIABILITY AND SURVIVAL ANALYSIS				
Type of Course	**DSE**				
Semester	VI				
Academic Level	300 – 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-		4
Pre-requisites					

COURSE OUTCOMES

	Up on Completion of the course, students should be able to:	Cognitive level	PSO addressed
CO1	Describe Reliability Concepts and System reliability	Understand	PSO-1
CO2	Determine reliability of lifetime distribution	Apply	PSO-1,3
CO3	Apply Likelihood Inference in censored data	Apply	PSO-1,3
CO4	Explain Regression Models and Competing Risks	Understand	PSO-1

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

COURSE CONTENT

Module	Content	Hrs
I	**Basic Reliability concepts**	15
	Basic Reliability concepts- system reliability, series and parallel systems, k out of n systems and its reliability, coherent system, reliability of coherent systems cuts and paths.	
II	**Reliability Functions**	15
	Survival function, Hazard function, mean residual function, mean time to failure. Reliability functions of exponential and gamma distribution. Notions of ageing- basic concepts on IFR, IFRA, NBU, and NBUE(definitions only).	
III	**Censoring**	15
	Censoring: Type I &Type II censoring. Likelihood Inference with Censored Data. Single sample methods, Life tables.	
IV	**Regression models**	15

	Regression models: covariates and their uses, Definition and interpretation of Cox's proportional hazard model and additive hazard model, their applications, and concept of competing risks.	

REFERENCES
1. Smith, P.J. (2002): Analysis of Failure and Survival Data. CRC.
2. Kleinbaum, D. G. and Klein, M. (2012). Survival Analysis: A Self-Learning Text, 3rd Ed, Springer, New York
3. Md. Rezaul Karim and M. Ataharul Islam (2019). Reliability and Survival Analysis, Springer,New York
4. Barlow, R. E. and Proschan, F. (1975): Statistical theory of reliability and life testing. Holt, Reinhart and Winston.
5. Lawless, J. F. (2003). Statistical models and methods for lifetime data. John Wiley & Sons.

Name of the Course: RELIABILITY AND SURVIVAL ANALYSIS
Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO1	Describe Reliability Concepts and System reliability	PSO-1 PO 1	Understand	F, C	L	
CO2	Determine reliability of lifetime distribution	PSO-1,3 PO 1,2	Apply	P	L	
CO3	Apply Likelihood Inference in censored data	PSO-1,3 PO 1,2	Apply	P	L	
CO4	Explain Regression Models and Competing Risks	PSO-1 PO1	Understand	C,P	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3						3							
CO2	1		3	0			1	2						
CO3	1		3	0			1	2						

CO 4	1					1							

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High
3	Substantial / High

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Examination
- Practical Evaluation
- End Semester Examinations

Mapping of COs to Assessment Rubrics :

	Internal Exam	Quiz / Assignment/ Discussion / Seminar	Practical Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓

University of Kerala

Discipline	STATISTICS (Specialisation in OR)				
Course Code	UK6DSESTA304				
Course Title	**DECISION AND GAME THEORY**				
Type of Course	**DSE**				
Semester	VI				
Academic Level	300 – 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites					

COURSE OUTCOMES

Up on completion of the course, students should be able to		Cognitive level	PSO Addressed
CO1	Explain the concept of decision and game theory for scientific study of strategic decision making.	Understand	PSO 1
CO2	Classify the decision making in uncertain cases	Analyse	PSO 3
CO3	Explain the concept of game problem	Understand	PSO 1
CO4	Apply various methods for solving a games	Apply	PSO 3,4

COURSE CONTENT

Module	Content	Hrs
I	**Introduction to Probability**	15
	Probability: Probability Axioms, independent events, Conditional Probability Random Variables: Discrete and continuous, Distribution function, pdf and pmf and their properties, Mathematical Expectation and its properties	
II	**Multidimensional Random Variable**	15
	Multidimensional Random Variable: Joint, Marginal and Conditional Distributions. Independent Random Variables. Conditional Expectation and Conditional Variance	
III	**Decision making**	15
	Decision making without and with experimentation. Decision Trees. Utility theory. Decision under risk: expected value, expected value - variance, aspiration - level, and most likely future criteria. Decision under uncertainty	

IV	Game Theory	15
	Concepts of Game problem. Two- person zero-sum game. Pure and Mixed strategies. Saddlepoint and its existence. Fundamental Theorem of Rectangular games. Concept of Dominance. Dominance and Graphical method of solving Rectangular games. Relationship between rectangular game and Linear Programming Problem. Solving rectangular game by Simplex method	

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REFERENCES

1. Kanti Swarup, Gupta, P. K and Manmohan. (1993). *Operations Research*. Sulthan Chand & Sons
2. Ravindran, A., Philips, D.T. and Solberg, J. (2007). Operations Research: Principles and Practice, John Wiley & Sons, New York.
3. Sharma, J.K. (2009). Operations Research Theory and Applications, Macmillan India Limited
4. Taha, H. A. (2010). Operations Research, Macmillan India Limited

Name of the Course: DECISION AND GAME THEORY
Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	Explain the concept of decision and game theory for scientific study of strategic decision making.	PO1, 2 PSO 1.	Understand		L	
2	Classify the decision making in uncertain cases	PO 2,7 PSO 3.	Analyse		L	
3	Explain the concept of game problem	PO1, 2 PSO 1.	Understand		L	
4	Apply various methods for solving a games	PO 2,3,6,7 PSO 3,4.	Apply		L	

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3						3	1						
CO2			3			-		3					1	-
CO3	1		3			-	1	3						-

CO 4			1	1			1	1				1	1	

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Examination
- Practical Evaluation
- End Semester Examinations

	Internal Exam	Assignment	Practical Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓

University of Kerala

Discipline	STATISTICS				
Course Code	UK6DSESTA305				
Course Title	**ORDER STATISTICS**				
Type of Course	**DSE**				
Semester	VI				
Academic Level	300 – 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-		4
Pre-requisites					

COURSE OUTCOMES

	Up on Completion of the course, students should be able to:	Cognitive level	PSO addressed
CO1	Describe the concept of Order Statistics and their probability distributions	Understand	PSO-1
CO2	Demonstrate computation moments of order statistics and their recurrence relations	Apply	PSO-1,3
CO3	Demonstrate the distribution theory of order statistics arising from specific probability distributions	Apply	PSO-1,3
CO4	Describe record values , concomitants and ranked set sampling	Understand	PSO-1

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

COURSE CONTENT

Module	Content	Hrs
I	**Order Statistics**	15
	Definition of Order Statistics, Example, Basic distribution theory: Distribution of single order statistic. Joint distribution of two or more order statistics, conditional distributions and Markov chain property. Distribution of median, range and mid-ranges.	
II	**Moments of order statistics**	15
	Moments of order statistics. Identities on the moments of order statistics, recurrence relations on the single and product moments of order statistics.	
III	**Order Statistics from special distributions**	15
	Order statistics from s uniform, exponential, normal , Weibull and logistic distributions	
IV	**Other Ordered Observations**	15

Record values, upper and lower record values(definition and examples only), Concomitants of order statistics (definition and examples only), Ranked set sampling (definition and examples only).		

Text Books

1.Arnold.B.C. and Balakrishnan.N(1989).Relations.Bounds and Approximations for order statistics. Lecture notes in Statistics No.53,Springer-Velag, New York.

2.Arnold,B.C., Balakrishnan,N. and Nagaraja.H.N.(1992).A first course in Order Statistics. John Wiley, New York.

3. David,H.A. and Nagaraja,H.N.(2003).Order statistics, 3rd edition, John Wiley , New York.

Name of the Course: Order Statistics
Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO1	Describe the concept of Order Statistics and their probability distributions	PSO-1 PO 1	Understand	F, C	L	
CO2	Demonstrate computation moments of order statistics and their recurrence relations	PSO-1,3 PO 1,2	Apply	P	L	P
CO3	Demonstrate the distribution theory of order statistics arising from specific probability distributions	PSO-1,3 PO 1,2	Apply	P	L	P
CO4	Describe record values , concomitants and ranked set sampling	PSO-1 PO 1	Understand	F	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
CO 1	3						3							
CO 2	1		3			-	1	3						-
CO 3	1		3			-	1	3						-
CO 4	3						3							

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High
3	Substantial / High

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Examination
- Practical Evaluation
- End Semester Examinations

Mapping of COs to Assessment Rubrics :

	Internal Exam	Quiz / Assignment/ Discussion / Seminar	Practical Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓

University of Kerala

Discipline	STATISTICS				
Course Code	UK6DSESTA306				
Course Title	**REGRESSION METHODS**				
Type of Course	**DSE**				
Semester	VI				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites					

COURSE OUTCOMES

	Up on Completion of the course, students should be able to:	Cognitive level	PSO addressed
CO1	Describe simple and multiple linear regression models and its assumptions.	Understand	PSO-1
CO2	Apply the principle of least squares method to estimate the parameters in simple and multiple linear regression models.	Apply	PSO-1,23,4
CO3	Demonstrate multi collinearity problem, autocorrelation and its consequences, residual analysis and residual plots.	Understand	PSO-1
CO4	Apply the strategy of variable selection and model building	Apply	PSO-1,2,3,4
CO5	Describe Poisson regression and logistic regression.	Understand	PSO-1

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create
COURSE CONTENT

Module	Content	Hrs
I	**Regression methods**	25
	Basic concepts of regression, identification of variables, models, regression models, fitting of models - principle of least squares, simple linear regression model, properties of least square estimators, significance test and confidence intervals, prediction problems, angle between the regression lines, coefficient of determination. Practical in R	
II	**Multiple linear regression models**	15
	Multiple linear regression models, least square estimation, properties of least square estimators, R^2 and adjusted R^2, hypothesis testing on regression parameters, ANOVA, interval estimation, prediction of new observations.	

III	**Multicollinearity and Auto Correlation**	15
	Problem of multicollinearity and auto correlation - meaning, sources and consequences, residual analysis- methods of scaling residuals, residual plots, partial residual plots, PRESS statistic.	
IV	**Polynomial regression**	20
	Polynomial regression, estimation and inference on structural parameters, indicator variables, uses of indicator variables, influential points (outliers and leverage), variable selection and model building strategy, basic concepts of Poisson regression and logistic regression. Practical in R	

REFERENCES:
1. Draper, N.R. and Smith, R. (2003). Applied Regression Analysis, John Wiley and Sons inc., New York
2. Gupta S. C. and Kapoor, V. K. (1984). Fundamentals of Mathematical Statistics. Sulthan Chand & Co. 3rd edition. New Delhi.
3. Montgomery, D. C., Peck, E.A. and Vining, G.G. (2003). Introduction to Linear Regression Analysis, John Wiley & Sons, Asia
4. Rao, C.R. (1973). Linear Statistical Inference and its Applications, Wiley, New York.
5. Seber, G.A.F. (1977). Linear Regression Analysis, John Wiley and Sons, New York

PRACTICAL/LABWORK
List of Practical worksheet
1. Use R to perform least squares estimation for linear regression models.
2. Calculate and interpret the estimated coefficients, standard errors, and confidence intervals
3. Use R to perform simple linear regression analysis on sample datasets.
4. implement polynomial regression models and visualize the results.

Name of the Course: REGRESSION METHODS
Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO1	Describe simple and multiple linear regression models and its assumptions.	PSO-1 PO 1	Understand	F, C	L	
CO2	Apply the principle of least squares method to estimate the parameters in simple	PSO-1,2,3,4 PO 1, 2 ,3	Apply	C, P	L	P

	and multiple linear regression models.					
CO3	Demonstrate multi collinearity problem, autocorrelation and its consequences, residual analysis and residual plots.	PSO-1 PO 1	Understand	F.C	L	P
CO4	Apply the strategy of variable selection and model building	PSO-1,2,3, PO 1,2	Apply	C,P	L	
CO5	Describe Poisson regression and logistic regression.	PSO-1 PO1	Understand	C	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PS O1	PS O2	PS O3	PS O4	PS O5	PS O6	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO 1	3						3							-
CO 2	1	1	3	3			1	3	3					-
CO 3	3						3							-
CO 4	2	1	2	-	-	-	2	3	-	-	-		-	-
CO 5	3						3							-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High
3	Substantial / High

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar

- Internal Examination
- Practical Evaluation
- End Semester Examinations

Mapping of COs to Assessment Rubrics :

	Internal Exam	Quiz / Assignment/ Discussion / Seminar	Practical Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓		✓
CO 4	✓	✓	✓	✓
CO 5	✓	✓	✓	✓

University of Kerala

Discipline	STATISTICS				
Course Code	UK6SECSTA301				
Course Title	STATISTICAL COMPUTING USING R				
Type of Course	SEC				
Semester	VI				
Academic Level	300 – 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	3	2 hours	-	2 hours	4
Pre-requisites					

COURSE OUTCOMES

Up on Completion of the course, students should be able to:		Cognitive level	PSO addressed
CO1	Analysis of basic designs -CRD, RBD, LSD in R	Analyse	PSO-1,2,3,4,5
CO2	Analyse index numbers in R.	Analyse	PSO-1,2,3,4,5
CO3	Demonstrate proficiency in constructing and interpreting control charts, chart using R.	Apply	PSO-1,2,3,4,5

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

COURSE CONTENT

Module	Content	Hrs
I	**Basic Designs in R**	15
	Design of Experiments: CRD,RBD,LSD Analysis using R, Analysis of one missing observation -: RBD,LSD	
II	**Index Numbers using R**	15
	Construction of price and quantity index numbers by Laspeyre's formula, Paasche's formula, Marshall-Edgeworth's formula, Fisher's Formula.Test on Index Numbers :Time reversal and Factor reversal .	
III	**Statistical Quality Control and Vital Statistics Using R**	15
	Construction and interpretation of X bar & R-chart, p-chart (fixed sample size) and c-chart. Computation of measures of mortality, measures of fertility and population growth, Completion of life table.	

PRACTICAL/LABWORK

List of Practical worksheet

1	Basic Designs
2	Index Numbers
3	Test On Index Numbers
4	Statistical Quality Control: X Bar & R Chart
5	P Chart & C Chart
6	Vital Statistics: Measures Of Mortality & Fertility
7	Population Growth
8	Life Table

REFERENCES
1. Dalgaard, P.(2008). *Introductory Statistics with R*, Springer, New York.
2. Kerns, G J. (2010). *Introduction to Probability and Statistics using R.* ISBN-10 : 0557249791
3. Lander J. P. (2017). *R for everyone* 2/e. Addison-Wesley Professional, U. S.
4. Michael J. Crawley (2013*). The R Book*, 2/e, Wiley, New York.
5. Purohit, S. G., Deshmukh, S.R., & Gore, S. D. (2008). *Statistics using R*. Alpha Science International, United Kingdom.

Web Resources:
1. https://cran.r-project.org
2. https://cran.r-project.org/manuals.html
3. https://www.r-project.org/other-docs.html
4. https://journal.r-project.org/
5. https://www.r-bloggers.com

Name of the Course: STATISTICAL COMPUTING USING R
Credits: 2:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO1	Analysis of basic designs - CRD, RBD, LSD in R.	PSO-1,2,3,4,5 PO-1,2,7	Analyse	C,P,M	L	P
CO2	Analyse index numbers in R.	PSO-1,2,3,4,5 PO-1,2,7	Analyze	C,P,M	L	P
CO3	Demonstrate proficiency in	PSO-1,2,3,4,5	Apply	C, M	L	P

	constructing and interpreting control charts, using R.	PO-1,2,7				

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO 1	3	3	2	3	2	-	2	2	-	-	-	-	3	-
CO 2	3	3	2	3	2	-	2	2	-	-	-	-	3	-
CO 3	3	3	2	3	2	-	2	2	-	-	-	-	3	-

Correlation Levels:

Lev el	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Examination
- Practical Evaluation
- End Semester Examinations

Mapping of COs to Assessment Rubrics :

	Internal Exam	Quiz / Assignment/ Discussion / Seminar	Practical Evaluation	End Semester Examinations
CO 1	✓	✓	✓	✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓	✓	✓

University of Kerala

Discipline	STATISTICS				
Course Code	UK6SECSTA302				
Course Title	STATISTICAL COMPUTING USING PYTHON				
Type of Course	SEC				
Semester	VI				
Academic Level	300 – 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	3	2 hours	-	2 hours	4
Pre-requisites					

COURSE OUTCOMES

	Up on Completion of the course, students should be able to:	Cognitive level	PSO addressed
CO1	Apply Python tools for descriptive measures	Apply	PSO-1,2,3,4,5
CO2	Apply Python functions for statistical distributions	Apply	PSO-1,2,3,4,5
CO3	Evaluation of hypotheses with Python.	Evaluate	PSO-1,2,3,4,5

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

COURSE CONTENT

Module	Content	Hrs
I	**Descriptive Statistics**	20
	Measure of Central Tendency- Calculate Mean, Median, mode using Python - numpy.mean(), numpy.median(), scipy.stats.mode(), Measure of Dispersion- Range, Standard Deviation and Variance with Python using numpy.ptp(), numpy.std(), numpy.var(), Coefficient of Variation.	
II	**Distributions**	20
	Discrete Distribution-Learn about Binomial Distribution and Poisson distribution generate random numbers using Python: numpy. random.binomial(), numpy.random.poisson(), Continuous Distribution- Understand about Normal Distribution and create visualizations using Python: numpy.random.normal().	
III	**Testing of Hypothesis**	20
	Normality Check using: scipy.stats.normaltest(), statsmodels.graphics. gofplots.qqplot(), shapiro(),Proportion Tests:Perform one-sample and two-sample	

proportion tests using Python: scipy.stats.binom_test(), statsmodels.stats.proportion.proportions_ztest(), z- test, t- test(paired and independent)- scipy.stats.zscore(),scipy.stats.ttest_1samp(),scipy.stats.ttest_ind(); Analyze different group designs (CRD, RBD)using- scipy.stats.f_oneway(), statsmodels.stats.anova.anova_lm()

PRACTICAL/LABWORK

List of Practical worksheet

1	Measure of Central Tendency
2	Measure of Dispersion
3	Probability Distributions - Binomial
4	Poisson Distribution
5	Normal Distribution
6	Testing of Hypothesis-Proportion Test
7	Z- test
8	t-test
9	One Way ANOVA
10	Two Way ANOVA

REFERENCES

1. An Introduction to Statistics with Python: With Applications in the Life Sciences (2022). Thomas Haslwanter
2. Peter Bruce, Andrew Bruce, and Peter Gedeck. *Practical Statistics for Data Scientists*. O'Reilly Media,2020
3. Wes Mckinney: *Python for Data Analysis-Data wrangling with Panda, Numpy and Jupter,* O'Reilly Media,2012.

Name of the Course: STATISTICAL COMPUTING USING PYTHON
Credits: 2:0:1(Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO1	Compute stats, simulate distributions, and conduct tests using Python.	PSO-1,2,3,4,5 PO-1,4,7	Apply	C,P	L	P
CO2	Analyze data effectively, make informed decisions, and communicate findings.	PSO-1,2,3,4,5 PO-1,4,7	Apply	C,P	L	P
CO3	Develop	PSO-	Evaluate	C, M	L	P

	expertise in Python for analyzing data statistically and interpreting.	1,2,3,4, 5 PO- 1,4,7				

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO 3	PO4	PO5	PO6	PO7	PO8
CO 1	3	3	2	3	2	-	2	-	-	2	-	-	3	-
CO 2	3	3	2	3	2	-	2	-	-	2	-	-	3	-
CO 3	3	3	2	3	2	-	2	-	-	2	-	-	3	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Examination
- Practical Evaluation
- End Semester Examinations

Mapping of COs to Assessment Rubrics :

	Internal Exam	Quiz / Assignment/ Discussion / Seminar	Practical Evaluation	End Semester Examinations
CO 1	✓	✓	✓	✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓	✓	✓

University of Kerala

Discipline	STATISTICS				
Course Code	UK7DSCSTA401				
Course Title	ADVANCED MULTIVARIATE METHODS				
Type of Course	**DSC**				
Semester	VII				
Academic Level	400 – 499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3hours	-	2 hours	5
Pre-requisites					

COURSE OUTCOMES

	Up on Completion of the course, students should be able to:	Cognitive level	PSO addressed
CO1	Explain the distribution of Wishart distribution and quadratic forms	Understand	PSO-1
CO2	Evaluate sampling distribution of sample mean vector and sample dispersion matrix	Evaluate	PSO-1,2
CO3	Perform test of hypothesis about mean vector, dispersion matrix and correlation coefficient	Apply	PSO-1,2,3,4
CO4	Classify multivariate data set	Analyse	PSO-1,2,3, 4,5
CO5	Perform exploratory factor analysis	Apply	PSO-1,2,3,4,5
CO6	Perform cluster analysis	Apply	PSO-1,2,3,4,5

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

COURSE CONTENT

Module	Content	Hrs
I	**Sampling from Multivariate Normal**	**12**
	Distribution of quadratic forms, Sampling from multivariate normal population, Sample mean vector and sample covariance matrix, maximum likelihood estimators of mean and covariance matrix. Sampling distribution of mean vector, Wishart distribution, distribution of sample covariance matrix.	
II	**Testing of Hypotheses**	**13**

	Tests of hypothesis about mean vector – single sample and two samples, Hotelling's T^2 and Mahalanobis' D^2, MANOVA, Profile analysis, Tests of significance of sample correlation coefficient and multiple correlation coefficient (derivation of sampling distributions not required) ,		
III	**Classification problems**	**10**	
	Classification problems: Classifying to one of k multivariate normal populations, Bayes' solution, Fisher's discriminant function, Definition of principal components-extraction of principal components, Definition and derivation of canonical variables and canonical correlation.		
IV	**Exploratory factor analysis**	**10**	
	Exploratory factor analysis – Orthogonal factor model, Estimation of loadings and communalities – principal component method and maximum likelihood method, Choice of number of factors, Factor rotation, Application of factor analysis**.** Cluster analysis – measures of similarity and dissimilarity, hierarchical clustering methods – nearest neighbour, farthest neighbour, average linkage, centroid, Dendrogram, Multidimensional scaling.		
V	**Practicum**	**30**	
	Practical based on these Module to be done using R package		

PRACTICAL/LABWORK
List of Practical worksheets

1. Tests of hypotheses for the parameters of a multivariate normal distribution (one sample and two sample problems).
2. Carry out MANOVA
3. Tests of significance of sample correlation coefficient and multiple correlation coefficient.
4. Carry out principal component analysis.
5. Carry out factor analysis
6. Carry out cluster analysis

REFERENCES

1. Anderson, T.W. (2003). An Introduction to Multivariate Statistical Analysis, John Wiley, New York.
2. Johnson, R.A. and Wichern, D.W. (1992). Applied Multivariate Statistical Analysis, 3rd edn., Prentice- Hall, London.
3. Muirhead, R.J. (1982). Aspects of Multivariate Statistical Theory, John Wiley, New York.
4. Rencher A.C. and Christensen W.F. (2012), Methods of Multivariate Analysis, Third Edition, Wiley, New York.
5. Crawley, M. J. (2012). The R book. John Wiley & Sons.

Name of the Course: ADVANCED MULTIVARIATE METHODS Credits: 3:0:1
(Lecture: Tutorial: Practical)

No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)

CO1	Explain the distribution of Wishart distribution and quadratic forms	PSO-1 PO 1	Understand	F	L	
CO2	Evaluate sampling distribution of sample mean vector and sample dispersion matrix	PSO-1,2 PO 1	Evaluate	P	L	P
CO3	Perform test of hypothesis about mean vector, dispersion matrix and correlation coefficient	PSO-1,2,3,4 PO 1,4, 7	Apply	P	L	P
CO4	Classify multivariate data set	PSO-1,2,3, 4,5 PO 1 2 3 7	Analyse	P	L	P
CO5	Perform exploratory factor analysis	PSO-1,2,3,4,5 PO 1 2 3 7	Apply	C,P	L	P
CO6	Perform cluster analysis	PSO-1,2,3,4,5 PO 1 2 3 7	Apply	C,P	L	p

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO 1	3	-		-	-	-	1		-	-	-	-		

CO 2	2	1	-		-	-	1		-	-	-	-	
CO 3	2	2	1	1	1		3	-		1	-		1
CO 4	2	3	1	3	-	-	1	1	1	-	-	-	1
CO 5	2	3	1	3	-	-	1	1	1	-	-	-	1
CO 6	2	3	1	3	-	-	1	1	1	-	-	-	1

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Exam
- Practical Evaluation
- End Semester Examination

Mapping of COs to Assessment Rubrics :

	Internal Exam	Quiz / Assignment/ Discussion / Seminar	Practical Evaluation	End Semester Examination
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓	✓	✓
CO5	✓	✓	✓	✓
CO6	✓	✓	✓	✓

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University of Kerala
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Discipline	STATISTICS				
Course Code	UK7DSCSTA402				
Course Title	STOCHASTIC PROCESS				
Type of Course	**DSC**				
Semester	VII				
Academic Level	400 – 499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites					

COURSE OUTCOMES

	Up on Completion of the course, students should be able to:	Cognitive level	PSO addressed
CO1	Explain the concepts of stochastic processes	Understand	PSO-1
CO2	classify various types of stochastic processes, such as Markov chains and Poisson processes, and understand their properties and distributions.	Analyse	PSO-1,2,3
CO3	Determine the pgf of branching process and probability of ultimate extinction	Evaluate	PSO 1,2,3
CO4	Explain renewal process theory	Understand	PSO-1

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

COURSE CONTENT

Module	Content	Hrs
I	**Introduction to stochastic processes**	**15**
	Collection of random variables, joint probability distributions, consistency theorem (statement only), probability generating function, distribution of sum of random variables, conditional distributions and conditional expectation, Introduction to stochastic processes - time and state space, classification of stochastic processes, processes with independent increments, Stationary processes-definition and examples, Gaussian process, Martingales, Markov process.	
II	**Markov chain**	**15**
	Markov chain, transition probabilities and stationary transition probabilities, transition probability matrix, Chapman - Kolmogorov equation: classification of	

		states, first passage time distribution, stationary distribution, irreducible Markov chain, aperiodic chain, ergodic theorem.	
III	**Poisson process**		**15**
	Poisson process - Properties of Poisson process and related distributions, compound Poisson process, pure birth process, birth immigration process, time dependent Poisson process, pure death process and birth and death process.		
IV	**Renewal process & branching process**		**15**
	Renewal process - definition and examples, renewal function and renewal density, renewal equation, statement and applications of renewal theorems, stopping time, Wald's equation, residual and excess life times, backward and forward recurrence times, Poisson process as a renewal process, branching process - definitions and examples, generating function of branching process, Galton - Watson branching process, probability of ultimate extinction, distribution of total number of progeny		

.

Text books:
1. Karlin, S. and Taylor, H.M. (1975). A First Course in Stochastic Processes, Academic Press.
2. Medhi, J. (2009). Stochastic Processes, New Age International Publishers, New Delhi.
3. Bhat, B. R. (2004). Stochastic models: analysis and applications. New Age International.
4. Ross, S. M. (1995). Stochastic processes. John Wiley & Sons.

Name of the Course: Stochastic process **Credits: 4:0:0 (Lecture: Tutorial: Practical)**

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO1	Explain the concepts of stochastic processes	PSO-1 PO 1	Understand	C, P	L	
CO2	classify various types of stochastic processes, such as Markov chains and Poisson processes, and understand their properties and distributions.	PSO-1,2,3 PO 1, 3	Analyse	C, M	L	
CO3	Determine the pgf of branching process and probability of ultimate extinction	PSO 1,2,3 PO 1,2, 3	Evaluate	P, C	L	

CO4	Explain renewal process theory	PSO-1 PO 1	Understand	C, M		L		

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	3		-	-	-	-	1		-	-	-	-
CO 2	3	3	3	-	-	-	1		2	-	-	-
CO 3	3	3	3	-	-	-	1	1	2	-	-	-
CO 4	3		-	-	-	-	1		-	3	-	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Internal Exam
- Practical Evaluation
- End Semester Examination

Mapping of COs to Assessment Rubrics :

CO	Internal Exam	Quiz / Assignment/ Discussion / Seminar	Practical Evaluation	End Semester Examination
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓

University of Kerala

Discipline	STATISTICS				
Course Code	UK7DSCSTA301				
Course Title	STATISTICS AND RESEARCH METHODOLOGY				
Type of Course	**DSC**				
Semester	VII				
Academic Level	300 – 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites					

COURSE OUTCOMES

	Up on Completion of the course, students should be able to:	Cognitive level	PSO addressed
CO1	Explain the concepts & objectives of research and formulation of research process and Learn about report writing	U	PSO-1,3,4,5,6
CO2	Describe the role of statistics in research	U	PSO-1,3,5,6
CO3	Design a questionnaire & conduct sample survey and design a research design	Ap	PSO-2,3
CO4	Explain basic concepts of testing of hypothesis	Ap	PSO-2,3

R-Remember, U-Understand, Ap -Apply, An-Analyse, E-Evaluate, C-Create

COURSE CONTENT

Module	Content	Hrs
I	**Introduction to Research**	15
	Concept and objectives of research, types of research, research methods v/s research methodology, steps involved in scientific research, flow chart of research process, formulation of research problems, literature survey, formulation of hypothesis, preparation of research design/research plan. Variables-definition, discrete and continuous, qualitative and quantitative, subjective and objective, dependent and independent. Measurement and scaling - motivation of scaling, different types of scaling - nominal, ordinal, interval and ratio, caling of rates and ranks, scaling of judgements. Data - definition, univariate, bivariate and multivariate, cross-sectional and time series.	
II	**Statistics and Research**	15

		Definition of statistics, role of statistics in research methodology, primary and secondary data, population and sample, sampling frame, census and sampling surveys, methods of collecting primary data, observational method, interview method, questionnaire and schedule method, local correspondents methods. Designing a questionnaire and schedule, collection of secondary data, selection of appropriate method for data collection. Sampling design, various types of sampling designs, sampling and non-sampling errors, selection of sample size, steps in sampling design, collection of data, scrutiny of data.	
III	**Analysis Tools**		**15**
	Representation of data, classification and tabulation, bar chart, pie chart, histogram, box plot, stem and leaf diagram, frequency curve, scatter plots. Descriptive measures - mean, standard deviation, testing of hypothesis, hypothesis, types of errors, p value, one tailed and two tailed test (Basic Concepts only, No Problem) ,Interpretation of results.		
IV	**Report writing**		**15**
	Report writing-meaning of interpretation, need of interpretation types of report, different steps in report writing, lay out of research report, precautions for writing research reports.		

REFERENCES
1. Kothari, C. R. (2001). Research Methodology-Methods and Techniques, 2nd Ed. Viswa Prakashan, New Delhi.
2. PANNEERSELVAM, R. (2014). Research methodology. PHI Learning Pvt. Ltd.
3. Singh, Y. K. (2006). Fundamental of research methodology and statistics. New Age International.
4. Bairagi, V., & Munot, M. V. (Eds.). (2019). Research methodology: A practical and scientific approach. CRC Press.

Name of the Course: STATISTICS AND RESEARCH METHODOLOGY
Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO1	Explain the concepts & objectives of research and formulation of research process and Learn about report writing	PSO-1,3,4,5,6 PO-1,2,6,8	U	F, C	L	
CO2	Describe the role of statistics in research	PSO-1,3,5,6 PO-1,3	U	F	L	

CO3	Design a questionnaire & conduct sample survey and design a research design	PSO-2,3 PO- 3,6	Ap	P	L	
CO4	Explain basic concepts of testing of hypothesis	PSO-2,3 PO- 3,6	Ap	P	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	1	3	3	3	3	3	2	-	-	-	3	-	8
CO2	3	1	3		3	3	3	1	3	-	-	-	2	1
CO3	1	3	3	1	-	-	-	2	3	1	1	3	1	1
CO4	1	3	3	1	1	-	1	1	3	0	0	3	1	0

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Exam
- Practical Evaluation
- End Semester Examination

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Practical Evaluation	End Semester Examination
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓

University of Kerala

Discipline	STATISTICS				
Course Code	UK7DSCSTA302				
Course Title	STATISTICAL INFERENCE				
Type of Course	**DSC**				
Semester	VII				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites					

COURSE OUTCOMES

	Up on Completion of the course, students should be able to:	Cognitive level	PSO addressed
CO1	Proficient in concepts related to Confidence interval and statistical hypotheses	Ap	PSO-3
CO2	Exhibit proficiency in conducting large sample tests	An,E	PSO-2,3,4
CO3	Demonstrate mastery of Tests of Significance and ANOVA	An,E	PSO-2,3,4
CO4	Exhibit proficiency in Non-Parametric Tests and Measurement Scales	An,E	PSO-2,3,4

R-Remember, U-Understand , Ap-Apply, An-Analyse, E-Evaluate , C-Create

COURSE CONTENT

Module	Content	Hrs
I	**Confidence intervals**	10
	Concept of Confidence intervals, confidence intervals for the parameters of a normal distribution- one sample and two sample problems (Derivation not required). Concepts of statistical hypotheses, Null and Alternative hypothesis, Critical region, two types of errors, Level of significance and Power of a test. One and two tailed tests. P-value, Neyman-Pearson's approach of testing of hypothesis (concept only).	
II	**Large sample tests**	10
	Large sample tests for single sample mean, difference of means, single sample proportion, difference of proportions. Test for specified variance, chi-square test of goodness of fit and test for independence of attributes (rxs, 2xk and 2x2 contingency tables).	
III	**Small sample tests**	15
	Tests of significance based on student's - t – t-test for single sample specified mean, difference of means for independent and related samples, sample	

		correlation coefficient. F - test for equality of population variances. ANOVA-One way and two way		
IV	**. Non-parametric tests**		**10**
	Measurement scale - nominal, ordinal, interval and ratio. Non-parametric tests: One sample runs test, sign test and Wilcoxon-signed rank tests (single and paired samples). Two independent sample tests: Median test, Wilcoxon –Mann-Whitney U test, Wald Wolfowitz's runs test, Kruskall Walli's test, Friedman est.		
V	**Practicum**		**30**
	Practical based on Modules I to IV. Practical is to be done using R package.		

PRACTICAL/LABWORK
List of Practical worksheets (to be done using statistical software.)

7. Tests of hypotheses for the parameters of a normal distribution (one sample and two sample problems).
8. Chi-square tests of association.
9. Chi-square test of goodness-of-fit.
10. Test for correlation coefficient.
11. Sign test for median.
12. Wilcoxon two-sample test.
13. Analysis of Variance of a one-way classified data
14. Analysis of Variance of a two-way classified data.

REFERENCES

1. Goon, A.M, Gupta, M.K and Das Gupta (1994). An outline of statistical theory Vol-I, World Press Calcutta.
2. Gupta, S.C and Kapoor, V.K (2002). Fundamentals of Mathematical Statistics, Sultan Chands.
3. Hogg, R.V., Craig, A.J. (2011). Introduction to Mathematical Statistics, 4thedition, Collier McMillan.
 4. Mood, A.M, Graybill, F.A. and Bose, D.P. (1972). Introduction to theory of statistics, 3rdedition–Mc Graw Hill.
 5. Rohatgi, V.K. (1984). An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern, New York.
 6. Rohatgi, V.K and Saleh, A.K. MD. (2001). An Introduction to Probability and Statistics, 2ndedition. John Wiley & Sons, Inc., New York.
7. Wilks, S.S(1962). Mathematical Statistics, John Wiley, New York.

Name of the Course: Statistical Inference **Credits: 4:0:0 (Lecture:Tutorial:Practical)**

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO1	Proficient in concepts related to Confidence interval and statistical	PSO-3 PO-1	Ap	F, C	L	P

	hypotheses				
CO2	Exhibit proficiency in conducting large sample tests	PSO-2,3,4	An,E	P	L	P
CO3	Demonstrate mastery of Tests of Significance and ANOVA	PSO-2,3,4	An,E	P	L	P
CO4	Exhibit proficiency in Non-Parametric Tests and Measurement Scales	PSO-2,3,4	An,E	P	L	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PS O1	PS O2	PS O3	PS O4	PS O5	PS O6	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO 1	3	2	2	2	-	-	3	2	2	-	-	2	1	-
CO 2	2	3	3	3	1	-	3	3	3	1	-	3	2	-
CO 3	2	3	3	3	1	-	3	3	3	1	-	3	2	-
CO 4	2	3	3	3	1	-	3	3	3	1	-	3	2	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Internal Exam
- Practical Evaluation
- End Semester Examination

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Practical Evaluation	End Semester Examination
CO 1	✓		✓	✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓	✓	✓
CO 4	✓	✓	✓	✓

University of Kerala

Discipline	STATISTICS				
Course Code	UK7DSCSTA303				
Course Title	TIME SERIES ANALYSIS				
Type of Course	**DSC**				
Semester	VII				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites					

COURSE OUTCOMES

	Up on Completion of the course, students should be able to:	Cognitive level	PSO addressed
CO1	Explain the concept of Time series	Understand	PSO1,2
CO2	Calculate various time series models	Apply	PSO 1,2,3,4,5
CO3	Apply various forecasting methods	Evaluate	PSO 1,2,3,4,5
CO4	Explain the concept of ARMA and ARIMA models.	Understand	PSO 1,2

COURSE CONTENT

Module	Content	Hrs
I	**Time Series**	15
	Time Series and their Features, examples of time series, objectives of time series analysis, types of variation, stationarity of time series, auto correlation and partial auto correlations (without mathematical details), and their interpretations, Concept and uses of forecasting, process of forecasting,	
II	**Basic statistical tools for time series modelling**	20
	Basic statistical tools for time series modelling: Graphical Displays, Time Series Plots, Plotting Smoothed Data, Numerical Description of Time Series Data, Use of Data Transformations and Adjustments, some commonly used transformation techniques, trend and seasonal adjustments (without mathematical details), General Approach to Time Series Modeling and Forecasting, Evaluating and Monitoring Forecasting Model Performance, Practical based on Modules I to IV. Practical is to be done using R package.	

III	**Time Series Models**	20
	Models: Concept of method of least squares, regression models for general time series data, detection of auto-correlation, Durbin-Watson test (application only), forecasting methods based on averaging, exponential smoothing for trend, exponential Smoothing Adjusted for Trend and Seasonal Variation. . Practical is to be done using R package.	
IV	**ARIMA modelling**	20
	ARIMA modelling: Introduction to ARMA and ARIMA models (without mathematical details), modelling procedures with ARMA, ARIMA models and Seasonal ARIMA models, model selection criteria, Practical is to be done using R package.	

PRACTICAL/LABWORK
List of Practical worksheets (to be done using statistical software.)

1. Time Series Data Cleaning, Loading and Handling Times series data, Pre-processing Techniques
2. Checking stationarity of time series, making a time series stationary
3. Estimation and elimination of trend (e.g.: aggregation, smoothing) elimination of trend and seasonality (differencing, decomposition).
4. Modelling time series using moving average, exponential smoothing, ARIMA and SARIMA.

REFERENCES

1. Douglas C. Montgomery, Cheryl L. Jen(2015) Introduction To Time Series Analysis And Forecasting, 2nd Edition, Wiley Series In Probability And Statistics,.
2. Chris Chatfield, and Haipeng Xing (2019) The Analysis of Time Series: An Introduction with R. CRC Press, London.
3. Box, G.E.P., Jenkins G.M. and Reinsel, G.C. (2007) Time Series Analysis, Forecasting and Control, Pearson Education.
4. Brockwell,P J. and David R. A. (2002). Introduction to time series and forecasting, 2nd edition, Springer.

Name of the Course: TIME SERIES ANALYSIS
Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO1	Explain the concept of Time series	PSO1,2 PO 1	Understand	F, C	L	
CO2	Calculate various time series models	PSO 1,2,3,4,5 PO	Apply	P	L	P

		1,2,6,7				P
CO3	Apply various forecasting methods	PSO 1,2,3,4,5 PO 1,2,6,7	Evaluate	P	L	
CO4	Explain the concept of ARMA and ARIMA models.	PSO 1,2 PO 1	Understand	C	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO 1	3	2		-	-	-	3	2	2	-	-	2	-	-
CO 2	2	3	3	2	1	-	2	3	3	-	-	2	1	-
CO 3	2	3	3	2	1	-	2	3		-	-	2	1	-
CO 4	3	2		-	-	-	3						-	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Exam
- Practical Evaluation
- End Semester Examination

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Practical Evaluation	End Semester Examination
CO 1	✓			✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓			✓

University of Kerala

Discipline	STATISTICS				
Course Code	UK7DSCSTA304				
Course Title	BASIC STATISTICAL TECHNIQUES FOR ALL DISCIPLINES				
Type of Course	**DSC**				
Semester	VII				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites					

COURSE OUTCOMES

	Up on Completion of the course, students should be able to:	Cognitive level	PSO addressed
CO1	Demonstrate mastery of techniques for analyzing univariate data	U	PSO-1
CO2	Exhibit proficiency in analyzing bivariate and multivariate data	E,C	PSO-3
CO3	Understanding of statistical inference and testing concepts	E,C	PSO-3
CO4	will exhibit proficiency in applying miscellaneous statistical tools	E,C	PSO-3

R-Remember, U-Understand , Ap-Apply, An-Analyse, E-Evaluate , C-Create

COURSE CONTENT

Module	Content	Hrs
I	**Techniques for univariate data**	15
	Techniques for univariate data: Variable, notion of population and sample, types of data, primary and secondary data, and their methods of collection, presentation of data, summary measures on data with central tendency (emphasis for arithmetic mean, median, mode), dispersion (emphasis for range, quartile deviation, standard deviation, coefficient of variation), ideas of skewness and kurtosis Practical is to be done using R package.	
II	**Techniques for bivariate and multivariate data**	20
	Techniques for bivariate and multivariate data: Paired data and concepts of different measures of associations (without mathematical details), primarily Pearson's correlation coefficient, Spearman's Rank correlation, measures of association of attributes through contingency table, two-variable linear	

		regression and multiple linear regression (without derivation of the regression coefficients' formulae). Practical is to be done using R package.	
III		**Statistical Inference**	**20**
		Statistical Inference (testing of hypothesis): Concept of normal population and its properties (without derivation), concept of statistical hypothesis, idea of test statistic and decision making in terms of critical value and p-value for some standard testing problems: test for normality, test of mean based on single (normal) sample, test on comparing means based on two-sample, and paired sample data. Practical is to be done using R package.	
IV		**Miscellaneous tools**	**20**
		Miscellaneous tools: Applications of one-way and two-way ANOVA (without derivation and details), Kruskal-Wallis test and Friedman Test (without derivation and details), sample size determination, estimate of population mean and variability for finite population, idea and application of logistic regression for binary response data . Practical is to be done using R package.	

PRACTICAL/LABWORK
List of Practical worksheets (to be done using statistical software.)

1. Measures of mean, median, mode, range, QD, SD, CV for univariate data case.
2. Fitting of linear regression on bivariate and on three-variable multivariate data.
3. measures of Pearson's correlation coefficients, Spearman's Rank correlation, measures of association of attributes through contingency table.
4. Tests of means for single sample, two-sample, and paired sample data
5. Applications of one way ANOVA, two way ANOVA, Kruskal-Wallis test and Friedman test.
6. Sample size determination, estimate of population mean and variability for finite population
7. Fitting of logistic regression for binary response data

REFERENCES
1. Gun, A.M., Gupta, M.K. and Dasgupta, B. (2008): Fundamentals of Statistics, Vol. I, 9th Edition World Press, Kolkata
2. Das, N.G.: Statistical Methods, Vol I, Tata McGraw Hill Pub. Co. Ltd
3. Johnson, R.A. and Wichern, D.W. Applied Multivariate Statistical Analysis, PHI.
4. Hardle W. and Simar, L. Applied Multivariate Statistical Analysis. Kutner, M.H. et.al., Applied Linear Statistical Models.
5. Belsley D.A. et.al., Regression Diagnostics.
6. Draper N.R. and Smith, H. Applied Regression Analysis.

Name of the Course: BASIC STATISTICAL TECHNIQUES FOR ALL DISCIPLINES
Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)

CO1	Demonstrate mastery of techniques for analyzing univariate data	PSO-1 PO-2	U	F, C	L	
CO2	Exhibit proficiency in analyzing bivariate and multivariate data	PSO-3 PO-6	E,C	M	L	P
CO3	Understanding of statistical inference and testing concepts	PSO-3 PO-3	E,C	M	L	P
CO4	will exhibit proficiency in applying miscellaneous statistical tools	PSO-3 PO-6	E,C	M	L	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3		3			-		3			-	3		-
CO2	3		3			-						3		-
CO3	3		3			-						3		-
CO4	3		3			-						3		-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Exam
- Practical Evaluation
- End Semester Examination

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Practical Evaluation	End Semester Examination
CO 1	✓	✓		✓
CO 2	✓	✓	✓	✓
CO 3	✓		✓	✓
CO 4	✓		✓	✓

University of Kerala

Discipline	STATISTICS
Course Code	UK7DSESTA401
Course Title	**ADVANCED DISTRIBUTION THEORY**
Type of Course	**DSE**
Semester	VII
Academic Level	400 - 499

Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites					

COURSE OUTCOMES

	Up on Completion of the course, students should be able to:	Cognitive level	PSO addressed
CO1	Illustrate various types of discrete and continuous distributions and a their properties	Analyse	PSO-1,2,3
CO2	Illustrate the properties and applications of sampling distributions	Analyse	PSO-1,2,3
CO3	Demonstrate the properties and applications of families of distributions	Apply	PSO-1,2

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

COURSE CONTENT

Module	Content	Hrs
I	**Univariate distributions**	15
	Univariate distributions: Binomial distribution, Poisson distribution,, Negative Binomial, Hyper-geometric distributions; Multinomial distributions.	
II	**Continuous distributions**	15
	Continuous distributions: Normal, Uniform, exponential, Beta, Gamma, Pareto, Weibull, Cauchy, Laplace, Logistic, Log-logistic, Log-normal, Rayleigh and Pearson family; Compound, truncated and mixture distributions, Gumbel's bivariate exponential distribution	
III	**Sampling distributions**	15
	Sampling distributions: Sampling distributions of the mean and variance from normal population, independence of mean and variance, Chi-square, students t and F distribution and their non-central forms- properties and applications	
IV	**Families of distributions**	15

	Families of distributions Power series, log modified power series, Logarithamic series, Pearson family and exponential family.	

REFERENCES

1. Fisz, M (1963) Probability Theory and Mathematical Statistics, 3rd Edition, John Wiley.
2. Hogg, R.V. and Craig, A.T.(1989) Introduction to Mathematical Statistics, Macmillan Publishing Company
3. Johnson, N.L. and Kotz,S. (1969) Distributions in Statistics; Discrete distributions. John Wiley and Sons, New York.
4. Johnson, N.L. Kotz,S. and Balakrishnan, N (1994) Continuous Univariate Distributions -1 ,2nd Edition John Wiley and Sons ,New York.
5. Johnson, N.L. and Kotz,S. (1995) Continuous Univariate Distributions -2 ,2nd Edition, John Wiley and Sons ,New York.
6. Rohatgi,V.K and Saleh.(2001). An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern Ltd.
7. Gumbel,E,J(1960) Bivariate exponential distribution,JASA,Vol 55,PP698-707
8. MATHEMATICAL STATISTICS (HONS. M.SC).. (2012). India: BOOKS & ALLIED Limited.

Name of the Course: Advanced Distribution Theory,
Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO1	Illustrate various types of discrete and continuous distributions and a their properties	PSO-1,2,3 PO1,2,6	Analyse	C,P	L	
CO2	Illustrate the properties and applications of sampling distributions	PSO-1,2,3 PO 1 2 6	Analyse	C,P	L	
CO3	Demonstrate the properties and applications of families of distributions	PSO-1,2 PO 1	Apply	P	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	3	2	-	-	-	3	2		-	-	2	-	-

CO 2	2	3	2	-	-	-	3	2		-	-	2	-	-
CO 3	2	3		-	-	-	3			-	-		-	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High
3	Substantial / High

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Examination
- Practical Evaluation
- End Semester Examinations

Mapping of COs to Assessment Rubrics :

	Internal Exam	Quiz / Assignment/ Discussion / Seminar	Practical Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓

University of Kerala

Discipline	STATISTICS				
Course Code	UK7DSESTA402				
Course Title	**ADVANCED PROBABILITY THEORY**				
Type of Course	**DSE**				
Semester	VII				
Academic Level	400 - 499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites					

COURSE OUTCOMES

	Up on Completion of the course, students should be able to:	Cognitive level	PSO addressed
CO1	Demonstrate properties of Probability Measure and distribution function	Apply	PSO 1, 3
CO2	Present Properties of expectation and various inequalities	Apply	PSO-1, 3
CO3	Demonstrate the concept of convergence of sequences of random variables	Apply	PSO-1,3
CO4	Apply the weak and strong laws of large numbers to sequences of random variables	Apply	PSO-1,3
CO5	Illustrate whether CLT holds for a given sequence of random variables	Analyse	PSO-1,3

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

COURSE CONTENT

Module	Content	Hrs
I	**Probability measure**	15
	Probability space, limit of sequence of events, monotone and continuity properties of probability measure, addition theorem, independence of finite number of events, sequence of events, Borel Cantelli lemma, Borel zero one law. Random variable, its probability distribution and distribution function, properties of distribution function, decomposition of distribution function, discrete and continuous type random variables, discrete and continuous and other types of distributions.	
II	**Mathematical expectation**	15
	Mathematical expectation, moments of random variables, random vectors, independence of random variables and sequence of random variables, Markov, Chebyshev's and Lyapounov inequalities. Characteristic function and their elementary properties, uniform continuity and nonnegative definiteness of	

		characteristic function, characteristic function and moments, inversion theorem (proof not required), uniqueness theorem, Fourier inversion theorem, continuity theorem, Bochner-Khintchine theorem of characteristic functions (proof not required).	
III	**Sequence of Random Variables**		**15**
	Stochastic convergence of sequence of random variables:- convergence in distribution, convergence in probability, almost sure convergence and convergence in the rth mean, their interrelationships, examples and counter examples.		
IV	**Convergence of series of random variables**		**15**
	Stochastic convergence of series of random variables:- Law of large numbers, weak law of large numbers: Bernoulli, Chebyshev and Khintchine, Kolmogorov inequality, strong law of large numbers: Kolmogorov- iid & non-iid cases (proof not required), central limit theorem: Classical, Demoiver-Laplace, Liapounov and Lindberg-Feller (without proof).		

REFERENCES

1. Bhat, B.R. (1985): Modern Probability Theory: An Introductory Text Book, 2nd edition, Wiley Eastern.
2. Chung. L. (2001): A Course in Probability Theory, Third Edition, Academic Press,
3. Feller, W. (1966) An Introduction to Probability Theory and Its Applications, Volume II, Wiley Eastern
4. Gnedenoko, B.V. (1969): The Theory of Probability, Mir Publishers, Moscow.
5. Laha, R.G. and Rohatgi, V.K. (1979) : Probability Theory, John Wiley, New York.
6. **Loeve, M. (1968): Probability Theory, D.Van Nostrand Co.Inc., Princeton, New Jersey.**

Name of the Course: Advanced Probability Theory,
Credits: 4:0:0(Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO1	Demonstrate properties of Probability Measure and distribution function	PSO 1, 3 PO 1,2	Apply	C	L	
CO2	Present Properties of expectation and various inequalities	PSO-1, 3 PO 1,2	Apply	C	L	
CO3	Demonstrate the concept of convergence of sequences of random variables	PSO-1,3 PO 1,2	Apply	P	L	

CO4	Apply the weak and strong laws of large numbers to sequences of random variables	PSO-1,3 PO 1,2	Apply	P		L		
CO5	Illustrate whether CLT holds for a given sequence of random variables	PSO-1,3 PO 1,2	Analyse	P		L		

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO 1	1		3				3	3					-	-
CO 2	1		3				3	3					-	-
CO 3	1		3				3	3					-	-
CO 4	1		-				3	3					-	-
CO 5	2		1				3	3					-	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Examination
- Practical Evaluation
- End Semester Examinations

Mapping of COs to Assessment Rubrics :

	Internal Exam	Quiz / Assignment/ Discussion / Seminar	Practical Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓	✓	✓
CO 5	✓	✓	✓	✓

University of Kerala

Discipline	STATISTICS(Specialisation in OR)				
Course Code	UK7DSESTA403				
Course Title	**INVENTORY MANAGEMENT AND QUEUING THEORY**				
Type of Course	**DSE**				
Semester	VII				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites					

COURSE OUTCOMES

Up on completion of the course, students should be able to		Cognitive level	PSO Addressed
CO1	Explain the concept of fundamental issues in production and inventory planning and control and at the same time	Understand	PSO 1
CO2	Describe the concept of queuing theory	Understand	PSO 1
CO3	Apply different inventory models	Apply	PSO 3,4
CO4	Apply various queuing models	Apply	PSO 3,4

COURSE CONTENT

Module	Content	Hrs
I	**Random Variable**	15
	Discrete Random Variables (Binomial, Poisson and Geometric). Continuous Random Variables (Normal, Exponential, Uniform and Gamma).	
II	**Inventory models**	15
	Type of inventory models, inventory decisions**,** Different costs in inventory system, classification of inventory models, The concept of Economic ordering quantity (EOQ) model (withand without shortages), EOQ with finite supply (with and without shortages), EOQ with backorders, Determination of reorder point for all the models. Multi-item EOQ model with constraints, All-unit quantity discount model.	
III	**Inventory models with uncertain demand**	15
	Inventory models with uncertain demand, models with discrete and continuous cases, Single period probabilistic inventory models with discrete and continuous demand. Multi-period probabilistic models with	

IV	**Queueing Systems**	15
	constant lead time.	
	Queueing Systems: General concepts of a queueing system, transient and steady states, classification of queuing models, solution of queuing models, (M/M/1): (∞|SIRO) model, Erlang model, M/M/1): (N|FCFS) model, (M/M/s): (∞|FCFS) model, , (M/M/s): (N|FCFS) model, (M/M/s): (S|FCFS) model,	

REFERENCES

1. Kanti Swarup, Gupta, P. K and Manmohan. (1993). *Operations Research*. Sulthan Chand & Sons
2. Ravindran, A., Philips, D.T. and Solberg, J. (2007). Operations Research: Principles and Practice, John Wiley & Sons, New York.
3. Sharma, J.K. (2009). Operations Research Theory and Applications, Macmillan India Limited
4. Taha, H. A. (2010). Operations Research, Macmillan India Limited

Name of the Course: INVENTORY MANAGEMENT AND QUEUING THEORY, Credits: 4:0:0(Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	Explain the concept of fundamental issues in production and inventory planning and control and at the same time.	PO1, 2 PSO 1.	Understand		L	
2	Describe the concept of queuing theory	PO 1,2 PSO 1	Understand		L	
3	Apply different inventory models	PO 2,3,6,7 PSO 3,4	Apply		L	
4	Apply various queuing models	PO 2,3,6,7 PSO 3,4.	Apply		L	

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	1						3	3					-	-
CO2	1						3	3					-	-
CO3			3	1				3	1			1	1	-

CO 4			1	1				3	1			1	1	-

Assessment Rubrics:
- Quiz / Assignment/ Discussion / Seminar
- Internal Examination
- Practical Evaluation
- End Semester Examinations

	Internal Exam	Assignment	Practical Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓