Course Structure for F.Y.B.Sc. (Computer Science) Statistics
As per NEP 2.0 (2024 Pattern)

Sem.	Course Type	Course Code	Course Name	Theory / Practical	Credits
I	DSC-III (General)	COSST-101-GEN	Descriptive Statistics	Theory	02
	DSC-III (General)	COSST-102-GEN	Statistics Practical-I	Practical	02
II	DSC-III (General)	COSST-151-GEN	Statistical Methods	Theory	02
	DSC-III (General)	COSST-152-GEN	Statistics Practical-II	Practical	02

CBCS Syllabus as per NEP 2.0 for F.Y.B.Sc. (Computer Science) (2024 Pattern)

Name of the Programme : B.Sc. (Computer Science)

Programme Code : USCOS

Class : F.Y.B.Sc. (Computer Science)

Semester : I

Course Type : Major Mandatory (Theory)

Course Code : COSST-101-GEN

Course Title : Descriptive Statistics

No. of Credits : 02

No. of Teaching Hours : 30

Course Objectives:

The students will acquire knowledge about the;

CO1. Students will develop a strong foundation to analyze and interpret data in various fields.

CO2. Compute various measures of central tendency and dispersion.

CO3. Summarize data using frequency distributions and graphical representations.

CO4. Gain knowledge of different types of data.

CO5. Acquire proficiency in calculating and interpreting various quantiles.

CO6. Develop critical thinking and problem-solving skills by applying descriptive statistics techniques to real-world scenarios and data sets.

CO7. Develop effective written and oral communication skills to present and explain descriptive statistics results clearly and accurately.

TOPICS/CONTENTS:

UNIT 1: Data Representation (8L)

1.1 Definition, importance, scope and limitations of statistics.

1.2 Scales of measurements: Nominal, Ordinal, Interval & Ratio.

1.3 Data Condensation: Types of data (Primary and secondary), Attributes and Variables, Discrete and Continuous variables, classification and construction of frequency distribution.

1.4 Graphical Representation: Histogram, Frequency polygon, Frequency curve, Ogive Curves, Steam and leaf chart.

1.5 Numerical problems related to real life situations.

UNIT 2: Measures of central tendency (8L)

2.1 Concept of central tendency, requisites of good measures of central tendency.

2.2 Arithmetic mean: Definition, computation for ungrouped and grouped data, combined mean, weighted mean, merits and demerits.

2.3 Median and Mode: Definition, formula for computation for ungrouped and grouped data, graphical method, merits and demerits. Empirical relation between mean, median and mode. (without proof)

2.4 Partition Values: Quartiles, Percentiles, Deciles, Box Plot.

2.5 Numerical problems related to real life situations.

UNIT 3: Measures of Dispersion (6L)

3.1 Concept of dispersion and measures of dispersion, requisites of good measures of dispersion, absolute and relative measures of dispersion.

3.2 Range and Quartile Deviation: definition for ungrouped and grouped data and their coefficients, merits and demerits.

3.3 Variance and Standard deviation: definition for ungrouped and grouped data, coefficient of variation, combined variance & standard deviation, merits and demerits.

3.4 Numerical problems related to real life situations.

UNIT 4: Moments, Skewness and Kurtosis (8L)

4.1 Raw and central moments: definition for ungrouped and grouped data (only first four moments), relation between central and raw moments upto fourth order. (without proof)

4.2 Measures of Skewness: Types of skewness, Pearson's and Bowley's coefficient of skewness, Measures of skewness based on moments.

4.3 Measures of Kurtosis: Types of kurtosis, Measures of kurtosis based on moments

4.4 Numerical problems related to real life situations.

References:

1. Goon A. M., Gupta M. K., Das Gupta B. (1999): Fundamentals of Statistics, Vol.II, World Press, Calcutta.
2. Gupta and Kapoor: Fundamentals of Mathematical Statistics, Sultan Chand and Sons, New Delhi.
3. Sharma K. V. S. (2001) Statistics made it simple: Do it yourself on PC. Prentce Hall of India, New Delhi.
4. Gupta and Kapoor : Fundamentals of Applied Statistics, Sultan Chand and Sons, New Delhi.

Programme Outcomes and Course Outcomes Mapping:

CO-PO Mapping Table

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	2	1	3	3	2	2	2	2	1	1	2	1
CO2	3	2	1	3	3	2	2	2	2	1	1	2	1
CO3	3	2	1	3	3	2	2	2	2	1	1	2	1
CO4	2	1	1	2	3	2	2	2	1	1	1	2	1
CO5	2	2	1	2	3	2	2	2	1	1	1	2	1
CO6	3	2	2	3	3	2	2	3	2	1	1	2	1
CO7	2	2	1	2	3	3	2	2	2	1	1	2	1

This mapping table and the justifications show how each Course Outcome (CO) aligns with the Program Outcomes (POs) and the extent of their relationship.

Justification for Mapping PO and CO

PO1: Comprehensive Knowledge and Understanding

- **CO1 (3)**: Strongly related as analyzing and interpreting data requires a deep understanding of foundational concepts in statistics.
- **CO2 (3)**: Strongly related because computing measures of central tendency and dispersion is fundamental to understanding data.
- **CO3 (3)**: Strongly related due to the need to summarize data using foundational statistical methods.
- **CO4 (2)**: Moderately related as gaining knowledge of different types of data helps in broadening understanding.
- **CO5 (2)**: Moderately related as interpreting quantiles is a key statistical concept.
- **CO6 (3)**: Strongly related because critical thinking and problem-solving are essential for comprehensive understanding.
- **CO7 (2)**: Moderately related as communication skills help in explaining complex concepts.

PO2: Practical, Professional, and Procedural Knowledge

- **CO1 (2)**: Moderately related as practical skills in data analysis are developed.
- **CO2 (2)**: Moderately related due to the practical application of statistical measures.
- **CO3 (2)**: Moderately related as summarizing data is a practical skill in professional scenarios.
- **CO4 (1)**: Partially related as it provides foundational knowledge for practical applications.

- **CO5 (2)**: Moderately related as calculating and interpreting quantiles has practical applications.
- **CO6 (2)**: Moderately related due to the practical application of descriptive statistics.
- **CO7 (2)**: Moderately related because effective communication is a key professional skill.

PO3: Entrepreneurial Mindset and Knowledge

- **CO1 (1)**: Partially related as data analysis can help identify business opportunities.
- **CO2 (1)**: Partially related since understanding central tendencies can inform business decisions.
- **CO3 (1)**: Partially related as data summarization can help in understanding market trends.
- **CO4 (1)**: Partially related due to its relevance in business data analysis.
- **CO5 (1)**: Partially related as understanding quantiles can assist in risk assessment.
- **CO6 (2)**: Moderately related because critical thinking in data analysis can drive innovation.
- **CO7 (1)**: Partially related since clear communication of data analysis can support entrepreneurial activities.

PO4: Specialized Skills and Competencies

- **CO1 (3)**: Strongly related due to the specialized skill of data analysis.
- **CO2 (3)**: Strongly related as computing statistical measures is a specialized competency.
- **CO3 (3)**: Strongly related because summarizing data requires specialized knowledge.
- **CO4 (2)**: Moderately related due to the relevance of data types in specialized fields.
- **CO5 (2)**: Moderately related since interpreting quantiles requires specialized skills.
- **CO6 (3)**: Strongly related as critical thinking in data analysis is a specialized competency.
- **CO7 (2)**: Moderately related because communication of statistical results is a specialized skill.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning

- **CO1 (3)**: Strongly related due to the application of data analysis in problem-solving.
- **CO2 (3)**: Strongly related as computing statistical measures involves analytical reasoning.
- **CO3 (3)**: Strongly related because summarizing data helps in problem-solving.
- **CO4 (3)**: Strongly related due to the application of knowledge in various scenarios.
- **CO5 (3)**: Strongly related as calculating quantiles involves analytical reasoning.
- **CO6 (3)**: Strongly related because critical thinking is crucial for problem-solving.
- **CO7 (3)**: Strongly related since clear communication aids in analytical reasoning.

PO6: Communication Skills and Collaboration

- **CO1 (2)**: Moderately related as explaining data analysis results requires communication skills.
- **CO2 (2)**: Moderately related since communicating statistical measures is essential.
- **CO3 (2)**: Moderately related because summarizing data effectively requires communication.
- **CO4 (2)**: Moderately related as understanding data types aids in clear communication.
- **CO5 (2)**: Moderately related since interpreting quantiles needs effective communication.
- **CO6 (2)**: Moderately related due to the importance of communication in problem-solving.
- **CO7 (3)**: Strongly related because effective communication is crucial for presenting statistical results.

PO7: Research-related Skills

- **CO1 (2)**: Moderately related as data analysis is fundamental to research.
- **CO2 (2)**: Moderately related since statistical measures are used in research.
- **CO3 (2)**: Moderately related because summarizing data is part of research methodologies.
- **CO4 (2)**: Moderately related as knowledge of data types is important in research.
- **CO5 (2)**: Moderately related since interpreting quantiles is used in research analysis.
- **CO6 (2)**: Moderately related due to the application of descriptive statistics in research.
- **CO7 (2)**: Moderately related because clear communication is important in reporting research findings.

PO8: Learning How to Learn Skills

- **CO1 (2)**: Moderately related as data analysis fosters continuous learning.
- **CO2 (2)**: Moderately related since computing measures involves ongoing learning.
- **CO3 (2)**: Moderately related because summarizing data aids in learning.
- **CO4 (2)**: Moderately related as knowledge of data types encourages learning.
- **CO5 (2)**: Moderately related since interpreting quantiles requires learning.
- **CO6 (3)**: Strongly related because critical thinking and problem-solving are key to learning.
- **CO7 (2)**: Moderately related because communication skills aid in the learning process.

PO9: Digital and Technological Skills

- **CO1 (2)**: Moderately related as data analysis often uses digital tools.
- **CO2 (2)**: Moderately related since computing measures involves technology.
- **CO3 (2)**: Moderately related because summarizing data uses digital tools.
- **CO4 (1)**: Partially related as understanding data types can involve technology.
- **CO5 (1)**: Partially related since interpreting quantiles can use software.

- **CO6 (2)**: Moderately related due to the use of technology in problem-solving.
- **CO7 (2)**: Moderately related because communication often involves digital tools.

PO10: Multicultural Competence, Inclusive Spirit, and Empathy

- **CO1 (1)**: Partially related as data analysis can be used in multicultural studies.
- **CO2 (1)**: Partially related since understanding data can inform multicultural research.
- **CO3 (1)**: Partially related because summarizing data can include multicultural perspectives.
- **CO4 (1)**: Partially related as knowledge of data types is useful in diverse settings.
- **CO5 (1)**: Partially related since interpreting quantiles can be applied in multicultural contexts.
- **CO6 (1)**: Partially related due to the relevance of critical thinking in diverse environments.
- **CO7 (1)**: Partially related because communication is important in multicultural settings.

PO11: Value Inculcation and Environmental Awareness

- **CO1 (1)**: Partially related as data analysis can include environmental data.
- **CO2 (1)**: Partially related since statistical measures can be applied to environmental studies.
- **CO3 (1)**: Partially related because summarizing data can include ethical considerations.
- **CO4 (1)**: Partially related as knowledge of data types can include environmental data.
- **CO5 (1)**: Partially related since interpreting quantiles can be used in ethical analysis.
- **CO6 (1)**: Partially related due to the importance of critical thinking in ethical contexts.
- **CO7 (1)**: Partially related because communication can include ethical considerations.

PO12: Autonomy, Responsibility, and Accountability

- **CO1 (2)**: Moderately related as data analysis requires independent thinking.
- **CO2 (2)**: Moderately related since computing measures involves responsibility.
- **CO3 (2)**: Moderately related because summarizing data requires accountability.
- **CO4 (2)**: Moderately related as knowledge of data types fosters independent work.
- **CO5 (2)**: Moderately related since interpreting quantiles requires responsibility.
- **CO6 (2)**: Moderately related due to the importance of critical thinking in independent work.
- **CO7 (2)**: Moderately related because communication skills aid in accountability.

PO13: Community Engagement and Service

- **CO1 (1)**: Partially related as data analysis can be used in community projects.
- **CO2 (1)**: Partially related since statistical measures can inform community decisions.
- **CO3 (1)**: Partially related because summarizing data can benefit community studies.

- **CO4 (1)**: Partially related as knowledge of data types can support community research.
- **CO5 (1)**: Partially related since interpreting quantiles can be used in community service.
- **CO6 (1)**: Partially related due to the relevance of critical thinking in community projects.
- **CO7 (1)**: Partially related because communication can aid in community engagement.

CBCS Syllabus as per NEP 2.0 for F.Y.B.Sc. (Computer Science) (2024 Pattern)

Name of the Programme : B.Sc. (Computer Science)

Programme Code : USCOS

Class : F.Y.B.Sc. (Computer Science)

Semester : I

Course Type : Major Mandatory (Practical)

Course Code : COSST-102-GEN

Course Title : Statistics Practical-I

No. of Credits : 02

No. of Teaching Hours : 60

Course Objectives:

1) Students will develop a strong foundation to analyze and interpret data.
2) Compute various measures of central tendency and dispersion.
3) Summarize data using frequency distributions and graphical representations.
4) Acquire proficiency in calculating and interpreting various quantiles.
5) Understand the concept of sample spaces, events, probability, conditional probability including Bayes' theorem and independence of events.
6) Calculating and interpreting measures of central tendency (mean, median, mode) and dispersion (variance, standard deviation) for discrete random variables.
7) Computation of probabilities to solve real-world problems.

Course Outcome:

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

CO1. understand the fundamental concepts of descriptive statistics, including measures of central tendency and measures of dispersion.

CO2. utilize appropriate graphical representations and descriptive statistics measures to present and interpret data.

CO3. utilize probability and discrete probability distributions to solve practical problems.

CO4. utilize probability distributions to calculate probabilities of outcomes.

CO5. to perform data analysis, generate summary statistics, and visualize data by using R software.

CO6. apply critical thinking and problem-solving skills to real-world scenarios by effectively applying descriptive statistics and probability concepts.

CO7. apply knowledge and skills gained from the course to solve practical problems and make informed decisions.

Sr. No.	Title of Experiment
1	Introduction to MS-Excel (Equivalent to 2 Practicals)
2	Use of Random Number Tables to Draw SRSWOR, SRSWR, Stratified Sample and Systematic Sample
3	Diagrammatic Representation of Statistical Data (Simple and Subdivided Bar Diagrams, Multiple Bar Diagram, Percentage Bar Diagram, Pie Diagram)
4	Graphical Representation of Statistical Data (Histogram, Frequency Curve and Ogive Curves, Determination of Mode and Median Graphically)
5	Measures of Central Tendency – I
6	Measures of Central Tendency – II
7	Measures of Dispersion – I
8	Measures of Dispersion – II
9	Moments
10	Skewness
11	Kurtosis
12	Project equivalent to 3 Practicals

Note:

1. Every practical is equivalent to four hours per batch per week
2. Practical batch should be of 15 students
3. For project, a group of maximum 15 students be made
4. Different data sets from newspapers, internet and magazines may be collected and students will be asked to use Statistical techniques/tools which they have learnt.
5. Students must complete all the practicals to the satisfaction of the teacher concerned.
6. Students must produce at the time of practical examination, the laboratory journal along with the completion certificate signed by the Head of the Department.

Programme Outcomes and Course Outcomes Mapping:

CO-PO Mapping Table

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	2	1	3	3	2	2	2	2	1	1	2	
CO2	2	3	1	3	3	2	2	2	2	1	1	2	
CO3	1	1	1	2	2	1	2	1	1	1	1	1	
CO4	1	1	1	3	2	1	2	1	1	1	1	1	
CO5	2	3	1	3	3	2	2	2	3	1	1	2	
CO6	3	3	2	3	3	2	2	3	2	1	1	2	
CO7	3	3	1	3	3	3	2	2	2	1	1	3	

This mapping table and the justifications show how each Course Outcome (CO) aligns with the Program Outcomes (POs) and the extent of their relationship.

Justification for Mapping PO and CO

PO1: Comprehensive Knowledge and Understanding

- **CO1 (3)**: Strongly related because understanding descriptive statistics requires a profound grasp of foundational theories and concepts in statistics.
- **CO2 (2)**: Moderately related as using appropriate graphical representations involves understanding statistical principles within a practical context.
- **CO3 (1)**: Partially related because probability and distributions are related but not central to comprehensive understanding unless applied in statistical analysis.
- **CO4 (1)**: Partially related as probability distributions are a specific subset of statistical knowledge.
- **CO5 (2)**: Moderately related because using R software involves applying statistical principles in a practical, technical manner.
- **CO6 (3)**: Strongly related because critical thinking in applying statistical concepts deepens understanding.
- **CO7 (3)**: Strongly related because applying knowledge to solve problems requires a comprehensive understanding of statistical methods.

PO2: Practical, Professional, and Procedural Knowledge

- **CO1 (2)**: Moderately related as practical skills in descriptive statistics are essential for professional tasks.
- **CO2 (3)**: Strongly related because using descriptive statistics for data interpretation is a practical and procedural skill.
- **CO3 (1)**: Partially related since probability may not always directly relate to practical tasks in every field.

- **CO4 (1)**: Partially related as specific probability distributions may not be universally applicable in all professional contexts.
- **CO5 (3)**: Strongly related because data analysis and visualization using R are practical skills in many professions.
- **CO6 (3)**: Strongly related because applying critical thinking in problem-solving is crucial for practical and professional tasks.
- **CO7 (3)**: Strongly related as applying statistical knowledge to solve practical problems is a key professional skill.

PO3: Entrepreneurial Mindset and Knowledge

- **CO1 (1)**: Partially related because basic statistical concepts may inform entrepreneurial decisions but are not central to an entrepreneurial mindset.
- **CO2 (1)**: Partially related as graphical representations can aid in understanding market dynamics but are not solely entrepreneurial.
- **CO3 (1)**: Partially related as probability may play a role in risk management strategies but is not exclusive to entrepreneurship.
- **CO4 (1)**: Partially related as specific probability distributions may have limited direct impact on entrepreneurial activities.
- **CO5 (1)**: Partially related as data analysis skills can inform business decisions but are not inherently entrepreneurial.
- **CO6 (2)**: Moderately related because critical thinking in applying statistics can aid in innovative thinking.
- **CO7 (1)**: Partially related as problem-solving with statistics is valuable but not exclusive to entrepreneurial contexts.

PO4: Specialized Skills and Competencies

- **CO1 (3)**: Strongly related because proficiency in descriptive statistics is a specialized competency.
- **CO2 (3)**: Strongly related because using statistical measures and graphical representations are specialized skills.
- **CO3 (2)**: Moderately related because probability skills are specialized within certain analytical fields.
- **CO4 (2)**: Moderately related as understanding probability distributions is a specialized statistical skill.
- **CO5 (3)**: Strongly related because data analysis and visualization in R are specialized technical competencies.

- **CO6 (3)**: Strongly related because critical thinking in applying statistics is a specialized analytical skill.
- **CO7 (3)**: Strongly related because applying statistical knowledge to solve problems is a specialized competency.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning

- **CO1 (3)**: Strongly related because applying descriptive statistics requires analytical reasoning and problem-solving skills.
- **CO2 (3)**: Strongly related because interpreting data using statistical measures involves application and problem-solving.
- **CO3 (2)**: Moderately related because probability skills contribute to analytical reasoning but may not always be central.
- **CO4 (2)**: Moderately related as probability distributions support problem-solving in certain contexts.
- **CO5 (3)**: Strongly related because data analysis and visualization in R involve practical application and analytical reasoning.
- **CO6 (3)**: Strongly related because critical thinking and problem-solving are essential for applying statistical concepts.
- **CO7 (3)**: Strongly related because applying statistical knowledge to make informed decisions requires problem-solving skills.

PO6: Communication Skills and Collaboration

- **CO1 (2)**: Moderately related because effective communication of statistical findings is important.
- **CO2 (2)**: Moderately related as presenting data using graphical representations requires clear communication.
- **CO3 (1)**: Partially related as probability may not always require extensive communication skills.
- **CO4 (1)**: Partially related as specific probability distributions may not always necessitate communication skills.
- **CO5 (2)**: Moderately related because communicating data analysis findings using R software is important.
- **CO6 (2)**: Moderately related as critical thinking can influence how statistical findings are communicated.
- **CO7 (3)**: Strongly related because effective communication of statistical insights aids in collaboration and decision-making.

PO7: Research-related Skills

- **CO1 (2)**: Moderately related because research involves analyzing and interpreting data.
- **CO2 (2)**: Moderately related as statistical measures are often used in research data analysis.
- **CO3 (2)**: Moderately related because probability skills are relevant in research methodology.
- **CO4 (2)**: Moderately related as probability distributions inform research outcomes.
- **CO5 (2)**: Moderately related because data analysis using R supports research activities.
- **CO6 (2)**: Moderately related because critical thinking is crucial in research data interpretation.
- **CO7 (2)**: Moderately related as applying statistical knowledge in research leads to informed conclusions.

PO8: Learning How to Learn Skills

- **CO1 (2)**: Moderately related because learning descriptive statistics fosters self-directed learning.
- **CO2 (2)**: Moderately related as understanding statistical measures involves continuous learning.
- **CO3 (1)**: Partially related as probability may not always be central to learning skills.
- **CO4 (1)**: Partially related since probability distributions are a specific subset of learning outcomes.
- **CO5 (2)**: Moderately related because learning to analyze data using R software requires adaptive learning skills.
- **CO6 (3)**: Strongly related because critical thinking in learning statistics enhances adaptive learning abilities.
- **CO7 (2)**: Moderately related because applying statistical knowledge enhances learning effectiveness.

PO9: Digital and Technological Skills

- **CO1 (2)**: Moderately related because digital tools are often used in descriptive statistics.
- **CO2 (2)**: Moderately related because digital tools are used in presenting and interpreting statistical data.
- **CO3 (1)**: Partially related as probability may not always require digital skills.
- **CO4 (1)**: Partially related as specific probability distributions may not necessitate extensive digital skills.
- **CO5 (3)**: Strongly related because data analysis using R software requires proficiency in digital tools.

- **CO6 (2)**: Moderately related because critical thinking can guide the effective use of digital tools in statistical analysis.
- **CO7 (2)**: Moderately related because digital skills aid in applying statistical knowledge effectively.

PO10: Multicultural Competence, Inclusive Spirit, and Empathy

- **CO1 (1)**: Partially related as statistical analysis may involve diverse data sources.
- **CO2 (1)**: Partially related because graphical representations can convey data from diverse perspectives.
- **CO3 (1)**: Partially related because probability analysis may consider diverse scenarios.
- **CO4 (1)**: Partially related as probability distributions may apply across diverse contexts.
- **CO5 (1)**: Partially related since data analysis may include diverse datasets.
- **CO6 (1)**: Partially related because critical thinking can encompass diverse viewpoints.
- **CO7 (1)**: Partially related because applying statistical knowledge may involve considering diverse impacts.

PO11: Value Inculcation and Environmental Awareness

- **CO1 (1)**: Partially related because statistical analysis may include environmental data.
- **CO2 (1)**: Partially related because statistical measures can inform decisions impacting environmental sustainability.
- **CO3 (1)**: Partially related as probability may consider ethical implications in decision-making.
- **CO4 (1)**: Partially related as probability distributions may inform ethical considerations.
- **CO5 (1)**: Partially related because data analysis can support ethical decision-making.
- **CO6 (1)**: Partially related because critical thinking can aid in ethical analysis.
- **CO7 (1)**: Partially related because applying statistical knowledge may involve ethical considerations.

PO12: Autonomy, Responsibility, and Accountability

- **CO1 (2)**: Moderately related because autonomy in statistical analysis requires responsibility.
- **CO2 (2)**: Moderately related because using statistical measures involves accountable decision-making.
- **CO3 (1)**: Partially related as probability may not always directly impact autonomy and accountability.
- **CO4 (1)**: Partially related as specific probability distributions may not always necessitate accountability.

- **CO5 (2)**: Moderately related because data analysis and decision-making require responsibility.
- **CO6 (2)**: Moderately related because critical thinking fosters responsible decision-making.
- **CO7 (3)**: Strongly related because applying statistical knowledge demands accountability in decision-making.

PO13: Community Engagement and Service

- **Not directly related** to any specific COs.

CBCS Syllabus as per NEP 2020 for F.Y.B.Sc. (Computer Science) (2024 Pattern)

Name of the Programme : B.Sc. (Computer Science)
Programme Code : USCOS
Class : F.Y.B.Sc. (Computer Science)
Semester : II
Course Type : Major Mandatory (Theory)
Course Code : COSST-151-GEN
Course Title : Statistical Methods
No. of Credits : 02
No. of Teaching Hours : 30

Course Objectives:

1. To understand the basic concepts of correlation
2. To understand the basic concepts of regression analysis.
3. To computation of correlation coefficients, Regression coefficients and their interpretation.
4. To identify real life situations where multiple regression can be used.
5. To understand the properties of regression coefficients
6. To fit the appropriate time series model that can be used in real life situations. Study of various index numbers and utilities with real life situations.
7. To develop the skills to interpret the results from time series analysis.

Course Outcome:

The students will acquire knowledge about the;

CO1. understand the concept of Simple regression.
CO2. understand the concept of multiple regression.
CO3. fit quadratic and exponential curves to the bivariate data to investigate relation between two variables.
CO4. compute the correlation coefficient for bivariate data and interpret it.
CO5. fit linear regression model to the bivariate data, interpretation of coefficients, and prediction of outcomes.
CO6. forecasting the time series variable.
CO7. identify and distinguish between the various components of time series data.

TOPICS/CONTENTS:

UNIT 1: Correlation (For ungrouped data) (07L)

1.1Concept of bivariate data, scatter diagram, its interpretation, concept of correlation, Positive correlation, negative correlation, zero correlation.

1.2 Karl Pearson's coefficient of correlation, properties of correlation coefficient, Interpretation of correlation coefficient, coefficient of determination with interpretation.

1.3 Spearman's rank correlation coefficient (formula with and without ties).

1.4Numerical problems

UNIT 2: Regression (for ungrouped data) (10L)

2.1Concept of linear and nonlinear regression.

2.2 Illustrations, appropriate situations for regression and correlation

2.3 Linear regression: Fitting of both lines of regression using least square method.

2.4 Concept of regression coefficients.

2.5 Properties of regression coefficients : $b_{xy} \cdot b_{yx} = r^2$, $b_{xy} * b_{yx} \leq 1$, $b_{xy} = r\,(\sigma_x / \sigma_y)$ and $b_{yx} = r\,(\sigma_y / \sigma_x)$.

2.6 Nonlinear regression models: Second degree curve, exponential curves of the type $Y=ab^x$ and $Y=ax^b$.

2.7 Numerical problems related to real life situations

UNIT3: Multiple Regression (For Trivariate Data) (7 L)

3.1 Concept of multiple regressions, Yule's Notations.

3.2 Fitting of multiple regression planes.[Derivation of equation to the plane of regression of X_1on X_2 and X_3 is expected. Remaining two equations to be written analogously.]

3.3 Concept of partial regression coefficients, interpretations.

3.4 Concept of multiple correlation: Definition of multiple correlation coefficient and its formula.

3.5 Concept of partial correlation. Definition of partial correlation coefficient and Its formula.

UNIT4: Time series (6L)

4.1 Meaning and utility

4.2 Components of time series

4.3 Additive and multiplicative models

4.4 Methods of estimating trend, moving average method, least squares method and exponential smoothing method (with graph and interpretation).

4.5 Numerical problems related to real life situations

References:

1. Introduction to Linear Regression Analysis, Douglas C. Montgomery, Elizabeth A. Peck, G. Geoffrey Vining, Wiley
2. Time Series Methods, Brockwell and Davis, Springer, 2006.
3. Time Series Analysis, 4th Edition, Box and Jenkin, Wiley, 2008.
4. Fundamentals of Applied Statistics(3rd Edition), Gupta and Kapoor, S. Chand and Sons,
   New Delhi, 1987.
5. Fundamentals of Statistics, Vol. 1, Sixth Revised Edition, Goon, A. M., Gupta, M. K. and Dasgupta, B. (1983). The World Press Pvt. Ltd., Calcutta
6. Statistical Computing Using R- Software, Vishwas R. Pawgi, Third Edition

Programme Outcomes and Course Outcomes Mapping:

CO-PO Mapping Table

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	2	3	1	3	3	2	2	2	2	1	1	2	1
CO2	2	3	1	3	3	2	2	2	2	1	1	2	1
CO3	1	2	1	2	2	1	2	1	1	1	1	1	1
CO4	2	2	1	3	3	1	2	1	1	1	1	1	1
CO5	3	3	1	3	3	2	2	2	2	1	1	2	
CO6	1	2	1	2	3	1	2	2	2	1	1	2	
CO7	1	2	1	2	2	1	2	1	1	1	1	1	

This mapping table and the justifications show how each Course Outcome (CO) aligns with the Program Outcomes (POs) and the extent of their relationship.

Justification for Mapping PO and CO

PO1: Comprehensive Knowledge and Understanding

- **CO1 (2)**: Moderately related because understanding simple regression involves foundational statistical concepts within a specific context.
- **CO2 (2)**: Moderately related as multiple regression extends understanding into more complex statistical methodologies.
- **CO3 (1)**: Partially related because fitting curves is specific to statistical modeling and not broadly multidisciplinary.
- **CO4 (2)**: Moderately related as correlation coefficient interpretation requires foundational statistical knowledge.

- **CO5 (3)**: Strongly related because interpreting regression coefficients deepens understanding of statistical principles.
- **CO6 (1)**: Partially related because time series forecasting is a specialized area within statistics.
- **CO7 (1)**: Partially related as time series components are specific to statistical analysis.

PO2: Practical, Professional, and Procedural Knowledge

- **CO1 (3)**: Strongly related because understanding regression is essential for practical statistical analysis.
- **CO2 (3)**: Strongly related because multiple regression is crucial in professional data analysis scenarios.
- **CO3 (2)**: Moderately related as curve fitting contributes to practical applications in data analysis.
- **CO4 (2)**: Moderately related as correlation analysis informs decision-making in various professional contexts.
- **CO5 (3)**: Strongly related because applying regression models is practical in professional data-driven environments.
- **CO6 (2)**: Moderately related as time series forecasting requires practical application of statistical knowledge.
- **CO7 (2)**: Moderately related because understanding time series components aids in procedural data analysis.

PO3: Entrepreneurial Mindset and Knowledge

- **CO1 (1)**: Partially related as regression concepts may inform decision-making but are not central to entrepreneurship.
- **CO2 (1)**: Partially related because multiple regression may be used in business analytics but does not define entrepreneurial mindset.
- **CO3 (1)**: Partially related because curve fitting is less directly relevant to entrepreneurial activities.
- **CO4 (1)**: Partially related as correlation coefficients may inform risk assessment but are not exclusive to entrepreneurship.
- **CO5 (1)**: Partially related as regression for prediction can be used in entrepreneurial planning but is not definitive of an entrepreneurial mindset.
- **CO6 (1)**: Partially related because time series forecasting may support business planning but is not core to entrepreneurial mindset.
- **CO7 (1)**: Partially related because time series analysis is applied in business contexts but does not define entrepreneurial thinking.

PO4: Specialized Skills and Competencies

- **CO1 (3)**: Strongly related because understanding regression is a specialized statistical competency.
- **CO2 (3)**: Strongly related because multiple regression skills are specialized in statistical analysis.
- **CO3 (2)**: Moderately related as curve fitting requires specialized statistical modeling skills.
- **CO4 (3)**: Strongly related because computing and interpreting correlation coefficients are specialized skills.
- **CO5 (3)**: Strongly related because regression interpretation and prediction are specialized technical skills.
- **CO6 (2)**: Moderately related as time series forecasting involves specialized analytical skills.
- **CO7 (2)**: Moderately related because identifying time series components is a specialized skill in data analysis.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning

- **CO1 (3)**: Strongly related because applying regression models requires analytical reasoning and problem-solving skills.
- **CO2 (3)**: Strongly related because interpreting regression outputs involves applied analytical reasoning.
- **CO3 (2)**: Moderately related because curve fitting requires problem-solving in statistical modeling.
- **CO4 (3)**: Strongly related because interpreting correlation coefficients involves analytical reasoning.
- **CO5 (3)**: Strongly related because applying regression for prediction demands problem-solving and analytical reasoning.
- **CO6 (3)**: Strongly related because time series forecasting requires advanced analytical reasoning and problem-solving.
- **CO7 (2)**: Moderately related because understanding time series components enhances analytical reasoning in data analysis.

PO6: Communication Skills and Collaboration

- **CO1 (2)**: Moderately related because effective communication of regression results requires clarity.
- **CO2 (2)**: Moderately related as communicating multiple regression findings demands clarity and accuracy.

- **CO3 (1)**: Partially related as curve fitting communication may require less extensive communication skills.
- **CO4 (1)**: Partially related because correlation coefficient communication may not always involve complex communication.
- **CO5 (2)**: Moderately related because communicating regression predictions requires effective communication skills.
- **CO6 (1)**: Partially related because time series forecasting communication may not always be complex.
- **CO7 (1)**: Partially related as time series components communication may not require extensive collaboration.

PO7: Research-related Skills

- **CO1 (2)**: Moderately related because research may involve regression analysis.
- **CO2 (2)**: Moderately related because research often uses regression techniques for data analysis.
- **CO3 (2)**: Moderately related because research may involve curve fitting in data analysis.
- **CO4 (2)**: Moderately related as research often includes correlation analysis.
- **CO5 (2)**: Moderately related because research may require regression for data interpretation.
- **CO6 (2)**: Moderately related because research often uses time series forecasting for analysis.
- **CO7 (2)**: Moderately related as research includes identifying time series components.

PO8: Learning How to Learn Skills

- **CO1 (2)**: Moderately related because learning regression involves adaptive learning and skill development.
- **CO2 (2)**: Moderately related because continuous learning in regression techniques fosters skill development.
- **CO3 (1)**: Partially related because learning curve fitting is specific to statistical learning.
- **CO4 (1)**: Partially related as learning correlation coefficients is specific to statistical learning outcomes.
- **CO5 (2)**: Moderately related because learning regression with prediction enhances adaptive learning.
- **CO6 (2)**: Moderately related because learning time series forecasting requires adaptive learning skills.

- **CO7 (1)**: Partially related because learning time series components is specific to statistical learning.

PO9: Digital and Technological Skills

- **CO1 (2)**: Moderately related because digital tools are used in regression analysis.
- **CO2 (2)**: Moderately related because digital tools are integral in multiple regression analysis.
- **CO3 (1)**: Partially related as curve fitting may require specific digital tools.
- **CO4 (1)**: Partially related as digital tools are used in correlation coefficient calculations.
- **CO5 (2)**: Moderately related because R software is commonly used for regression and prediction.
- **CO6 (2)**: Moderately related because digital tools support time series forecasting.
- **CO7 (1)**: Partially related as digital tools may support identification of time series components.

PO10: Multicultural Competence, Inclusive Spirit, and Empathy

- **CO1 (1)**: Partially related because regression analysis may include diverse datasets.
- **CO2 (1)**: Partially related as multiple regression may analyze data from diverse perspectives.
- **CO3 (1)**: Partially related because curve fitting may involve data from diverse contexts.
- **CO4 (1)**: Partially related as correlation analysis may consider diverse datasets.
- **CO5 (1)**: Partially related because regression prediction may impact decisions with diverse impacts.
- **CO6 (1)**: Partially related because forecasting outcomes may involve diverse stakeholders.
- **CO7 (1)**: Partially related as time series components may impact diverse groups differently.

PO11: Value Inculcation and Environmental Awareness

- **CO1 (1)**: Partially related because statistical analysis may include environmental data considerations.
- **CO2 (1)**: Partially related because statistical analysis can inform decisions impacting ethical considerations.
- **CO3 (1)**: Partially related as curve fitting may involve ethical considerations in data use.
- **CO4 (1)**: Partially related because correlation analysis may include ethical implications in decision-making.
- **CO5 (1)**: Partially related as regression prediction may impact ethical decision-making.

- **CO6 (1)**: Partially related because time series forecasting may consider ethical implications.
- **CO7 (1)**: Partially related because time series components may involve ethical considerations.

PO12: Autonomy, Responsibility, and Accountability

- **CO1 (2)**: Moderately related because autonomy in learning regression requires responsibility.
- **CO2 (2)**: Moderately related because using regression models involves accountable decision-making.
- **CO3 (1)**: Partially related as learning curve fitting may not directly enhance autonomy.
- **CO4 (1)**: Partially related because understanding correlation coefficients may not directly enhance accountability.
- **CO5 (2)**: Moderately related because using regression for decision-making requires responsibility.
- **CO6 (2)**: Moderately related because time series forecasting demands accountable decision-making.
- **CO7 (1)**: Partially related as understanding time series components may not enhance accountability directly.

PO13: Community Engagement and Service

- **CO1 (1)**: Partially related as statistical analysis may inform community-related data.
- **CO2 (1)**: Partially related because community service may benefit from multiple regression insights.
- **CO3 (1)**: Partially related because curve fitting may not directly influence community engagement.
- **CO4 (1)**: Partially related as correlation analysis may inform community-based decisions.

CBCS Syllabus as per NEP 2020 for F.Y.B.Sc. (Computer Science) (2024 Pattern)

Name of the Programme : B.Sc. (Computer Science)
Programme Code : USCOS
Class : F.Y.B.Sc. (Computer Science)
Semester : II
Course Type : Major Mandatory (Practical)
Course Code : COSST-152-GEN
Course Title : Statistics Practical-II
No. of Credits : 02
No. of Teaching Hours : 60

Course Objectives:

1) To provide fundamental skills and knowledge with effective utilization of R Software for data analysis and management.
2) To understand the basics of R Software and its various applications.
3) To introduce basic concepts, formulas, functions, and tools within R Software, enabling students to create, edit, format, and analyze data and perform calculations.
4) To convert mixed data types into appropriate types using R Software.
5) To enhance the skill of effectively clean data by Using R software.
6) To compute descriptive statistics, such as mean, median, mode, standard deviation, and variance etc. using R Software in data analysis point of view.
7) Computation of correlation coefficients, Regression coefficients and their interpretation.

Course Outcome:

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

CO1. compute correlation coefficient, regression coefficients and to interpret the results.
CO2. demonstrate the basic mechanics and navigation of an R Software.
CO3. proficiency in using the R programming language for data analysis, which includes data manipulation, visualization, and statistical analysis.
CO4. create charts and graphs student can easily explain complex information or data.
CO5. to write and understand basic R code.
CO6. to understand and be able to compute descriptive statistics to summarize and describe datasets, including measures of central tendency and variability.
CO7. to create clear and concise reports and presentations summarizing their data

analysis findings using tools like R Software..

Topics and Learning Points

Sr. No.	Title of Experiments
1	Data Exploration using R Software
2	Data Cleaning using R Software
3	Data Transformation using R Software
4	Handling Outliers using R Software
5	Merging and Joining Datasets in R Software.
6	Diagrammatic representation of the Data in R software
7	Graphical representation of the Data in R software
8	Measuring Central Tendency for Categorical as well as continuous data In R Software.
9	Exploring Variability in the data: Practical Exercises on Range, Variance, and Standard Deviation in R Software.
10	Identifying Data Distribution Characteristics: Skewness and Kurtosis Analysis in R Software.
11	Linear correlation and regression (use of scatter plot for explaining the linear Relationship between two variables) using Excel.
12	Fitting of second degree curve, exponential curve of type $y = ab^x$, $y = ax^b$
13	Fitting of the linear regression model (Simple and Multiple) by using R-Software.
14	Time Series- Estimation of trend by using the method of moving averages.
15	Time series: Estimation and forecasting of trend by fitting of AR (1) model, exponential smoothing.

Note:

1. Every practical is equivalent to four hours per batch per week.
2. Practical batch should be of 15 students.
3. Students must complete all the practicals to the satisfaction of the teacher concerned.
4. Students must produce at the time of practical examination, the laboratory journal along with the completion certificate signed by the Head of the Department.

Programme Outcomes and Course Outcomes Mapping:

CO-PO Mapping Table

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	3	1	3	3	2	3	2	2	1	1	2	
CO2	1	2	1	2	2	1	2	2	3	1	1	2	
CO3	2	3	1	3	3	3	3	3	3	1	1	2	
CO4	1	2	1	2	2	2	2	2	2	1	1	2	
CO5	1	2	1	2	2	2	2	2	2	1	1		
CO6	3	3	1	3	3	3	3	3	2	1	1		
CO7	2	3	1	3	3	3	3	2	2	1	1		

This mapping table and the justifications show how each Course Outcome (CO) aligns with the Program Outcomes (POs) and the extent of their relationship.

Justification for Mapping PO and CO

PO1: Comprehensive Knowledge and Understanding

- **CO1 (3)**: Strongly related because computing and interpreting correlation and regression coefficients require deep understanding of statistical theories and methodologies.
- **CO2 (1)**: Partially related as basic mechanics of R software are more procedural and less theoretical.
- **CO3 (2)**: Moderately related because proficiency in R for data analysis enhances understanding of methodologies within a specific context.
- **CO4 (1)**: Partially related because creating charts and graphs, while part of data analysis, is more about practical application than deep understanding.
- **CO5 (1)**: Partially related as writing basic R code is procedural rather than foundational knowledge.
- **CO6 (3)**: Strongly related because computing descriptive statistics involves foundational statistical concepts.
- **CO7 (2)**: Moderately related because creating reports and presentations involves both technical skills and theoretical understanding.

PO2: Practical, Professional, and Procedural Knowledge

- **CO1 (3)**: Strongly related because practical knowledge of computing correlation and regression coefficients is essential in professional data analysis.
- **CO2 (2)**: Moderately related because basic R software navigation is procedural knowledge useful in practical scenarios.

- **CO3 (3)**: Strongly related because proficiency in R for data analysis is directly applicable in professional tasks.
- **CO4 (2)**: Moderately related because creating clear charts and graphs supports effective communication in professional settings.
- **CO5 (2)**: Moderately related because writing basic R code is a practical skill needed in professional data analysis.
- **CO6 (3)**: Strongly related because applying descriptive statistics is crucial in practical data analysis tasks.
- **CO7 (3)**: Strongly related because creating reports and presentations summarizes professional data analysis findings.

PO3: Entrepreneurial Mindset and Knowledge

- **CO1 (1)**: Partially related because understanding correlation and regression is more about analytical skills than entrepreneurial mindset.
- **CO2 (1)**: Partially related because basic R software skills are more procedural than entrepreneurial.
- **CO3 (1)**: Partially related as R programming proficiency is more technical than fostering an entrepreneurial mindset.
- **CO4 (1)**: Partially related as chart creation is practical rather than fostering entrepreneurial skills.
- **CO5 (1)**: Partially related as writing basic R code is procedural rather than fostering entrepreneurial mindset.
- **CO6 (1)**: Partially related because descriptive statistics are analytical rather than entrepreneurial.
- **CO7 (1)**: Partially related because report creation is more about technical communication than entrepreneurial mindset.

PO4: Specialized Skills and Competencies

- **CO1 (3)**: Strongly related because proficiency in computing correlation and regression coefficients is a specialized statistical competency.
- **CO2 (2)**: Moderately related as basic R software navigation supports technical skills but is not as specialized as statistical competency.
- **CO3 (3)**: Strongly related because R programming proficiency is a specialized skill in data analysis.
- **CO4 (2)**: Moderately related because creating charts and graphs is a specialized skill in data presentation.

- **CO5 (2)**: Moderately related because writing basic R code is a specialized skill in data manipulation and analysis.
- **CO6 (3)**: Strongly related because applying descriptive statistics is a specialized analytical competency.
- **CO7 (3)**: Strongly related because creating reports and presentations is a specialized skill in communicating data analysis findings.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning

- **CO1 (3)**: Strongly related because applying correlation and regression involves problem-solving and analytical reasoning.
- **CO2 (2)**: Moderately related because basic R software navigation supports applied data analysis.
- **CO3 (3)**: Strongly related because using R for data analysis requires problem-solving and analytical reasoning.
- **CO4 (2)**: Moderately related because creating charts and graphs supports effective problem-solving in data communication.
- **CO5 (2)**: Moderately related because writing basic R code involves applying analytical reasoning in data manipulation.
- **CO6 (3)**: Strongly related because applying descriptive statistics requires analytical reasoning and problem-solving skills.
- **CO7 (3)**: Strongly related because creating reports and presentations summarizes analytical findings requiring problem-solving.

PO6: Communication Skills and Collaboration

- **CO1 (2)**: Moderately related because communicating correlation and regression results requires clear communication.
- **CO2 (1)**: Partially related as basic R software navigation does not directly enhance communication skills.
- **CO3 (2)**: Moderately related because using R involves communicating findings through visualizations and reports.
- **CO4 (2)**: Moderately related because creating charts and graphs supports effective communication of complex information.
- **CO5 (1)**: Partially related because writing basic R code focuses more on technical skills than communication.
- **CO6 (2)**: Moderately related because descriptive statistics communication requires clear presentation of results.

- **CO7 (3)**: Strongly related because creating reports and presentations demonstrates communication skills.

PO7: Research-related Skills

- **CO1 (3)**: Strongly related because research often involves using correlation and regression for data analysis.
- **CO2 (2)**: Moderately related because R software navigation supports research-related data analysis.
- **CO3 (3)**: Strongly related because R programming skills are crucial in research for data manipulation and analysis.
- **CO4 (2)**: Moderately related because creating charts and graphs aids in visualizing research findings.
- **CO5 (2)**: Moderately related because writing basic R code is necessary for implementing research methodologies.
- **CO6 (3)**: Strongly related because descriptive statistics are fundamental in summarizing research data.
- **CO7 (3)**: Strongly related because creating reports and presentations is essential in research for communicating findings.

PO8: Learning How to Learn Skills

- **CO1 (2)**: Moderately related because learning correlation and regression involves adaptive learning and skill development.
- **CO2 (2)**: Moderately related because learning R software navigation requires self-directed learning.
- **CO3 (3)**: Strongly related because learning R programming involves significant self-directed learning and adaptation.
- **CO4 (2)**: Moderately related because learning to create charts and graphs involves adapting to data presentation needs.
- **CO5 (2)**: Moderately related because learning basic R code requires self-directed learning and adaptation.
- **CO6 (3)**: Strongly related because learning descriptive statistics involves adapting to different data sets and analysis methods.
- **CO7 (2)**: Moderately related because learning to create reports and presentations involves adapting to communication needs.

PO9: Digital and Technological Skills

- **CO1 (2)**: Moderately related because digital tools are used in computing correlation and regression.

- **CO2 (3)**: Strongly related because R software navigation is a fundamental digital skill in data analysis.
- **CO3 (3)**: Strongly related because proficiency in R programming enhances digital skills in data manipulation and analysis.
- **CO4 (2)**: Moderately related because creating charts and graphs develops digital skills in data presentation.
- **CO5 (2)**: Moderately related because writing basic R code develops digital skills in data manipulation.
- **CO6 (2)**: Moderately related because applying descriptive statistics involves digital skills in data analysis.
- **CO7 (2)**: Moderately related because creating reports and presentations develops digital skills in data communication.

PO10: Multicultural Competence, Inclusive Spirit, and Empathy

- **CO1 (1)**: Partially related because statistical analysis may involve data from diverse contexts.
- **CO2 (1)**: Partially related because R software navigation does not specifically address multicultural competence.
- **CO3 (1)**: Partially related because R programming proficiency does not directly enhance multicultural competence.
- **CO4 (1)**: Partially related because creating charts and graphs does not directly involve multicultural competence.
- **CO5 (1)**: Partially related because writing basic R code is procedural and does not enhance multicultural competence.
- **CO6 (1)**: Partially related because descriptive statistics focus on analytical skills rather than multicultural competence.
- **CO7 (1)**: Partially related because creating reports and presentations primarily involves technical communication.

PO11: Value Inculcation and Environmental Awareness

- **CO1 (1)**: Partially related because statistical analysis may consider ethical implications.
- **CO2 (1)**: Partially related because R software navigation does not directly address value inculcation or environmental awareness.
- **CO3 (1)**: Partially related because R programming proficiency does not directly enhance value inculcation or environmental awareness.
- **CO4 (1)**: Partially related because creating charts and graphs does not directly involve ethical considerations.

- **CO5 (1)**: Partially related because writing basic R code does not directly involve ethical considerations.
- **CO6 (1)**: Partially related because descriptive statistics focus on analytical skills rather than ethical considerations.
- **CO7 (1)**: Partially related because creating reports and presentations primarily involves technical communication.

PO12: Autonomy, Responsibility, and Accountability

- **CO1 (2)**: Moderately related because applying correlation and regression requires accountable decision-making.
- **CO2 (2)**: Moderately related because navigating R software requires responsible use of data analysis tools.
- **CO3 (2)**: Moderately related because using R programming involves responsible data handling.
- **CO4 (2)**: Moderately related because creating charts and graphs involves accountable presentation of data.

PO13: Community Engagement and Service

- **Not directly related** to any specific COs.