

Programme	BS Computational Statistics and Data Analytics	Course Code	CSTA-301	Credit Hours	3
	Multivariate Analysis				
Course Introduction					
<p>This course introduces the theory and applications of multivariate statistical methods. It focuses on techniques used to analyze data consisting of multiple variables, exploring how these variables interrelate. Topics include multivariate normal distribution, hypothesis testing, principal component analysis, factor analysis, discriminant analysis, and cluster analysis.</p>					
Learning Outcomes					
<p>By the end of this course, students will be able to:</p> <ol style="list-style-type: none"> 1. Understand and apply multivariate statistical methods. 2. Analyze multivariate data and interpret the results. 3. Use statistical software to perform multivariate analyses. 4. Develop skills to critically evaluate multivariate analyses in research. 					
Course Content					Assignments/Readings
Week 1	Unit – I Definition and scope of multivariate analysis.				
	Refreshing fundamental concepts in matrix algebra: matrices, vectors, operations (addition, subtraction, multiplication), and properties				
Week 2	Unit – II Examples of multivariate data.				
	Unit – III				
	Multivariate Distributions:				
	Introduction to multivariate distributions and their significance in statistical modeling				
Week 3	Unit – IV Overview of probability density functions for multivariate data				
	Unit – V Notions of Multivariate Distributions: Understanding the concept of multivariate distributions and their characteristics				
Week 4	Unit – VI Exploration of joint probability distributions for multiple random variables				
	Unit – VII The Multivariate Normal Distribution: Detailed study of the multivariate normal distribution as a fundamental distribution in multivariate analysis				

	Unit – VIII Properties and characteristics of the multivariate normal distribution	
Week 5	Unit – IX Multivariate Normal Distribution Properties: Advanced properties of the multivariate normal distribution: mean, variance, covariance, and correlation	
	Unit – X Understanding the implications of multivariate normality in statistical analysis	
Week 6	Unit – XI Estimation of the Mean Vector: Techniques for estimating the mean vector of multivariate data samples	
	Unit – XII Understanding the properties and limitations of mean vector estimation methods	
Week 7	Unit – XIII The Covariance Matrix: Understanding the covariance matrix and its role in describing the relationships between variables in multivariate data	
	Unit – XIV Properties and interpretations of the covariance matrix	
Week 8	Unit – XV Conditional Distribution of M.V normal Mean and variance of conditional Distribution	
	Unit –XVI Hotelling’s T^2 test Inferences for Multivariate Means	
Week 9	Unit – XVII Confidence regions for multivariate means.	
	Unit – XVIII Practical Application of mean vectors inferences	
Week 10	Unit – XIX Factor Analysis Exploratory factor analysis, model specification, and identification.	
	Unit – XX Confirmatory factor analysis, rotations in factor analysis, and interpretation of factors.	
Week 11	Unit – XXI Canonical Correlation Analysis (CCA) Concept of canonical variables, estimation and interpretation.	
	Unit – XXII Practical applications of CCA and case studies.	

Week 12	Unit – XXIII Discriminant Analysis linear Discriminant Analysis	
	Unit – XXIV Quadratic Discriminant Analysis	
Week 13	Unit – XXV Principal Component Analysis (PCA) The concept and objectives of PCA,	
	Unit – XXVI Eigenvalues and eigenvectors.	
Week 14	Unit – XXVII Application of PCA Interpreting principal components, applications	
	Unit – XXVIII Dimension Reduction Use of PCA in dimensionality reduction.	
Week 15	Unit – XXIX Cluster Analysis Hierarchical Clustering	
	Unit – XXX K-means clustering	
Week 16	Unit – XXXI Optimum number of clustering	
	Unit – XXXII Overview and summary	

Textbooks and Reading Material

Text Book

1. Johnson, R.A., & Wichern, D.W. (2008). *Applied multivariate statistical analysis*. Pearson Education: Singapore.

Suggested Readings

1. Anderson, T.W. (2003). *An introduction to multivariate statistical analysis* (3rd ed.). John Wiley & Sons: New York.
2. Chatfield, C., & Collins, A.J. (1981). *Introduction to multivariate analysis*. Chapman and Hall: London.
3. Morrison, D.F. (2004). *Multivariate statistical methods* (4th ed.). McGraw Hill Publishing Co, New York.

Teaching Learning Strategies

Class Lecture method, which includes seminars, discussions, assignments and projects. (Audio-visual tools are used where necessary)

Assignments: Types and Number with Calendar

According to the choice of respective teacher.

Assessment

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	It takes place at the mid-point of the semester.
2.	Formative Assessment	25%	It is continuous assessment. It includes: Classroom participation, attendance, assignments, and presentations, homework, attitude and behavior, hands-on-activities, short tests, quizzes etc.
3.	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

