Semester	**Six**
Course	**Major**
Paper Code	
Paper Title	**Multivariate Probability Distributions & Large Sample Theory-I**
No. of Credits	**4**
Theory/Composite/Practical	**Theory**
Minimum No. of preparatory hours per week a student has to devote	**4** **Module 1: 2 periods/week** **Module 2: 2 periods/week**
Module	**2**
Syllabus	**Module 1: Multivariate Probability Distributions** **UNIT I:** ***Random Vector:*** Probability mass/density functions, distribution function, mean vector, dispersion matrix and correlation matrix. Marginal and conditional distributions. [4L] **UNIT 2:** ***Relation between Jointly Distributed Random Variables:*** Definition and statement of the expressions of multiple regression, multiple correlation and partial correlation. Special cases for linear relation. [4L] **UNIT 3:** ***Theoretical Distributions:*** Multinomial distribution, multivariate normal distribution, Dirichlet distribution and their properties. [14L] **UNIT 4:** ***Sampling distributions:*** Wishart distribution (definition and statement of properties). Statement of the sampling distributions for mean vector and variance-covariance matrix from multivariate normal population. Concentration Ellipsoid. [4L] **Module 2: Large Sample Theory – I** **UNIT 1:** ***Limit Theorems:*** Sequence of random variables, convergence in probability, convergence in mean square and convergence in distribution and their interrelations. Weak laws of large numbers and their applications. Slutsky's Theorem. De-Moivre-Laplace Limit Theorem. Normal approximation to Poisson distribution. Statement of central limit theorem (iid case) and its use in tests and confidence intervals for Binomial proportions and Poisson means. [14L] **UNIT 2:** ***Asymptotic Property of Estimators:*** Consistency, Asymptotic efficiency, asymptotic relative efficiency (ARE). CAN and BAN estimators. Large sample properties of maximum likelihood

	estimators (statement only) and their uses in testing and interval estimation. [12L]
Learning outcomes	1. Understand the notions multivariate probability distributions. 2. Comprehend multiple regression, multiple correlation and partial correlation in the probability setup. 3. Understand the genesis of multinomial, multivariate normal and Dirichlet's distributions. 4. Analyse the properties of multinomial, multivariate normal and Dirichlet's distributions. 5. Apply multinomial, multivariate normal and Dirichlet's distributions in practice 6. Synthesise concentration ellipsoid 7. Understand the various modes of convergence for sequences of random variables and analyze the interrelationships among them. 8. Apply the Weak Laws of Large Numbers, Slutsky's Theorem, and De-Moivre-Laplace Theorem to real-life statistical scenarios. 9. Interpret the Central Limit Theorem and use it to construct tests and confidence intervals for binomial proportions and Poisson means. 10. Evaluate asymptotic properties of estimators and differentiate between CAN and BAN estimators. 11. Recall the properties of maximum likelihood estimators and demonstrate their utility in constructing tests and confidence intervals.
Reading/Reference Lists	1. Anderson, T.W. (2003): An Introduction to Multivariate Statistical Analysis, 3rdEdn., John Wiley. 2. Mukhopadhyay, P. (2006) : Mathematical Statistics. 3rd Edn, Books and Allied limited, Kolkata. 3. Applied Multivariate Analysis by Prof. Sugata Sen Roy, University of Calcutta (***https://onlinecourses.swayam2.ac.in***). 4. Goon A.M., Gupta M.K., Das Gupta, B. (2005): Outline of Statistics, Vol. I & II, World Press, Calcutta. 5. Rohatgi, V. K. and Saleh, A.K. Md. E. (2009): An Introduction to Probability and Statistics. 2ndEdn. (Reprint) John Wiley and Sons. 6. Miller, I. and Miller, M. (2002): John E. Freund's Mathematical Statistics (6th addition, low price edition), Prentice Hall of India.

	7. C.R. Rao (1983): Linear Statistical Inference and its Application. 3rd Edn, Wiley Eastern Limited. 8. R.V. Hogg and A.T. Craig (2002): Introduction to Mathematical Statistics. 5th Edn, Pearson Education.

Evaluation	CIA: 30 End-Sem: 70 Total: 100	
Paper Structure for Semester Exam	**Module 1 (35 marks)**	**Module 2 (35 marks)**
	Short questions (5 marks each): 4 out of 6 Long questions (15 marks each): 1 out of 2	Short questions (5 marks each): 4 out of 6 Long questions (15 marks each): 1 out of 2