Semester	**FIVE**
Course	**Major**
Paper Code	**C3ST230511T**
Paper Title	**Statistical Inference II**
No. of Credits	**4**
Theory / Practical /Composite	**Theory**
Classes per week	**Module I: 2 periods/week** **Module II: 2 periods/week**
Module	**2**

Course Outcomes for Module I

1. **Remember** the definitions of sufficiency, completeness, exponential family, MVUE, Cramér–Rao inequality, and Maximum Likelihood Estimation.
2. **Understand** the theoretical foundations and properties of Maximum Likelihood Estimators and Minimum Variance Unbiased Estimators.
3. **Apply** the Rao–Blackwell and Lehmann–Scheffé theorems to obtain MVUEs and use the Cramér–Rao inequality to assess efficiency**.**
4. **Analyze** the structure of statistical models to determine sufficient and complete statistics using the Factorization Theorem.
5. **Evaluate** the optimality and efficiency of estimators under different distributional settings.
6. **Create** original estimation problems involving exponential family distributions and develop appropriate inferential solutions

Course Outcomes for Module II

1. **Remember** the statements of the Neyman–Pearson Lemma, Likelihood Ratio Test, Sequential Probability Ratio Test, and Wald's fundamental identity.
2. **Understand** the theoretical principles underlying SPRT, Operating Characteristic (OC) curves, and Average Sample Number (ASN) functions.
3. **Apply** Neyman–Pearson Lemma and Likelihood Ratio principle to construct appropriate tests for Normal, Poisson, Binomial, and Exponential distributions.
4. **Analyze** hypothesis testing problems to determine most powerful, uniformly most powerful, and unbiased tests.
5. **Evaluate** the performance of statistical tests in terms of size, power, and optimality criteria.
6. **Create** real-world decision-making scenarios requiring the formulation and implementation of optimal statistical tests, including sequential procedures.

Syllabus

Unit/Module	Content	No. of lectures	CO mapping	Cognitive levels
Module I				
	Sufficiency, Completeness and Exponential family of distributions	6	CO1	K1
	Factorization theorem. Minimum variance unbiased estimator (MVUE), Rao-Blackwell and Lehmann-Scheffe theorems and their applications.	10	CO1 CO2 CO3 CO4	K1 K2 K3 K4
	Cramer-Rao inequality and MVB estimators	4	CO1 CO2	K1 K2
	Maximum Likelihood Estimator and its properties.	6	CO1 CO2 CO3 CO5 CO6	K1 K2 K3 K5 K6
Module II				
	Most powerful test, uniformly most powerful test, Neyman Pearson Lemma (statement and applications to the construction of most powerful test), Unbiased test.	9	CO1 CO3 CO4 CO5	K1 K3 K4 K5
	Likelihood Ratio test and its properties. (without proof)	10	CO1 CO3 CO5	K1 K3 K5
	Sequential Probability Ratio Test (SPRT) for simple vs simple hypotheses. Fundamental relations among α, β, A, and B. [statement only]	3	CO1 CO2 CO6	K1 K2 K6
	Wald's fundamental identity. Operating Characteristics (OC) and Average Sample Number (ASN) functions [statement only]. Problems based on Normal, Poisson, Binomial, and Exponential distributions.	4	CO1 CO2 CO6	K1 K2 K6

Reading/Reference list

1. Goon A.M., Gupta M.K.: Das Gupta. B. (2005), Fundamentals of Statistics, Vol. I, World Press, Calcutta.

2.	Rohatgi V. K. and Saleh, A.K. Md. E. (2009): An Introduction to Probability and Statistics. 2ndEdn. (Reprint) John Wiley and Sons.
3.	Miller, I. and Miller, M. (2002): John E. Freund's Mathematical Statistics (6th addition, low price edition), Prentice Hall of India
4.	Dudewicz, E. J., and Mishra, S. N. (1988): Modern Mathematical Statistics. John Wiley & Sons.
5.	Mood A.M, Graybill, F.A., and Boes, D.C (2001): Introduction to the Theory of Statistics, McGraw Hill, New Delhi.
6.	Bhat B.R, Srivenkatramana T and Rao Madhava K.S. (1997) Statistics: A Beginner's Text, Vol. I, New Age International (P) Ltd.
7.	Snedecor G.W and Cochran W.G.(1967) Statistical Methods. lowa State University Press.

Evaluation

	CIA: 30 End-Sem: 70 Total: 100	
Paper Structure for Theory Semester Exam	Module-I (35 marks)	Module-II (35 marks)
	To answer Short: 4 out of 6 (5 marks) Long: 1 out of 2 (15 marks)	To answer Short: 4 out of 6 (5 marks Long: 1 out of 2 (15 marks)

CO	CO Description for Module I	Cognitive levels
CO1	**Remember** the definitions of sufficiency, completeness, exponential family, MVUE, Cramér–Rao inequality, and Maximum Likelihood Estimation	K1
CO2	**Understand** the theoretical foundations and properties of Maximum Likelihood Estimators and Minimum Variance Unbiased Estimators.	K2
CO3	**Apply** the Rao–Blackwell and Lehmann–Scheffé theorems to obtain MVUEs and use the Cramér–Rao inequality to assess efficiency**.**	K3
CO4	**Analyze** the structure of statistical models to determine sufficient and complete statistics using the Factorization Theorem.	K4
CO5	**Evaluate** the optimality and efficiency of estimators under different distributional settings.	K5
CO6	**Create** original estimation problems involving exponential family distributions and develop appropriate inferential solutions.	K6

CO	CO Description for Module II	Cognitive levels
CO1	**Remember** the statements of the Neyman–Pearson Lemma, Likelihood Ratio Test, Sequential Probability Ratio Test, and Wald's fundamental identity	K1

CO2	**Understand** the theoretical principles underlying SPRT, Operating Characteristic (OC) curves, and Average Sample Number (ASN) functions.	K2
CO3	**Apply** Neyman–Pearson Lemma and Likelihood Ratio principle to construct appropriate tests for Normal, Poisson, Binomial, and Exponential distributions.	K3
CO4	**Analyze** hypothesis testing problems to determine most powerful, uniformly most powerful, and unbiased tests.	K4
CO5	**Evaluate** the performance of statistical tests in terms of size, power, and optimality criteria	K5
CO6	**Create** real-world decision-making scenarios requiring the formulation and implementation of optimal statistical tests, including sequential procedures.	K6