DEPARTMENT OF STATISTICS				*CLASS: I M.Sc. Statistics*				
Sem	**Course Type**	**Course Code**	**Course Title**	**Credits**	**Contact Hours/week**	**CIA**	**Ext**	**Total**
II	Major Core – 5	21P2SMC5	Statistical Estimation Theory	4	5	25	75	100

Nature of Course				
Knowledge and skill	✓		Employability oriented	
Skill oriented			Entrepreneurship oriented	

Course Objectives:

1. To make the students acquainted with the classical approach of the inferential procedure for drawing conclusions from the data while allowing for random variation
2. To forming the foundations of the basic elements if statistical inference, viz. point estimation and interval estimation

Unit	Description	Hours	K-level	CLO(s)
I	Parametric point estimation. Consistency – weak consistency, consistency in rth mean, strong consistency, sufficient conditions for consistency. Efficiency of estimators. Sufficient statistics – Factorization theorem, Distributions admitting sufficient statistic, procedure for finding minimal sufficient statistic.	15	K2	**1**
II	Unbiased estimator. Uniformly minimum variance unbiased estimator (UMUE) - necessary and sufficient conditions for an unbiased estimator to be UMVUE; Completeness and boundedly completeness; relationship between complete statistic and minimal sufficient statistic; Rao-Blackwell theorem, Lehmann-Scheffe theorem, Basu's theorem. Information inequality – Cramer-Rao (CR) inequality, Kiefer-Chapman-Robbins (KCR) inequality, Bhattacharya inequality.	16	K3	**2**
III	Methods of point estimation – Method of Moments, Method of Maximum Likelihood. Method of scoring, EM algorithm. Method of minimum chi-square, Method of modified minimum chi-square. Properties of these estimators (both large and small samples).	12	K3	**3**
IV	Interval estimation – Fundamental notions of interval estimation, applications of Chebychev's inequality. Shortest length confidence intervals and their construction. Construction of confidence intervals applying maximum likelihood estimator and central limit theorem.	14	K4	**4**
V	Bayes estimation – concept of prior, posterior distributions. Conjugate and non-informative priors. Bayes estimator under quadratic error loss function – Elementary notions of minimax estimation – application.	18	K4	**5**

Books for Reference:

1. Rajagopalan M and Dhanavanthan P, (2012), Statistical Inference, PHI Learning Pvt. Ltd., New Delhi.
2. Rohatgi, V.K and Saleh, A.K.Md.E, (2011), An Introduction to Probability and Statistics Second Edition, John Wiley & Sons, New York.
3. Mukhopadhyay, P, (2002), Mathematical Statistics, Book and Allied Publishers, New Delhi.
4. Lehmann, E.L. and Casella,G. (1998) Theory of Point Estimation, 2/e , Springer , New York.
5. Casella G and Berger R L, (2002). Statistical Inference, Second Edition, Thompson Learning, New York. (Reprint, 2007).
6. Goon, A M, Gupta M.K and Dasgupta B, (1989), An Outline of Statistical Theory, Vol. II, World Press, Kolkata.
7. Bansal, A.K, (2007), Bayesian Parametric Inference, Narosa Publishing House, New Delhi.
8. Mood A.M, Graybill F.A and Boes D.C, (1974), Introduction to Theory of Statistics, Third Edition, McGraw-Hill International Edition.
9. Berger, J.O, (1985), Statistical Decision Theory and Bayesian Analysis, Second Edition, Springer Verlag, New York.
10. Kale, B.K, (2005), A First Course in Parametric Inference, Second Edition, Narosa Publishing House, New Delhi. (Reprint, 2007).
11. Kale, B.K., and Muralidharan, K, (2015), Parametric Inference, Narosa Publishing House, New Delhi.
12. Keith, K, (2000), Mathematical Statistics, Chapman and Hall/CRC, New York.
13. Rao, C.R, (2009), Linear Statistical Inference and Its Applications, Second Edition, John Wiley & Sons, New York, US.
14. Santhakumaran A. (2004), Probability Models and their Parametric Estimation, K.P. Jam Publication, Chennai.

Web references:

1. Point Estimation
   http://web.mit.edu/14.381/www/Estimation.pdf
2. Unbiased estimator
   https://www.math.arizona.edu/~jwatkins/N_unbiased.pdf
3. Properties of Point Estimators and Methods of Estimation
   http://www.utstat.toronto.edu/~olgac/sta255_2013/notes/sta255_Lecture9.pdf
4. Interval estimation
   http://www.yorku.ca/ptryfos/ch5000.pdf
5. Prior and posterior distributions
   https://www.probabilitycourse.com/chapter9/9_1_1_prior_and_posterior.php

Rationale for Nature of the course

The course provides knowledge to identify various types of estimators and their properties. The student estimates the result using various methodology in estimators.

Activities having direct bearing on Skill development / Employability / Entrepreneurship

Problem solving on estimation and its properties

Pedagogy

Chalk and Talk, PPT, Seminar, Interaction, Problem solving.

Lecture Schedule

Unit	Topics	Hours	Mode
I	Consistency – weak consistency, consistency in r^{th} mean, strong consistency, sufficient conditions for consistency	5	PPT, Chalk and Talk and Assignments
	Efficiency of estimators – Properties	5	
	Sufficient statistics – Factorization theorem, Distributions admitting sufficient statistic, procedure for finding minimal sufficient statistic.	5	
II	Unbiased estimator. Uniformly minimum variance unbiased estimator (UMUE) - necessary and sufficient conditions for an unbiased estimator to be UMVUE	4	PPT, Chalk and Talk and Assignments
	Completeness and boundedly completeness; relationship between complete statistic and minimal sufficient statistic	4	
	Rao-Blackwell theorem, Lehmann-Scheffe theorem, Basu's theorem.	4	
	Information inequality – Cramer-Rao (CR) inequality, Kiefer-Chapman-Robbins (KCR) inequality, Bhattacharya inequality.	4	
III	Methods of point estimation – Method of Moments, Method of Maximum Likelihood	3	PPT, Chalk and Talk, Assignments and seminar
	Method of scoring, EM algorithm. Method of minimum chi-square	3	
	Method of modified minimum chi-square.	3	
	Properties of these estimators (both large and small samples)	3	
IV	Interval estimation – Fundamental notions of interval estimation, applications of Chebychev's inequality.	5	PPT, Chalk andTalk, Assignments and seminar
	Shortest length confidence intervals and their construction.	4	
	Construction of confidence intervals applying maximum likelihood estimator and central limit theorem.	5	
V	Bayes estimation – concept of prior, posterior distributions.	5	PPT, Chalk and Talk, Assignments and seminar
	Conjugate and non-informative priors.	4	
	Bayes estimator under quadratic error loss function	5	
	Elementary notions of minimax estimation – application.	4	

Course Learning Outcomes

On the successful completion of the course, students will be able to

CLO's	Course Learning Outcomes	Knowledge Level
CLO-1	Properties of point estimator such Consistency, Unbiasedness, Sufficiency	Up to K2
CLO-2	Obtain minimum variance unbiased estimator	Up to K3
CLO-3	Obtain estimators using methods of estimation.	Up to K3
CLO-4	Acquire the knowledge of Interval estimation and Construct Confidence Interval	Up to K4
CLO-5	Inferring the concepts of Bayes estimation in different fields of applications	Up to K4

MAPPING CLOs WITH PSOs

#	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CLO-1	2		2	2	2	1	2
CLO-2			2	2	2	1	2
CLO-3		3	2	2	2	1	2
CLO-4	3	3	2	2	2	1	2
CLO-5	3	3	2	2	2	1	2

Advance application – 3; Intermediate level – 2; Basic level - 1

CIA I – Blue Print

Units	CLOs	K- Level	Section A		Section B		Section C	
			Short Answers		(Either/or Choice)		(Open Choice)	
			No. of Questions	K- Level	No. of Questions	K- Level	No. of Questions	K- Level
1	CLO 1	Up to K2	2	K1 , K2	2	K1,K2	1	K2
2	CLO 2	Up to K3	3	K1, K2,K3	2	K2,K3	2	K3, K3
No. of Questions to be asked			5		4		3	
No. of Questions to be answered			5		2		2	
Marks for each question			2		5		10	
Total Marks for each section			10		10		20	

CIA-I :: Distribution of Section-wise Marks with K levels

K –Levels	Section A (No choice)	Section B (Either/ or)	Section C (Open choice)	Total marks	% of marks without choice	Consolidated
K1	4	5	-	9	15.00	55%
K2	4	10	10	24	40.00	
K3	2	5	20	27	45.00	45%
K4	-	-	-	-	-	-
K5	-	-	-	-	-	-
Total Marks	10	20	30	60	100	100%

CIA II – Blue Print

Units	CLOs	K- Level	Section A		Section B		Section C	
			Short Answers		(Either/or Choice)		(Open Choice)	
			No. of Questions	K- Level	No. of Questions	K- Level	No. of Questions	K- Level
1	CLO 3	Up to K3	2	K1,K2,	2	K1,K2	1	K3
2	CLO 4	Up to K4	3	K1, K2, K3	2	K3,K4	2	K3,K4
No. of Questions to be asked			5		4		3	
No. of Questions to be answered			5		2		2	
Marks for each question			2		5		10	
Total Marks for each section			10		10		20	

CIA –II :: Distribution of Section-wise Marks with K levels

K Levels	Section A (No choice)	Section B (Either/ or)	Section C (Open choice)	Total marks	% of marks without choice	Consolidated
K1	4	5	-	9	15.00	30%
K2	4	5	-	9	15.00	
K3	2	5	20	27	45.00	45%
K4	-	5	10	15	25.00	25%
K5	-	-	-	-	-	-
Total Marks	10	20	30	60	100	100%

SummativeExamination – Blue Print

S. No.	CLOs	K Level	Section A		Section B		Section C (Either/or Choice)	Section D (Open Choice)
			MCQs		Short Answers			
			No. of questions	K Level	No. of questions	K level		
1	CLO 1	Up to K2	2	K1 & K1	1	K1	2(K1 & K1)	1(K2)
2	CLO 2	Up to K3	2	K2 & K3	1	K1	2(K2 & K2)	1(K3)
3	CLO 3	Up to K3	2	K2 & K3	1	K2	2(K3 & K3)	1(K3)
4	CLO 4	Up to K4	2	K3 & K4	1	K2	2(K4 & K4)	1(K4)
5	CLO 5	Up to K4	2	K3 & K4	1	K3	2(K4 & K4)	1(K4)
No. of Questions to be asked			10		5		10	5
No. of Questions to be answered			10		5		5	3
Marks for each question			1		2		5	10
Total Marks for each Section			10		10		25	30

Distribution of section wise marks with K levels for SummativeExamination

K Levels	Section A MCQs	Section B (Short Answers)	Section C (Either/ or)	Section D (Open choice)	Total marks	% of marks without choice	Consolidated
K1	2	4	10	-	16	13.33	35%
K2	2	4	10	10	26	21.67	
K3	4	2	10	20	36	30	30%
K4	2	-	20	20	42	35	35%
Total marks	10	10	50	50	120	100	100%

Course Designers:

1. **Dr.P. Vetri Selvi**
2. **Dr. A. Saberunnisa**