BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, Pilani
Pilani Campus
AUGS/ AGSR Division

SECOND SEMESTER 2023-2024
COURSE HANDOUT

Date: 09 January, 2024

In addition to part I (General Handout for all courses appended to the Time table), this portion gives further specific details regarding the course.

Course No : **MATH F315**
Course Title : **Introduction to Statistical Inference**
Instructor-in-Charge : **Farida Parvez Barbhuiya**
Instructor : **Farida Parvez Barbhuiya**

1. Course Description: After a brief overview and motivation, the course will cover the following topics.
(i) Point Estimation: Parametric point estimation: unbiasedness, consistency, efficiency; method of moments and maximum likelihood; lower bounds for the variance of an estimator; Frechet-Rao-Cramer bounds; Sufficiency, minimal sufficiency, factorization theorem; Rao-Blackwell theorem, completeness, Lehmann-Scheffe Theorem, UMVUE, Basu's theorem, invariance, best equivariant estimators.
(ii) Testing of Hypotheses: Tests of hypotheses, simple and composite hypotheses; types of error; Neyman-Pearson lemma; families with monotone likelihood ratio, UMP, UMP unbiased and UMP invariant tests. Likelihood ratio tests - applications to one sample and two sample problems, Chi-square tests. Wald's sequential probability ratio test.
(iii) Interval estimation: Methods for finding confidence intervals, shortest length confidence intervals.

2. Scope and Objectives:
In the most common situations, the analyst cannot directly assess the entire population of interest. In such situations, a set of statistical methods are used to infer the population parameters from sample data. Statistical inference actually provides the linkage between the observed sample and the underlying population. The present course builds up fundamental concepts of various theoretical concepts related to statistical inference and their implications. There are two major thrust areas in a course of statistical inference, namely the estimation (point and interval) and hypothesis testing. Thus, several properties of estimators and hypothesis tests will be discussed along with illustrative examples.

3. Text Book:
1. V. K. Rohatgi and A. K. Md. E. Saleh, An Introduction to Probability and Statistics, 3rd Edition, Wiley.

4. Reference Books:
1. G. Casella and R. L. Berger, Statistical Inference, 2nd Edition, Cengage.
2. B. K. Kale, A First Course on Parametric Inference, 2nd Edition, Alpha Science International.
3. J. A. Rice, Mathematical Statistics and Data Analysis, 2nd Edition, International Thomson Publishing.
4. R. V. Hogg, J. W. McKean, A. T. Craig, Introduction to Mathematical Statistics, 8th Edition, Pearson Education.
5. H. Liero, S. Zwanzig, Introduction to the Theory of Statistical Inference, CRC Press.

5. Tentative Course Plan:

Lecture	Lecture Session	Reference	Learning Outcomes
1	Introduction and motivation	Ch-6	Understanding of the course.
2-3	Basic concepts of point estimation: unbiasedness, consistency and efficiency of estimators, examples.	8.1, 8.2, 8.4	Students learn the concepts of desirable properties of an estimator.
4-7	Finding Estimators: method of moments and	8.6-8.7	Students gain knowledge

	maximum likelihood estimators, properties of maximum likelihood estimators, problems.		of several estimation techniques and their properties.
8-11	Lower Bounds for the variance: Frechet-Rao-Cramer and generalization of Frechet-Rao-Cramer to higher dimensions, problems.	8.5	It enhances the understanding of the concepts related to lower bounds for variance. Several theorems are studied.
12-15	Data Reduction: Sufficiency, Factorization Theorem, Rao-Blackwell Theorem, minimal sufficiency, completeness, Lehmann-Scheffe Theorem, applications in deriving uniformly minimum variance estimators, UMVUE, Ancillary statistics, Basu's Theorem, problems.	8.3	Students will learn concepts of sufficient statistic, factorization theorem, Rao-Blackwell theorem, the UMVUE, and associated ideas.
16-17	Invariance: Best equivariant estimators, problems.	8.9	It encourages to learn methods of equivariant estimators.
18-20	Bayes and Minimax Estimation: Concepts and applications.	8.8	Students will learn other methods of estimation.
21-23	Testing of Hypotheses: Basic concepts, simple and composite hypotheses, critical region, types of error, most powerful test, Neyman-Pearson lemma; problems and applications	9.1-9.3	To understand the classical theory for parametric hypothesis
24-28	Tests for Composite Hypotheses: Families with monotone likelihood ratio, uniformly most powerful (UMP) tests, applications	9.4	Students will learn UMP test and its applications.
29-30	Unbiasedness: Unbiased tests, similarity and completeness, UMP unbiased tests.	9.5	It helps to learn unbiased tests and UMP unbiased tests.
31-34	Likelihood Ratio Tests - applications to one sample and two sample problems.	9.6, 10.1, 10.2	It encourages to learn likelihood ratio tests.
35	Invariant Tests; problems	9.5	Students will learn methods of invariant tests, Chi-square goodness of fit tests.
36	Contingency Tables & Chi-square tests.	13.5	
37-40	Interval estimation: methods for finding confidence intervals, shortest length confidence intervals, problems.	11.1-11.5	Concepts of interval estimation will be briefly covered.

6. Evaluation Scheme:

Evaluation Component	Duration	Weightage	Date & Time	Nature of Component
Two Quizzes	40 minutes each	20%	Will be announced	Open Book
One assignment	Will be announced	10%	Will be announced	Open book
Mid Semester	90 minutes	30%	11/03 - 4.00 - 5.30PM	Closed Book
Comprehensive Exam	180 Minutes	40%	07/05 AN	Closed Book

7. Consultation hours: To be announced in class.

8. Notices: All notices in relation to the above course will be displayed on CMS or Google Classroom.

9. Make up policy: Make up will be granted only in genuine cases. Students should follow proper guideline for applying make ups.

10. Academic Honesty and Integrity Policy: Academic honesty and integrity are to be maintained by all the students throughout the semester and no type of academic dishonesty is acceptable.

Instructor in Charge

MATH F315