MTH418a: Inference-I
2023-2024-II Semester

Prerequisites: MSO205a: Introduction to Probability Theory/MTH211A: Theory of Statistics/MSO201A: Probability and Statistics/MTH311A: Probability Theory-I

Instructor: Dr. Neeraj Misra
Faculty Building 515, Department of Mathematics & Statistics
7087 (Talk); neeraj@iitk.ac.in (E-mail)
http://home.iitk.ac.in/∼neeraj/ (Webpage)

Lectures: Days: Tue, Wed, Fri (15:00-15:50 Hrs) at L-08 (Lecture Hall Complex);

Tutorials: Day: Th (09:00-09:50 Hrs.) at L-08 (Lecture Hall Complex).

Office Hours: Faculty Building, Room No. 515 (Through prior appointment)

Course Webpage: http://home.iitk.ac.in/∼neeraj/mth418a/mth418a.htm

Reference Books:

(i) Statistical Inference, by George Caella and Roger L Berger, Duxbury, Thomsan Learning;
(ii) Mathematical Statistics, by Jun Shao, Springer;
(iii) Theory of Point Estimation, by E.L. Lehmann and George Casella, Springer;
(iv) Theory of Statistical Hypotheses, by E L Lehmann, Wiley;
(v) Introduction to Probability and Statistics, by V K Rohatgi and A K Md. Ehsanes Saleh, Wiley.
(vi) Linear Statistical Inference and Its Applications, by C.R. Rao, Wiley.

Course Content:

Parametric models, parameters, random sample and its likelihood, statistic and its sampling distributions, problems of inference. Examples from standard discrete and continuous models such as Bernoulli, Binomial, Poisson, Negative Binomial, Normal, Exponential, Gamma, Weibull, Pareto etc. Concept of sufficiency, minimal sufficiency, Neyman factorization criterion, Fisher information, exponential families. Maximum likelihood estimators, method of moment estimators, percentile estimators, least squares estimators, minimum mean squares estimators, uniformly minimum variance unbiased estimators, Rao Blackwell theorem, Cramer Rao lower bond, different examples. Statistical Hypotheses: simple and composite, statistical tests, critical regions, Type I and Type II errors, size and power of a test, Neyman Pearson lemma and its different applications. Most powerful test, uniformly most powerful test, unbiased test and uniformly most powerful unbiased test. Likelihood ratio test. Interval estimation, confidence intervals, construction of confidence intervals, shortest expected length confidence interval, most accurate

one sided confidence interval and its relation to UMP test.

Course Objectives

The sequence of courses MTH418a: Inference-I and MTH515a: Inference-II are designed to expose students to basic principles and statistical theory of statistical inference with main emphasis on statistical estimation and statistical testing problems. In the course MTH418a, the students in the beginning will be introduced to data reduction notions of sufficiency, minimal sufficiency and completeness. Various methods of estimation (MLE, MME, UMVUE etc.) and their properties will be discussed. In addition basic principles of hypothesis testing problems and various associated notions (Type I and II errors, power and size of the test, MP, UMP and UMPU tests) will be discussed. Techniques to derive UMP and UMPU tests will be developed. Problems of interval estimation and confidence intervals will be introduced and techniques to find confidence intervals of specified confidence, shortest expected length CI and most accurate one sided CI will be discussed. Interrelation of CI with UMP tests will also discussed.

In the course MTH515a, some other methods of estimation and hypothesis testing will be introduced. Principles of invariance in estimation and testing problems will be discussed. Bayes and minimax estimation procedures will be introduced and asymptotic (as the sample size approaches ∞) properties of MLE and MME will be discussed. Some asymptotically efficient estimation and testing procedures will be discussed. Methods for deriving invariant, unbiased and likelihood ratio tests will be taught and their asymptotic properties will be studied.

Prerequisites

Students are expected to have knowledge of advanced calculus, elementary probability theory, and elementary statistical distribution theory. Whenever possible, above topics will be reviewed in the context while developing various topics in the course MTH418a.

Course Policies

I. Weightages

There will be a mid-semester examination of two hour duration (on one of the days during 19-02-24 to 24-02-24, to be announced by the DOAA), carrying 25% wieghtage; an end-semester examination of three hour duration (on one of the days during 22-04-24 to 01-05-24, to be announced by the DOAA) carrying 50% weightage; and two long quizzes of forty five minutes duration each (on 03-02-24 (Saturday) and 21-03-24 (Thursday)), each carrying a weightage of 12.5%.

II. Academic Performance Evaluation Scheme

The relative grading policy (with minimum performance requirement for each grade) will

be followed. The minimum performance requirements for various grades are as follows:

A* Grade:	75% Marks
A Grade:	70% Marks
B+ Grade:	63% Marks
B Grade:	55% Marks
C+ Grade:	48% Marks
C Grade:	40% Marks
D+ Grade:	35% Marks
D Grade :	30% Marks
E Grade:	20% Marks

III. Attendance & Course Drop Policy

Except for reasons beyond student's control, every student is expected to attend all sessions (lectures, tutorials, examinations, quizzes) of the course. As students are expected to attend all sessions of the course, attendance may be taken on random days (especially on the days of low attendance in the lectures/tutorials of the course). Habitual absentees may be awarded F grade.

Students who have made sincere efforts in the course (as evidenced through regularity in attending lectures and examinations/quizzes) will be allowed to drop the course unconditionally.

IV. Code of Conduct and Ethics

Students are expected to maintain highest standards of ethics, honesty and integrity. There will be zero tolerance for cheating during examinations and quizzes. Students caught using unfair means during examinations or quizzes will in addition to getting F grade may also face disciplinary action, as per institute's policy. Students are also expected to maintain proper decorum during lectures, tutorials and examinations. Any act of indiscipline will be dealt with appropriately.

V. Makeup Examination Policy

There will be no makeup examinations for missed Mid Semester Examination or Quizzes. If a student does not appear in the Mid Semester Examination or a Quiz due to bonafide reasons, he/she may be considered for prorating the missed portion of grade with the average grades in remaining portions of evaluation. Proration of not more than one component of evaluation will be considered. For missing Mid Semester Examination or a Quiz due to bonafide and non-emergent situation, request for proration shall be made well before the date of mid semester examination or quiz. For missing Mid Semester Examination or a Quiz due to an emergent situation, request for proration shall be made as soon as possible after the date of mid semester examination or quiz. In case of medical emergency the student must present a letter from the doctor stating that the student was not in condition to take the examination/quiz (simply producing a note stating that the student reported to the doctor will not be acceptable). Makeup examination for

end-semester examination will be as per the policy of the institute.

VI. Lecture Notes, Assignment Problems and Examination/Quizzes

Students are expected to go through the course lecture notes and suggested text books for further understanding of the course material covered during lectures. Whenever required Lecture notes will be made available on the web page of the course.

A list of suggested home assignment problems will be provided during lectures and, whenever possible, on the web page of the course.

For mastering the course material and doing well in examinations, student must first try to solve home assignment problems of their own. All difficulties may be discussed during tutorial sessions or through prior appointment with the instructor.