

# MTH211A: Theory of Statistics

## First Course Handout

**Instructor in charge:** Minerva Mukhopadhyay ([minervam@iitk.ac.in](mailto:minervam@iitk.ac.in))

**Credits:** 11 (3-1-0-0)

**Lecture hours:** TWF 11AM-12 noon    **Tutorial:** Th 11AM-12 noon

**Venue:** T110

**Course webpage:** <http://surl.li/ovknq>

**Objective:** This course covers concepts in various aspects of classical statistics. Students will be introduced to statistical inference, starting with frequentist and Bayesian estimation and hypothesis testing. Focus will be on the theoretical underpinnings of concepts.

### References:

1. Casella, G., Berger, R. L. (2021). Statistical Inference. Cengage Learning. (Textbook)
2. Rohatgi, V. K., Saleh, A. M. E. (2015). An Introduction to Probability and Statistics. John Wiley and Sons.
3. Hogg, R. V., McKean, J., Craig, A. T. (2005). Introduction to Mathematical Statistics. Pearson Education.
4. Ross, S.E. (2004). Probability and Statistics for Engineers and Scientists. Elsevier.

### Course Content:

- (I) Introduction to Statistical Inference (1.5 Lectures)
  - Concepts of population and random sample
  - Statistical model and parameters
  - Statistic and sampling distributions
- (II) Revisiting Some Concepts from Probability Theory (3.5 Lectures)
  - Some important sampling distributions
  - Popular results including additive properties, distribution of important transformations
  - Some important statistics including moments and order statistics, and their properties
  - Important large sample results
- (III) Point Estimation (12 Lectures)
  - Sufficiency, completeness, unbiasedness, UMVUE
  - Information inequalities, Cramer-Rao lower bound
  - Methods of estimation: maximum likelihood estimator (MLE), method of moments (MoM)
  - Properties of MLE and MoM

- (IV) Testing of Hypothesis (12 Lectures)
  - Null and alternative hypothesis
  - simple and composite hypothesis
  - size, power
  - Neyman-Pearson lemma for simple vs simple and its use for testing composite hypothesis
  - UMP test, likelihood ratio tests
- (V) Confidence Interval (5 Lectures)
  - Pivotal statistics, methods of constructions
- (VI) Bayesian Statistics (5 Lectures)
  - Basics, point estimation as a decision problem
  - Prior distribution, Bayes risk, Bayes estimators under losses
  - Credible sets

### **Grading and Evaluation:**

- (i) There will be 4 **surprise quizzes**, a mid-semester and an end-semester exams.
- (ii) Questions will be of descriptive and theoretical type.
- (iii) Grading scheme is *relative*. The weights of different evaluations are as follows:
  - Quizzes: 10% each
  - Midterm: 20%
  - Endterm: 35%
  - Attendance: 5%
- (iv) If a student misses up to two quizzes, then s/he will be evaluated based on the other quizzes. If s/he misses more than two quizzes, then s/he will get zero marks in the missed quizzes.
- (v) If a student misses the mid-semester exam, then s/he will have to take an appropriate make-up exam.

### **General Guidelines:**

- (i) An outline of the lecture notes will be uploaded on the course webpage on a weekly basis. Students are encouraged to combine the classnotes and the uploaded lecture notes while studying.
- (ii) MTH211A is a 11-credit theoretical course. Students are expected to spend 11 hours per week for good performance in this course.
- (iii) If a student found to follow unfair means (in any of the exams), then irrespective of the circumstances “*one grade down*” policy will be applied. No explanation/negotiation will be entertained.