FIRST COURSE HANDOUT, INTRODUCTION TO PROBABILITY THEORY (MSO205), 2024-25 ODD SEMESTER

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1. Pre-requisites and Course Objectives

Pre-requisites: Students are expected to be familiar with Real Analysis at the level of MTH101A (equivalently, MTH111M+MTH112M). No pre-requisites for M.Sc 2-year students.

Objectives: Core concepts of Probability (random variables/vectors and probability distributions) shall be covered in this course. At the end of the course, the students are expected to have enough familiarity with the subject to apply them in their own fields of study.

2. Course contents and References

2.1. **Course contents.**

(Topic 1) Basic definitions and ideas such as random experiment, sample space and event, Classical definition and relative frequency definition of probability, Axiomatic definition of probability, Elementary properties of probability function, Probability inequalities such as Boole's inequality and Bonferroni inequality.

(Topic 2) Conditional probability and its basic properties, Examples of conditional probability and multiplication law, Theorem of total probability and related examples, Bayes theorem and related examples, Independent events.

(Topic 3) Random variables and their distribution function, Induced probability space, Discrete and continuous random variables, Function of random variables (Discrete and Continuous), Expectation and moments of random variables, MGF of random variables and its application, Markov, Chebyshev and Jensen's inequality, Characteristics function and its application.

(Topic 4) Standard discrete distributions and their properties (e.g., Bernoulli, Binomial, Geometric, Negative Binomial, Hypergeometric, Poisson) Standard continuous distributions and their properties (e.g., Normal, Exponential, Gamma, Beta, Cauchy).

(Topic 5) Random vectors and their joint distribution functions, Marginal distribution, independent random variables, Conditional distribution of random vectors/variables, Expectation and moments of random vectors, Conditional Expectation, variance and covariance and their applications.

(Topic 6) Idea of limiting distribution, Convergence in distribution and probability, and related results, Convergence of moments and almost sure convergence, Various examples and counter examples.

(Topic 7) Weak law of large numbers, Central limit theorem, Applications, e.g., continuous mapping theorem and delta method.

Date: July 29, 2024.

2.2. **Important dates.**

Week #	Dates	Remarks
1	July 30 - August 2	Shorter Week: one less lecture hour
2	August 5 - 9	
3	August 12 - 16	Holiday: August 15 (Thursday)
4	August 19 - 23	
5	August 26 - 30	Quiz 1*, Holiday: August 26 (Monday)
6	September 2 - 7	Working Saturday (Monday schedule)
7	September 9 - 13	
Mid Sem Exam	September 17 - 22	As per schedule announced by DOAA
8	September 23 - 27	Quiz 2*
9	September 30 - October 4	Holiday: October 2 (Wednesday)
Mid Sem Recess	October 5 - 13	
10	October 14 - 19	Working Saturday (Thursday schedule), Drop deadline: Oct 17
11	October 21 - 25	Quiz 3*
12	October 28 - November 1	Holiday: October 31 (Thursday)
13	November 4 - 8	
14	November 11 - 14	Shorter Week: one less lecture hour
End Sem Exam	November 17 - 26	As per schedule announced by DOAA
Make-up Exam	November 29 - December 1	(if required) As per schedule announced by DOAA

*to be confirmed and details such as syllabus, schedule and question format to be announced later

2.3. **Reference materials.**

- An Introduction to Probability and Statistics by V. K. Rohatgi and A. K. Md. E. Saleh.
- Introduction to Probability and Statistics for Engineers and Scientists by S. M. Ross.
- Introduction to Mathematical Statistics by R. V. Hogg, A. Craig and J. W. McKean.
- Introduction to Probability Theory by P. G. Hoel, S. Port and C. Stone
- Introduction to the Theory of Statistics by D. C. Boes, F. A. Graybill and A. M. Mood
- A First Course in Probability by S. M. Ross.
- An Introduction to Probability Theory and its Applications, Vol. 1 & 2, W. Feller.
- Lecture notes on Probability and Statistics by M. Krishnapur (`http://math.iisc.ac.in/~manju/UGstatprob18/statprob2018.html`)
- Lecture notes on MSO201A Probability and Statistics by N. Misra (`http://home.iitk.ac.in/~neeraj/mso201a/mso201a.htm`)
- Lecture notes on MSO201A Probability and Statistics by S. Dutta (`https://www.sites.google.com/site/tijahbus/home/courses`)

3. Lecture and Tutorial Schedule and Office Hours

- Lectures: Mondays, Thursdays and Fridays 11:00 - 11:50 hrs, venue: L2 (supplementary materials shall be made available over helloIITK portal).
- Tutorials: Wednesdays 11:00 - 11:50 hrs, venue: L2
- Office Hours: Students should communicate their need to discuss doubts by email and take appointments for the same.

4. Weightages for different components of evaluation (out of 100)

Component Name	Weightage
Mid-semester Examination	28
End-semester Examination	42
Quiz (Best of 2 out of 3)	2x15 = 30

- Mid/End Semester Examination: The examinations shall be conducted as per the schedule announced by DOAA. The syllabus and other details shall be announced later on.
- Quiz: There shall be 3 Quizzes (15 marks in each) and the best 2 of these 3 shall be used in grading. Syllabi and other details of the quizzes shall be announced from time to time.
- Exercises/Practice Problems: Exercises and/or practice problems will be provided on a weekly basis and students are expected to solve them on their own. There is no need to submit the solutions. However, students are strongly encouraged to discuss amongst themselves and also solve problems from the books mentioned above. These problems may be discussed during the tutorials.

5. Course Policies: Attendance, Grading, Honesty practices, Withdrawal

- There is no extra weightage for attendance. However, it is strongly advised to attend all lectures and tutorials.
- The policy of relative grading will be followed for awarding final grades. However, if the highest marks is below 92, then A* grade may not be awarded.
- No make-up opportunity shall be provided for a missed Mid Semester Examination or a quiz.
- In the case where a student misses the Mid-Semester examination (or a quiz) due to a bonefide non-emergency situation, then a request for proration may be considered. However, such a request must be made well in advance and the final decision to allow prorating rests with the instructor.
- For missing the Mid Semester examination (or a quiz) due to an emergent situation, request for proration must be made as soon as possible after the exam/quiz date. In case of a medical emergency, the student must present a letter from the doctor stating that the student was not in a condition to take the examination. The final decision to allow prorating rests with the instructor.
- Make-up option for the End-semester examination will be as approved by DOAA. Applications for the same need to be supported with proof, such as, a medical certificate or a proof of sanctioned leave.
- Any dishonest practice during examinations or quizzes will be reported to DOAA and appropriate action would be taken to penalize such action.
- Students are allowed to withdraw from the course as per the guidelines set by DOAA.