MAT221E: Probability Theory

Fall 2021

Instructor Information

Instructor: Gül İnan

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Office: Room 424 @ Department of Mathematics

Office hour: You can ask me your questions right after the class, or send me an e-mail for your queries and/or for scheduling an online appointment via Zoom.

Course Information

Course Type: Must course for undergraduate students.

Course Credits: 3 local credits.

Course Prerequisites: None.

Course Description: This course is an introductory level probability class on introducing following concepts: sample space, probability measure on a sigma-algebra, Kolmogorov axioms, conditional probability, combinatorial methods, Bayes theorem. Random variables, discrete density functions, continuous density functions, functions of random variables, bivariate joint density functions, marginal and conditional density functions, independent random variables. Definition and properties of expectations. Chebyshev inequality. Moment generating functions. Special discrete and continuous distributions. Limit theorems, law of large numbers, central limit theorem. Slutsky's theorem.

Class Schedule: Thursdays between 11:30-14:30 p.m.

Classroom: Room D201 @ Faculty of Arts and Sciences.

Course Objectives: This course aims to:

1. To provide the basic concepts of probability.
2. To set up probability models for a range of random phenomena, both discrete and continuous.
3. To develop critical thinking skills and abilities to apply calculus techniques (i.e., limits, derivatives, integration, infinite series) to assess the probability of an event.

Course Tentative Plan: We will closely follow the weekly schedule given below. However, weekly class schedules are subject to change depending on the progress we make as a class.

Week 1. Experiments and events, algebra of events, sigma-algebra of events, probability measure on a sigma-algebra, sigma algebra of borel sets, Kolmogorov axioms, and finite sample spaces.

Week 2. Counting methods, combinatorial methods, product rule, permutation, combination, binomial expansion, multinomial expansion, tree diagram.

Week 3. Conditional probability, Bayes' rule, the law of total probability, independence of events.

Week 4. Random variables and their distributions: Random variables, distributions and probability mass functions, Bernoulli, Binomial, Hypergeometric, and discrete uniform distributions.

Week 5. Cumulative distribution function, functions of random variables, independence of random variables.

Week 6. Definition of Expectation, Special expectations: mean and variance. Geometric, Negative Binomial, and Poisson distributions.

Week 7. Continuous random variables: Probability density functions, Uniform, Normal and Exponential distributions.

Week 8. ITU Fall Break

Week 9. **Midterm on December 2, 2021 during lecture hour and place.**

Week 10. Moments: Summaries of a distribution, sample moments, moment generating functions.

Week 11. Joint distributions: Joint, marginal, and conditional distributions. Covariance and correlation. Multinomial distribution. Multivariate Normal distribution.

Week 12. Transformations: Change of variables, convolutions, Beta and Gamma distributions.

Week 13. Marginal and conditional density functions, independent random variables.

Week 14. Conditional expectation. Conditional variance.

Week 15. Inequalities. Limit theorems: law of large numbers and central limit theorem. Slutsky's theorem. Chi-square, Student-t, and F distributions.

Student Learning Outcomes: A student who completed this course successfully is expected to:

1. Understand and apply basic concepts of probability.
2. Understand probability distributions for both discrete and continuous phenomena.

3. Calculate basic characteristics such as mean and variance of probability distributions, and any probability associated with this distributions.
4. Use special probability distributions for modeling events.
5. Use limit theorems.

immediately following the course, and/or a few months after the course.

Textbook: All lecture materials. Lecture materials (notes, assignments, etc) will be uploaded on https://ninova.itu.edu.tr.

Course Workload: 2 quizzes, 1 midterm exam, and 1 final exam (see the grading policy below).

Recommended Bibliography: Students are encouraged to consult the following sources on their own:

1. Hogg, V.H. and Craig, A.T. (1995). *Introduction to Mathematical Statistics*. New Jersey: Prentice-Hall International. [Hard copy available at ITU Mustafa Inan Library with CALL #QA276 .H643 1995]. (Available on Ninova)
2. Hogg, R. V., Tanis, E. A., and Zimmerman, D.L. (2010). *Probability and Statistical Inference*. Upper Saddle River, NJ, USA: Pearson/Prentice Hall. (Available on Ninova)
3. DeGroot., M.H. and Schervish, M.J. (2012). *Probability and Statistics*. Boston: Addison-Wesley, c2012. [Hard copy available at ITU Mustafa Inan Library with CALL #QA273 .D445 2012]. (Available on Ninova)

Off-Campus Access to the ITU Library E-sources:

Access to library e-sources remotely is possible with a library account. Users without a library account should apply for the library registration at https://kutuphane.itu.edu.tr/en/register. After setting the web configurations given at https://kutuphane.itu.edu.tr/en/services /web-browser-proxy-settings only once on your computer, you will able to have an access to ITU Library e-sources.

Selected Important Dates: For the official ITU Fall 2021 academic calendar, please visit:

https://www.sis.itu.edu.tr/TR/ogrenci/akademik-takvim/akademik-takvimler/takvim2022/lisans-akademik-takvimi.php

Here are some selected important dates in Fall 2021 semester:

October 4, 2021: First day of classes.

October 4-8, 2021: Add-drop week.

October 29, 2021: Republic Day of Turkey (Friday, No classes).

November 22-26, 2021: ITU Fall Break (No classes).

January 1, 2022: New year (Saturday).

January 14, 2022: Last day of classes.

January 17-30, 2022: Final exam week.

I also honor other national and religious holidays. Students, who needs flexibility on individual-based studies overlapping with these special days, can inform me.

Course Policies

Please read the information below as a reference for how this class will be conducted.

Grading Policy:

- Assessment Method Total Contribution to Final Grade:
  - 2 quizzes each 10%,
  - 1 midterm exam 40%,
  - 1 final exam 40%.
- **Midterm date**: December 2, 2021 during the lecture hour in class.
- Quizzes will be held during the lecture hours and the dates will be announced at well in advance. No make-up for quizzes.
- **Student studies, namely, quizzes and exam papers which are not written well, does not follow a proper mathematical writing language, and are hard to review, will get "0" credit for that question.**
- Please see an example for **a good homework** on Ninova.
- Please read the general advice given at:

  http://ma117.math.metu.edu.tr/course-info/general-advice/.

Late Submission Policy: There are **NO** make-ups for missed quizzes.

Final Exam Attendance Policy: At least 30 points from in-semester studies (e.g., (Midterm * 0.4 + Quiz 1 * 0.1 + Quiz 2 * 0.1) greater than or equal to 30)

Make-Up Exam Policy: The students who miss either midterm exam or final exam due to a health problem can take a make-up exam as long as they have a valid medical report taken on the exam day. The medical report should be handed in immediately (within two days of its expiration).

Class Attendance Policy:

The students are encouraged to attend classes, whereas the attendance is not mandatory in Fall 2021 semester due to Covid-19 pandemic. For that reason, the student is deemed responsible to manage his/her absences.

Participation Policy:

The students are expected to ask and answer questions, participate in in-class activities, and show their interest and engagement in the class.

E-mail Policy:

Please:

1. Use a proper descriptive subject line (which may consist of the course number MAT221E followed by a short phrase summarizing the subject of your e-mail).
2. Start off your e-mail with a proper greeting, introduce yourself (give your name), then state your problem as short as possible.
3. Finally, use a proper closing and then finish your e-mail with your first name and so on.

Feel free to send me e-mails. But be sure you that give me enough time to get back to you. In the past, I have had pretty much tolerance for e-mail messages sent after business hours and at weekends. But, now, due to pandemic, I should say that I may not appreciate these e-mails anymore. Lastly, e-mails asking for grade grubbing at the end of the semester are not welcomed.

Academic Honesty Policy:

At every stage of the academic life, every ITU student is responsible for obeying the academic honesty policy of ITU stated below:

https://odek.itu.edu.tr/en/code-of-honor/ethics-in-university-life.

Equity, Diversity, and Inclusion:

In this class, I am committed to cultural and individual differences and diversity as including, but not limited to, age, disability, ethnicity, gender, gender identity, language, national origin, race, religion, culture, and socioeconomic status and I acknowledge the value of differences.

Student with Special Needs:

If you are a student with special needs, let me know that how we can adjust the course environment and materials in accordance with your needs. Furthermore, you are also invited to contact the office of students with special needs at:

http://engelsiz.itu.edu.tr/.