ISYE 2027 PROBABILITY WITH APPLICATIONS

Required for BSIE

Credit: 3-0-3

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Prerequisite(s): MATH 2550 or MATH 2551 or MATH 2561 (minimum grade of C) or MATH2X51 (minimum grade of T). MATH 1522 or MATH 1553 or MATH 1554 or MATH 1564 (minimum grade of C) or MATH 1X53 or MATH 1X54 (minimum grade of T). MATH 2551 can be taken with concurrency.

References

1. Dekking, F. M. C. Kraaikamp, H. P. Lopuhaa, and L. E. Meester, *A Modern Introduction to Probability and Statistics: Understanding Why and How*, Springer, London, 2005. Electronic version available for free at the Georgia Tech library.
2. Hajek, B. *Probability with Engineering Applications*, Course Notes, available at http://www.ifp.illinois.edu/~hajek/Papers/probability.html, free.
3. Mukherjee, D. *Probability with Applications*, Course Notes, available at https://drive.google.com/file/d/18N9aZA0GRLiIKaJN9dYc7iTqKuNS7jpW/view?usp=sharing, free.

Catalog Description:
Topics include conditional probability, density and distribution functions from engineering, expectation, conditional expectation, laws of large numbers, central limit theorem, and introduction to Poisson Processes.

Course description
In this course, the students will learn the basic tools used in developing and analyzing probabilistic models with their applications.

Topical Outline

Topics	Weeks
Basic Definitions and Properties: Sample spaces, events, and the axioms of probability. Basic relationships involve the probability of complements and unions of events. Finite sample spaces with equally likely outcomes. Counting techniques include the multiplication principle, permutations, combinations, and the binomial theorem. Conditional probabilities and independent events. The birthday problem. The law of total probability and Baye's Theorem.	4

Random Variables: Definition of a random variable. Discrete random variables and probability mass functions. Continuous random variables and probability density functions. Cumulative distribution functions. Important discrete distributions include Bernoulli, binomial, geometric and Poisson. Important continuous distributions include uniform, exponential, and normal. The expectation of a random variable. Uses and shortcomings of the mean in decision making. Functions of a random variable. Expectations of functions of random variables and the law of the unconscious statistician. The variance, standard deviation, and median of a random variable. Selected applications such as insurance, the newsvendor problem, and travel times in order picking and carousels.	5
Random Vectors: Joint, marginal and conditional distributions. Conditional expectations. Functions of random vectors including the minimum, maximum, and sums. Means and variances of linear combinations of random variables. Covariances, correlations, and independence. Selected applications such as travel times in miniload as/rs systems.	4
Limit Theorems and Their Applications: Markov's and Chebyshev's inequalities. Laws of Large Numbers and the Central Limit Theorem.	2

Course learning outcomes and their relationship to

At the end of this course, students will be able to:

1. Grasp which distributions might be appropriate in modeling a particular situation
2. Understand measures of a distribution's location and spread
3. Model and analyze problems at a level of the newsvendor problem or the travel time for carousels and miniloads.
4. Understand the role of probability in decision-making.
5. Understand how randomness affects system behavior and performance.
6. Compute probabilities and moments such as the expected value and variance of random variables and combinations/functions of random variables.
7. Understand relationships among multiple random quantities.
8. Be able to use the central limit theorem to approximate probabilities related to sums of i.i.d. random variables. Know how much probability is within 1, 2 and 3 standard deviations of the mean of a normal distribution.

Course outcome \ Program Outcomes	**1. identify, formulate solve engg prob by engg, sci & Math**	**2. produce solutions consider public health, safety, welfare, global, cultural, social, environ & economic**	**3 communicate with a range of audience**	**4 recognize ethical & professional responsibilities, make informed judgement consider resolutions in global, economic, environ and societal context.**	**5. effective on a team provide leadership, collaborative and inclusive envirn, plan tasks & meet objectives**	**6. develop and conduct experiment, analyze and interpret data & use engineering judgement to draw conclusions.**	**7. acquire and apply new knowledge using appropriate learning strategies**

1. Grasp which distribution is appropriate in a particular application	H						
2. Understand measures of distribution's location and spread	H						
3. Model and analyze problems as newsvendor problem or the travel times							
4. Understand the role of probability in decision making							
5. Understand how randomness affects system behavior and performance							
6. Compute probabilities and moments	H						
7. Understand relationships among multiple random quantities.							
8. Be able to use the central limit theorem to approximate probabilities							

Evaluation of the important outcomes
Course outcomes 1, 2, 6 will be assessed in a complex word problem involving calculus.