MATH 320: Probability (4 credits)
Syllabus

1. *Prerequisite*: C- or better in MATH 166 or permission of the department chairperson.

2. *Course Description*: Probability theory for discrete and continuous sample spaces, random variables, density functions, distribution functions, marginal and conditional distributions, mathematical expectation, moment-generating functions, common distributions, sampling distribution theory, central limit theorem, and t, chi-square, and F distributions.

3. *Course Objectives:* Students will be able to—
    - Use counting methods and probability rules to calculate probabilities, including conditional probabilities.
    - Use univariate discrete and continuous distributions, including those from common parametric families of distributions, to calculate probabilities, expected values and variances.
    - Derive and identify moment generating functions of parametric families of distributions; use moment generating functions to compute moments and to identify underlying probability distributions.
    - Use bivariate discrete and continuous distributions to calculate probabilities, expected values, covariance and correlation.
    - Use sampling distribution theory to find distributions of functions of random variables and sums of independent random variables, including when sampling from a normal distribution.
    - Use the Central Limit Theorem to approximate distributions and calculate probabilities.

4. *Course Rationale*: The concepts of probability are of great importance in a wide variety of applications. The theory of probability, as the foundation upon which the methods of statistics are based, should command the attention of those who what to understand as well as apply statistical techniques. This course, therefore, is a required course for those who want to major in statistics or actuarial science and is an excellent course for those who are in mathematics, business, and other allied fields.

5. *Course Content*:
    Probability
        Random Experiments
        Random Variables
        Properties of Probability
        Methods of Enumeration
        Conditional Probability
        Bayes' theorem
        Independent Events

    Distributions of Discrete Type
        Random Variables of Discrete Type
        Mathematical Expectation
        Mean and Variance
        Moment Generating functions
        Bernoulli and Binomial Distributions
        Geometric and Negative Binomial Distributions
        Multivariate Distributions of Discrete Type
        Correlation Coefficient
        Conditional Distributions

Multinomial Distribution

Distributions of Continuous Type
- Samples, Histograms, and Ogives
- Exploratory Data Analysis
- Random Variables of continuous Type
- Uniform Distribution
- Exponential and Gamma Distributions
- Normal Distribution
- Multivariate Distributions of Continuous Type
- Bivariate Normal Distribution
- Sampling from Bivariate Distributions
- Mixed Distributions and Censoring

Sampling Distribution Theory
- Distributions of functions of Random Variables
- Sums of Independent Random Variables
- Chi-square Distribution
- The t and F Distributions
- Central Limit theorem
- Approximations for Discrete Distributions
- Limiting Moment generating Functions
- Transformations of Random Variables

6. *Course Format*: Lecture/discussion. The amount of material to be covered may not allow for complete treatment during class of all topics listed under the Course Content. Thus, students may need to supplement class overviews with readings.

7. *Methods of Evaluating Student Performance*: Course grades are determined primarily on student performance of tests and the final examination, augmented by evaluation of performance on homework.

8. *Evaluation of the Course*: The instruction of the course is evaluated by departmental student evaluations and peer evaluation. The course is reviewed and revised periodically by the Departmental Graduate Programs Committee.

9. *Addendum:* Suggested resources for this course: Probability and Statistical Interference, 10^{th} Ed. by Hogg/Tanis/Zimmerman; Publisher, Pearson.

[Ali; 2002, Nelson; 10/2005, M. Begum; Spring 2013, UPC R. Pierce Chair; Fall 2016, UPC R. Pierce Chair; Fall 2018, UPC R. Pierce Chair; Spring 2019, UPC R. Pierce Chair; Spring 2023, UPC D. Rutherford Chair]