MATH 321: Mathematical Statistics (4 hours)
Syllabus

1. *Prerequisite*: C- or better in MATH 320 or permission of the department chairperson.

2. *Course Description*: Random sampling, statistical inference, and sampling distributions, point and interval estimation, matching moments, maximum likelihood, mean square error, consistency, efficiency, uniformly minimum-variance unbiased estimator (**UMVUE**), Neyman-Pearson Lemma, Likelihood ratio tests, classical tests of significance, goodness-of-fit, contingency tables, correlation, regression, nonparametric methods, Bayesian methods.

3. *Course Objectives*: Students will become familiar with both the theory and applications of the three steps a statistician faces - model selection, model verification, and model interpretation. Students will practice selecting the appropriate model to fit a real-life problem. Students will analyze and evaluate the reasonableness of the model. Students will draw appropriate conclusions from the model to solve the proposed problem.

4. *Course Rationale*: Mathematical statistics is the study of how to deal with data by means of probability models. It grew out of methods for treating data that were obtained by some repetitive operation such as those encountered in games of chance and in industrial processes. These methods soon found application in such diverse fields as medical research, insurance, marketing, agriculture, chemistry, and in industrial experimentation. This course is, therefore, a required course for statistics and actuarial science majors and is an excellent course for those who may need in their work statistical methods at a reasonably sophisticated level.

5. *Course Content*:

   Estimation
   - Matching moments
   - Maximum Likelihood Estimation
   - Properties of Estimators, such as, consistency and efficiency
   - Uniformly minimum-variance unbiased estimator (UMVUE)
   - Mean square error
   - Confidence Intervals for Means
   - Confidence Intervals for Variances
   - Confidence Intervals for Proportions
   - Sample Size
   - Sufficient Statistics
   - Chebyshev's Inequality

   Tests of Statistical Hypotheses
   - Critical Region
   - Type I and type II Errors
   - Power
   - Best Critical Regions
   - Neyman-Pearson Theorem
   - Likelihood Ratio Tests
   - Information Criteria
   - Tests About Means and Proportions
   - Test About Variance
   - Tests About Difference of Means

Nonparametric Methods
- Order Statistics
- Confidence Intervals for Percentiles
- Binomial Tests for Percentiles
- Wilcoxon Test
- Two-Sample Distribution-Free Tests
- Run Tests and Tests for Randomness
- Kolmogorov-Smirnov Goodness-of-Fit Test

Chi-square Tests for Models
- Basis Chi-square Statistic
- Testing Probabilistic Models
- Comparisons of Several Distributions
- Contingency Tables

Linear Statistical Models
- Simple Regression
- Tests of Equality of Means
- Two-Factor Analysis of Variance

Bayesian Decision Theory
- Compound distributions
- Decision Theory
- Bayesian Methods

6. *Course Format*: Lecture/discussion. The amount of material to be covered may not allow for a complete treatment in class of all topics listed in the Course Content, so students may need to supplement overviews in class with individual reading.

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 Undergraduate Programs Committee.

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

[Ali; 2002, Nelson; 10/05, M. Begum; Spring 2013, UPC R. Pierce Chair; Fall 2016, UPC R. Pierce Chair; Spring 2019, UPC R. Pierce Chair]