STEPHEN F. AUSTIN STATE UNIVERSITY

Department of Mathematics and Statistics

MTH 502 – Mathematical Statistics I
Course Syllabus

Course description: Random variables, discrete and continuous distributions, multiple random variables, distributions of functions of random variables, convergence concepts.

Credit hours: 3

Course Prerequisites and Corequisites: MTH 439 or equivalent

Course outline: Approximate time spent

- **Probability Functions and Spaces** 5%
  - Review of Set Theory
  - Probability Functions & the Axioms
  - The Probability Space
  - Elementary Probability Rules Based on the Axioms
- **Results of Conditioning & Independence**
  - Conditional Probability 10%
  - Theorem of Total Probabilities
  - Bayes' Rule
  - Independent Events
- **Language of Random Variables** 10%
  - Discrete vs. Continuous Random Variables
  - Cumulative Distribution Function
  - Mass and Density Functions
- **Summary of Random Variables** 10%
  - Expected Value (Discrete and Continuous)
  - Variance and Standard Deviation of Random Variables
  - Moment Generating Functions (and other Generating Functions)
- **Discrete Distribution Theory** 20%
  - Uniform Distributions
  - Bernoulli Trials
    - Binomial Models
    - Geometric Models
    - Negative Binomial Models
  - Hypergeometric Models
  - Poisson Models and the Poisson Process
  - Relationships Between Discrete Probability Models
- **Continuous Distribution Theory** 25%
  - Uniform Distributions
  - Exponential and Gamma Models
  - The Normal Distribution
  - The Beta and Other Continuous Models
  - Relationships Between Models
    - Exponential and Poisson
    - Gamma and Poisson
    - Uniform and Exponential
  - Truncation and Mixtures of Random Variables

- **Multivariate Probability Models** 15%
  - Joint Cumulative Distribution Functions
  - Joint Mass Functions
    - The Multinomial Distribution
  - Joint Density Functions
    - The Multivariate Normal Distribution
  - Multivariate Expectation
  - Conditional Distributions
    - Independent Random Variables
    - Conditional Expectation and Variance
    - Double Expectation Theorem
  - Covariance and Correlation
- **Transformations of Random Variables** 5%
  - The Cumulative Distribution Function Method
  - The Moment Generating Function Method
  - Transformation Theorems

Student Learning Outcomes (SLO): At the end of MTH 502, a student who has studied and learned the material should be able to:

1. Apply the axioms of probability and basic probability laws in order to compute likelihood of events in various scenarios. [MTH-PLO: 3,4], [STA-PLO: 1]
2. Recognize when conditional probabilities are relevant and be able to calculate a variety of conditional probabilities using several techniques. [MTH-PLO: 2, 4], [STA-PLO: 1]
3. Explain the need for summarizing random variables and successfully compute the expected value and standard deviation of random variables useful in practice. [MTH-PLO: 2, 3, 4], [STA-PLO: 1, 4]
4. Explain the role and meaning of random variable. [MTH-PLO: 3, 5], [STA-PLO: 1, 4]
5. Model random natural phenomena using discrete and continuous probability distributions. [MTH-PLO: 2, 4], [STA-PLO: 2]
6. Explain the relationships which exist between the major probability distributions. [MTH-PLO: 3, 5], [STA-PLO: 2, 5]
7. List the main features of the popular discrete and continuous probability models. [MTH-PLO: 3], [STA-PLO: 1, 2]
8. Calculate probabilities in higher dimensions and model multivariate random variables. [MTH-PLO: 2, 4], [STA-PLO: 1]
9. Explain the need for functions of random variables and determine the appropriate density function for the function of a continuous random variable. [MTH-PLO: 4, 5], [STA-PLO: 1, 5]
10. Delineate between the major methods useful for finding the distribution of a function of random variables. [MTH-PLO: 2, 4], [STA-PLO: 1, 5]
11. Calculate and explain the relevance of correlation and its interpretation. [MTH-PLO: 2, 5], [STA-PLO: 1, 5]

Program Learning Outcomes (MTH - PLO):

Students graduating from SFASU with a M.S. degree and a major in mathematics will:

2. **[*Skills*]** Execute advanced mathematical procedures and build upon these standard procedures. (learning of new skills, applying or extending skills in new situations)
3. **[*Concepts*]** Demonstrate knowledge of core mathematical concepts. (definitions and theorems in analysis, definitions and theorems in linear or abstract algebra, definitions and theorems in theoretical statistics)
4. **[*Problem Solving*]** Demonstrate initiative in using various mathematical tools, including technology, to formulate, represent, and solve problems. (implement algorithms or definitions, discuss algorithmic proficiency, find numerical approximations)
5. **[*Communication*]** Demonstrate proficiency in communicating mathematics in a format appropriate to expected audiences. (written, visual, oral)

Program Learning Outcomes (STA - PLO):

Students graduating from SFASU with an M.S. degree and a major in statistics will demonstrate:

1. A command of core probability and statistical concepts through major definitions and theorems. **[*Concepts*]** (Probability and Statistical Inference)
2. Strategic competence in formulating a standard probabilistic/statistical model for a given problem. **[*Modeling*]** (Model Choice and Model Interpretation)
4. The ability to independently apply principles of probability and statistics to model and solve new or non-standard problems. **[*Independent Thinking and Application*]** (Existing Literature Comprehension, Independent Progression, Resourcefulness)
5. Proficiency in communicating probability and statistics in a format appropriate to expected audiences. **[*Communication*]** (Written Communication, Oral Communication)

Date of document: 04/01/2009