NVCC COLLEGE-WIDE COURSE CONTENT SUMMARY
MTH 243 - PROBABILITY AND STATISTICS I (3 CR)

Course Description

Uses calculus to develop the theory of probability and statistics including discrete and continuous distribution theory, Poisson processes, moment generating functions, central limit theorem, hypothesis testing and estimation. Lecture 3 hours per week.

General Course Purpose

This course is designed to provide students with the ability to analyze data and make inferences based on that data. The course sequence is primarily intended for students in computer science, economics, engineering, and the sciences.

Entry Level Competencies

Prerequisite: MTH 174 - "Calculus with Analytic Geometry II" or equivalent. Corequisite is MTH 277 - "Vector Calculus"

A. Integration abilities should include being able to:
   1. Integrate polynomial functions in one and two variables
   2. Integrate exponential functions
   3. Make a change of variable in an integral
   4. Perform integration by parts
B. Working with series should include the ability to:
   1. Sum infinite geometric series
   2. Integrate and differentiate power series
   3. Expand $(p + q)^N$

Course Objectives

As a result of the learning experiences provided in this course, the student should be able to:

A. define simple, compound, complementary, independent, mutually exclusive, disjoint and conditional events,
B. state and apply the laws of probability concerning these events,
C. compute the expected value and variance of each of the distributions studied,
D. recognize the situations to which each of the distributions is applicable, and solve applied problems,
E. compute probabilities, marginal densities, conditional densities and conditional probabilities for multivariate probability distributions,
F. compute the expected value, variance and covariance of each of the multivariate distributions studied,
G. use transformation of variables to find probability distributions for functions of random variables,
H. use moment generating functions to find the probability distributions for sums of random variables.

Major Topics To Be Included

A. Probability
   1. Set notation
   2. Sample spaces
   3. Calculating the probability of an event
      a. simple
      b. compound
      c. complementary

    d. independent
    e. mutually exclusive
    f. conditional
4. Expected value of a game

B. Discrete probability distributions
1. Definition of random variable
2. Uniform: derivation and application
3. Binomial: derivation and application
4. Geometric: derivation and application
5. Hypergeometric: derivation and application
6. Poisson: derivation and application
7. Empirical distributions
8. Expected value and variance

C. Continuous probability distributions
1. Uniform: application
2. Exponential: derivation and application
3. Gamma and Chi-square: derivation and application
4. Beta: application to estimating proportions
5. Normal: use of tables

D. Multivariate Probability Distributions
1. Marginal probability distributions
2. Conditional probability distributions
3. Independent random variables
4. Expected value
5. Variance and covariance
6. Application to sampling distributions

E. Functions of Random Variables
1. Finding the probability distribution of a functions or random variables
2. Method of distribution functions
3. Method of transformations
4. Moment generating functions
5. Applications
    a. show Gamma is a sum of exponentials
    b. show that the sum and average of Normal is Normal
    c. show that the square of a normal is Chi-square
    d. show that the sum of Chi-square is Chi-square

F. Sampling Distributions
1. Sampling from normal populations
2. Distributions related to the normal, Chi-square, t, and F
3. The Central Limit Theorem and its applications

Extra Topics (optional)

A. Bayes's Theorem
B. Chebychev's Theorem
C. Distributions: Negative Binomial, Cauchy, Multinomial, Multivariate Hypergeometric
D. Heuristic proof of Central Limit Theorem using moment generating functions