

NOVA COLLEGE-WIDE COURSE CONTENT SUMMARY MTH 283 – PROBABILITY AND STATISTICS (3 CR.)

Course Description

Presents basic concepts of probability, discrete and continuous random variables, and probability distributions. Presents sampling distributions and the Central Limit Theorem, properties of point estimates and methods of estimation, confidence intervals, hypothesis testing, linear models and estimation by least squares, and analysis of variance. Lecture 3 hours. Total 3 hours per week.

General Course Purpose

The first part of the content provides understanding of the basic concepts of probability required for further study in statistics. The statistics content provides a solid foundation and training in some of the fundamental tools used by statistical practitioners.

Course Prerequisites/Corequisites

Prerequisite: Completion of MTH 264 with a grade C or better or equivalent.

Corequisite: Enrollment in MTH 265. Prior completion of MTH 265 is preferred.

Course Objectives

Upon completing the course, the student will be able to:

- Basic Concepts of Probability
 - Relate the probability of an event to the likelihood of this event occurring.
 - Explain how relative frequency is used to estimate the probability of an event.
 - Determine the sample space of a given random experiment, including by using methods of enumeration.
 - Demonstrate probabilities through simulations.
 - Find the probability of events in the case in which all outcomes are equally likely.
 - State and apply the laws of probability concerning these events.
 - Use tools such as Venn Diagrams or probability tables as aids for finding probabilities.
 - Explain the reasoning behind conditional probability, and how this reasoning is expressed by the definition of conditional probability.
 - Find conditional probabilities and interpret them.
 - Determine whether two events are independent or not.
 - Use the general multiplication rule to find the probability that two events occur ($p(a \text{ and } b)$).
 - Use probability trees as a tool for finding probabilities.
 - Understand the total probability and Bayes' theorem.
- Discrete Distributions
 - Identify discrete random variable.
 - Find the probability distribution of discrete random variables, and use it to find the probability of events of interest.
 - Compute the expected value and variance of a discrete random variable, and apply these concepts to solve real-world problems.
 - Explain the concepts of Bernoulli Trials and discrete models such as binomial distribution, geometric, negative binomial distribution, hypergeometric distribution, and Poisson Distribution.
 - Recognize the situations to which each of the distributions is applicable, and solve applied problems.
 - Find the mean and variance using the moment generating function.
- Continuous Distributions
 - Distinguish between discrete and continuous random variables
 - Explain how a density function is used to find probabilities involving continuous random variables.

- Compute the expected value and variance of each of the distributions studied.
- Find probabilities associated with the normal distribution.
- Perform probabilities associated with uniform, exponential distributions, gamma, chi-square distributions, Weibull Distribution, joint probability distributions, and mixed type distributions.
- Recognize the situations to which each of the distributions is applicable, and solve applied problems.
- Bivariate Distributions
 - Compute probabilities, marginal densities, conditional densities and conditional probabilities for multivariate probability distributions.
 - Compute the expected value, variance and covariance of each of the multivariate distributions studied.
 - Apply the rules of means and variances to find the mean and variance of a linear transformation of a random variable and the sum of two independent random variables.
 - Graphically display the relationship between two quantitative variables and describe: a) the overall pattern, and b) striking deviations from the pattern.
 - Interpret the value of the correlation coefficient, and be aware of its limitations as a numerical measure of the association between two quantitative variables.
 - Perform bivariate normal distribution problems
- Distributions of Functions of Random Variables
 - Use transformation of a random variable to find probability distributions for functions of one random variable.
 - Use moment generating functions to find the probability distributions for sums of random variables.
 - Use transformations of two random variables to find the probability distribution.
 - Compute with several independent random variables.
 - Derive random functions associated with normal distribution
- Estimation
 - Use basic statistical techniques in the analysis and interpretation of data in the various disciplines and physical phenomena.
 - Determine point estimates in simple cases and make the connection between the sampling distribution of a statistic, and its properties as a point estimator.
 - Define and calculate maximum likelihood estimators of various distributions.
 - Explain the application of the Central Limit Theorem to sampling distributions.
 - Explain what a confidence interval represents and determine how changes in sample size and confidence level affect the precision of the confidence interval.
 - Find confidence intervals for the mean, the difference between two means, a proportion, Perform simple regression analysis.
- Tests of Statistical Hypotheses
 - Explain the logic behind and the process of hypotheses testing. Explain what the p-value is and how it is used to draw conclusions.
 - Specify (in a given context) the null and alternative hypotheses for the appropriate population parameters.
 - Carry out hypothesis testing for the population parameters and draw conclusions in context.
 - Apply the concepts of sample size, statistical significance vs. practical importance, and the relationship between hypothesis testing and confidence intervals.
 - Determine the likelihood of making type i and type ii errors, and explain how to reduce them, in context.
 - Determine confidence intervals for the least squares estimators.
 - Estimate the regression coefficients.
 - Find confidence intervals for the parameters of a regression model.
 - Identify and distinguish among cases where use of calculations specific to independent samples, matched pairs, and ANOVA appropriate.
 - Perform ANOVAs.(one-way)
- Nonparametric Methods
 - Perform Chi-Square goodness of fit tests and Chi-square test for independence. (Chop 10)
- Technology Applications
 - Demonstrate the application of statistics through a comprehensive project.
 - Use a statistical package to investigate and analyze data and to generate statistical information.

Major Topics to be Included

- a) Basic Concepts of Probability
- b) Discrete Distributions
- c) Continuous Distributions
- d) Bivariate Distributions
- e) Distributions of Functions of Random Variables
- f) Estimation
- g) Tests of Statistical Hypotheses
- h) Nonparametric Methods
- i) Technology Applications