Quinsigamond Community College School of Math, Science, & Engineering

Instructor's Information

Instructor: Professor XX (she/her/hers)
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Course Information

Course: MAT 237 Probability & Statistics for Engineers and Scientists – Section XX
Meets: Mondays and Wednesdays from 9:30am – 10:45am
Room: 177A
Credits: 3 credits
Semester: Fall 2024

Course Description

This course focuses on statistics and engineering. It covers interpretation, description, and treatment of data; probability and probability distributions; binomial, geometric, and hypergeometric methods; Poisson processes; gamma, beta, and Weibull distribution; populations and samples; inferences, hypotheses, and significance tests; Bayesian estimates; curve fitting; the method of least squares; curvilinear regression, correlation, and experimental design. Students use calculators and statistical software to solve statistical problems.

Prerequisites

MAT 234 Calculus II

Required Textbook/Materials/Website

Textbook: *Probability and Statistics for Engineering and the Sciences*, by Devore, 9th edition, Cengage © 2016
Materials: Graphing calculator (recommended)
Website: Access to Cengage's WebAssign

Student Learning Outcomes

Upon completion of this course, students will be able to:

1. Use statistical technology to summarize measures of center and variation for a given data set.
2. Use proper theory and formulas to solve probability problems.
3. Calculate the probability of different discrete probability distributions, including binomials, hypergeometric, and Poisson.
4. Calculate the expected value and standard deviation of discrete and continuous probability distributions.
5. Apply the Central Limit Theorem to find probabilities of continuous random variables.

6. Apply the Central Limit Theorem to estimate a population mean or population proportion.
7. Use technology to accurately perform statistical tests, such as linear regression and correlation, hypotheses, analysis of variance, and goodness-of-fit tests.

Course Topics & Required Section Readings/Assignments

Overview and Descriptive Statistics

- Populations, Samples, and Processes
- Pictorial and Tabular Methods in Descriptive Statistics
- Measures of Location
- Measures of Variation

Probability

- Sample Spaces and Events
- Axioms, Interpretations, and Properties of Probability
- Counting Techniques
- Conditional Probability
- Independence

Discrete Random Variables and Probability Distributions

- Random Variables
- Probability Distributions for Discrete Random Variables
- Expected Values
- The Binomial Probability Distribution
- Hypergeometric and Negative Binomial Distributions
- The Poisson Probability Distribution

Continuous Random Variables and Probability Distributions

- Probability Density Functions
- Cumulative Distribution Functions and Expected Values
- The Normal Distribution
- The Exponential and Gamma Distributions
- Other Continuous Distributions

Joint Probability Distribution and Random Samples

- Jointly Distributed Random Variables
- Expected Values, Covariance, and Correlation
- Statistics and Their Distributions
- The Distribution of the Sample Mean

Statistical Intervals Based on a Single Sample

- Basic Properties of Confidence Intervals
- Large-Sample Confidence Intervals for a Population Mean and Proportion
- Intervals Based on a Normal Population Distribution

Tests of Hypotheses Based on a Single Sample

- Hypotheses and Test Procedures
- *z* Tests for Hypotheses about a Population Mean
- The One-Sample *t* Test
- Tests Concerning a Population Proportion

The Analysis of Variance

- Single-Factor ANOVA
- More on Single-Factor ANOVA

Simple Linear Regression and Correlation

- The Simple Linear Regression Model
- Estimating Model Parameters
- Correlation

Goodness-of-Fit Tests and Categorical Data Analysis

- Goodness-of-Fit Tests When Category Probabilities Are Completely Specified
- Two-Way Contingency Tables

Instructional Objectives

- Know the difference between a population and a sample.
- Construct a stem-and-leaf display, histogram, dot plot, frequency distribution, and relative frequency distribution.
- Identify several popular distribution shapes – bimodal, right or left skewed, uniform, normal.
- Calculate measures of location for any given data set – mean, trimmed mean, median, mode – knowing which measures are resistive (to extreme behavior) measures.
- Distinguish between discrete data and continuous data.
- Define percentile and be able to locate any given percentile (or quartile) and find its value.
- Calculate measures of variability for any given data set – range, sample variance, sample standard deviation, population variance, and population standard deviation.
- Become familiar with probability terms such as Sample Space, elements, events, complement, union, intersection, null set.
- Know the difference between mutually exclusive events and independent events.
- Use Venn diagrams to solve common set theory problems.
- Use the General Addition rule to calculate simple probabilities.
- Use the General Multiplication rule to calculate simple probabilities.
- Correctly apply the counting rules of Permutation and Combination to various counting and probability situations.
- Know the formula for and solve conditional probability scenarios.
- Apply Bayes' Theorem when necessary or appropriate for conditional probabilities.
- Create a proper discrete probability distribution.
- Identify a Bernoulli distribution, a binomial probability distribution, a hypergeometric distribution, a negative binomial probability distribution, and a Poisson probability distribution.
- Be able to calculate the probabilities, using the appropriate formulas, for the previously mentioned distributions.
- Calculate the Expected value and Variance of any discrete probability distribution.
- Apply the knowledge for discrete random variable distributions to continuous random variable distributions.
- Given a PDF (probability distribution function), use calculus to find its CDF (cumulative distribution function), as well as its Expected value. Given a CDF, find its PDF, using calculus.
- Recognize the pdf for a normal distribution.
- Understand what a standard normal distribution is, and find any probability given its z-value. Find the z-value given a probability.

- Standardize any given (non-standard) random variable, given its mean and standard deviation.
- Know the Empirical Rule (68-95-99.7 Rule).
- Approximate a binomial distribution using a normal distribution, when appropriate, using continuity correction techniques.
- Recognize and calculate the probabilities of skewed distributions such as Exponential, Gamma, and Chi-Squared; or other distributions such as Weibull, Lognormal, and Beta.
- Apply the principles learned for a single-variable distribution to jointly distributed random variables, finding the appropriate probabilities for a given joint PDF.
- Know what is meant by a distribution of the sample mean.
- Calculate the standard error of the mean.
- Be able to know when and how to appropriately apply the Central Limit Theorem to find the probability of a sample mean.
- Find and interpret the confidence interval of a population mean for various confidence levels, including, but not limited to, 90%, 95%, or 99%.
- Know when and how to use a Student t-distribution instead of a normal (z) distribution.
- Calculate the necessary sample size of any given Confidence Interval for a given width.
- Conduct a one-tail or two-tailed hypothesis test, showing all appropriate steps, for a population mean and a population proportion, including the null and alternative hypotheses, the significance level, the test statistic, the p-value, the statement regarding the null hypothesis, and a conclusion statement regarding the original claim.
- Given concise examples of a Type I error and a Type II error, knowing the difference between the two.
- Conduct a single-factor ANOVA test.
- Be able to read an ANOVA table and identify each part of it.
- Use appropriate F-distribution tables to be able to state the appropriate decision regarding the claim for ANOVA tests.
- Investigate the relationship between two variables in a linear fashion, using regression analysis.
- Given a set of experimental predictor variables and response variables, calculate the linear regression equation (least squares line) that best fits the data set.
- Know what residuals are given a least squares line.
- Find the correlation coefficient, as well as the coefficient of determination for a given bivariate data set. Interpret the meaning of each statistic or parameter.
- Conduct a Chi-Squared goodness-of-fit test for observed data compared to its expected values.
- If necessary, calculate the expected values for discrete random variables before comparing them to the observed values.
- Appropriately use the correct tables for Chi-Squared distributions to be able to determine the goodness-of-fit, making the correct statement regarding any claims.

Grading Breakdown

20%	Homework
10%	Quizzes
10%	<Attendance>
35%	Exams
25%	Comprehensive Final Exam

Grade	Range	Grade	Range	Grade	Range
A	95 – 100	B –	80 – 82	D +	67 – 69
A –	90 – 94	C +	77 – 79	D	63 – 66
B +	87 – 89	C	73 – 76	D –	60 – 62
B	83 – 86	C –	70 – 72	F	0 – 59

Teaching Procedures

Most classes will be a combination of lectures, group activities, and in-class assignments. You will be given homework assignments to be completed outside of class. Occasionally, a quiz or exam will be given in class.

Attendance Policy

Students are expected to attend all classes for the entire period. Attendance will be taken in every class. If you are absent from class, proper documentation will excuse your absence.

Diversity, Equity, and Inclusion Statement for the School of Math & Science

The School of Math and Science is motivated to teach and learn from the diverse community we have at QCC. In Science, Technology, Engineering, and Mathematics (STEM), it is advantageous to approach problems from multiple perspectives. The power of diversity, equity and inclusion allows us to persevere and overcome challenges.

The faculty of the School of Math and Science pledge to help students meet the demands of STEM regardless of race/ethnicity, gender identity and expression, sexual orientation, faith, abilities/disabilities, age, socioeconomic background, political leaning, ancestry, national origin, home language and all other identities. We are dedicated to nurturing a culture of collaboration, mutual respect and understanding; and to empowering members of our community to embrace their full potential.

Accessibility Statement

Quinsigamond Community College is committed to providing access and inclusion for all persons with disabilities. Students who require an accommodation in this course should notify the professor as soon as possible. Students are responsible for forwarding the Accommodation Letter to the professor (via email or hard copy). Students may request accommodations at any time during the semester, which begin upon receipt (accommodations are not retroactive). Please discuss any barriers which may arise during the semester with your professor or coordinator in the Student Accessibility Services office.

Contact Information for Student Accessibility Services (SAS):
Call: 508-854-4471
Sorenson Video Phone: 508-502-7647
Email: disabilityservices@qcc.mass.edu

Services for Veterans

If you are a veteran of the US Armed Forces, please visit the Veteran Affairs Office located in 258A (Administration Building) or contact them at veteranaffairs@qcc.mass.edu.

Academic Honesty and Plagiarism

Our purpose of education is to seek the truth; this work requires trust and honesty between teacher and student. If we are not honest about what we know and don't know, our learning will always be impaired. Because our teaching and learning depends on this honest communication, we expect all students to understand what plagiarism is and why it is unacceptable.

Plagiarism means taking someone else's ideas or words and presenting them as one's own. The offense can take many forms including cheating on a test, passing in a paper taken from the Internet or from another student, or failing to properly use and credit sources in an essay. Sometimes the issue is subtle, involving getting too much help on an assignment from someone else. In every instance, plagiarism means cheating both oneself and the owner of the source. Since cheating sabotages a student's learning experience, consequences range from no credit for the assignment to failure for the course and possible expulsion from the college.

The penalty for getting caught cheating in this course is a failure of the quiz or test, or failure of the entire course. This is solely at the discretion of the instructor.

For further information concerning plagiarism, refer to the QCC Student Handbook.

Math Center & QCC Math YouTube Channel

The Math Center provides free, drop-in tutoring assistance for students in any QCC mathematics course. Located on the second floor of the Harrington Learning Center (HLC), the Math Center is a welcoming place where students have the opportunity to work collaboratively with tutors and classmates. Students can work intensively to improve their mathematical skills or simply drop by to ask a few questions. In addition to tutoring, the Math Center houses various math-related resources, and computers and software for math coursework. Visit their website for details and the semester schedule: https://www.qcc.edu/services/tutoring/math-center

For further help, visit the QCC Math YouTube channel. This channel has a playlist specifically for this course, with many short videos created with students like you in mind, covering many of the topics in this course: https://www.youtube.com/user/QCCmath

Assignment & Test Schedule

<list all assignments, quizzes, and exam dates>