American Public University System
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MATH303 16

Course Summary

Course : MATH303 **Title :** Probability and Statistics for Engineers and Scientists
Length of Course : 16 **Faculty :**
Prerequisites : N/A **Credit Hours :** 3

Description

Course Description:

This course in advanced statistics is designed to provide students with a more in-depth understanding of statistics that MATH302. Topics covered include: the principles and applications of descriptive and inferential statistics, probability, common distributions and hypothesis testing. Regression and correlation will also be considered.

Course Scope:

This course covers topics from probability and statistics that are useful to students who are perusing studies in engineering and science. The course covers descriptive statistics, probability, various types of hypothesis testing, and linear regression.

Objectives

1. Summarize key terminology of statistics and probability, including random variables, estimation theory, linear regression, Type I and Type II errors, and types of probability distributions and conditional probability.

2. Represent data using appropriate statistical display approaches.

3. Solve engineering and scientific problems using the concepts of statistics and probability.

4. Conduct hypothesis-testing procedures for populations and samples.

5. Determine the goodness of fit of data, the independence of variables, and the homogeneity of population proportions.

Outline

Week 1: Basic Data Collection and Descriptive Statistics

Learning Outcomes

LO1: Identify population, sample, parameter, statistic

LO2: Distinguish between qualitative and quantitative data

LO3: Create and interpret stem-and-leaf graphs, line graphs, bar graphs, histograms, frequency polygons, and time series graphs

Required Readings

Illowsky & Dean, Chapter1: Introduction, sec1-4, Ch2: Introduction, sec 1 & 2

HELM Workbook: 36. Descriptive Statistics: 1. Describing Data (up to p.9)

Assignments

Introduction Discussion

Discussion Week 1

Assignment 1

Recommended Optional Reading
Recommended Media

All students should download GNU Octave and install the additional statistics package:

https://www.gnu.org/software/octave/download

https://octave.sourceforge.io/statistics/index.html

Week 2: Measures of the Center and Spread of Data

Learning Outcomes

LO1: Calculate quartiles and percentiles

LO2: Create and interpret box plots

LO3: Calculate mean, median, and mode

LO4: Describe the spread and skewness of the distribution

Required Readings

Illowsky & Dean, Ch2:sec3-7

HELM Workbook: 36. Descriptive Statistics: 1. Describing Data (p.9 to the end of the section) &

2. Exploring Data

Assignments

Discussion Week 2

Assignment 2

Recommended Optional Reading
Recommended Media

Week 3: Introduction to Probability

Learning Outcomes

LO1: Understand the concept of sets and subsets

LO2: Be able to identify independent events and mutually exclusive events

LO3: Be able to use the Addition Rule, Multiplication Rule, and Bayes Rule

Required Readings

Holmes, Illowsky, Dean & Hadley Ch3: Introduction, sec 1-5

HELM Workbook: 35. Sets and Probability: all sections

Assignments

Discussion Week 3

Assignment 3

Recommended Optional Reading
Recommended Media

Week 4: Introduction to Discrete Random Variables

Learning Outcomes

LO1: Be able to identify a Probability Distribution Function for a discrete random variable

LO2: Determine Cumulative Distribution Functions for discrete random variables

LO3: Calculate the Expected Value and Variance of a Discrete Random Variable

LO4: Recognize the discrete uniform random variable and the binomial random variable and use the formula for calculating probabilities based on those distributions

Required Readings

Illowsky & Dean, Ch4: Introduction

Montgomery and Runger Ch3: sec 1-6

Assignments

Discussion Week 4

Assignment 4

Recommended Optional Reading

Illowsky & Dean, Ch4: sec 1-3

HELM Workbook: 37. Discrete Probability Distributions: 1. Discrete Probability Distributions & 2. The Binomial Distribution

Recommended Media

Week 5: Additional Discrete Random Variables

Learning Outcomes

LO1: Recognize the geometric random variable and use the formula for calculating probabilities based on that distribution

LO2: Recognize the negative binomial random variable and use the formula for calculating probabilities based on that distribution

LO3: Recognize the hypergeometric random variable and use the formula for calculating probabilities based on that distribution

LO4: Recognize the Poisson random variable and use the formula for calculating probabilities based on that distribution

Required Readings

Montgomery and Runger Ch3 sec 7-9

Assignments

Discussion Week 5

Assignment 5

Recommended Optional Reading

Illowsky & Dean, Ch4: sec 4-6

HELM Workbook: 37. Discrete Probability Distributions: 3. The Poisson Distribution & 4. The Hypergeometric Distribution

Recommended Media

Week 6: Continuous Random Variables

Learning Outcomes

LO1: Recognize a continuous random variable

LO2: Calculate the mean and variance of a continuous random variable

LO3: Recognize the uniform distribution and use the formula for calculating probabilities

LO4: Recognize the exponential distribution and use the formula for calculating probabilities

LO5: Recognize the Weibull distribution and be able to calculate the associated probabilities

Required Readings

Montgomery and Runger Ch4 sec 1-5, 8, 10

Assignments

Assignment 6

Discussion Week 6

Recommended Optional Reading

Illowsky & Dean, Ch5: Introduction, sec 1-3

HELM Workbook: 38. Continuous Probability Distributions: all sections

Recommended Media

Week 7: The Normal Distribution

Learning Outcomes

LO1: Recognize the normal probability distribution and apply it appropriately

LO2: Calculate probabilities based on the standard normal distribution

Required Readings

Montgomery and Runger Ch4 sec 6

HELM Workbook: 39. The Normal Distribution: 1. The Normal Distribution (Table 1 may be found on the last page of the section labeled “3. Sums and Differences of Random Variables”)

Assignments

Assignment 7

Discussion Week 7

Recommended Optional Reading

Holmes, Illowsky, Dean & Hadley, Ch6: Introduction, sec 1&2

Recommended Media

Week 8: The Central Limit Theorem

Learning Outcomes

LO1: Recognize when to apply the Central Limit Theorem

LO2: Calculate probabilities based on the Central Limit Theorem

LO3: Determine the point estimate of a parameter

Required Readings

Holmes, Illowsky, Dean & Hadley, Ch7: Introduction, sec 1&2

HELM Workbook: 40. Sampling Distributions and Estimation:

1. The Sampling Distribution (only up to p.4)

Montgomery and Runger Ch7 sec 1- 3.3

Assignments

Assignment 8

Discussion Week 8

Recommended Optional Reading
Recommended Media

Week 9: Confidence Intervals for estimating one population parameter

Learning Outcomes

LO1: Calculate a confidence interval for a population mean and discriminate between problems applying the normal and the Student's t distributions.

LO2: Recognize how the confidence level and sample size affect the confidence interval

LO3: Calculate a confidence interval for a population proportion

LO4: Be able to calculate the sample size needed for a given level of confidence

Required Readings

Montgomery and Runger Ch8 sec 1, 2, 4, 5

Assignments

Assignment 9

Discussion Week 9

Recommended Optional Reading

Holmes, Illowsky, Dean & Hadley Ch8:Introduction, sec 1-3

HELM Workbook: 40. Sampling Distributions and Estimation: 1. Sampling Distributions (p.6 to the end of the section)

Recommended Media

Week 10: Hypothesis Testing for One Sample for a mean

Learning Outcomes

LO1: Understand hypothesis testing in general and in practice for a one sample case for a mean

LO2: Understand how to interpret a p-value

LO3: Understand what is meant by the terms type I error and type II error

Required Readings

Montgomery and Runger Ch9 sec 1 - 3

Holmes, Illowsky, Dean & Hadley Ch9 sec 2

Assignments

Assingment 10

Discussion Week 10

Recommended Optional Reading

Holmes, Illowsky, Dean & Hadley Ch9: Introduction, sec 1,3

HELM Workbook: 41. Hypothesis Testing: 1. Statistical Testing

Recommended Media

Week 11: Hypothesis testing based two samples for the difference in means

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Learning Outcomes

LO1: Conduct hypothesis testing and construct confidence intervals for the difference between means when variances known

LO2: Conduct hypothesis testing and construct confidence intervals for the difference between means when variances unknown

LO3: Conduct hypothesis testing and construct confidence intervals for the difference between means for paired data

Required Readings

Montgomery and Runger Ch10 sec 1, 2, 4

Assignments

Assignment 11

Discussion Week 11

Recommended Optional Reading
Recommended Media

Week 12: Hypothesis testing for one proportion and the difference of two proportions

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Learning Outcomes

LO1: Conduct hypothesis testing and construct confidence intervals for a one sample case for a proportion

LO2: Conduct hypothesis testing and construct confidence intervals for a two-sample case for a proportion

Required Readings

Montgomery and Runger Ch9 sec 5, Ch10 sec 6

Assignments

Assingment 12

Discussion Week 12

Recommended Optional Reading
Recommended Media

Week 13: Using the Chi-Square Distribution

Learning Outcomes

LO1: Conduct a goodness of fit test

LO2: Conduct and interpret chi-square test of independence

LO3: Conduct and interpret chi-square test of homogeneity

Required Readings

Montgomery and Runger Ch9 sec 7 & 8

Holmes, Illowsky, Dean & Hadley Ch11 sec 6

Montgomery and Runger Ch8 sec 3 (only to understand the chi-square distribution)

Assignments

Assignment 13

Discussion Week 13

Recommended Optional Reading

Holmes, Illowsky, Dean & Hadley Ch11: Introduction, sec 1, 3, 4, 5

HELM Workbook: 42. Goodness of Fit and Contingency Tables: all sections

Recommended Media

Week 14: Linear Regression and Correlation

Learning Outcomes

LO1: Create and interpret a line of best fit

LO2: Calculate the correlation coefficient and determine if there is a linear relationship

LO3: Use the regression line to make predictions

Required Readings

Montgomery and Runger Ch11 sec 1-4,6, 7, 8

Montgomery and Runger Ch10 sec 5.5 (Just to have a modest understanding of the F distribution)

Assignments

Assingment 14

Discussion Week 14

Recommended Optional Reading
Recommended Media

Week 15: Analysis of Variance

Learning Outcomes

LO1: Conduct and interpret one-way ANOVA

LO2: Conduct a post ANOVA multiple comparison of means

Required Readings

Montgomery and Runger Ch13 sec 1- 3

Assignments

Assingment 15

Discussion Week 15

Recommended Optional Reading
Recommended Media

Week 16: Review and Other topics to explore

Learning Outcomes

LO1: Review the material for the course and recognize how the weekly topics tie together

LO2: Understand that this course provides a basis for understanding statistics and realize that there are other methods and topics to explore

Required Readings
Assignments

Assignment Week 16

Discussion Week 16

Recommended Optional Reading
Recommended Media

Evaluation

Staying on task and adhering to the published schedule are typically among the most challenging aspects of completing an academic course successfully. This is especially true for online and part-time non-resident programs. To avoid the pitfall of falling behind, students in this course should complete the assigned reading, which can be accessed via the links in the Content section of the online classroom, in a timely manner.

Student grades for the course will be based on participation in weekly discussions and weekly assingments. Discussions contribute a combined total of 40% of your final grade; Assignments contribute a combined total of 60% of your final grade.

Class Participation: Naturally, I value punctuality, familiarity with the required readings, and classroom questions or comments that are relevant and insightful. Whether helping someone understand a point, seeking clarification of a concept you may not completely understand, or contributing to the positive flow of the class discussion based on your experience, it is important for you to realize that learning is an action process—and sharing is a key ingredient in undertaking that process successfully. Therefore, I urge you to participate actively and do your best to contribute to a positive and effective learning environment--for yourself and others.

I urge you to utilize the Question and Answer Discussion as a means to interact with your classmates. If while working through examples or problems from our textbook you have a question or a comment, please post the question or comment in the Question and Answer Discussion. Naturally, I hope that question and answers posted in the Question and Answer Discussion will facilitate interactions among the members of our class.

Your first required discussion post is the Week 1 Introduction Discussion. This must be completed by 11:55PM Eastern Time on Sunday during the first week of our course. My evaluation of your participation in our forums will be based on the extent to which you participated and fostered a positive and effective learning environment--for yourself and others. Participating and sharing are the keys. I will post my wrap-up comments

for each of our weekly discussion after their due dates. Naturally, I urge you to read my wrap-up post, the posts of your classmates, and any summary feedback I provide.

The Week 1 Introduction Discussion: During the first week of class each student must make a post to the Week 1 Introduction Discussion. You are to use this Discussion to introduce yourself and state your goals and objectives as they relate to our course. You are required to make a post to the Week 1 Introduction Discussion in order to complete your enrollment in the course. Your post must be **at least 250 words**, and you must complete it by the end of the first week. This is a university requirement.

Assingments: There are weekly assignments in this course, meant to provide you a means to apply your understanding from the weekly readings. However, you should expect to be challenged by the graded exercises. Specific instructions will be provided for each assingment in the Content section of our classroom. Each of these graded exercises is to be completed on an individual basis. You may consult published textbooks, articles, and other printed materials. However, **no collaboration is permitted on the assignments.** You are not to discuss, orally, in print—in any manner—any aspect of the graded exercises with anyone other than your instructor. Clearly, student-teacher relationships are built on trust. This is especially true in the case of an online course. For example, students must trust that teachers have made appropriate decisions about the structure and content of the courses they teach, and teachers must trust that students complete assignments as directed. Acts that violate this trust undermine the educational process and compromise the integrity of the perpetrator. Don't cheat. Don't compromise your integrity. To do so invalidates the very purpose which likely motivated you to undertake this course—to learn, to become a better decision maker, to broaden your perspective, and to increase your skill set.

The notations used in statistical work aren't found in many word processing programs, making it difficult to produce many of the symbols used in our course. You may wish to use the Symbol font in Microsoft Word and the Insert/Object/Microsoft Equation feature in Word when preparing documents related to our course. Insert/Symbol is also sometimes useful. Of course, you will also want to familiarize yourself with the Insert/Edit Equation feature contained in the Rich Text Editor that is available in the Rich Text Editor toolbar in our classroom. Additionally, since many of the computations and analyses required in our course can be easily carried out using Microsoft Excel, you may wish to familiarize yourself with the process whereby Excel outputs can be copied and pasted into a Word or pdf file.

Students' final grades will be posted within 7 days of the end of the course.

Please see the Student Handbook to reference the University's grading scale.

Grades for the course will be based on the following.

Grading:

Name	Grade %

Materials

1. Illowsky & Dean: https://openstax.org/books/introductory-statistics/pages/preface (please note errata page: https://openstax.org/errata/?book=Introductory%20Statistics)
2. Holmes, Illowsky & Dean: https://openstax.org/books/introductory-business-statistics/pages/preface (please note errata page: https://www.oercommons.org/courses/introductory-statistics-6/view)
3. Montgomery & Runger: https://learning-oreilly-com.ezproxy2.apus.edu/library/view/applied-statistics-and/9780470053041/Coverpage.html (please note errata page: https://higheredbcs-wiley-com.ezproxy2.apus.edu/legacy/college/montgomery/0470053046/errata/errata03.pdf)
4. Helping Engineers Learn Mathematics: HELM Workbooks: https://learn.lboro.ac.uk/archive/olmp/olmp_resources/pages/wbooks_fulllist.html

Course Guidelines

Citation and Reference Style

- Attention Please: Students will follow the APA Format as the sole citation and reference style used in written work submitted as part of coursework to the University. Assignments completed in a narrative essay or composition format must follow the citation style cited in the APA Format.

Tutoring

- Tutor.com offers online homework help and learning resources by connecting students to certified tutors for one-on-one help. AMU and APU students are eligible for 10 free hours* of tutoring provided by APUS. Tutors are available 24/7 unless otherwise noted. Tutor.com also has a SkillCenter Resource Library offering educational resources, worksheets, videos, websites and career help. Accessing these resources does not count against tutoring hours and is also available 24/7. Please visit the APUS Library and search for 'Tutor' to create an account.

Late Assignments

- Students are expected to submit classroom assignments by the posted due date and to complete the course according to the published class schedule. The due date for each assignment is listed under each Assignment.
- Generally speaking, late work may result in a deduction up to 15% of the grade for each day late, not to exceed 5 days.
- As a working adult I know your time is limited and often out of your control. Faculty may be more flexible if they know ahead of time of any potential late assignments.

Turn It In

- Faculty may require assignments be submitted to Turnitin.com. Turnitin.com will analyze a paper and report instances of potential plagiarism for the student to edit before submitting it for a grade. In some cases professors may require students to use Turnitin.com. This is automatically processed through the Assignments area of the course.

Identity Verification & Live Proctoring

- Faculty may require students to provide proof of identity when submitting assignments or completing assessments in this course. Verification may be in the form of a photograph and/or video of the student's face together with a valid photo ID, depending on the assignment format.
- Faculty may require live proctoring when completing assessments in this course. Proctoring may include identity verification and continuous monitoring of the student by webcam and microphone during testing.

Academic Dishonesty

- Academic Dishonesty incorporates more than plagiarism, which is using the work of others without citation. Academic dishonesty includes any use of content purchased or retrieved from web services such as CourseHero.com. Additionally, allowing your work to be placed on such web services is academic dishonesty, as it is enabling the dishonesty of others. The copy and pasting of content from any web page, without citation as a direct quote, is academic dishonesty. When in doubt, do not copy/paste, and always cite.

Submission Guidelines

- Some assignments may have very specific requirements for formatting (such as font, margins, etc) and submission file type (such as .docx, .pdf, etc) See the assignment instructions for details. In general, standard file types such as those associated with Microsoft Office are preferred, unless otherwise

specified.

Disclaimer Statement

- Course content may vary from the outline to meet the needs of this particular group.

Communicating on the Discussion

- Discussions are the heart of the interaction in this course. The more engaged and lively the exchanges, the more interesting and fun the course will be. Only substantive comments will receive credit. Although there is a final posting time after which the instructor will grade comments, it is not sufficient to wait until the last day to contribute your comments/questions on the discussion. The purpose of the discussions is to actively participate in an on-going discussion about the assigned content.
- “Substantive” means comments that contribute something new and hopefully important to the discussion. Thus a message that simply says “I agree” is not substantive. A substantive comment contributes a new idea or perspective, a good follow-up question to a point made, offers a response to a question, provides an example or illustration of a key point, points out an inconsistency in an argument, etc.
- As a class, if we run into conflicting view points, we must respect each individual's own opinion. Hateful and hurtful comments towards other individuals, students, groups, peoples, and/or societies will not be tolerated.

University Policies

Student Handbook

- Drop/Withdrawal policy
- Extension Requests
- Academic Probation
- Appeals
- Disability Accommodations

The mission of American Public University System is to provide high quality higher education with emphasis on educating the nation’s military and public service communities by offering respected, relevant, accessible, affordable, and student-focused online programs that prepare students for service and leadership in a diverse, global society.