

SYLLABUS MATH 2406 – Probability and Statistics

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Lectures: Monday 08:30, **Seminars:** Thursday 08:30, Thursday 10:00, Friday 08:30.

Office hours: Monday, Tuesday, Wednesday, Friday 10:00-11:00

Office: B 316

Description

This course is designed for undergraduate students majoring in mathematics, engineering, computer science and IT. It introduces introduction to probability and statistics. Topics include basic statistical concepts, probability axioms, Bayes' rule, discrete and continuous probability distributions, jointly distributed random variables, Law of Large Numbers, Central Limit Theorem, estimation, confidence intervals, testing of hypothesis and regression.

Learning Outcomes

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

- Define and describe basic statistical terms.
- Define and explain fundamental probability concepts.
- Differentiate between various sampling methods
- Summarize and interpret data using measures of central tendency and measures of dispersion.
- Construct and interpret frequency distributions and histograms.
- Calculate probabilities of simple and compound events.
- Apply probability rules, including the addition and multiplication rules.
- Describe and use common probability distributions
- Construct and interpret confidence intervals for population parameters.
- Perform basic hypothesis testing and draw conclusions.
- Analyze the relationship between two variables.
- Develop and interpret linear regression models.
- Apply statistical concepts to real-world problems and draw meaningful conclusions.
- Critically evaluate statistical claims and research studies, considering factors like sampling bias and study design.
- Utilize statistical software (e.g., R) to perform data analysis and visualize results.
- Interpret output from statistical software and make informed decisions based on the analysis.

Prerequisite: Math 1111 (Calculus I).

Textbooks: Probability and statistics with R for engineers and scientists / Michael G. Akritas, The Pennsylvania State University, 1st edition.
ISBN 978-0-321-85299-1 – ISBN 0-321-85299-0

Lectures: The MATH 2406 course material will be defined by the lectures. These lectures will cover selected parts of the textbook but not necessarily in the order presented in the book. In addition, there will be some material presented in the lectures that is not to be found in the textbook. For all these reasons, it is imperative that you keep up with the material presented in lectures.

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R Software Package: R will be used as a software tool in the lectures, quizzes and HWs.

R can be downloaded for free at: <http://www.R-project.org/>.

A great introduction to R can be found at: <https://www.youtube.com/watch?v=eR-XRSKsuR4>

Homework Assignments: HW Assignments will be available on Blackboard. Students may be invited to a meeting with the professor for a further discussion of the submitted HW assignments.

Quizzes: Quizzes will be announced and taken during lectures or seminars. There will be 10 quizzes, 3 lowest quiz grades will be dropped. There will be no makeup quizzes. (Consider the quizzes as class participation.)

Examinations: The dates and times of the exams will be announced on Blackboard. More information about the covered material, format, etc. will be posted on Blackboard. The final examination will be scheduled by the Registrar.

Missed quizzes and examinations: There will be no make-up quizzes. For missed exams ADA University policy will be applied.

Grade Components:

- Homework assignments: 10%
- Quizzes: 20%
- Mid-term exam: 30%
- Final exam: 40%

Attendance Policy

Regular attendance is important and can be checked any time during the lectures.

Calendar (Tentative)

Week		Quiz / Exam	HW
1	Basic Statistical Concepts: Sampling, Random Variables, Statistical populations, Basic Graphics for Data Visualization, Proportions, averages, and variances, medians, percentiles, and boxplots, Comparative Studies		
2	Probability: Sample Spaces, Events, and Set Operations, Definition and Interpretation of Probability, Counting Techniques, Probability Mass Functions and Simulations, Axioms and Properties of Probabilities, Conditional Probability, Independent Events		HW 1
3	Random Variables and their Distributions: Random Variables, Cumulative Distribution Function, Density Function of a Continuous Distribution, Parameters of Probability Distributions (Expected Value, Variance and Standard Deviation, Population Percentiles)	Quiz 1	

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4	Models for Discrete Random Variables: The Bernoulli and Binomial Distributions, The Hypergeometric Distribution, The Geometric and Negative Binomial Distributions, The Poisson Distribution		
5	Models for Continuous Random Variables: The Exponential Distribution, The Normal Distribution		HW 3
6	Jointly Distributed Random Variables: Describing Joint Probability Distributions, Mean Value of Functions of Random Variables, Quantifying Dependence, Models for Joint Distributions	Quiz 2	
7	Approximations: The Law of Large Numbers, Convolutions, The Central Limit Theorem		
8	Revision and Midterm Examination	Midterm Exam	
9	Fitting Models to Data: Unbiased Estimation, Model-Free vs Model-Based Estimation, The Method of Moments, The Method of Maximum Likelihood, The Method of Least Squares, Comparing Estimators: The MSE Criterion		HW 4
10	Confidence and Prediction Intervals: Z Confidence Intervals, The T Distribution and T Confidence Intervals, T CIs for the Mean, Z CIs for Proportions, T CIs for the Regression Parameters;		
11	χ^2 CIs for the Normal Variance and Standard Deviation, Prediction Intervals, Basic Concepts, Prediction of a Normal Random Variable, Prediction in Normal Simple Linear Regression	Quiz 3	
12	Testing of Hypotheses: Introduction, Setting Up a Test Procedure, The Null and Alternative Hypotheses, Test Statistics and Rejection Rules, Z Tests and T Tests, P-Values		HW 5
13	Types of Tests: T Tests for the Mean, Z Tests for Proportions, T Tests about the Regression Parameters, The ANOVA F Test in Regression		
14	The Sign Test for the Median, χ^2 Tests for a Normal Variance, Precision in Hypothesis Testing, Type I and Type II Errors, Power, and Sample Size Calculations	Quiz 4	
15	Comparing Two Populations: Two-Sample Tests and CIs for Means, Comparing Two Variances		
		Final Exam	