

MGIMO University
School of Government and International Affairs

Syllabus approved

Dean, The MGIMO School of Government and International Affairs

Mikhail Troitskiy

« » **2021**

Mathematics and Statistics for Economics and Business
Undergraduate Course Syllabus

Instructor
Alexander V. Zhdanov

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This syllabus is designed in accordance with the MGIMO Educational Standard for the Bachelor Program in Economics.

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INSTRUCTOR INFORMATION AND COURSE DESCRIPTION

1.1 General information

- Full course title: Mathematics and Statistics for Economics and Business
- Type of course: Required
- Level of course B.Sc.
- Year of study: 1st
- Number of ECTS credits allocated:
- Instructor: Alexander V. Zhdanov
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1.2 Course aims and learning outcomes

Overview:

Calculus, statistics and linear algebra are three critical fields of mathematics with widespread applications across multiple industries in the modern world. This two semester course is intended to give students a solid foundation in all three in a concise manner. The presentation of the subject matter is significantly, but not exclusively, tailored to students interested in economics, business and finance.

Pacing:

The first two thirds of the fall semester are devoted to differential and integral single variable calculus. The last third introduces the mathematical machinery of first year statistics. The spring semester picks up where the fall semester concludes, beginning with the basic applications of statistical methods. The final two thirds of the spring semester covers the essentials of linear algebra.

Structure:

Lectures present the topic of the week with a modest amount of accompanying examples. Seminars provide the time for expansive use of examples and discussions of lecture material.

Learning outcomes:

At the end of the year, students should be prepared for more advanced coursework in areas including, but not limited to, multivariable calculus, differential equations, and intermediate level applications of statistics and linear algebra.

1.3 Course requirements, grading, and class hours

Course requirements

Students are required to attend no less than 75% of classes and be prepared for class discussions.

Grades

Three in-class tests each semester.

Three review problem sets (one before each test)

Final exam.

Classes

Fall 2021

Lectures Tuesdays: 9:00 am - 10:20 am

Seminars Tuesdays: 12:10 pm - 1:30 pm

Spring 2022

To be announced

Resources:

It would be burdensome for both students and the instructor to manage three textbooks for one course. To this end only the statistics portion of the course has an accompanying text. The choice was made because of the three subjects covered, statistics is the one with the most heavy use of notation, and a textbook may be helpful as a reference. Calculus and linear algebra have relatively fewer disparate concepts to keep track of, and are thus presented through the aid of online resources and class handouts.

Statistics:

Newbold P., Statistics for Business and Economics. Prentice-Hall, (N). 6th edition, 2007;

Linear algebra and single variable calculus course materials from MIT open courseware:

Calculus: <https://ocw.mit.edu/search/ocwsearch.htm?q=single%20variable%20calculus>

Linear Algebra: <https://ocw.mit.edu/search/ocwsearch.htm?q=linear%20algebra>

Other helpful resources:

<https://www.youtube.com/playlist?list=PLZHQObOWTQDMsr9K-rj53DwVRMYO3t5Yr>

https://www.youtube.com/playlist?list=PLZHQObOWTQDPD3MizzM2xVFitgF8hE_ab

COURSE SCHEDULE

FALL 2021

PART I: Calculus (10 weeks)

Week 1 - Introduction, Course Outline, Course Motivation, Review

Tuesday, September 7th

Explaining the structure of the course, teaching materials, expectations and grading.
Review and lead-in to limits and derivatives.

Week 2 - Limits and the Definition of the Derivative

Tuesday, September 14th

The algebraic definition of the derivative of a function is presented.

Week 3 - Derivatives of Polynomial Functions

Tuesday, September 21st

Rules and examples for dealing with derivatives of polynomial equations.
Examples from economics and physics are provided.
Geometric intuition is given for specific simple cases.

Week 4 - The Product Rule and the Chain Rule

Tuesday, September 28th

Tools for finding derivatives of composite functions are presented.

Week 5 - Derivatives of Other Functions

Tuesday, October 12th

Derivatives of functions beyond basic polynomials are presented. In particular, trigonometric, exponential and logarithmic functions are discussed.

Week 6 - L'Hôpital's rule and Indeterminate Forms

Tuesday, October 5th

L'Hôpital's rule, a useful tool for handling certain edge cases is presented.

Week 7 - Introduction to Integral Calculus

Tuesday, October 19th

*****Test #1 on Derivatives*****

Integration is introduced via the concept of the antiderivative. Examples from economics and physics are given. Numerical integration is mentioned as an alternative to the algebraic/analytic approach. Distinction is made between definite and indefinite integrals.

Week 8 - Integrals of Additional Functions

Tuesday, October 26th

Just like for derivatives, functions more complex than polynomials have their own rules for integration. Trigonometric, exponential and logarithmic functions are covered.

Integration by substitution is mentioned as a rough analogue of the chain rule.

Week 9 - Solids of Revolution and Calculating Volumes

Tuesday, November 2nd

Applying single variable integration to a narrow subset of three dimensional problems.

Week 10 - Infinite Series and Convergence

Tuesday, November 9th

How can an infinite number of terms sum to a finite number?

Examples from finance and other fields.

(Week TBD) - Previews of Advanced Calculus Topics

A very light surface-level treatment of topics beyond first year calculus

E.g. multivariable calculus, differential equations.

Examples include option pricing and machine learning.

PART IIa: Foundations of Statistics (6 weeks)

Week 11 - Introduction to Probability and Statistics

Tuesday, November 16th

*****Test #2 on Integrals*****

The basics of probability starting with coin flips, dice, cards.

Week 12 - Measures of Central Tendency and Dispersion

Tuesday, November 23rd

Mean, median, mode, variance and standard deviation are presented.

Week 13 - Joint Probability, Conditional Probability and Bayes' Rule

Tuesday, November 30th

Probabilities of multiple simultaneous events.
Statistical dependence and independence.
Updating probabilities based on new information.

Week 14 - Discrete Random Variables

Tuesday, December 7th

Formal introduction of the concept of a random variable.
Definition of a statistical distribution.
Introduction of common discrete distributions.
Cumulative discrete distributions.

Week 15 - Continuous Random Variables

Tuesday, December 14th

******Test #3 on Probability******

Discrete vs. continuous: point vs. interval.
Cumulative continuous distributions.

Week 16 - The Normal Distribution and the Central Limit Theorem

Tuesday, December 21st

Normal (gaussian) distributions are introduced.
Lognormal distributions are briefly mentioned.
Semester concludes with a discussion of the Central Limit Theorem

SPRING 2022

PART IIb: Statistics Applications (6 weeks)

Sampling
Point Estimation
Interval Estimation
Hypothesis Testing

PART III: Linear Algebra (10 weeks)

Systems of Linear Equations
Linear Dependence, Independence and Basis Vectors
Matrices, Transformations and Nullspaces
Matrix Multiplication, Inversion and Transposition
Dot Product and Cross Product
Eigenvectors and Eigenvalues
Vector Spaces and their Axioms

Additional topics briefly mentioned if time permits:

Dual Spaces
Change of Basis
Matrix Decomposition