SYLLABUS, 18.01 FALL 2023

This is an outline of the topics we will study in the course.

Part 1: Integrals and derivatives

Derivatives and integrals are the language of calculus. In this part of the course, we discuss in depth what derivatives mean and what integrals mean so that we can apply them to a wide variety of problems all through the course.

Integrals: The meaning of integrals and setting up integrals. An integral describes a quantity as a sum of many small pieces. We will practice setting up integrals to solve problems from geometry and physics. We will emphasize figuring out how to set up an integral to model a situation we haven't discussed before in class. This requires understanding really well what integrals mean.

Derivatives: The idea of derivative and straight line approximation. The graphs of most functions look curved, but if we look at a very small piece of the graph under a microscope it looks almost like a straight line. Derivatives help us find this straight line approximation. We will study straight line approximation and use it to approximately solve problems that are hard to solve exactly. We will also use derivatives to help sketch the graphs of functions, and we will practice computing derivatives using the chain rule, the product rule, etc.

The relationship between integrals and derivatives. Accumulation functions. Rates. The fundamental theorem of calculus. Practice computing integrals.

The first midterm will be Thursday Oct. 5, 7:30 - 9:30 pm.

Part 2: Vectors and differential equations

Vectors are a mathematical language to describe something that has a magnitude and a direction, such as a velocity or a force. A lot of applications of calculus to physics use vectors. Vectors are also a fundamental tool in statistics and computer science. In this class, we will study vectors, emphasizing the tools and ideas that are used in first semester physics (8.01L or 8.01).

Geometry of vectors. Notations for vectors. Magnitude and direction. Decomposing vectors into components in different directions. Dot products and their geometric meaning.

Vectors in calculus. We will combine vectors and calculus. Trajectories and parametrized curves. We will discuss integrals and derivatives involving vectors.

Differential equations describe change over time. They are one of the most common tools for modeling physical systems, and therefore they are used in a wide variety of engineering disciplines. In addition, they describe feedback loops in computer science, electrical engineering, and biology.

Introduction to differential equations. How to set up a differential equation to model a situation in science/engineering. The Euler method for approximating solutions to differential equations.

Solving differential equations. Exponentials, separation of variables. We will practice starting with a real world situation, describing it mathematically using differential equations, using calculus tools to study the solution of the differential equation, and interpreting what we learn in terms of the real world situation.

The second midterm will be Thursday November 9, 7:30 - 9:30 pm,

Part 3: Taylor series and other approximations

Taylor series are a fundamental tool for getting a more accurate understanding of problems that are too complex to solve exactly.

Introduction to Taylor series. Refining linear approximation with higher order terms. Estimating the error in linear approximation and/or Taylor approximation.

Applications of Taylor series. Taylor series are relevant to many of the topics that we have studied in the course so far. We will consider a variety of applications of Taylor series, and in the process we will revisit many topics from the course.

There will be a final exam during final exam period. The date and time are to be decided.