Single Variable Calculus

Syllabus

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Introduction

Prerequisites

Single Variable Calculus is a first-year, first-semester course at MIT. The prerequisites are high school algebra and trigonometry. Prior experience with calculus is helpful but not essential.

Course Overview

Calculus is a foundational course at MIT; it plays an important role in the understanding of science, engineering, economics, and computer science, among other disciplines. This introductory calculus course covers differentiation and integration of functions of one variable, with applications. Topics include:

- Concepts of Function, Limits and Continuity
- Differentiation Rules, Application to Graphing, Rates, Approximations, and Extremum Problems
- Definite and Indefinite Integration
- The Fundamental Theorem of Calculus
- Applications to Geometry: Area, Volume, and Arc Length
- Applications to Science: Average Values, Work, and Probability
- Techniques of Integration
- Approximation of Definite Integrals, Improper Integrals, and L'Hôspital's Rule

Course Goals

After completing this course, students should have developed a clear understanding of the fundamental concepts of single variable calculus and a range of skills allowing them to work effectively with the concepts.

The basic concepts are:

1. Derivatives as rates of change, computed as a limit of ratios
2. Integrals as a "sum," computed as a limit of Riemann sums

After completing this course, students should demonstrate competency in the following skills:

- Use both the limit definition and rules of differentiation to differentiate functions.
- Sketch the graph of a function using asymptotes, critical points, the derivative test for increasing/decreasing functions, and concavity.
- Apply differentiation to solve applied max/min problems.
- Apply differentiation to solve related rates problems.
- Evaluate integrals both by using Riemann sums and by using the Fundamental Theorem of Calculus.
- Apply integration to compute arc lengths, volumes of revolution and surface areas of revolution.
- Evaluate integrals using advanced techniques of integration, such as inverse substitution, partial fractions and integration by parts.
- Use L'Hospital's rule to evaluate certain indefinite forms.
- Determine convergence/divergence of improper integrals and evaluate convergent improper integrals.
- Determine the convergence/divergence of an infinite series and find the Taylor series expansion of a function near a point.

Course Structure

This course, designed for independent study, has been organized to follow the sequence of topics covered in an MIT course on Single Variable Calculus. The content is organized into five major units:

1. Differentiation
2. Applications of Differentiation
3. The Definite Integral and its Applications
4. Techniques of Integration
5. Exploring the Infinite

Each unit has been further divided into parts (A, B, C, etc.), with each part containing a sequence of sessions. Because each session builds on knowledge from previous sessions, it is important you progress through the sessions in order. Each session covers an amount you might expect to complete in one sitting.

Within each unit you will be presented with sets of problems at strategic points, so you can test your understanding of the material. As you begin each part of a unit, review the problem set at its end so that you may work toward solving those problems as you learn new material.

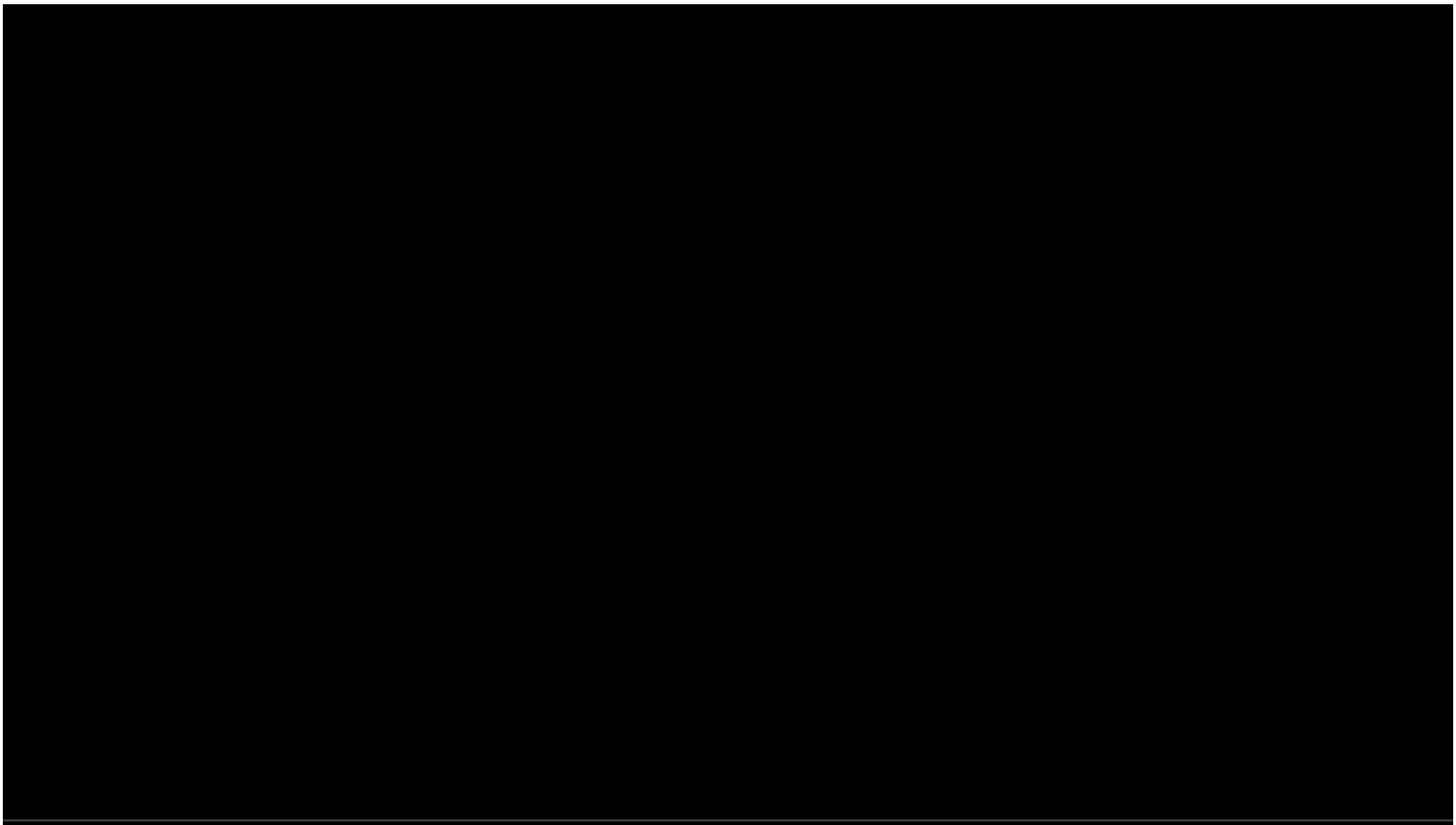
MIT expects its students to spend about 150 hours on this course. More than half of that time is spent preparing for class and doing assignments. It's difficult to estimate how long it will take you to complete the course, but you can probably expect to spend an hour or more working through each individual session.

Lecture Video

Most sessions include video clips from lectures of Professor David Jerison teaching 18.01, recorded live on the MIT campus in the fall of 2007. The video was carefully segmented by the developers of this OCW Scholar course to take you step-by-step through the content. The lecture video clips are accompanied by supporting course notes.

Recitation Video

This OCW Scholar course includes dozens of Recitation Videos – brief problem solving sessions taught by an experienced MIT Recitation Instructor – developed and recorded especially for you, the independent learner. Meet the recitation instructors and learn more about how to benefit from this help by watching their introductory video.



VIEW VIDEO PAGE

Readings, Assignments and Exams

No textbook is required for this OCW Scholar course.

The notes that accompany the video clips present their content slightly more formally than Professor Jerison does. If you are wondering exactly what conditions must hold for a statement to be true or if you wish to see the details of the calculations displayed on the blackboard, check the notes.

“Worked examples” present a problem or problems to be solved; many of these problems have appeared on homework assignments at MIT. After you have solved these problems you can check your answer against a detailed solution.

Some worked examples will be accompanied by a Mathlet. These interactive learning tools will improve your geometric intuition and illustrate how changes in certain factors affect the results of different calculations.

Problem sets occur at the end of each part; these were taken directly from homework assigned at MIT in the Fall of 2009. As you start each part, familiarize yourself with the problems in the problem set. This will enable you to work on each problem as you gain the knowledge you need to solve it. Once you have completed the problem set you can check your answers against the solutions provided. (The problem sets are carefully selected from a longer list of questions available to you. Do not hesitate to work any problem that piques your interest.)

Each unit ends in an exam. To prepare for an exam, check that you are proficient in each of the topics listed in the exam review lecture and review your work on the unit’s examples and problem sets. Allow yourself one hour to work each exam and three hours to complete the final. The exams are quite challenging; do not be surprised if you are unable to complete all of the questions correctly in the time allowed.

Textbook

This OCW Scholar course is self-contained and no textbook is required. If you have access to a single variable calculus text it will probably serve as a useful companion to this course, although you might have to deal with slight differences in terminology and notation.

Technical Requirements

This course includes features that do not display correctly in Internet Explorer. For best results, we recommend viewing this course with Firefox, Safari or Chrome.

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