Learning Objectives
Survey of Calculus MATH 2043

The goal of this course is for students to gain proficiency in calculus computations. In calculus, we use three main tools for analyzing and describing the behavior of functions: limits, derivatives, and integrals. Students will use these tools to solve application problems in a variety of settings ranging from physics and biology to business and economics.

Course Level Learning Objectives:

Upon successful completion of this course, students will be able to:

- Compute limits, derivatives, and integrals.
- Analyze functions using limits, derivatives, and integrals.
- Recognize the appropriate tools of calculus to solve applied problems.

Unit 1: Limits and Rate of Change

Lesson 1-Algebra Review (CH R-2)

In this section, we focus on basic graphs and algebra skills students should know for the course. Students will be able to:

- Graph basic functions.
- Solve linear and quadratic equations.
- Simplify expressions involving exponents.
- Convert between radical and exponential forms.

Lesson 2-Graphical and Tabular/Numerical Limits (most of 3.1)

We introduce two methods of finding limits in this section. Students will be able to:

- Evaluate limits by way of tables and graphs.
- Determine the existence of and find limits at real numbers.
- Use rules of limits.

Lesson 3-Continuity and Algebraic Limits (3.1 and 3.2)

This lesson defines continuity at a point using limits. Because we know many functions are continuous, we use substitution to find limits of continuous functions. For functions with discontinuities, we introduce two other algebraic principles for finding limits. Students will be able to:

- Use rules of limits.
- Evaluate limits algebraically by means of substitution, factoring, and using special limits.
- Use limits to determine whether a function is continuous at a point.

Lesson 4-Rates of Change (3.3)

Average rate of change is defined as a slope between two points. We relate this to the slope of the secant line and the difference quotient before introducing the notion of instantaneous rate of change. Students will be able to:

- Compute the average rate of change of a function between two points.
- Set up and simplify the difference quotient for functions.
- Find instantaneous rates of change using limits.

Unit 2: Differentiation and Extrema

Lesson 1-Limit Definition of Derivative (3.4)

This section defines the derivative in terms of the limit of the difference quotient. Graphically, this is seen as the slope of the tangent line. Students will be able to:

- Express the derivative of a function as a limit
- Evaluate this limit of the difference quotient algebraically.
- Write the equation of the tangent line at a given point.

Lesson 2-Basic Rules and Higher Order Derivatives (4.1)

Noticing patterns from the limit definition, we give "short cuts" or the basic rules of differentiation. Students will be able to:

- Use formulas to take derivatives of polynomial, radical, exponential, and logarithmic functions.
- Relate the first derivative to velocity and the second derivative to acceleration.

Lesson 3- Product and Quotient Rules (4.2)

In this lesson, we extend the rules of differentiation to products and quotients. Students will be able to:

- Use the product and quotient rules to take derivatives.
- Solve applied problems involving derivatives.

Lesson 4-The Chain Rule (4.3, 4.4, 4.5)

This lesson focuses on using the chain rule to differentiate three types of functions: a function raised to a power, exponential functions, and logarithmic functions. Students will be able to:

- (R) Break down a composition of two functions into basic functions.
- Apply the chain rule to find derivatives of functions raised to a power, exponential functions, and logarithmic functions.

Lesson 5-Combining Rules and Applications (4.3, 4.4, 4.5)

This lesson allows students to see how to apply multiple rules to take derivatives of more complicated functions. Students will be able to:

- Take derivatives of functions involving two rules.
- Solve rate of change application problems.

Lesson 6-Increasing and Decreasing Functions (5.1)

In this lesson, the first derivative is used to describe the graphical behavior of functions. Students will be able to:

- Find critical numbers and critical points.
- Find intervals where a function is increasing or decreasing.

Unit 3: Applications of Derivatives and Antiderivatives

Lesson 1-Absolute and Relative Extrema (5.2, 6.1)

The first derivative test is introduced as a means of find the maximums and minimums of a function. Students will be able to:

- Find absolute extrema on a closed interval.
- Find relative extrema using the first derivative test.
- Solve application problems.

Lesson 2-Multi-Variable Functions (9.1 and 9.2)

In this lesson, the students will focus on taking partial derivatives. Students will be able to:

- Evaluate a multi-variable function at a point.
- Compute 1^{st} and 2^{nd} order partial derivatives.

Lesson 3-Extrema of Multi-Variable Functions (9.3)

This lesson continues with the use of partial derivative to find extrema of mulit-variable functions. Students will be able to:

- Use the "D-test" to find relative maximums, minimum, and saddle points of multi-variable functions.
- Solve applied problems related to extrema.

Lesson 4-Concavity (5.3, 5.4)

In this lesson, the second derivative is used to describe the graphical behavior of functions. Students will be able to:

- Find intervals where a function is concave up or concave down.
- Find inflection points.
- Use the second derivative test to find local extrema. (if time)

Lesson 5-Optimization (6.2)

In this lesson, the students will solve word problems related to extrema. Students will be able to:

- Identify the objective function.
- Identify the constraints.
- Solve applied problems involving maximizing or minimizing a function.

Lesson 6-Antiderivatives and Area Functions (7.1)

This lesson will introduce basic properties of antiderivatives. We will concentrate on functions which lie above the x-axis. Students will be able to:

- Calculate indefinite integrals of basic polynomial, radical, and exponential functions.

Unit 4: Applications and Additional Topics

Lesson 1-Substitution (7.2)

This lesson will introduce a new method used to integrate more complicated (composition) functions. Students will be able to:

- (R) Breakdown a composition of functions into basic functions.
- Recognize composition functions and identify useful substitutions.
- Calculate differentials.
- Integrate functions using substitution.

Lesson 2-The Fundamental Theorem of Calculus (7.4)

This lesson will continue with integration and relate the antidifferentiation to finding the area beneath a curve. We will introduce the Fundamental Theorem of Calculus. Students will be able to:

- Evaluate definite integrals to find net area between a curve and the x-axis using the Fundamental Theorem of Calculus.
- Use basic integration properties to solve graphical net area problems.

Lesson 3-Definite Integrals and Area between Two Curves (7.5)

This lesson will continue with definite integrals and relating this to area. Students will be able to:

- Use properties to definite integrals to solve graphical net area problems.
- Use definite integrals to find the area between two curves.

Lesson 4-Consumer and Producer Surplus Applications (7.5)

This lesson will introduce business applications which require integration. Students will be able to:

- Find the equilibrium point of supply and demand.
- Use definite integrals to calculate consumer and producer surplus.