

School District of Springfield Township

Springfield Township High School Course Overview

Course Name: Academic Calculus

Course Description

Calculus (Academic) prepares students for college calculus. Topics include an intensive review of elementary functions, limits, the derivative and applications, and an introduction to integrals. Required: TI-83+/84 graphing calculator

Course Prerequisites

A minimum final grade of “C” in Trig/PreCalc (Honors) or a minimum final grade of “B” in Trig/PreCalc (Academic) and teacher recommendation

Unit Titles

Unit 1: Prerequisites

Unit 2: Limits

Unit 3: Differentiation

Unit 4: Applications of Differentiation

Essential Questions

Unit 1: Prerequisites

1. How do you calculate the domain and range of a function?
2. How do you determine the transformations of a function compared to its parent function and then graph the new function?
3. How can you sketch the graph of a trigonometric function?
4. How can you find missing side lengths and/or angle measure of a given right triangle using trigonometry?
5. How can you simplify expressions with like bases and variables using exponential rules?
6. How can you sketch the graph of a rational function?
7. How can you identify where a function is undefined and why it is undefined?

Unit 2: Limits

1. In what circumstances are limits undefined and why?
2. How can we calculate limits using a graph, table, and/or a function?
3. How can we calculate limits algebraically?
4. What circumstances must exist for a limit to exist?
5. Under what circumstances will a limit not exist?
6. How can a limit be calculated algebraically?
7. How can a limit be approximated graphically?
8. What do asymptotes, horizontal and/or vertical, effect the limits of a function?
9. How does the continuity of a function effect limits involving that function?

Unit 3: Differentiation

1. How can we estimate the slope of a curve at a point using a linear equation?
2. How can we estimate the slope of a curve at a point using limits?
3. How can we calculate the rate of change of a non-linear function?
4. How can we simplify functions and expressions so we can use rules of differentiation?
5. How can we relate differentiation to real-world situations involving projectiles?
6. How does the first derivative relate to functions that model projectiles?
7. How does the second derivative relate to the functions that model projectiles?
8. In which situations should we use the product, quotient, and/or chain rules to calculate derivatives?
9. How can we calculate the derivative of a relation that is not written in terms of the given variable?
10. How can we use derivatives of functions to solve problems involving two or more rates of change?

Unit 4: Applications of Differentiation

1. If we set derivatives equal to zero and solve for a variable, then what might that tell us about the graph of the given function?
2. If we set the second derivative to zero and solve for a variable, then what might that tell us about the graph of the given function?
3. How can we calculate intervals on which a function is increasing or decreasing?
4. How can we calculate intervals on which a function is concave up or concave down?
5. How can we calculate relative minimums and relative maximums of a function?
6. How can we calculate points of inflection of a given function?
7. How can we use the first derivative of a function to sketch its graph?
8. How can we use the second derivative of a function to sketch its graph?
How do asymptotes affect the graph of a function?
9. When a function's first derivative is undefined then what affect does this have on its graph?
10. When a function's second derivative is undefined then what affect does this have on its graph?
11. How can we use the graphs of functions to calculate minimum or maximum values involving real-world scenarios?
12. How can we calculate the x-intercepts of a function?

Topics of Study

Unit 1: Prerequisites

- Properties of functions and their graphs
- Trigonometric Functions
- Right Triangle Trigonometry
- Exponential Properties
- Polynomial Properties

Unit 2: Limits

- Finding limits graphically and numerically
- Evaluating limits analytically
- Continuity and one-sided limits

- Infinite limits
- Limits at infinity

Unit 3: Differentiation

- The derivative and the tangent line problem
- Basic differentiation rules and rates of change
- The product and quotient rules
- Higher order derivatives
- The chain rule
- Implicit differentiation
- Related rates

Unit 4: Applications of Differentiation

- Extrema on an interval
- Increasing and decreasing functions and the first derivative test
- Concavity and the second derivative test
- Curve sketching
- Optimization problems
- Newton's method

Key Competencies/Skills/Procedures

Unit 1: Prerequisites

- Identify shapes and behavior of polynomial, rational, exponential and trigonometric functions
- Calculate outcomes using function notation
- Identify the domain and range of a function
- Calculate and/or identify the x-intercepts of a function algebraically and graphically
- Calculate and/or identify the y-intercepts of a function algebraically and graphically
- Calculate and/or identify where a function is undefined
- Factor quadratics and higher degree polynomials using polynomial long division and/or synthetic division
- Calculate and/or identify holes and vertical asymptotes graphically and algebraically
- Identify transformations of functions from parent functions
- Calculate missing sides and angles of right triangles using trigonometry

Unit 2: Limits

- Use tables of functions to estimate limits
- Determine when a limit does not exist
- Use the properties of limits to evaluate limits of polynomials, composite functions, trigonometric functions, and rational functions
- Calculate limits by substitution
- Calculate limits by factoring and dividing out
- Calculate limits by rationalization
- Evaluate one-sided limits
- Calculate limits at vertical asymptotes
- Calculate horizontal asymptotes and limits at infinity

Unit 3: Differentiation

- Calculate the slope of a tangent line using the definition of the tangent line and the limiting process
- Calculate the equation of the tangent line at a given point on a function
- Calculate derivatives using the power rule
- Calculate the derivative of polynomials, absolute value, rational, trigonometric and exponential functions
- Calculate the velocity of a function using derivatives
- Calculate the maximum height of a projectile using derivatives
- Calculate higher-order derivatives
- Calculate derivatives using the chain rule
- Implicitly differentiate a function for a given variable
- Use implicit differentiation to solve real-world scenarios involving related rates

Unit 4: Applications of Differentiation

- Use the first derivative test to calculate extrema on an interval
- Use the first derivative test to calculate when a function is increasing or decreasing
- Use the first derivative to find critical values
- Use the second derivative test to calculate the concavity of a function on an interval
- Use the second derivative test to calculate points of inflection
- Apply the calculation of intervals on which a function is increasing or decreasing and concave up or concave down to make a sketch of its graph
- Use the graph of a function to maximize or minimize real-world situations
- Apply Newton's method to calculate the intercepts of a function

Core Vocabulary

Unit 1: Prerequisites

root, zero, vertex, asymptote, reflection, transformation, parabola, polynomial, slope, perpendicular, parallel, dependent, independent, function, relation, domain, range, degree, factor

Unit 2: Limits

limit, indeterminate form, rationalize, removable, non-removable, discontinuity, one-sided limit, infinite limit

Unit 3: Differentiation

tangent line, secant line, derivative, differentiable, position function, velocity function, power rule, product rule, quotient rule, chain rule, implicit differentiation, explicit form, related rate

Unit 4: Applications of Differentiation

minimum, maximum, extrema, absolute minimum, absolute maximum, critical number, increasing, decreasing, first derivative test, second derivative test, concavity, concave up, concave down, point of inflection, optimization

Core Resource

Larson, Ron; Hostetler, Robert P.; Edwards, Bruce H. *Calculus of a Single Variable*, 7th Edition. 2002.

Pennsylvania State Standards and/or Pennsylvania State Assessment Anchor Standards
Guiding Course

There are no Pennsylvania state standards for Calculus.

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