AP® Calculus AB
Syllabus

Course Description

Calculus AB is a college-level, yearlong course designed to prepare students for the Advanced Placement® Calculus AB exam. The goal of this course is to provide students with new tools to solve problems. Through a combination of direct instruction, videos, and readings, students will explore limits, derivatives, and integrals and the ways to apply them to mathematical and real-world problems.

Topics covered include graphs of functions, limits, differentiation, and integration. Students will demonstrate their understanding and acquisition of skills through practice problems, discussion questions, and practice AP exams.

Course Materials

Required Text

Students must have one of the following texts to complete the course:

- Stewart, J. (2002). Calculus. (5th ed.). Belmont, CA: Brooks Cole.
- Larson, R., Hostetler, R. P., and Edwards, B. H. (2002). Calculus: Early transcendental functions. (3rd ed.). Boston, MA: Houghton Mifflin.
- Thomas, G. B., Finney, R. L., Weir, M. D., and Giordano, F. R. (2003). Thomas' calculus. (10th ed.). Boston, MA: Addison-Wesley, Incorporated.
- Edwards, H. C., and Penney, D. E. (2002). Calculus. (6th ed.). Upper Saddle River, NJ: Prentice Hall.
- Smith, R. T., and Minton, R. B. (2003). Calculus. (2nd ed.). New York, NY: McGraw-Hill Science/Engineering/Math.

Course Goals

- Understand the graph of a function including domain, range, intercepts, asymptotes, and holes.
- Understand limits, derivatives, and integrals both graphically and algebraically, how to calculate each, and how to apply them to solve real-world problems.

Course Outline

Unit 1 - Functions and Graphs

This unit will explore basic concepts essential to the study of calculus. Students will use functional notation to define, recognize, solve, graph, and find the inverses and compositions of functions. Students will interpret the relationship between similar functions and describe the relationship as transformations of their graphical representations.

Readings

- Calculus (Brooks Cole), pp. 11–47 and 434–440
- Calculus: Early Transcendental Functions (Houghton Mifflin), pp. 2–9, 19–29 and 36–53
- Thomas' Calculus (Addison-Wesley), pp. 10–30 and 44–59
- Calculus (Prentice Hall), pp. A–44
- Calculus (McGraw-Hill), pp. 2–33 and 40–71

Key Activities

Discussion Questions:

- Exponential and Logarithmic Functions: How does the interest rate affect the interest earned? How does changing the time between compounding the interest affect the interest earned?
- Trigonometric Functions: How does changing different values in a trigonometric function affect the graph of the function?

AP Test Prep Practice: Unit Test

Content

Important calculus/mathematical concepts covered in this unit include, but are not limited to, absolute value functions; piecewise functions; exponential functions; logarithmic functions; trigonometric functions; power functions; polynomial functions; rational functions; inequalities; interval form; composition of functions; symmetry of graphs; transformations of functions; radians and arc length; trigonometric identities; variation problems; and the number e.

Direct Instruction:

- Functions and Function Notation
- Absolute Value and Piecewise Defined Functions
- Inequalities
- Composition and Combination of Functions
- Exponential and Logarithmic Functions
- Transformation of Functions
- Trigonometric Functions
- Power, Polynomial, and Rational Functions

Unit 2 - Limits and Continuity

This unit will explore the concept of a limit both graphically and algebraically. Students will learn to calculate limits as functions approach specific numbers, including infinity and negative infinity, including one-sided limits. Students will also learn about horizontal, vertical, and oblique asymptotes.

Readings

- *Calculus* (Brooks Cole), pp. 70–91, 102–111, 169–174, and 249–262
- *Calculus*: Early Transcendental Functions (Houghton Mifflin), pp. 60–105 and 230–239
- *Thomas' Calculus* (Addison-Wesley), pp. 85–111 and 112–133
- *Calculus* (Prentice Hall), pp. 63–98 and 271–280
- *Calculus* (McGraw-Hill), pp. 82–136

Key Activities

Discussion Questions:

- Limits of Special Trigonometric Functions: Use limits of some special trigonometric functions to prove the limits of similar special trigonometric functions using basic limit properties.
- Intuitive Definition of a Limit: Investigate limits using a graphing calculator.

AP Test Prep Practice: Unit Test

Free Response:

Follow the link to the Free Response Question from the 2008 exam. Complete ONLY Part A, page 2, question #2. Follow the instructions provided in the document. You have 20 minutes to complete this assignment.

http://apcentral.collegeboard.com/apc/public/repository/ap11_frq_calculus_ab_formb.pdf

Content

Important calculus/mathematical concepts covered in this unit include, but are not limited to, definition of limits; one-sided limits; infinite limits; continuity at a point or on an interval; Intermediate Value Theorem; limits at infinity; end behavior of functions; horizontal asymptotes; oblique asymptotes; vertical asymptotes; and special limits involving trigonometric functions.

Direct Instruction:

- Intuitive Definition of a Limit
- Algebraic Techniques for Finding Limits
- One–sided Limits
- Infinite Limits
- Limits at Infinity
- Limits of Special Trigonometric Functions
- Continuity

Unit 3 - Derivitives

This unit will explore the concept of a derivative and the different rules about how to calculate derivatives. Students will learn the product, quotient, and chain rules to calculate derivatives of functions including polynomial, trigonometric, exponential, and logarithmic functions.

Readings

- Calculus (Brooks Cole), pp. 127–133, 145–156, 175–189, 413–433, and 441–459
- Calculus: Early Transcendental Functions (Houghton Mifflin), pp. 112–167 and 169–174
- Thomas' Calculus (Addison-Wesley), pp. 147–159, 173–206, and 457–484
- Calculus (Prentice Hall), pp. 102–114, 120–132, and 175–198
- Calculus (McGraw-Hill), pp. 150–228 and 487–494

Key Activities

Discussion Questions:

- ◊ Derivatives of Inverse Functions: What relationship exists between the slopes of a function and its inverse? How can you use function values and slopes of a function to find the function values and slopes of its inverse?
- ◊ Differentiability and Continuity: What does it mean if a function is differentiable at a given point? What does it mean if a function is not differentiable at a given point? What does it mean if a function is continuous at a given point? What does it mean if a function is not continuous at a given point?

AP Test Prep Practice: Unit Test

- ◊ Definition of the Derivative: Practice finding derivatives using a calculator and graphing derivatives.

Content

Important calculus/mathematical concepts covered in this unit, include, but are not limited to, derivatives of exponential, logarithmic, and inverse functions; definition of derivative as slope, rate of change, and as a function; constant rule; power rule; product rule; quotient rule; sum and difference rules; trigonometric rules; and the chain rule of differentiation.

Direct Instruction:

- Definition of the Derivative
- Differentiation Rules
- Chain Rule
- Derivatives of Exponential Functions
- Derivative of Logarithmic Functions
- Derivatives of Inverse Functions
- Differentiability and Continuity
- Implicit Differentiation
- Logarithmic Differentiation

Unit 4 - Application of the Derivative

This unit will explore several applications of the derivative to real-world problems. Students will learn to use the first derivative and second derivative tests to analyze functions including their extrema and concavity.

Readings

- *Calculus* (Brooks Cole), pp. 112–120, 198–212, 223–248, and 278–288
- *Calculus*: Early Transcendental Functions (Houghton Mifflin), pp. 112–122, 175–183, 198–220, 222–229, 250–260, 262–268, and 276–286
- *Thomas' Calculus* (Addison-Wesley), pp. 134–140, 161–166, 207–215, 225–256, and 266–296
- *Calculus* (Prentice Hall), pp. 54–62, 151–163, 188–198, 218–246, 257–270, and 302–315
- *Calculus* (McGraw-Hill), pp. 150–163, 220–240, 242–250, 258–285, and 298–309

Key Activities

Discussion Questions:

- ◊ Related Rates: How does the rate of change of the volume of a solid figure relate to the rate of change of its surface area and to one-dimensional measurements? How does the rate of change of area of a polygon relate to the rate of change of a side in the polygon or the perimeter of the polygon?
- ◊ Differentials: How can you use the limit definition of the derivative to calculate propagated error?

AP Test Prep Practice: Unit Test

Free Response:

Follow the link to the Free Response Question from the 2008 exam. Complete ONLY Part B, page 7, question #6. Follow the instructions provided in the document. You have 20 minutes to complete this assignment.

http://apcentral.collegeboard.com/apc/public/repository/ap08_calculus_ab_form_b_frq.pdf

Content

Important calculus/mathematical concepts covered in this unit include, but are not limited to, tangent lines; normal lines; position; velocity; acceleration; relative extremes; concavity; first and second derivative tests; increasing and decreasing functions; related rates; extreme value theorem; linear approximations; differentials; Rolle's rule; and the Mean Value Theorem.

Direct Instruction:

- Tangent and Normal Lines
- Position, Velocity, and Acceleration (PVA)
- Related Rates
- Relative Extrema and the First Derivative Test
- Concavity and the Second Derivative Test
- Absolute Extrema and Optimization
- Rolle's Rule and the Mean Value Theorem
- Differentials

Unit 5 - Antiderivatives and Definite Integrals

This unit will explore the definition of antiderivatives and definite integrals. Students will learn how to calculate the antiderivatives and definite integrals of various functions including polynomial, exponential, logarithmic, and trigonometric functions. Students will learn the basic rules of antidifferentiation, including the chain rule and substitution.

Readings

- Calculus (Brooks Cole), pp. 300–307, 326–349, 360–367, 421–433, 441–450, 477–485, 525–531, and 628–636
- Calculus: Early Transcendental Functions (Houghton Mifflin), pp. 276–286, 299–334, 342–356, 382–395, and 506–514
- Thomas' Calculus (Addison-Wesley), pp. 312–328, 340–363, 457–498, and 565–569
- Calculus (Prentice Hall), pp. 302–315, 328–337, 339–367, 467–476, 517–522, and 560–569
- Calculus (McGraw-Hill), pp. 322–333, 350–383, 480–486, 495–542, and 568–576

Key Activities

Discussion Questions:

- ◊ The Definite Integral: How can you use definite integrals to calculate the area between two curves?
- ◊ Use a graphing calculator to make rectangle approximations and calculate definite integrals.

AP Test Prep Practice: Unit Test

Free Response:

Follow the link to the Free Response Question from the 2010 exam. Complete ONLY Part A, page 3, question #3. Follow the instructions provided in the document. You have 20 minutes to complete this assignment.

http://apcentral.collegeboard.com/apc/public/repository/ap10_frq_calculus_ab_formb.pdf

Content

Important calculus/mathematical concepts covered in this unit include, but are not limited to, differential equations; slope fields; antiderivatives of functions including trigonometric, natural exponential, general exponential, natural logarithmic, and general logarithmic functions; antiderivatives that lead to inverse trigonometric functions; the Fundamental Theorem of Calculus; the Mean Value Theorem; area between curves; Reimann sums; and definite integrals.

Direct Instruction:

- Differential Equations and Slope Fields
- Antiderivatives
- The Chain Rule for Antiderivatives
- Antiderivatives of Exponentials
- Antiderivatives and Logarithms
- Antiderivatives and Inverse Trigonometric Functions
- Trigonometric Substitutions
- The Definite Integral
- Fundamental Theorem of Calculus

Unit 6 - Application of Antiderivatives and Definite Integrals

This unit will explore antiderivatives and definite integrals to answer real-world problems. Students will practice solving work, volume, displacement, net change, center-of-mass, and other problems.

Readings

- *Calculus* (Brooks Cole), pp. 350–359, 382–401, 597–617, and 637–646
- *Calculus*: Early Transcendental Functions (Houghton Mifflin), pp. 287–298, 382–395, 421–438, 450–457, and 459–475
- *Thomas' Calculus* (Addison-Wesley), pp. 333–334, 393–412, 421–450, and 485–498
- *Calculus* (Prentice Hall), pp. 402, 408–427, 432–447, and 570–576
- *Calculus* (McGraw-Hill), pp. 402–433, 453–465, and 512–520

Key Activities

Online Discussion: Visit the Collaboration Corner to see the discussion questions for this unit.

Simulation Activity: Complete the simulation to learn more about using integrals to determine the volume of a solid object.

AP Practice: Unit Test

Free-response:

1. Follow the link to the Free Response Question from the 2009 AP Exam. Complete ONLY Part B, page 4, question #4. Follow the instructions provided in the document. You have 20 minutes to complete this assignment.

   http://apcentral.collegeboard.com/apc/public/repository/ap09_frq_calculus_ab.pdf

2. Follow the link to the Free Response Question from the 2006 AP Exam. Complete ONLY Part B, page 5, question #4. Follow the instructions provided in the document. You have 20 minutes to complete this assignment

   http://www.collegeboard.com/prod_downloads/student/testing/ap/calculus_ab/ap06_frq_calculus%20ab.pdf

Content

Important calculus/mathematical concepts covered in this unit include, but are not limited to, finding the volume of a solid given a known cross-section or function rotated around an axis; solving work problems; Net Change Theorem; calculating displacement and total distance given a velocity or displacement function; locating centers of mass; minimizing costs; and separable differential equations.

Direct Instruction:

- Net Change and Displacement
- Volume
- Separable Differential Equations
- Work
- Other Applications of Definite Integrals