

Calculus AB Syllabus

Introduction

Our study of calculus, the mathematics of motion and change, is divided into two major topics: differential and integral calculus. Differential calculus enables us to calculate rates of change, to find the slope of a curve, and to calculate velocities and accelerations of moving bodies. Integral calculus is used to find the area of an irregular region in a plane, to measure lengths of curves, and to calculate centers of mass of arbitrary solids.

As with all mathematics courses at our high school, problems will be presented and solved using the rule of four: analytically, numerically, graphically, and verbally. Students are expected to relate the various representations to each other. Students are expected to complete one to two hours of homework for every hour in class. Students will work individually, in small groups, they will analyze and discuss solutions, and give informal and formal oral and written presentations to the class. At least one major project is also presented to school and community members who are not part of the class, so that students learn to communicate to a nonmathematically oriented audience.

The first seven months of the class will be devoted to studying the topics covered in a typical college Calculus I course. The next four weeks will be review and preparation for the AP exam. Throughout the year, information concerning the administration, scoring, and content of the exam will be discussed. All major exams will model the AP Calculus AB exam. After taking the exam in May, students will complete projects relating to the topics they have studied in this class during the year.

Use of Graphing Calculators

All students have access to TI-83 Plus, TI-84 series, TI-89 series, and TI-200 calculators while in class. Most students have their own graphing calculator. I issue graphing calculators to students not able to buy one of their own. The graphing calculators are used nearly everyday for a variety of tasks and topics. We use the calculators to explore and discover new concepts and to reinforce ideas already discussed. I stress the use of the graphing calculator in the four required functions for AP Calculus:

- Finding a root
- Approximating a derivative at a given point
- Approximating a definite integral at a given point
- Sketching a function in a given window

Course Outline

Unit Zero: Review of functions (done over the summer as a worksheet)

- ✓ Review of the major types of functions: linear, polynomial, rational, exponential, logarithmic, trigonometric, inverse trigonometric, and piecewise defined.
- ✓ Analyzing functions graphically and numerically

Unit One: Limits and their properties (3 weeks)

- ✓ Find limits graphically and numerically.
- ✓ Evaluate limits analytically.
- ✓ Continuity and one-sided limits
- ✓ Intermediate Value Theorem
- ✓ Infinite limits and vertical asymptotes

Unit Two: Differentiation (9 weeks)

- ✓ The derivative and the tangent line problem
- ✓ Differentiability and continuity
- ✓ Basic differentiation rules and rates of change (average and instantaneous)
- ✓ Product and quotient rules and higher order derivatives
- ✓ The Chain Rule
- ✓ Implicit differentiation
- ✓ Related rates
- ✓ Extrema on an interval
- ✓ Rolle's Theorem and the Mean Value Theorem
- ✓ Increasing and decreasing functions
- ✓ The first derivative test
- ✓ Concavity and points of inflection
- ✓ The second derivative test
- ✓ Limits at infinity (horizontal asymptotes)
- ✓ Summary of curve sketching (including monotonicity)
- ✓ Optimization problems
- ✓ Business problems
- ✓ Differentials
- ✓ Local linear approximations

First trimester project: Calculator/CBL Lab (see following)

First trimester exam: The final exam includes problems from past AP exams that test the students' abilities to connect concepts graphically, analytically, numerically, and verbally. This exam determines 20% of the student's trimester average.

Unit Three: Introduction to integral calculus (5 weeks)

- ✓ Antiderivatives and indefinite integration
- ✓ Differential equations
- ✓ Position, velocity, acceleration problems
- ✓ Riemann sums
- ✓ Definite integrals solved using geometric formulas
- ✓ Properties of definite integrals
- ✓ Trapezoidal rule
- ✓ The Fundamental Theorem of Calculus
- ✓ Average value of a function
- ✓ Second Fundamental Theorem of Calculus
- ✓ Integration using u-substitution
- ✓ Displacement and definite integrals

Unit Four: Transcendental functions (7 weeks)

- ✓ The natural logarithmic function and differentiation
- ✓ The natural logarithmic function and integration
- ✓ Inverse functions
- ✓ Exponential functions: differentiation and integration
- ✓ Bases other than e and applications
- ✓ Differential equations: growth and decay
- ✓ Differential equations: separation of variables
- ✓ Differential equations: slope fields

- ✓ Inverse trigonometric functions and differentiation
- ✓ Inverse trigonometric functions and integration

Second trimester project: Square pegs in round holes (see following)

Second trimester exam: The final exam includes problems from past AP exams that test the students' abilities to connect concepts graphically, analytically, numerically, and verbally. This exam determines 20% of the student's trimester average.

Unit Five: Applications of integration (2 to 3 weeks)

- ✓ Area of a region between two curves
- ✓ Volume: known cross-sections
- ✓ Volume: disc method
- ✓ Volume: washer method

Unit Six: AP review (3 to 4 weeks)

- ✓ Amsco AP Calculus Review: multiple choice and free response practice
- ✓ 1997, 1998, and 2003 AP Exams
- ✓ Free response questions; 2000 to present

The review for the AP Exam includes problems from past AP exams that test the students' abilities to connect concepts graphically, analytically, numerically, and verbally. This review determines 40% of the student's trimester average.

Unit Seven: Projects (4 to 5 weeks)

- ✓ Volume of a known cross section model
- ✓ Vegetable lab
- ✓ Research Project: Calculus in careers and everyday life
 - A field trip to Fred Hutchinson Cancer Research Center in Seattle, WA and/or the Cancer Primary Care Facility in Sequim, WA will be included in this project. Other appropriate field trips will be considered. Other trips we have taken in the past include Battelle Research Lab in Sequim, WA.; the University of Washington; The Museum of Flight at Boeing Field; Microsoft; Boeing Flight Center; the NOAA Sand Point campus in Seattle.
- ✓ Final exam covering the entire year

Assessments

Students can expect either a quiz or test each week. Most of these will have a calculator portion and a noncalculator portion. All unit and final exams follow the AP format and will consist of four sections: Multiple Choice with and without a calculator, and Free Response with and without a calculator. Special emphasis will be placed on helping students learn to justify answers in complete sentence form at all times. Quizzes account for 10% of a student's trimester grade, unit tests make up 40% of the trimester grade, assignments make up 30% and the trimester final exam accounts for the last 20% of the grade.

Activities/projects

- ❖ Calculator/CBL Lab: Students use the calculators with a CBL unit, motion detector, and accelerometer to investigate the relationship between position, velocity and acceleration. They model their results with equations and graphs, then analyze and compare their models' first and second derivatives with the observed data. They will put together a presentation for the precalculus and physics classes.
- ❖ Square pegs in round holes (from A Watched Cup Never Cools): Students compare rectangular approximations of area with approximations using trapezoids and finally lead into Simpson's method. Then they apply these methods by taking stream depth and speed measurements to determine the cross-sectional area and stream flow per hour.
- ❖ Free response practice: Students will be given four AP free response questions from previous tests to solve in class either individually or in groups. The questions will represent and require analytical, numerical, graphical, and verbal skills. There will be both calculator and non-calculator questions. These practices will take place 2 or 3 times per trimester before the AP Review and then occur twice a week until the AP exam.
- ❖ f, f', f'' activity: Students will be given a set of cards that include graphs of f, f', f'' and written descriptions of f, f', f'' . They will work in groups to match each f, f', f'' set both graphically and verbally.
- ❖ Volume of a known cross-section model project: Students will build a 3-D model of an assigned solid and will calculate the volume numerically using a spreadsheet and cross-sections and also analytically using the cross-section formula. They will hand in a written report that describes how they determined the volume and their findings, with emphasis on justification of the mathematics, then present their findings to the class.
- ❖ Vegetable and fruit lab: Students will work in pairs to determine the volume of a banana, squash, potato, etc., using graph paper and their calculators and the disk or washer method for determining volumes of solids of revolution. They will hand in a written report that describes how they determined the volume and their findings, with emphasis on justification of the mathematics, then present their findings to the class.

Textbook and Resources

Larson, Ron, Robert P. Hostetler, and Bruce H. Edwards. Calculus of a Single Variable. Boston: Houghton Mifflin, 1998, 6th edition.

McMullin, Lin. Visualizing Differential Equations: Slope Fields. College Entrance Examination Board, 2004.

Kamischke, Ellen. A Watched Cup Never Cools. Emoryville: Key Curriculum Press, 1999.

Antinone, Linda, Thomas Dick, Kevin Fitzpatrick, Michael Grasse, Mark Howell. Texas Instruments Calculus Activities. Dallas: Texas Instruments, 2004.

Foerster, Paul A. Calculus Explorations. Emoryville: Key Curriculum Press, 1998.

Lifshitz, Maxine. AMSCO'S AP Calculus AB/BC: Amsco School Publications, Inc. 2004

AP Calculus Multiple Choice Questions, 1969-1997
AP Calculus Free Response Questions, 1969-1978; 1979-1988; 1989-1998
AB Free Response Questions posted on apcentral (1999-2006)
APCD for Calculus AB
TI-SmartView software (a computer emulator of the TI-84)
TI-84 overhead calculator
Each student provides one of the following: TI-83, TI-84, TI-89 calculator.
APEX Virtual School ClassTools: various problems as needed.

Supplementary readings from various internet sources