AP® Calculus AB Course Syllabus

Grant Community High School

Mr. Rous

Textbook

Finney, Ross L., Franklin D. Demana, Bert K. Waits, and Daniel Kennedy. ***Calculus – Graphical, Numerical, Algebraic*** Addison Wesley Longman, 1999.

Calculator

Students are required to have a graphing calculator. TI-83 Plus or better is recommended because all example and programs will be done by the instructor on a TI-83 Plus.

Other Sources

Kelley, W. Michael. *The Complete Idiots Guide to Calculus*. Pearson Education, Inc., 2002.

Krantz, Steven G. *Calculus Demystified*. McGraw Hill, 2003.

Lefcourt Ruby, Tamara, James Sellers, Lisa Korf, Jeremy Van Horn, and Mike Munn. *Kaplan AP Calculus AB & BC 2006 Edition.* Simon & Schuster, 2006.

Stewart, James. *Calculus Concepts and Contents*. Thompson Brooks/Cole, 2005.

Expectations

AP® Calculus AB is a college-level course designed to expose you to a universe of knowledge that might otherwise be unexplored in high school. My main goal is to teach you how to ***think*** and to explain your conclusions. This course is especially useful to those pursuing studies in mathematics, as well as an ever-widening variety of engineering, science, economic, and business fields. Through the AP Exam, you have the opportunity to earn credit or advanced placement at most of the nation's colleges and universities, as well as colleges and universities in 28 other countries. Since the objective of this course is to prepare you for the AP Calculus AB Examination, ***I expect everyone in this class to take the AP Calculus AB Examination in early May***. You will have the opportunity to work with functions in a variety of ways (graphically, numerically, analytically, and verbally) and then be able to identify the connection among these representations. During this class, you will be encouraged to work in small groups and tutor each other.

The goals of this course, as stated by the College Board, are as follows:

1. Students should be able to work with functions represented in a variety of ways: graphical, numerical, analytical, or verbal. They should understand the connections among these representations.
2. Students should understand the meaning of the derivative in terms of a rate of change and local linear approximation and should be able to use derivatives to solve a variety of problems.
3. Students should understand the meaning of the definite integral both as a limit of Riemann sums and as the net accumulation of change and should be able to use integrals to solve a variety of problems.
4. Students should understand the relationship between the derivative and the definite integral as expressed in both parts of the Fundamental Theorem of Calculus.
5. Students should be able to communicate mathematics both orally and in well-written sentences and should be able to explain solutions to problems.
6. Students should be able to model a written description of a physical situation with a function, a differential equation, or an integral.
7. Students should be able to use technology to help solve problems, experiment, interpret results, and verify conclusions.
8. Students should be able to determine the reasonableness of solutions, including sign, size, relative accuracy, and units of measure.
9. Students should develop an appreciation of calculus as a coherent body of knowledge and as a human accomplishment.

Course Planner – Topics and Timeline

First Semester of AP Calculus AB

Chapter 1 – Prerequisites for Calculus (9 days)

- **1.1 Lines** – 1 day
  Slope, Parallel and Perpendicular Lines, Point-Slope Education, Standard Equation of a Line, Linear Regression and analysis using a graphing calculator, Applications
- **1.2 Functions and Graphs** – 2 days
  Definition of function, Domain and Range (definition of and notation for), Viewing and Interpreting Graphs, Even and Odd Functions-Symmetry, Piecewise Functions and how to graph them, Absolute Value Function, Composite Functions
- **1.3 Exponential Functions** – 1 day
  Exponential Growth, Exponential Decay, Applications
- **1.5 Functions and Logarithms** – 1 day
  One-to-One Functions, Inverse Functions, Finding Inverses, Logarithmic Functions, Properties of Logarithms,Change of a Base Formula, Graphing Logarithmic Functions, Natural Logarithms, Applications
- **1.6 Trigonometric Functions** – 2 days
  Radian Measure, Graphs of Trigonometric Functions, Periodicity, Even and Odd Trigonometric Functions, Transformations of Trigonometric Graphs, Applications, Inverse Trigonometric Function

- Students will complete a Unit Circle (without a calculator) to give the exact **sin**, **cos**, **tan**, **csc**, **sec**, and **cot** values starting at 0 and then for all multiples of π, $\pi/2$, $\pi/3$, $\pi/4$, and $\pi/6$ with a separate written description on how they found their solutions, especially for tan, cot, sec, and csc.

Review and Test – 2 days

Chapter 2 – Limits and Continuity (10 days)

- **2.1 Rates of Change and Limits** – 2 days
  Average and Instantaneous Speed, Definition of Limit, Properties of Limits, One-sided (right-hand and left-hand) and Two-sided Limits, Sandwich Theorem
- **2.2 Limits Involving Infinity** – 2 days
  Finite Limits as $x \to \pm\infty$, Sandwich Theorem Revisited, Infinite Limits as $x \to \pm\infty$, End Behavior Models, "Seeing" Limits as $x \to \pm\infty$ using $y = f(1/x)$ as $x \to 0$, Graphing Infinite Limits
- **2.3 Continuity** – 2 days
  Continuity at a Point, Types of Discontinuities, Continuous Functions, Algebraic Combinations, Composites of Continuous Functions, Intermediate Value Theorem for Continuous Functions
- **2.4 Rates of Change and Tangent Lines** – 2 days
  Average Rate of Change, Tangent to a Curve, Slope of a Curve, Normal to a Curve, Speed Revisited (instantaneous speed = instantaneous rate of change)

- Students will complete a packet finding the limits of various graphs and functions. If there is no limit, students will have to explain the reason why.

Review and Test – 2 days

Chapter 3 – Derivatives (30 days)

- **3.1 Derivative of a Function** – 3 days
  Definition of Derivative, Derivative Notation, Relationships between the Graphs of f and f', Graphing the Derivative from Data, One-sided Derivatives

- **3.2 Differentiability** – 3 days
  How f' (a) Might Fail to Exist (corner, cusp, vertical tangent, discontinuity), Differentiability Implies Local Linearity, Derivatives on a Calculator, Differentiability Implies Continuity, Intermediate Value Theorem for Derviatives
- **3.3 Rules for Differentiation** – 4 days
  Derivative of a Constant, Derivative of a Positive Integer Power Function, Derivative of a Constant Multiple, Derivatives Involving Sums and Differences of Functions, Product Rule, Quotient Rule, Derivatives of a Negative Integer Power Function, Second and Higher Order Derivatives
- **3.4 Velocity and Other Rates of Change** – 3 days
  Instantaneous Rates of Change, Motion in a Line (velocity, speed, acceleration), Sensitivity to Change, Derivatives in Economics (marginal cost and marginal revenue)
- **3.5 Derivatives of Trigonometric Functions** – 3 days
  Derivative of the Sine Function, Derivative of the Cosine Function, Simple Harmonic Motion, Jerk, Derivatives of Other Basic Trigonometric Functions (tan, cot, sec, csc)
- **3.6 Chain Rule** – 3 days
  Chain Rule, Repeated Use of the Chain Rule, Power Chain Rule
- **3.7 Implicit Differentiation** – 2 days
  Implicitly Defined Functions, Differentiating Implicitly, Tangents and Normal Lines, Rational Powers of Differentiable Functions
- **3.8 Derivative of Inverse Trigonometric Functions** – 2 days
  Derivatives of Inverse Functions, Derivative of Arcsine, Derivative of Arctangent, Derivative of Arcsecant, Derivatives of the Other Three Trigonometric Functions (arccosine, arccotangent, arccosecant)
- **3.9 Derivatives of Exponential and Logarithmic Functions** – 4 days
  Derivative of e^x, Derivative of a^x, Derivative of ln x, Derivative of $\log_a x$, Power Rule for Arbitrary Real Powers

- Students will complete a worksheet on the relationship between the position function, velocity, and acceleration.
- Students will learn how to use the calculator to determine the derivative.
- Students will complete a packet on matching a function to the graph of its derivative, matching a derivative to the graph of its original function, sketching a graph of the derivative given the original function, and sketching an original function given the graph of its derivative and explain how they arrived at their answers.
- Students will complete a 65-question packet on finding derivatives.

Review and Test – 3 days

Chapter 4 – Applications of Derivatives (25 days)

- **4.1 Extreme Values of Functions** – 5 days
  Absolute Extreme Values, Local (Relative) Extreme Values, Finding Extreme Values
- **4.2 Mean Value Theorem** – 2 days
  Mean Value Theorem, Physical Interpretation of the MVT, Increasing and Decreasing Functions, Antiderivative
- **4.3 Connecting f' and f'' with the graph of f** - 4 days
  First Derivative Test for Local Extrema, Concavity, Points of Inflection, Second Derivative Test for Local Extrema, Sign Charts
- **4.4 Modeling and Optimization** – 5 days

Examples from Business and Industry, Examples from Mathematics, Examples from Economics (maximizing cost and minimizing average cost) , Modeling Discrete Phenomena with Differentiable Functions

- **4.5 Linearization and Newton's Method** – 3 days
  Linear Approximation, Newton's Method, Differentials, Estimating Change with Differentials, Absolute, Relative, and Percentage Change, Sensitivity to Change
- **4.6 Related Rates** – 3 days
  Related Rate Equations

- Students will complete a worksheet on finding relative extrema and inflection points of a function with and without using a calculator.
- Students will complete a worksheet on matching a function to the graph of its second derivative as well as matching the second derivative graph to its first derivative and original function. Students will also sketch first and second derivative graphs given an original function's graph.

Review and Test – 3 days

Semester One Exam will consist of 50 multiple-choice questions based on the AP Calculus AB exam.

Second Semester of AP Calculus AB

Chapter 5 – The Definite Integral (26 days)

- **5.1 Estimating with Finite Sums** – 3 days
  Distance Traveled, Rectangular Approximation Method (RAM – LRAM, RRAM, MRAM), Volume of a Sphere, Cardiac Output
- **5.2 Definite Integrals** – 4 days
  Riemann Sums, Terminology and Notation of Integration, Definite Integral and Area (area under the curve), Constant Functions, Integrals on a Calculator, Discontinuous Integrable Functions
- **5.3 Definite Integrals and Antiderivatives** – 8 days
  Properties of Definite Integrals, Average Value of Function, Mean Value Theorem for Definite Integrals, Connecting Differential and Integral Calculus (taking the derivative of an integral)
- **5.4 Fundamental Theorem of Calculus** – 5 days
  Fundamental Theorem-Part 1, Graphing an Integral, Fundamental Theorem-Part 2, Finding Area using Antiderivatives, More Business Applications (cost from marginal cost and average daily inventory) **[C3], [C5]**
- **5.5 Trapezoidal Rule and Simpson's Rule** – 3 days
  Trapezoid Approximations, Simpson's Rule

- Students will complete a worksheet to determine areas using LRAM, RRAM, MRAM, Trapezoid Rule and Simpson's Rule and determine which method gives the most accurate answer on different shaped curves and data tables.
- Students will use calculator programs to determine and check areas using LRAM, RRAM, MRAM, Trapezoid Rule and Simpson's Rule.
- Students will learn to use the calculator to determine the answer of a definite integral.

Review and Test – 3 days

Chapter 6 – Differential Equations & Mathematical Modeling (21 days)

- **6.1 Antiderivatives and Slope Fields** – 4 days
  Solving Initial Value Problems, Slope Fields, Antiderivatives and Indefinite Integrals, Properties of Indefinite Integrals, Applications
- **6.2 Integration by Substitution** – 4 days

Power Rule in Integral Form, Trigonometric Integrands, Substitution in Indefinite Integrals, Substitution in Definite Integrals, Separable Differential Equations

- **6.4 Exponential Growth and Decay** – 4 days
  Law of Exponential Change ($P=e^{rt}$), Continuously Compounded Interest, Radioactivity (half-life), Newton's Law of Cooling, Resistance Proportional to Velocity
- **6.5 Population Growth** – 4 days
  Exponential Model, Logistic Growth Model, Logistic Regression
- **6.6 Numerical Methods** – 2 days

- Students will complete a packet doing *u*-substitution for indefinite and definite integrals.
- Students will complete a packet drawing slope field given a differential equation, matching slope fields to its original equation, matching slope fields to its differential equation, and sketching possible solution curves through a slope field given a point.
- Students will draw slope field manually and with a calculator program.

Review and Test – 3 days

Chapter 7 – Applications of Definite Integrals (21 days)

- **7.1 Integral as Net Change** – 5 days
  Linear Motion Revisited, General Strategy, Consumption over Time, Net Change from Data, Work (Hooke's Law)
- **7.2 Areas in the Plane** – 3 days
  Area Between Curves, Area Enclosed by Intersecting Curves, Boundaries with Changing Functions, Integrating with Respect to y, Saving Time with Geometry Formulas (when finding area)
- **7.3 Volumes** – 5 days
  Volume as an Integral (volume of a solid by slicing), Square Cross Sections, Circular Cross Sections, Cylindrical Shells (Shell Method), Other Cross Sections
- **7.5 Applications from Science and Statistics** – 5 days
  Work Revisited, Fluid Force and Fluid Pressure, Normal Probabilities

- Students will learn how to find the area between 2 functions manually and by using the calculator.
- Students will complete a worksheet on determining distance traveled when given the velocity function and when given a graph of the object's velocity.
- Students will complete a packet finding (manually and with a calculator) the area of various shaded regions and the volume of different objects from by revolving around the x-axis or y-axis using the slicing method or shell method. Volume problems will also have the base graphed with different shaped cross-sections. Students will have to justify the method used.

Review and Test – 3 days

Chapter 8 – L'Hôpital's Rule (1 day)

- **8.1 L'Hôpital's Rule**

Review for the AP Calculus AB Examination will begin in earnest before spring break. The first two weeks will be spent on multiple choice problems, with quizzes on questions where a calculator is and is not allowed. The second two weeks will be spent on free-response questions, with a quiz on one of each type of question (with and without a calculator). Students are graded as they would be graded on the AP® Exam. (Free-response questions and scoring guidelines are available on AP Central®.) Any remaining time before the scheduled AP® Exam is spent on sample questions alternating with multiple choice and free-response.

A final exam will consist of calculator and non-calculator questions.