Calculus AB (AP)

COURSE DESCRIPTION

The Advanced Placement Calculus AB course is equivalent to a first course in a college calculus sequence. The three major areas covered are **functions, graphs and limits** (analysis of graphs, limits, asymptotic and unbounded behavior, and continuity), **derivatives** (concept of a derivative, derivative at a point, derivative as a function, second derivatives, applications, and computation of derivatives) **and integrals** (interpretations and properties of definite integrals, applications of integrals, Fundamental Theorem of Calculus, techniques of anti-differentiation, applications of anti-differentiation, numerical approximations to definite integrals, and differential equations including slope-fields). Graphical, numerical, algebraic, and verbal methods are stressed throughout the course. The course is equivalent to at least a semester of calculus at most colleges and universities, perhaps to a year of calculus at some. All students take the Advanced Placement examination.

REQUIRED TEXT AND CALCULATOR

- Hughes-Hallett, Deborah, Andrew M. Gleason, William G. McCallum et al., *Calculus: Single Variable*, 4th edition, Hoboken, NJ: Wiley, 2005. ISBN 0-471-48481-4.
- Texas Instruments TI-83 or TI-84 Graphing Calculator (Plus and Silver Editions are OK).

INSTRUCTIONAL METHODS AND STRATEGIES

- *Lectures:* The teacher introduces new material and shows the students the necessary definitions, formulas, demonstrations and proofs. Students take notes and ask questions about the textbook reading.
- *Discussions/Oral Presentations:* Students practice solving problems in real time and presenting already attempted solutions. During whole-class discussions students teach each other, guided by questions from the teacher. Students give oral presentations of solutions. Students learn by example how to think on their feet and how to actually perform structured problem solving.
- *Investigations:* Similar to laboratories, these are in-class activities and explorations that students use to investigate a problem in depth, often using the graphing calculator with physical measurements or other real-world data. These provide "hands on" experience.
- *Homework/Problem Sets:* Students are given regular homework assignments that involve skill building and problem solving.
- *Study Groups:* Students are encouraged to work with others in study groups outside class.
- *Practice Tests:* Students practice AP Examination questions throughout the year to help them gain experience and experience and build confidence.
- *Website Research:* Students use learning resources on the Internet.

ASSESSMENT

Assessment Type
Homework
In-class work including note-taking, discussion and oral presentations
Informal observations by teacher
Investigations
Quizzes
Exams with multiple-choice, short answer and free response questions. Calculators are not allowed for about half of the questions

COURSE OBJECTIVES

1. Students will learn, mostly through individual and group problem solving, the course content in the areas of (a) functions, graphs, and limits (b) derivatives and (c) integrals—including applications to physical, biological and economic situations—as outlined in the *Course Description for AP Calculus AB and BC.*
2. Students will take notes during lectures, covering the theoretical aspects of calculus such as definitions, formulas, and proofs.
3. Students will participate fully during discussions and investigations.
4. Students will demonstrate their ability to communicate mathematical ideas using graphical, numerical, algebraic and verbal approaches.
5. Students will present select solutions to the problems sets orally to the class, showing their ability to communicate their thinking and to listen to other students.
6. Students will learn to adjust their study habits to the rigors of complex college level work, by studying collaboratively both in class and outside class, making use of personal, textbook and Internet resources.
7. Students will ask and answer structured questions to probe understanding and determine the reasonableness of solutions to

problems.

8. Students will demonstrate skills using a TI-83 or TI-84 graphing calculator including, but not limited to, being able to (a) plot the graph of a function in an arbitrary viewing window, (b) find the zeroes of functions, i.e. solve equations numerically, (c) numerically calculate the derivative of a function, and (d) numerically calculate the value of a definite integral.
9. Students will practice previous AP examination questions throughout the course, to prepare them for the AP examination.

COURSE GOALS AND MAJOR STUDENT OUTCOMES

This calculus course prepares students to be (1) creative complex thinkers who use creative approaches to problem solving, (2) life long learners who are comfortable learning and working collaboratively as well as individually, who feel empowered by knowledge and understand their own strengths, and who are prepared for further academic pursuits, and (3) effective communicators who can express themselves in a variety of ways and are able to articulate thoughts and ideas clearly.

- Students will be able to work with functions represented in a variety of ways: graphical, numerical, algebraic and verbal. They will understand how to illustrate a concept in different ways.
- Students will understand the meanings of derivatives and integrals and the relationships between them.
- Students will be able to communicate mathematics both orally and in well-written sentences and will be able to explain solutions to problems.
- Students will be able to model a written description of a physical situation using functions, differential equations and integrals.
- Students will be able to use technology to help solve problems, experiment, interpret results, and verify conclusions. The primary use of technology is their TI-83 or TI-84 graphing calculator.
- Students will be able to determine the reasonableness of solutions.
- Students will develop an appreciation of calculus as a coherent body of knowledge and as a human accomplishment.
- Students will begin to use effective strategies for succeeding at the college level, including studying individually and in groups.
- Students will take the Calculus Advanced Placement examination.

COURSE OUTLINE

Unit	*Time*	*Topics (with section numbers in the textbook)*
1	**2 weeks**	**A Library of Functions**
		Functions and Change (1.1)
		Exponential functions (1.2)
		New functions from old. Transformations. Compositions. Symmetry. (1.3)
		Logarithmic Functions (1.4)
		Trigonometric Functions (1.5)
		Powers, polynomials, rational functions. Local and global behavior. (1.6)
		Introduction to continuity. Intermediate Value Theorem (1.7)
		Limits (1.8)
		Graphing calculator skills.
2	**3 weeks**	**Key Concept: The Derivative**
		How do we measure speed? (2.1)
		The derivative at a point (2.2)
		The derivative function (2.3)
		Interpretations of the derivative. Verbal descriptions (2.4)
		The second derivative. Concavity (2.5)
		Differentiability. Piecewise functions (2.6)
3	**2 weeks**	**Short-Cuts to Differentiation**
		Powers and Polynomials (3.1)
		The exponential Function (3.2)
		The product and quotient rules (3.3)
		The Chain rule (3.4)

		The trigonometric functions (3.5)
		The chain rule and inverse functions (3.6)
		Implicit functions (3.7)
		Linear approximation (3.9)
		Theorems about differentiable functions. Mean Value Theorem. (3.10)
4	**3 weeks**	**Using the Derivative**
		Using first and second derivatives (4.1)
		Families of curves (4.2)
		Optimization. Extreme Value Theorem (4.3)
		Applications to marginality (4.4)
		Optimization and modeling (4.5)
		Rates and related rates (4.6)
5	**3 weeks**	**Key Concept: The Definite Integral**
		How do we measure distance traveled? Left and right sums (5.1)
		The definite integral. General Riemann sums (5.2)
		The First Fundamental Theorem and interpretations. Average value (5.3)
		Theorems about definite integrals (5.4)
6	**3 weeks**	**Constructing Antiderivatives**
		Antiderivatives graphically and numerically (6.1)
		Constructing antiderivatives analytically (6.2)
		Differential equations (6.3)
		Second Fundamental Theorem (6.4)
		Equations of Motion (6.5)
7	**1 week**	**Integration**
		Integration by substitution (7.1)
		Approximating the definite integral. Midpoint and trapezoidal rules. (7.5)
8	**2 weeks**	**Using the Definite Integral**
		Areas and volumes (8.1)
		Riemann sums; volumes and areas by definite integrals (8.1)
		Volumes of Solids of known cross-section (8.2)
		Solids of Revolution (8.2)
		Area of regions between curves (8.2)
		Applications to physics, economics and statistics (selected parts of 8.4-8.8)
9	**3 weeks**	**Differential Equations**
		What is a differential equation? (11.1)
		Slope fields (11.2)
		Separation of variables (11.4)
		Growth and decay (11.5)
		Applications and modeling (11.6)
10	**3 weeks**	**Course Review** including practice AP Examinations