<u>Calculus AB Syllabus</u>

Course Overview and Philosophy

The primary objectives of the course are to provide students with a strong foundation of single variable calculus and to have them understand the concepts and solutions graphically, numerically, analytically, and verbally. My secondary objectives are to instill in my students an appreciation of the beauty of calculus and to inspire them to pursue a higher mathematics education in college and in their careers.

AP Calculus AB is a yearlong course with 50-minute periods, five days per week. Students are expected to spend about an hour (sometimes more) on homework each evening.

I cover everything in the Calculus AB topic outline as it appears in the *AP Calculus Course Description*. In addition, as time permits, I cover some Calculus BC topics (such as integration by parts and parametric equations).

The primary textbook is *Calculus: Graphical, Numerical, Algebraic* by Finney, Thomas, Demana, and Waits. The secondary textbook is *Calculus: Graphical, Numerical, Algebraic: AP Edition* Finney, Demana, Waits, and Kennedy. Every student is issued both textbooks. The second text is used mostly for slope fields. I also provide supplements from other texts.

Each student in the class has two calculators, a TI-89 and a TI-83+. Most students own one and our school loans the other. I encourage students to use both. With each new concept, I teach the students how to use graphing calculators to help solve problems and to interpret results. We use the TI-83+ and the TI-89 daily. I encourage students to share their discoveries with the rest of the class and me. Frequently, students come up with a more efficient way to solve problems or display graphs on their TI-89's than the way I teach them. Knowing when it is appropriate to use the calculator and when an analytical approach would be the better choice is taught with the introduction of each new topic. To this effect, tests, quizzes and homework all contain some problems to be done without the use of a graphing calculator.

In AP Calculus AB, students are given the opportunity to work with functions represented in a variety of ways -- graphically, numerically, analytically, and verbally. With each new concept, I demonstrate the connections among these representations. Sometimes students must demonstrate their understanding of these connections by writing sentences in their homework. This is especially true when the homework assignment includes free response problems from previous years. At other times, students are asked to verbalize their understanding in front of the class. Occasionally, students are given a homework packet of twenty to 25 problems, and each student is responsible for presenting the solution of one particular problem to the class.

To further facilitate students' verbalization and writing skills, students will frequently be asked to post to a class blog. The purpose of the blog is to have students creating an open forum to discuss topics and particular problems. I believe it is important for the students to have an opportunity to think more deeply about the concepts that we are learning and use correct mathematical vocabulary in their discussions.

In a course of this nature, it is important to establish the ground rules for students working together. In class, I encourage students to work together in groups of three or four, and to help each other. Outside of class, I ask that students call each other on the phone to discuss homework problems. The temptation to copy is minimized that way. I emphasize the importance of learning and stress that the value of the course is in the education received, not the letter grade given. Students are encouraged to come to me for help. I give them my e-mail address and they may contact me at any time. They are permitted to get help from other sources, as well.

Teacher Resources

Primary Textbook:

Finney, Ross L., George B. Thomas, Franklin D. Demana, and Bert K. Waits. *Calculus: Graphical, Numerical, Algebraic.* Reading, MA: Addison Wesley.

Secondary Textbook:

Finney, Ross L., Franklin D. Demana, Bert K. Waits, and Daniel Kennedy. *Calculus: Graphical, Numerical, Algebraic: AP Edition* Menlo Park: Scott-Foresman Addison-Wesley.

Other texts used :

Ellis-Gulick *Calculus with Analytic Geometry*. Harcourt, Brace Jovanovich.

Foerster, Paul A. *Calculus: Concepts and Applications*. Emeryville, CA: Key Curriculum Press.

Hughes-Hallet, Deborah, et al. *Calculus: Single Variable*. New York: John Wiley & Sons.

Larson, Ron, Robert P. Hostetler, and Bruce H. Edwards. *Calculus I with Precalculus*. Boston: Houghton Mifflin.

Ostebee, Arnold, and Paul Zorn. *Calculus from Graphical, Numerical, and Symbolic Points of View*. Boston: Houghton Mifflin.

Stewart, James. *Single Variable Calculus: Concepts and Contexts*. Belmont, CA: Brookes/Cole.

Technology Resources:

Beckmann, Charlene E., and Theodore A. Sundstrom. *Exploring Calculus With a Graphing Calculator*. Reading MA: Addison-Wesley.

Fischbeck, Sally E. *The TI-89, A Graphing Calculator with Computer Algebra, Tips for TI-83 Users*. Texas Instuments. http://education.ti.com./us/product/tech/89/down/tips.html

Equation Plotter, http://mathplotter.lawrenceville.org/mathplotter

Geometer's SketchPad software, Key Curriculum Press, site license

The students and I also rely heavily on the TI-83+ and TI-89 manuals provided with the calculators.

Video Resources:

Theorem of the Mean Policeman
MAA CALCULUS FILM PROJECT–Volume 1: *A Function is a Mapping, Continuity of Mappings, Limit, I Maximize, Theorem of the Mean Policeman / Mathematical Association of America*

Course Planner

The following is an outline of the topics I cover. The timeline is only a guideline. Some classes need more time on a particular topic. There is time at the end of Chapter 8 to make adjustments in the schedule. I did not include the days spent on tests and quizzes and on tying concepts together.

Section	Topics	Timeline
A1	'Rule of four'; piecewise functions; review common trig values	1 day
A2	Library of basic functions; symmetry; domain, range	1 day
A3	Graphing transformations	1 day
A4	Synthetic division; roots of equation; composite functions	1 day
A5	Inverses; trig identities; algebra of exponentials & logarithms	1 day
A6	Interpreting graphs	1 day
2.1	Limits (definition, left- and right-hand); finding intuitively & algebraically, estimating from graphs/tables	3 days
2.2	Continuity (intuitive understanding, definition, in terms of limits, test for, types of discontinuities, composites)	2 days
2.2	Continuity (Intermediate Value Thm., Extreme Value Thm.)	2 days

2.3	Sandwich Thm., (sin theta / theta)	1 day
2.4	Limits involving infinity and end behavior models	2 days
2.5	Controlling function output values, using absolute values	2 days
3.1	Slopes and derivatives; limit of difference quotient; relationship between differentiability and continuity	2 days
3.2	Numerical derivatives; rates of change; derivative at a point & derivative as a function; how to do both on calculator	2 days
3.3	Differentiation rules	2 days
3.3	Derivative as a rate of change; s(t), v(t), & a(t); higher derivatives	2 days
3.4	Average & instantaneous velocity	2 days
3.5	Trigonometric derivatives	2 days
3.6	Chain rule; composite functions & chain rule	3 days
3.7	Implicit functions & implicit differentiation, fractional powers	3 days
	Derivatives of basic functions, basic rules of differentiation (sum, product, quotient, chain rule) & misc. applications of the derivative	2 days
3.8	Linear approximation and differentials	2 days
4.1	First Derivative Thm., Rolle's Thm., maxima, minima;	2 days
4.1	Mean Value Thm.	2 days
4.2	Using derivatives to graph functions	2 days
4.3	Polynomial functions; Newton's Method	2 days
4.3	Optimization	3 days
4.4	Rational functions; economic applications	1 day
4.5	Radical and transcendental functions	2 days
4.6	Related rates of change	3 days
	Curve sketching; local/absolute maxima/minima, critical pts., concavity, pts.of inflection, second derivative test for concavity, asymptotes in terms of graph; relationship between f and f'; monotonicity and concavity	2 days
4.7	Antiderivatives, initial value problems	2 days
	Mathematical modeling	1 day
5.1	Calculus and area; RAM, LRAM, RRAM, MRAM	2 days
5.2	Riemann sums, setting up and representing limit as a definite integral	2 days
5.3	Definite integrals and antiderivatives; definite integral of rate of change of quantity = change of quantity over interval	2 days
5.3	Mean Value Theorem, concept of average value of function-intuitively & with formula	
5.4	Fundamental Theorem Of Calculus	3 days
5.5	Indefinite integrals	2 days
5.6	Integration by substitution, changing the bounds	2 days
5.7	Trapezoid Rule; Simpson's Rule	2 days
6.1	Areas between curves	3 days
6.2	Volumes of solids of revolution-disks, washers	3 days
6.3	Volumes of solids of revolution- shells	1 day
6.9	Volume of solid with known cross sections	2 days
6.4	Arc length	2 days

6.5	Surface area	2 days
6.6	Work problems	3 days
6.7	Fluid pressures and fluid forces	2 days
6.8	Centers of mass	2 days
	Distance traveled by a particle along a line; also by using parametric equations	2 day
	Misc. applications of the integral	3 days
7.1	Natural logarithm function	2 days
7.2	Exponential function	1 day
7.2	Exponential function; inverse functions and derivatives	2 days
7.2	Applications of Exponential functions; cooling, growth & decay, continuously compounded interest	1 day
7.3	Other exponential & log functions	2 days
7.4	Law of exponential change	1 day
7.5	Indeterminate forms & L'Hopital's Rule	2 days
7.6	Growth rates of functions; relative magnitudes of functions	1 day
7.7	Inverse trig functions	1 day
7.8	Derivatives of Inverse trig functions	1 day
	Comparing F, f, f', f'' & what each tells about the other	2 days
	Slope fields	3 days
8.1	Formulas for elementary integrals	2 days
8.2	Integration by parts	2 days
8.7	Separable differential equations	2 days

Objectives / Teaching Strategies

Chapter 1:

- Review the prerequisite topics essential for learning calculus including: basic functions, regression, domain & range, and roots
- Review trigonometric, exponential, logarithmic, and piece-wise functions
- Review geometric transformations of a graph.
- Review parametric equations and parametrization of a function.

Students will complete exercises during their summer break and will prepare to be assessed on the topics during the first week of school. Students will need to come in on their own time to go over some topics. A few topics will be reviewed during the first couple of days of school.

Chapter 2:

- Students will be able to determine limits of a graph in terms of end behavior by an analytical approach with horizontal asymptotes, a graphical approach, and a numerical approach with our calculator's table of values.

- Students will determine two-sided and one-sided limits at a given point by using the graph, algebraically, and using a table of values.
- Students will gain an understanding of the concept of continuity and apply the definition using limits to check for continuity.
- Students will learn the implications of continuity: The Intermediate Value Theorem and the Extreme Value Theorem.

One of the major topics of this chapter that we will be exploring is limits. We will balance the theoretical concept (analytical) with a numeric and graphical approach. We will use the table of our graphing calculator to examine left-handed and right-handed limits of a function at particular values. We will examine the limits of a graph at point, infinite, and jump discontinuities. Our discussion about limits will lead us to examining continuity.

Chapter 3:

- Students will have an intuitive understanding of the concept of the derivative as the instantaneous rate of change of a curve (numerically) and as the slope of the tangent line at a given point (graphically).
- Students will examine the relationship between continuity and differentiability.
- Students will determine numerical derivatives analytically and using their graphing calculator.
- Students will compare the graphs of f with f' and see how particular characteristics of one graph affects the other.
- Students will learn the rules for differentiation: constant function, powers of x, constant multiple, sums, product rule, and quotient rule.
- Students will apply derivatives to problems involving velocity and other rates of change.
- Students will learn the rules for differentiating trigonometric, logarithmic, and exponential functions.
- Students will apply the chain rule to determine the derivative of a function.
- Students will apply the technique of implicit differentiation when appropriate.

Students will create a dynamic Geometer's SketchPad lesson to help them visualize the derivative as the slope of the tangent line. They will graph various functions and draw the tangent line through a point that they can drag along the function. We then can examine the values of the derivative at various places along the curve such as relative maximums, minimums, and points of inflection. We will be constantly switching between a numeric model and graphical model.

Chapter 4:

- Students will use derivatives to determine local and absolute extrema.

- Students will examine the geometric implications of the Mean Value Theorem.
- Students will analyze the relationships between f, f', and f" to find critical points and behavior of a function including relative max/min, points of inflection, and concavity.
- Students will model optimization problems and determine the maximum/minimum by using the derivative.
- Students will model and solve related rate problems.

Students will be asked to approximate the derivative of a function at a point. We will display a graph from our calculator on the SmartBoard. Students will estimate the derivative at various points and we will plot the graph of f'. One activity will pass out a graph of a function to each student and the students must find another student so that they match the function with the graph of the function's derivative. We will also use Geometer's SketchPad to set up visual models for related rate problems. Examining the relationships of a related rate problem with visual representations seems to help the students solve these types of problems.

Chapter 5:

- Students will approximate area under a curve using the various rectangular approximation methods and the Trapezoid Rule.
- Students will have an intuitive understanding of Riemann sums as it relates to the definition of the definite integral.
- Students will apply definite integrals to determine the area under a curve over a specific interval.
- Students will use their calculators to determine numerical values for definite integrals.
- Students will learn the Rules for Definite Integrals including: constant multiples, sums and differences, interval addition, and max-min.
- Students will use properties of indefinite integrals to determine analytically the antiderivative of a function.
- Students will use the Fundamental Theorem of Calculus to evaluate definite integrals, they will use the numerical integral on their calculator to check their work.
- Students will determine indefinite integrals by using the substitution method (including changing limits of integration).

The concepts of Riemann Sums, Simpson's Rule, and the Trapezoid Rule will be reinforced with an applet to help students visualize and compare the methods. http://www.math.ucla.edu/~ronmiech/Java_Applets/Riemann/. We will spend quite a bit of time comparing the analytical concept of the definite integral with the graphical representation and the numerical results given by our calculators. Students will be called upon to demonstrate various problems to their classmates involving the rules of antidifferentiation and integration by substitution.

Chapter 6:

- Students will be able to determine the area between curves numerically using Riemann sums and analytically using integrals.
- Students will be able to visualize and sketch solids of revolution.
- Students will determine the volumes of solids of revolution by using the techniques of slicing and shells.
- Students will determine surface areas for solids.
- Students will integrate various functions (velocity, consumption, and work) to determine net change.

To help students visualize the solids of rotation, we will use the Equation Plotter website (http://mathplotter.lawrenceville.org/mathplotter). This site allows us to project the solids on the SmartBoard and interact with them. Solids of revolution is can be a difficult concept for students. I will often have a student present their solution to facilitate discussion.

Chapter 7:

- Students will compare the F, f, f' for exponential and logarithmic functions.
- Students will model exponential growth with differential equations and solve.
- Students will apply L'Hopital's Rule to evaluate indeterminate forms of a function.
- Students will explore the rates at which functions grow.
- Students will graph the inverse trigonometric functions and evaluate expressions involving them.

We will analyze the numerical values of exponential functions and its derivative and integral. We will primarily use our graphing calculators for this analysis. Our exploration of exponential functions will lead to discussion about the properties of e^x and ln x. When solving differential equations involving exponential growth, students will integrate and then solve the resulting exponential both algebraically and graphically.

Slope Fields:

- Students will analyze the relationship between slope fields and the solution curve for differential equations.
- Students will be able to calculate the value of the slope at a point in the coordinate plane and put a segment representing that slope on the graph.

Functions will be projected onto the SmartBoard. Students will take turns putting segments on the grid to indicate calculated slope at that value. To help students visualize slope fields we will explore the following applet: http://www.batesville.k12.in.us/Physics/CalcNet/diff_eqn/euler_applet.htm

Chapter 8:

- Students will be able to use the technique of integration by parts to integrate appropriate functions analytically.
- Students will support the technique of integration by parts by determining the definite integral numerically.
- Students will use trigonometric substitutions to determine appropriate integrals.
- Students will solve differential equations for which the variables can be separated.

After discussing integration by parts, I will show the following website: http://archives.math.utk.edu/visual.calculus/4/int_by_parts.3/ . This site uses flash files to help students practice the integration by parts algorithm.

Student Evaluation

Quarter grades are based on homework, tests, quizzes and class work. Credit for homework is based mostly on effort. Occasionally, correct answers are required for credit. On the average, students are expected to spend 60-90 minutes per day doing homework. During the summer preceding the course, students solve selected problems from the first chapter of the textbook. The topics are mostly review from Pre-Calculus. This assignment has the same weight as a chapter test. Beginning in January, students are given sets of mock AP Exam problems (some multiple choice, some free response) and have one week to complete the assignment. The tests and semester exams are written in the format of the AP Exams as often as possible. Students are usually permitted to help each other and are encouraged to come to me for help. They may get help from other sources, as well.

Quarter grades are based on homework, tests and quizzes. Each quarter grade represents 40% of the semester grade. The semester exam represents 20% of the semester grade. AP Calculus AB is a yearlong course in our school and a student must complete both semesters and earn at least a ‘C’ to get the weighted credit for his/her GPA. Our school gives one extra point for AP course grades. (An ‘A’ is worth 5 points in figuring the student’s GPA.)