ADVANCED PLACEMENT CALCULUS (BC)

Description: This course is intended for students who have a thorough knowledge of algebra, geometry, trigonometry and elementary functions. The purpose of the course is to prepare the student for advanced placement into college calculus. The content of the course is driven by The College Board Advanced Placement Course Development Syllabus. Students are required to have completed an Honors Pre Calculus class. Exceptions, on a case by case, may be made for exceptionally motivated students who have completed a PreCalculus course with a grade of at least A.

During the first semester, the class meets four times per week. Three of these class meetings are 45 minutes; the fourth meeting is 70 minutes long. During the second semester, the class meets twice per day. In addition to the time periods in the first semester, an additional three 45-minute lab periods and one 70-minute lab period are included. During the lab periods, the class examines previous AP Calculus BC questions and their solutions. Students work on the problems themselves. Then, the class discusses approaches and acceptable responses to these problems. Difficulties and/or misunderstandings are addressed.

Students are required to complete a summer reading and problem solution assignment prior to admission into the course. The assignment is due on the first day of class in September. The graphing calculator is used extensively throughout the course while a balanced approach of graphical, numerical and algebraic methods is stressed. Problem solving is introduced early and integrated throughout the course as connections to other topical areas are made through practical applications. Models and technology are used when appropriate. Throughout the course, students are encouraged to use the language and symbology of mathematics.

Student Summer Preparation: During the summer preceding enrollment in AP Calculus BC, students are required to read The Idiot's Guide to Calculus, listed below, and to complete the problems in the first eleven chapters. These chapters introduce limits; continuity, including one-sided limits; the ideas of a derivative and differentiability; and the limit definition

$$f'(x) = \lim_{\Delta x \to 0} \frac{f(x+\Delta x) - f(x)}{\Delta x}$$

Daily Schedule: Quizzes are held every day. The quizzes are modeled after the multiple choice questions on the AP Calculus BC Exam, although they are frequently presented in "calculation form" with no answer choices given. The quizzes are presented in a form which resembles the AP Calculus BC Exam, to ensure that the students are accustomed to the Exam format. Daily quizzes last 5-10 minutes and are completed in lead pencil. At the completion of each quiz, students use a pen or colored lead pencil to mark their papers. We review the quizzes immediately and questions are answered. The class discusses any errors they have made so we can all learn from each other. Students submit their work and I give the solutions to the day's quiz with the solutions worked out step-by-step, printed on blue paper, to each student. Students are advised to keep a file of their "blue sheets" to use in preparation for the AP Calculus BC Exam.

Technology:

a. Each student is expected to have a TI-83, TI-84 or TI-89 series calculator and is required to bring the calculator to class every day.
b. I use the TI-Presenter to display my graphing calculator on the classroom television screen. I use wet-erase colored markers to write on the television screen to accentuate tangency, limits, cusps, functional behavior at infinity, etc.
c. I use a Smart Board to review old AP exam questions, solutions and rubrics.

Objectives: The student will be able to:

- Define and apply the properties of limits of functions
- Define continuity and determine where a function is continuous and discontinuous
- Find the derivative of an algebraic function by using the definition of a derivative
- Understand the relationship between continuity and differentiability
- Apply formulas to find the derivative of algebraic, trigonometric, exponential, and logarithmic functions and their inverses
- Apply formulas to find the derivative of the sum, product, quotient, inverse and composite (chain rule) of elementary functions
- Find the derivative of an implicitly defined function
- Use the first and second derivative to analyze graphs of functions and know the corresponding $f(x)$, $f'(x)$ and $f''(x)$,
- Apply the derivative to solve problems, including: tangent and normal lines to a curve; curve sketching; motion; related rates of change; linear approximations; differentials; and, optimization problems
- Find then indefinite integral of algebraic, exponential, logarithmic, and trigonometric functions
- Understand, interpret and generate slope fields for a family of functions.
- Understand the properties of the definite integral, including: the definite integral as an area and as a limit of Riemann sums and the Fundamental Theorem of Calculus
- Compute an approximate value for a definite integral by using Riemann sums, the Trapezoid Rule, and, Simpson's Rule
- Apply the definite integral to solve problems including motion problems with initial conditions; the average value of a function; area between curves; volumes of solids of revolution about the axes or about lines parallel to the axes using disk method and washer method; volumes of solids with known cross-sections, areas, growth and decay problems; and, solutions of separable differential equations

Course Content:

A. Chapter 1: Limits and Their Properties. Students begin Calculus with an intense study of limits and continuity. On the first day, I introduce the concept of limits by discussing running a mile. Not long ago, it was thought that no human could break the 4 minute mark. Running the mile in 2 minutes is presumably impossible. 3:50 is possible. Somewhere in between is the true limit. Then I ask the students if they would pay \$1 for a raffle ticket for a \$1000 prize. Would they pay \$2? Would they pay \$5? Some students have different limits than others. Eventually, we get to an amount which no one is willing to pay. During the first week, I use the TI-Presenter to display a function with a removable discontinuity at $x = 1$. From the standard window $[-4 \le x \le 4],[-3 \le y \le 3]$, the discontinuity is not discernible and a novice may conclude incorrectly from the graph that the function is continuous at $x = 1$. However, when I set the window limits for x as $[0.99 \le x \le 1.01]$, the "hole" in the function at $x = 1$ becomes clearly visible and I generally hear a collective "Ahhhhhh!" from the class. The students learn two important lessons: (1) the calculator has its limitations and calculator graphs cannot be accepted carte blanche; and, (2) it is important to combine the graphic, numerical and analytic approaches to finding limit and assess continuity. I follow up the first example with a discussion of the continuity of the function $f(x) = \dfrac{(x-1)^2(x-2)}{(x-1)(x-2)(x-3)}$. First, the class uses an analytical approach to determine function behavior at $x = 1$, $x = 2$, $x = 3$. Then, we investigate the graph of the function to confirm our conclusions. The student's learn to discern between removable and non-removable discontinuities, both graphically and analytically. Chapter 1 topics include:

1. A Preview of Calculus
   a. Understand what Calculus is and how it compares to PreCalculus
   b. Understand that the tangent line problem is basic to Calculus
   c. Understand that the area problem is also basic to Calculus
2. Finding Limits Graphically and Numerically
   a. Estimate a limit using a numerical approach
   b. Estimate a limit using a graphical approach
   c. Learn different ways in which a limit can fail to exist
3. Evaluating Limits Analytically
   a. Evaluate a limit using properties of limits
   b. Develop and use a strategy for finding limits
   c. Evaluate a limit using dividing out and rationalizing techniques
   d. Evaluate a limit using the Squeeze Theorem
4. Continuity and One-Sided Limits
   a. Determine continuity at a point and continuity on an open interval
   b. Determine one-sided limits and continuity on a closed interval
   c. Use properties of limits
   d. Understand and use the Intermediate Value Theorem
5. Infinite Limits
   a. Determine infinite limits from the left and from the right
   b. Find and sketch the vertical asymptotes of the graph of a function

The Chapter 1 Project is an analysis of trigonometric functions: $\sin x$, $\cos x$, $\tan x$ and $\dfrac{\sin x}{x}$.

B. <u>Chapter 2: Differentiation</u>. The meaning and rules for calculation of derivatives are explored. As the first step in problem solution, I ask the students to translate verbal descriptions, such as "the ladder is falling down the wall at a rate of 2 feet per sec" into calculus format, i.e.,

$\frac{dy}{dx}$ = 2 ft/sec. Students are required to include units of measurement in all calculations. An "ah-ha" moment occurs when I graph $f(x)=sin\ x$ on the interval $[-2\pi \le x \le 2\pi]$] on the television screen, using TI-Presenter. At multiples of $\frac{\pi}{6}$ and $\frac{\pi}{4}$, I ask my students to approximate visually the slope of the tangent line to the graph of $f(x)=sin\ x$. On the same screen, I then plot the values of the slopes they give me. When we have sufficient points plotted, I turn off the function and all which is remaining is the graph of the derivative, which they recognize as the graph of $f(x)=cos\,x$. I then graph the function $f(x)=cos\,x$, and go through the same process. Of course, this time the derivative is the graph of $f(x)=-sin\,x$. I have found this to be a very helpful exercise in getting the students to truly comprehend this relationship between $f(x)=sin\ x$ and $f(x)=cos\,x$. Chapter 2 topics include:

1. The Derivative and the Tangent Line Problem
    a. Find the slope of the tangent line to a curve at a point
    b. Use the limit definition to find the derivative of a function
    c. Understand the relationship between differentiability and continuity
2. Basic Differentiation Rules
    a. Find the derivative of a function using the Constant Rule
    b. Find the derivative of a function using the Power Rule
    c. Find the derivative of a function using the Constant Multiple Rule
    d. Find the derivative of a function using the Sum and Difference Rules
    e. Find the derivative of the sine function and of the cosine function
    f. Use derivatives to find rates of change
3. The Product Rule and the Quotient Rule
    a. Find the derivative of a function using the Product Rule
    b. Find the derivative of a function using the Quotient Rule
    c. Find the derivative of a trigonometric function
    d. Find a higher-order derivative of a function
4. The Chain Rule
    a. Find the derivative of a composite function using the Chain Rule
    b. Find the derivative of a function using the General Power Rule
    c. Simplify the derivative of a function using algebra
    d. Find the derivative of a trigonometric function using the Chain Rule
5. Implicit Differentiation
    a. Distinguish between functions written in implicit form and explicit form
    b. Use implicit differentiation to find the derivative of a function
6. Related Rates
    a. Find a related rate
    b. Use related rates to solve real-life problems

The Chapter 2 Project is a study of optical illusions created by families of curves. We find *dy/dx* at different values of *x*, and students discuss the relationship between *dy/dx* and the visual illusions we perceive.

C. Chapter 3: Applications of Differentiation. The applications of differentiation are studied. As a reinforcement of the relationship among $f(x)$, $f'(x)$ and $f''(x)$, on 3" x 3" pieces of paper, I print 2 dozen graphs, e.g., $\sin x$, $2\sin x$, $\cos 2x$, x^2, x^3, e^x, $\ln x$, $\frac{1}{x}$, $\sqrt{x}$, etc. I also print graphs of the first and second derivatives of these functions. The pieces of paper are all mixed up and the class, as a team, must match all the three graph sets, without knowing which are the original functions and which are the derivatives. They use tape to affix the graphs to the wall; the graphs can easily be moved if the students change their minds. This is a great exercise in working collaboratively, in meshing graphic and algebraic approaches to function analysis, in presenting mathematical arguments to persuade classmates, and, in using curve characteristics to distinguish between similar looking functions, such as $\ln x$ and $\sqrt{x}$. Chapter 3 topics include:

1. Extrema on an Interval
   a. Understand the definition of extrema of a function on an interval
   b. Understand the definition of relative extrema of a function on an open interval
   c. Find extrema on a closed interval
2. Rolle's Theorem and the Mean Value Theorem
   a. Understand and use Rolle's Theorem
   b. Understand and use the Mean Value Theorem
3. Increasing and Decreasing Functions and the First Derivative Test
   a. Determine the intervals on which a function is increasing or decreasing
   b. Apply the First Derivative Test to find relative extrema of a function
4. Concavity and the Second Derivative Test
   a. Determine the intervals on which a function is concave up or concave down
   b. Find any points of inflection of a graph of a function
   c. Apply the Second Derivative Test to find relative extrema of a function
5. Limits at Infinity
   a. Determine finite limits at infinity
   b. Determine the horizontal asymptotes, if any, of the graph of a function
   c. Determine infinite limits at infinity
6. Curve Sketching
   Analyze and sketch the graph of a function, using the following concepts: *x*-intercepts(s), *y*-intercept, symmetry, domain, range, continuity, differentiability, vertical and horizontal asymptotes, relative extrema, concavity, points of inflection, and infinite limits at infinity
7. Optimization
   Solve applied optimization problems, including maximum volume, endpoint maxima, minimum distance, minimum area and minimum length.
8. Differentials
   a. Understand the concept of a tangent line approximation
   b. Compare the value of the differential, dy, with the actual change in Δy.
   c. Estimate a propagated error using a differential
   d. Find the differential of a function using differentiation formulas

In Chapter 3, we have two chapter projects. The first is introduced after we have studied increasing and decreasing functions and before we study concavity. The class analyzes the Law of Refraction in relationship to rainbow angles. We find the minimum angle of deflection for angle α. The second project is introduced after optimization problems and before the study of differentials. The project concerns the water levels of the Connecticut River. We study a graph of the rate of change in feet per day versus time. From this, we ascertain when the river is rising most rapidly, when the river crested at the highest level, etc. The students are reminded that the graph is of the rate of change, not the water level.

D. Chapter 4: Integration. Students progress to Integral Calculus. The chapter project strengthens the learning of abstract concepts by demonstrating the Fundamental Theorem. We spend several days investigating Riemann sums, determining how to write the function in terms of i for $\sum_{i=1}^{n} f(x_i)\Delta x_i$, and comparing left endpoint sums, right endpoint sums and mid-point sums. Students compare the sums for different values of n and determine how well the Riemann sums perform as predictors of area. Chapter 4 topics include:

1. Antiderivatives and Indefinite Integration
   a. Write the general solution of a differential equation
   b. Use indefinite integral notation for Antiderivatives
   c. Use basic integration rules to find Antiderivatives
   d. Find a particular solution of a differential equation
2. Area
   a. Use sigma notation to write and evaluate a sum
   b. Understand the concept of area under the curve.
   c. Approximate the area of a plane region using upper sums, midpoint sums and lower sums
   d. Find the area of a plane region using limits
3. Riemann Sums and Definitive Integrals
   a. Understand the definition of a Riemann sum
   b. Evaluate a definite integral using limits
   c. Evaluate a definite integral using properties of definite integrals
4. The Fundamental Theorem of Calculus
   a. Evaluate a definite integral using the Fundamental Theorem of Calculus
   b. Understand and use the Mean Value Theorem for Integrals
   c. Find the average value of a function over a closed interval
   d. Understand and use the Second Fundamental Theorem of Calculus
5. Integration by Substitution
   a. Use pattern recognition to find an indefinite integral of a composite function
   b. Use a change of variables to find an indefinite integral
   c. Use the general Power Rule for Integration to find an indefinite integral
   d. Use a change of variables to evaluate a definite integral
   e. Evaluate a definite integral involving an even or odd function
6. Numerical Integration
   a. Approximate a definite integral using the Trapezoid Rule
   b. Approximate a definite integral using Simpson's Rule

   c. Analyze and approximate errors in the Trapezoid Rule and Simpson's Rule

The Chapter 4 Project focuses on demonstrating the Fundamental Theorem of Calculus. Using $F(x) = \int_0^x \sin^2 t \; dt$, we use a numerical approach to calculating the value at various values of *x*, from 0 to π. We use the integration capabilities of the graphing calculator to graph *F(x).* We then use the differentiation capabilities to graph *F'(x).* This is followed by a discussion of how the two are related and why.

E. <u>Chapter 5: Logarithmic, Exponential, and Other Transcendental Functions</u>. Students build on their basic knowledge on integration and advance to the integration of more complex functions. At this point, I begin regularly giving the class a free response question from a previous AP Exam. They work independently for 10-15 minutes. Then, we compare solutions and methodology. This exercise gets the students thinking about not only justifying their calculations, but also justifying their logic for the methodology they used. Students thrive on helping each other and learning from each others' errors. Sometimes, I will allow 10-15 minutes for independent work. Then, I have the students switch papers. I show the grading rubric on the Smart Board. We go through each step of the solution step by step and the students grade each other's papers according to the rubric. Students learn an incredible amount and gain confidence from each other in these exercises. Chapter 5 topics include:

1. Differentiation of the Natural Logarithmic Function
   a. Develop and use properties of the natural logarithmic function
   b. Understand the definition of the number e
   c. Find derivatives of functions involving the natural logarithmic function
2. Integration of the Natural Logarithmic Function
   a. Use the Log Rule for Integration to integrate a rational function
   b. Integrate trigonometric functions
3. Inverse Functions
   a. Verify that one function is the inverse function of another function
   b. Determine whether a function has an inverse function
   c. Find the derivative of an inverse function
4. Differentiation and Integration of Exponential Functions
   a. Develop properties of the natural exponential function
   b. Differentiate natural exponential functions
   c. Integrate natural exponential functions
5. Bases Other than e and Applications
   a. Define exponential functions which have bases other than e
   b. Differentiate and integrate exponential functions which have bases other than *e*
   c. Use exponential functions to model compound interest and exponential growth
6. Differentiation and Integration of the Inverse Trigonometric Functions
   a. Develop properties of the six inverse trigonometric functions
   b. Differentiate inverse trigonometric functions
   c. Understand and apply the basic differentiation rules for elementary functions
   d. Integrate functions whose Antiderivatives involve inverse trigonometric functions
   e. Use the method of completing the square to integrate a function

f. Understand and apply the basic integration rules involving electuary functions

The Chapter 5 Project is introduced after we study differentiation and integration of exponential and logarithmic functions with bases other than *e*. The students use graphing utilities to estimate slope. Using the piecewise function $f(x)=\begin{cases} |x|, & x\neq 0 \\ 1, & x=0 \end{cases}$, we investigate why the formula $\dfrac{f(x+\Delta x)-f(x-\Delta x)}{2\Delta x}$ can be used to approximate the derivative. Students again see that the calculator does have limitations and they realize that relying on the calculator without analytical thinking can easily lead to approximating the slope of a graph incorrectly..

F. Chapter 6: Differential Equations. Students proceed to Differential Equations. As an activity, the class completes the Slope Field packet from the AP Calculus course web site. For a second activity, on the television screen, using TI Presenter, I graph a family of functions in the form $f(x)+C$. Each student is given a value of *x* for which she/he calculates the slope of the tangent line. Each student then draws a small slope line segment for the tangent line on each of the functions. We then erase the functions and are able to view our slope The slope field handout from the AP Calculus course website is used. Chapter 6 topics include:

1. Slope Fields and Euler's Method
   a. use initial conditions to find particular solutions of differential equation
   b. use slope fields to approximate solutions of differential equations
   c. use Euler's Method to approximate solutions of differential equations
2. Differential Equations: Growth and Decay
   a. Use separation of variables to solve simple differential equations
   b. Use exponential functions to model growth and decay in applied problems
3. Separation of Variables and the Logistic Equation
   a. Recognize and solve differential equations which can be solved by separation of variables
   b. Recognize and solve homogenous differential equations
   c. Use differential equations to model and solve applied problems
   d. Solve and analyze logistic differential equations
4. First-Order Linear Differential Equations
   a. Solve first-order linear differential equations
   b. Solve a Bernoulli differential equation
   c. Use linear differential equations to solve applied problems

In the Chapter 6 Project, student's are given a differential equation which models weight loss based on weight, calorie consumption and time. We find the general solution for the differential equation and then work on particular solutions given original conditions of a person's weight and caloric intake. We then graph the solutions and try to ascertain the "limiting" weight of a person. We also determine time required for a desired amount of weight loss. We complete this process for several fictitious people.

G. Chapter 7: Applications of Integration. Students proceed to applications of integration. Before calculating volumes of solids with known cross sections, we work in teams and use PlayDough, small plastic rulers and “invisible” thread. My students are given the equation of a triangle or semicircle, and are instructed to form a solid such that every cross section which is perpendicular to the base is a semicircle or an equilateral triangle. We use the invisible thread to cut the cross sections to show that the desired shape of the cross sections has been achieved. Teams complete several constructions. This 3-dimensional, “hands-on” exercise gives the students a thorough understanding of the concept which they cannot get from the textbook, even though the textbook images are quite good. Also, the competitive spirit of these students usually emerges in full force during this exercise. Chapter 7 topics include:

1. Area of a Region between Two Curves
   a. Find the area of a region between two curves using integration
   b. Find the area of a region between intersecting curves using integration
   c. Describe integration as an accumulation process
2. Volume: Disk Method
   a. Find the volume of a solid of revolution using disk method
   b. Find the volume of a solid of revolution using the washer method
   c. Find the volume of a solid with known cross sections
3. Arc length of functions in the form $y = f(x)$ and $x = g(y)$, and parametrically defined curves

For the Chapter 7 project, students are put into groups of three and each group is given a large plain bagel. We assume that the shape of the bagel and the center hole are concentric circles. The shape of the bagels are assumed to be disks with height equal to one inch. The students may place the disk (bagel) anywhere on the coordinate axes and choose an axis of rotation. Their goal is to decide the equations, which when rotated around an axis, will produce the 3-dimensional shape of the disk (bagel). Once they have their equations and axis of rotation, they use integration to determine the volume of the bagel. Groups also receive on sheet of construction paper. They use the paper to construct a rectangular box without a lid. The volume must be the same as the volume found for the bagel. The bagel is then torn into small pieces and placed in the box. No stretching or squishing of the bagel pieces is permitted. If their integral is correct, the pieces of the bagel should fit into the box perfectly. This is a fun project which the students always enjoy. At this point in the course, they need some fun. During the project, edible bagels are also provided. ☺

H. Chapter 8: Integration Techniques, L’Hopital’s Rule, and Improper Integrals. Students study techniques to evaluate more complicated integrals. Students also learn L’Hopital’s Rule for evaluating limits. Chapter 8 topics include:

1. Basic Integration Rules:
   Review procedures for fitting an integrand to one of the basic integration rules
2. Integration by Parts
   a. Find an antiderivative using integration by parts
   b. Use a tabular method to perform integration by parts
3. Trigonometric Integrals

a. Solve trigonometric integrals involving powers of sine and cosine
b. Solve trigonometric integrals involving powers of secant and tangent
c. Solve trigonometric integrals involving powers of since-cosine products with different angles

4. Trigonometric Substitution
   a. Use trigonometric substitution to solve an integral
   b. Use integrals to model and solve real-world problems
5. Integration by Partial Fractions
   a. Understand the concept of a partial fraction decomposition
   b. Use partial fraction decomposition with linear factors to integrate rational functions
   c. Use partial fraction decomposition with quadratic factors to integrate rational functions
6. Integration by Tables and Other Integration Techniques
   a. Evaluate an indefinite integral using a table of integrals
   b. Evaluate an indefinite integral using reduction formulas
   c. Evaluate an indefinite integral involving rational functions of sine and cosine
7. Indeterminate Forms and L'Hopital's Rule
   a. Recognize limits which produce indeterminate forms
   b. Apply L'Hopital's Rule to evaluate a limit
8. Improper Integrals
   a. Evaluate an improper integral which has an infinite limit of integration
   b. Evaluate an improper integral which has an infinite discontinuity

The Chapter 8 project involves the return wave method for measuring tension in power lines.

I. <u>Chapter 9: Polynomial Approximations and Infinite Series</u>. The first part of this chapter covers infinite sequences and infinite series. The second part covers Taylor and Maclaurin polynomials and power series. Students discuss convergence and divergence or series. They find Taylor or Maclaurin polynomial approximations of elementary functions, Students discover how to find the radius and interval of convergence of a power series and how to differentiate and integrate power series. They also learn how to find a Taylor or Maclaurin series for a function. Chapter 9 topics include:

1. Sequences
   a. List the terms of a sequence
   b. Determine whether a sequence converges or diverges
   c. Write a formula for the n^{th} term of a sequence
   d. Use properties of monotonic sequences and bounded sequences
2. Series and Convergence
   a. Understand the definition of a convergent infinite series
   b. Use properties of infinite geometric series
   c. Use the n^{th}-Term Test for divergence of an infinite series
3. The Integral Test and p-Series

  a. Use the Integral Test to determine whether an infinite series converges or diverges
  b. Use properties of p-series and harmonic series

4. Comparisons of Series
   a. Use the Direct Comparison Test to determine whether a series converges or diverges
   b. Use the Limit Comparison Test to determine whether a series converges or diverges
5. Alternating Series
   a. Use the Alternating Series Test to determine whether a series converges or diverges
   b. Use the Alternating Series Remainder to approximate the sum of an alternating series
   c. Classify a convergent series as absolutely or conditionally convergent
   d. Rearrange an infinite series to obtain a different sum
6. The Ratio and Root Test
   a. Use the Ratio Root Test to determine whether a series converges or diverges
   b. Use the Root Test to determine whether a series converges or diverges
   c. Review the tests for convergence and divergence of an infinite series
7. Taylor Polynomials and Approximations
   a. Find polynomial approximations of elementary functions and compare them with the elementary functions
   b. Find Taylor and Maclaurin polynomial approximations of elementary functions
   c. Find the Lagrange form of the remainder for a Taylor polynomial
8. Power Series
   a. Understand the definition of a power series
   b. Find the radius and interval of convergence of a power series
   c. Determine the endpoint convergence of a power series
   d. Differentiate and integrate a power series.
9. Representation of Functions by Power Series
   a. Find a geometric power series which represents a function
   b. Construct a power series using series operations
10. Taylor and Maclaurin Series
    a. Find a Taylor of Maclaurin series for a function
    b. Find a binomial series
    c. Use a basic list of Taylor series to find other Taylor series
    d. Lagrange error bound for Taylor polynomials

The Chapter 9 project focuses on using grouping to establish the divergence of a harmonic series.

J. <u>Chapter 10: Conics, Parametric Equations and Polar Coordinates</u>. Students review circles, parabolas, ellipses and hyperbolas. Then, the properties of these conic sections are analyzed. Students learn to write and graph parametric equations and polar equations. Students learn how calculus is used to study these curves. They use sets of parametric equations to find the slope and tangent line to a curve and the arc length of a curve. Students also sketch graphs of equations in polar form, identify special polar graphs and find the area of a region bounded by two polar graphs. The chapter project addresses cycloids. Chapter 10 topics include:

1. Conic Sections
2. Areas of Surfaces of Revolution
3. Plane Curves and Parametric Equations
4. Parametric Equations and Calculus
   a. Slope and Tangent Lines
   b. Arc Length
5. Polar Coordinates and Polar Graphs
6. Areas and Arc Length in Polar Coordinates

The Chapter 10 Project addresses cycloids.

K. Supplemental Packet: Vectors. A supplemental packet on vector topics is provided to the students. Vector topics include:

1. Vectors in a Plane
2. Space Coordinates and Vectors in Space
3. Vector-Valued Functions
4. Differentiation and Integration of Vector-Values Functions
5. Velocity and Acceleration

The Chapter Project is an analysis of the Witch of Agnesi.

Evaluation: All students are required to participate in the nationwide AP Calculus BC exam. No other Final Exam in the course will be administered. Evaluation is based on homework, quizzes, chapter tests, projects and the midterm examination. Longer chapters will have more than one chapter test.

Text and Supplemental Materials:

1. Larson, Ron, and Hostetler, Robert P. (2010). Calculus of a Single Variable. Ninth Edition. Boston: Houghton Mifflin
2. Kelley, Michael W. (2002). The Idiot's Guide to Calculus. Indianapolis: Alpha Books
3. Supplemental packet on Vectors
4. TI-83, TI-84 or TI-89 series graphing calculator
5. Previously released AP Calculus exam questions
6. AP Calculus BC Practice Exam from apcentral.collegeboard.org
7. Supplementary books and materials
8. Graph paper
9. Lead Pencil
10. Colored Pencil (not green lead) or pen (not green ink)
11. Small ruler
12. A pencil pouch is recommended but not required.