Course Title: Advanced Placement Calculus BC (DL)

Meeting Times: This course meets for 36 weeks. Since this is a distance learning course student schedules vary, depending on their local school schedule. They either meet for 90 minutes every other day or for 45 minutes every day. Students are also expected to spend additional time outside of class on activities such as reading material and reviewing feedback as well as completing assignments.

Course Description:

AP Calculus BC provides a deeper understanding of the fundamental concepts and methods of single-variable calculus developed in AP Calculus AB. There is a continued emphasis on calculus applications and techniques, with the use of multiple representations including graphic, numeric, analytic, algebraic, and verbal and written responses. Topics of study include: functions (including parametric, polar and vector), limits, derivatives, the interpretation and application of integrals, and polynomial approximations and series. Technology is an integral part of the course and includes the use of graphing calculators, computers, and data analysis software. On a regular basis, graphing calculators are used to explore, discover, and reinforce concepts of calculus.

Though our system has an open enrollment policy, students should understand that this course is designed to be a fourth-year mathematics course and the equivalent of a year-long, college-level course in single variable calculus. The course requires a solid foundation of topics in advanced algebra, geometry, trigonometry, analytic geometry, and elementary functions. The breadth, pace, and depth of material covered exceeds the standard high school mathematics course, as does the college-level textbook, and time and effort required of students. AP Calculus BC is an extension of AP Calculus AB, and provides the equivalent of a second course in a college calculus sequence, while AP Calculus AB provides the equivalent of the first course in a college calculus sequence. Students are expected to take the AP Calculus BC Exam at the end of this course.

Course Purpose and Goals:

<u>Philosophy</u>

Understanding change is the basis of this course. The study of the concept of the derivative in calculus is the formal study of mathematical change. A key component of the course is fluency in the use of multiple representations that include graphic, numeric, analytic, algebraic, and verbal and written responses. Students build an understanding of calculus concepts as they construct relationships and make connections among the various representations. The course is more than a collection of topics; it is a coherent focused curriculum that develops a broad range of calculus concepts and a variety of methods and real-world applications. These include practical applications of integrals to model biological, physical, and economic situations. Although the development of techniques and fluency with algebraic symbolism to represent problems is important, it is not a primary focus of the course. Rather, the course emphasizes differential and integral calculus for functions of a single variable through the Fundamental Theorem of Calculus.

Technology is used to enhance students' understanding of calculus concepts and techniques. The College Board requires the use of graphing calculators for this course. Mathematical problem solving, investigations, and projects require adequate and timely access to technology including graphing calculators, databases, spreadsheets, Internet and on-line resources, and data analysis software. In this course, technology is introduced in the context of real-world problems, incorporates multiple representations, and facilitates connections among mathematics topics. Students use estimation, mental math, calculators, and paper-and-pencil techniques of calculus to conduct investigations and solve problems. According to the National Council of Teachers of Mathematics (2000), "Estimation serves as an important companion to computation. It provides a tool for judging the reasonableness of calculator, mental, and paper-and-pencil computations" (NCTM, p. 155).

The standards support the unifying themes of derivatives, integrals, limits, approximation, and applications and modeling in the course. Instruction is designed and sequenced to provide students with learning opportunities in appropriate settings. Teaching strategies include collaborative small-group work, pairs engaged in problem solving, whole-group presentations, peer-to-peer discussions, and an integration of technology when appropriate. In this course, students are often engaged in mathematical investigations that enable them to collaborative with peers in designing mathematical models to solve problems and interpret solutions. They are encouraged to talk about the mathematics of change in calculus, to use the language and symbols of calculus to communicate, and to discuss problems and methods of solution.

Goals

Students should be able to:

1. Develop an in-depth understanding of major topics of calculus including functions, limits, derivatives, integrals, and polynomial approximations and series.
2. Incorporate multiple representations of functions using graphic, numeric, analytic, algebraic, and verbal and written responses, and understand the connections among these representations.
3. Construct an understanding of derivatives as an instantaneous rate of change, applications of derivatives as functions, and use various techniques to solve problems including local approximations.
4. Understand definite integrals as a limit of Riemann sums, and as the net accumulation of sums, and use them to solve a variety of problems.
5. Develop an understanding of the Fundamental Theorem of Calculus as a relationship between derivatives and definite integrals.
6. Understand the concept of a series as a sequence of partial sums, and use the Power series and Taylor polynomial approximations and series.
7. Analyze parametric, polar, and vector functions through the use of parametric equations, polar coordinates, and derivatives and applications of these functions.
8. Use graphing calculators to problem solve, experiment with 'what if'hypotheses, display and interpret results, and justify conclusions.
9. Make sense of and determine the reasonableness of solutions.
10. Develop an appreciation for an historical perspective of calculus.

Conceptual Organization

The content and level of depth of the material for this course is equivalent to a college-level course. AP Calculus BC is an extension of AP Calculus AB, and the content is organized to emphasize major topics which include the following: (1) functions, graphs, and limits; (2) derivatives, (3) integrals, and (4) polynomial approximations and series. Building on students' prior knowledge, most of the first semester examines at a more in-depth level calculus concepts, methods, and applications from AP Calculus AB. During quarter 1, a variety of functions and their transformations are studied. Technology supports students' making connections between graphic, numeric, and algebraic representations. For example, limits and their properties are analyzed both graphically and numerically. This is followed with a focus on differentiation, applications of derivatives, and integration. In quarter 2, the sequence of topics includes differentiation and integration of trigonometric, logarithmic, and exponential functions, and applications of integration. During the second semester of the course, students broaden their understanding of calculus concepts and techniques to include the development of more integration techniques, use of L'Hopital's Rule, infinite series, and sequences. Lastly, parametric, polar, and vector functions are emphasized through the use of parametric equations, polar coordinates, and derivatives and applications of these functions.

This order of topics within the course, not only provides a logical and systemic study to calculus, but also accommodates the frequent transfer of students within the schools of the system, so that transfer students can maintain a consistent flow of learning.

Course Format and Policies:

The on-line courses have the same level of rigor and adhere to the same standards set forth by the school system and the College Board. To access the course students have access to a computer and the Internet via a web browser. The class is taught via the Blackboard Learning Management System.

To allow all students to adjust their individual school schedules to fit that of our class a chapter calendar is published prior to starting each new block of material. The calendar gives the students a guide that will ensure that they have adequate time to learn the material (lectures, activities, and examples are provided) and complete the assignments by the posted due dates. When a student is going to miss class for a scheduled trip, it is their responsibility to contact the teacher and work ahead. If a student cannot get all scheduled work in before their departure, the teacher and student will develop a plan for getting assignments in as soon as possible upon his or her return.

In any college-level course keeping pace with the class is essential to the success of the students. In a DL course this is particularly true. Thus a strict work schedule, complete with due-date late penalties and final deadlines for each chapter after which no more work will be accepted for credit, is adhered to once all students are on-line in the fall.

Throughout the course graphics are included in the on-line material to help students visualize what is happening, just as they would be given on the board, over-head, or computer screen. When a procedure is required on the calculator, the students can see what they should be doing and check their accuracy. Flash presentations and Power Point slides are also used to present material in an engaging manner. Even though the course is delivered on-line every attempt is made to accommodate different learning styles.

A section quiz, which is open-notes and self-graded, is given as a quick review before students tackle their homework. When a homework assignment is turned in (by fax or by sending scanned files), individual feedback is provided to the student. In addition, the student will then have access to group feedback that contains general observations and reminders about the assignment as well as detailed solutions and explanations for the homework problems. These documents then make excellent study guides for the tests. Extra credit problems that require more expansive thinking are included for every section of the book.

While quizzes are simply given participation points, all homework and tests are graded with attention to proper syntax, organization, and justification so that the students will learn proper habits for the AP Exam. All tests are modeled after the AP exam. There are both multiple choice and free response questions. The former are either right or wrong with no partial credit; the latter require organized work and justification for all answers and are graded on an AP point system. Part of each chapter test is no-calculator allowed and part is calculator required.

Tests are given at the end of each chapter. A mid-chapter test is given in chapter 7 to ensure that students have mastered the volumes of integration before moving on to new material that the students have not seen before. The second semester exam is given in late April and is a practice AP exam. Quarter grades are calculated as a straight percentage of student points earned out of total points possible. A traditional breakdown is used for letter grades (90-100 = A, 80-89 = B, etc.). Semester averages are a combination of the two quarter grades (40% each) and the semester exam (20%).

Once the first few chapters have been covered the students work in collaborative groups to solve old AP exam free response questions. This practice is essential to success on the AP exam because the questions they will see on the exam will not exactly mimic questions that they have done for homework assignments from the book. Each group project (GP) will be graded on participation in the on-line group discussion and the final paper that each student turns in. Discussion takes place among the students in their group in a discussion forum, where students can collaborate to find a solution to the problem. The final paper is graded on the same point scale used by the College Board and then detailed feedback is provided to the class on the solution, how points were earned, and what errors were common.

Grading Policy: Official system-wide Grading Scale: Weighted grades are calculated for students completing and taking the requisite exam of an AP course.

Unweighted Scale A=4	Weighted Scale A=5
Unweighted Scale B=3	Weighted Scale B=4
Unweighted Scale C=2	Weighted Scale C=3
Unweighted Scale D=1	Weighted Scale D=2
Unweighted Scale F=0	Weighted Scale F=1

Textbook, Materials and Other Resources:

Required Textbook

- Finney, R. L., Demana, F.D., Waits, B.K., and Kennedy, D. (2003). *Calculus: Graphical, numerical, algebraic*. Upper Saddle River, NJ: Pearson Education-Prentice Hall.

Supplemental Textbooks and Readings

- Finney, R. L., Demana, F.D., Waits, B.K., and Kennedy, D. (2003). *Advanced placement correlations and preparation for calculus: Graphical, numerical, algebraic*. Upper Saddle River, NJ: Pearson Education-Prentice Hall.
- Finney, R. L., Demana, F.D., Waits, B.K., and Kennedy, D. (2003). *Technology resources manual for calculus: Graphical, numerical, algebraic*. Upper Saddle River, NJ: Pearson Education-Prentice Hall.

Other Resources

- Computers. Each student has access to a computer with internet access at their local school during their scheduled class period. Most also have use of a computer at home. The entire course is conducted on-line. Most students also have access to a scanner or digital sender for submitting work, but a fax machine can be used if one is not available.
- Software. Students use the Microsoft Office programs for projects and for accessing lectures. QuickTime Video is used to run Flash presentations and activities. SameTime is an instant messaging program that we use for real-time communications with the students. Windows Media is required for watching video presentations and demonstrations.
- Graphing calculators are required by the AP Board. Students may use any approved model; most use the TI-83+.
  - Internet access and online resources.
    - Math Tools Website: http://www.mathforum.org/mathtools/cell.html?&new_co=c
    - Math Archives: Calculus Resources On-Line Website: http://archives.math.utk.edu/calculus/crol
    - AP Featured Question: http://apcentral.collegeboard.com/apc/members/courses/teachers_corner/23365.html
    - Slope Fields handout: http://apcentral.collegeboard.com/apc/public/repository/slopefieldhandoutapnc_11870.pdf

Course Content Outline:

Unit	Quarter	Week	Topics	Assessments
1 Prerequisites for Calculus			This chapter is assumed covered in previous courses and will not be specifically covered in the BC class. Topics include: Graphing and analyzing relations and functions; Equations of lines and applications; Properties of functions:	none

			absolute, composite, piecewise, even, odd; Logarithms; Function types: exponential, logarithmic, and trigonometric; Calculator skills: graphing equations, finding zeros	
2 Functions and Limits; Graphical and analytical analysis of limits	1	1	Rates of change; Intuitive introduction of limits; Definition of a limit; Properties of limits at a point; One-sided and two-sided limits; Sandwich Theorem; Limits related to infinity and description of asymptotic behavior; Visualizing limits with the calculator and properties of limits	HW 2-1, HW 2-2
Continuity of Functions	1	1-2	Continuous functions; Properties of continuous functions; Discontinuous functions: removable, jump, and infinite Intermediate Value Theorem for Continuous Functions	HW 2-3
Rates of Change of Functions	1	2	Comparing rates of change for different functions; Tangent and Normal lines to a curve; Slope of a curve	HW 2-4 Chapter 2 Test (more details on the tests are given in the Course Format and Policies)
3 Concept of the Derivative	1	2-3	Definition of the derivative; Using the calculator to illustrate the connection between slopes of the tangent line curve; Instantaneous rate of change;	HW 3-1, 3-2, 3-3

			Differentiability: local linearity, numerical, and relationship to continuity; Intermediate Value Theorem; Fluency with differentiation techniques: power, sums, products, and the quotients rule	
Derivatives and Functions	1	3-6	Rates of change: velocity, speed, and acceleration applications; Derivatives of functions: algebraic, trigonometric, inverse trigonometric, logarithmic, and exponential; Chain rule for composite functions; Implicit differentiation: differential and y' techniques	HW 3-4, 3-5, 3-6, 3-7, 3-8, 3-9 Chapter 3 Test
4 Applications of Derivatives	1	6-7	Extreme values of a function: absolute and relative extrema; Characteristics of increasing and decreasing functions; Mean Value theorem and Rolle's theorem; Analysis of graphs using 1^{st} and 2^{nd} derivatives, graphically and with derivatives; Relative and absolute maxima and minima; Concavity and points of inflection; Using the calculator to get a numerical value of the derivative of a function at a point.	HW 4-1, 4-2, 4-3
Business and Industry Applications	1	7-8	Optimization problems; Linearization models; Modeling related rates problems	HW 4-4, 4-5, 4-6 Chapter 4 Test

5 Definite Integral: Approximating Areas	1	8-9	Areas under curves; Riemann Sums: partition and subintervals; Trapezoidal Rule; Definite Integrals; Integration terminology and notation	Collaborative Activity: small groups working together to solve old AP free response questions over derivatives (more details on these in Course Format and Policies) HW 5-1, 5-2, 5-5
Definite Integrals and Antiderivatives	1	9-10	Properties of definite integrals; Upper and lower bounds; Evaluate definite integrals; Average Value Theorem; Using the calculator to evaluate a definite integral	HW 5-3
Fundamental Theorem of Calculus	1	10-11	Differential and Integral calculus; Integral Evaluation Theorem; Using anti-derivatives to find area	HW 5-4 Chapter 5 Test
6 Differential Equations	1-2	12	Antiderivatives; Properties of Indefinite Integrals; Applied differential equations; Integration by substitution and parts;	Collaborative Activity: small groups working together to solve old AP free response questions over the FTC HW 6-2, 6-3
Mathematical Modeling	2	13-14	Exponential growth and decay; Population growth and logistical equations; Euler's method, Slope Fields; Using the calculator to analyze all of the above topics.	HW 6-1, 6-4, 6-5, 6-6 Chapter 6 Test
7 Definite Integral Applications	2	15	Integrals as net change; Using calculator to visualize the concept of integration to find net change; Particle motion; Areas in planes	Collaborative Activity: small groups working together to solve old AP free response questions over chapter 6 material HW 7-1, 7-2

Definite Integral Applications	2	15-17	Volumes: Washers, disks, shells, and cross sections; Length of Curve; Applications from Science: Work, Fluid Force	HW 7-3, 7-4, 7-5 Chapter 7a Test over sections 7-1 -> 7-3 Chapter 7b Test over sections 7-4, 7-5
8 Integration Techniques and L'Hopital's Rule	2	18-20	Indeterminate forms: Examine graphically and solve analytically; Applying L'Hopital's Rule; Infinite limits of integration; Convergence and divergence of improper integrals; Applications: Volume and arcs; Method of partial fractions; Trigonometric substitutions	Collaborative Activity: small groups working together to solve old AP free response questions over volumes of rotation HW 8-1, 8-3, 8-4 Chapter 8 Test First Semester Exam
9 Infinite Series	3	21-23	Representing polynomials and other functions by an infinite series; Generating a Taylor Series approximation; Differentiation and integration of a Power Series; Harmonic and alternating series; Divergent and convergent series; Maclaurin and Taylor Series; Taylor's Theorem	HW 9-1, 9-2, 9-3, 9-5
Concept of a Series	3	24-25	Euler's formula and identities; Radius of Convergence; A range of tests for determining convergence of a series: nth term test, comparison tests, ratio test, integral test	HW 9-4 Chapter 9 Test

10 Functions: Parametric and Vector	3	25-27	Parametric equations: Lengths of curves, cycloids, and surface area; Definition of vectors in a plane; Vector operations, properties, and dot products; Unit vectors; Limits and derivatives of vector functions	Collaborative Activity: small groups working together to solve old AP free response questions over series HW 10-1, 10-2, 10-3
Applications: Projectile Motion and Polar Functions	3	28-29	Projectile motion: maximum height, flight time, and range; Parabolic trajectories; Polar graphs and coordinates; Rose curves; Polar curves: Area in a plane and between two polar curves, length of a curve, and surface area of a revolution	HW 10-4, 10-5, 10-6 Chapter 10 Test
	4	30-33	Review and AP Exam	Collaborative Activity: small groups working together to solve old AP free response questions Pop EC Quizzes over all work from the year Semester Exam –sample AP exam the week before the real exam AP Exam
Post-Exam	4	33-36	Project – choice of two	Project: A month-long project, after the AP exam, in which students work in a small group and then individually, to research a calculus topic. It includes a written paper with a visual component and a self-evaluation and peer-

				evaluation.

Assessment:

Assessment and evaluation are essential to learning and teaching. Ongoing assessment and evaluation are significant in supporting student achievement, motivating student performance and providing the basis upon which teachers make meaningful instructional decisions. All aspects of progress in mathematics are measured using multiple methods such as authentic, performance, observational, and formative assessments; group and individual projects, student presentations, and conventional summative assessments. Student understanding is evaluated using an assessment cycle that includes pre-, formative, and summative assessments. Pre-assessments are used to determine where the student understanding level is, as the unit is begun. The pre-assessment is used by a teacher to plan instruction. Formative assessments are used to check student understanding while learning is occurring, and provide students and teachers with learning progress information. Pre- and formative assessments are not used to determine grades. Summative assessments, such as unit and semester tests, evaluate student achievement, and along with other measures such as student presentations and project work are data points used to determine the level of student performance.

Assessment Type	Goal	Description
Unit Tests	To assess understanding of concepts, principles, applications, and techniques of calculus. To prepare students to see the material in a testing situation similar to that of the AP exam.	90 minute tests containing multiple-choice items, problems to solve, and constructed response items. Calculators are not allowed on the M/C section.
Semester Assessments	To assess understanding of concepts, principles, applications, and techniques of calculus for several units. To prepare students to see the material in a testing situation similar to that of the AP exam.	90 minute tests containing multiple-choice items, problems to solve, and constructed response items. Calculators are not allowed on the M/C section.
Student Group Projects	To give students an opportunity to work in small groups to solve problems that they are likely to see on the AP exam, free response section.	On-going throughout the year and becoming more frequent second semester, students will work with groups to solve old AP exam questions. Students receive a grade on their participation and the group solution.
Student Projects/Investigations	To provide students with an opportunity to examine a	A month-long project, after the AP exam, in which

	calculus topic of their choice in-depth and demonstrate the processes and skills of a well-designed investigation. It also provides an avenue for students to use their imaginations and do some creative thinking.	students work in a small group and then individually, to research a calculus topic. It includes a written paper with a visual component and a self-evaluation and peer-evaluation.

Supporting Services:

To help students maintain successful participation, each student has a designated local facilitator who servers as the liaison between the teacher, the student, parents and school administrators. Students are given access to fax machines, scanners, or digital senders to facilitate turning in assignments.

The goal of the distance learning class is to provide the same level of assistance as is available for in-house classes. Local math teachers and/or peer mentors are provided whenever possible to assist the students on a face-to-face basis with their work and community tutors are located with the help of school counselors when requested by students or parents. Phone access is provided at each school so that the student can call the teacher for immediate help, and the teacher will contact the student at home in the evenings or weekends whenever requested. Students are also provided access via Instant Messaging and e-mail.