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AP Calculus AB and BC Syllabus

The Advanced Placement (AP) Program is a cooperative education endeavor of secondary schools, colleges, and the College Board. Both AP Calculus AB and AP Calculus BC are designed for motivated, college bound students who have successfully completed PreCalculus with Trigonometry. Both calculus courses are intended to be challenging and demanding; they require a similar depth of understanding of common topics. The courses cover all topics listed in the College Board's course outline and are focused on developing a deep understanding of Calculus that will prepare the student for the AP exams to be given in May. In addition to AB topics such as limits, derivatives, applications of derivatives, integrals, and applications of integration, the BC course includes derivatives of parametric, polar, and vector functions, polynomial approximations, and convergence and divergence of series.

AP test preparation assignments and questions will be incorporated throughout the year. Typically, students with an AB exam score of 3 or better will be awarded one semester of university credit; students with a BC exam score of 3 or better will earn two semesters of credit. Although most colleges and universities award credit for an exam score of 3 or better, some do not. Students should contact those institutions in which they are interested for individual policies.

Primary Textbook: Larson, R., Hostetler, R., Edwards, B. (2002). *Calculus of a Single Variable,* 7th edition, Boston, MA: Houghton-Mifflin. Cost $84.27

Graphing Calculator: The AP Calculus exams are based on the assumption that all students have access to four basic graphing calculator capabilities used extensively in Calculus. Students should be familiar with the first two calculator functions from their precalculus experiences; calculator "how to's" will be included in unit lessons; tutorials for the TI 83+ and TI 84 series will be available on the teacher's website. In addition to the four basic graphing calculator functions, the list below includes instructional tasks that AP Calculus students will encounter that utilize the function.

- Plot the graph of a function within an arbitrary viewing window.
- Find the zeros of functions (solve equations numerically).
- Numerically calculate the derivative of a function.
- Numerically calculate the value of a definite integral.

All students are expected to become proficient with at least the TI-83+ graphing calculator. As stated earlier, the TI-84, TI-84+, and TI-89 graphing calculators will be demonstrated during class presentations. Please visit with your teacher if you do not own one of these models and cost is prohibitive.
Students will also use the CAS *Derive* for investigation and special assignments.

Expectations: This is a 6-point course and the workload and expectations are similar to those of university level work. It is strongly recommended that students read the assigned sections of the text. If a student needs extra help, teachers, including myself, will be available before and after school most days as well as one evening per week. Students should acquaint themselves with and utilize the tutoring lab facility. The internet can be an invaluable resource; check the teacher's website for helpful links. If you discover a good site, please share the URL.

Many educators of mathematics, your calculus teacher included, believe communication is a crucial part of mathematics. It is a way of sharing ideas and clarifying understanding. Through communication, ideas become objects of reflection, refinement, discussion, and amendment. The communication process also helps build meaning and permanence for ideas and makes them public. When students are challenged to think and reason about mathematics

and to communicate the results of their thinking to others orally or in writing, they learn to be clear and convincing. Listening to others' thoughts and explanation about their reasoning gives students the opportunity to develop their own understandings. Conversations between peers and teachers will foster deeper understanding of the knowledge of mathematical concepts. The AP Calculus teachers believe that study groups offer students a safe and empowering opportunity to begin conversations focused on mathematics, especially calculus. Students will be assigned to study groups throughout the year. Study groups offer students a small group of peers focused on the study of calculus. Each student *is required to attend at least 2 meetings for a total of 3 hours each chapter*. *At least one meeting should be held in the calculus teacher's classroom*. Each student is responsible for helping the group develop a "plan of study". This will help keep everyone on task.

Each student will be required to keep a Scholar Log. The log will include entries for at least three group meetings as well as assigned writing prompts. These journals are intended to help students focus study sessions as well as offer individual students the opportunity to reflect on progress, successes, and difficulties. Parents may also include reflections and suggestions in the student's log. *Scholar logs will be reviewed and graded at least twice each nine-week period.*

Assignments: Homework will be assigned and checked daily. At the end of each week, students will use corrected assignments to complete a homework quiz. A homework quiz will cover 3 to 5 assignments. During the homework quiz, students will copy specified problems from the completed assignments or demonstrate knowledge of the material by working the problems without the aid of notes or text. Late or missed homework will not be accepted unless the student has an excused absence.

To obtain full credit for the solution to a free-response problem on the AP exam, students must communicate their methods and conclusions clearly. Answers should show enough work so that the reasoning process can be followed throughout the solution. Students' assignments, as well as quiz and test responses, will be assessed in a manner that ensures that all students have sufficient opportunities to practice and improve their abilities to communicate mathematically.

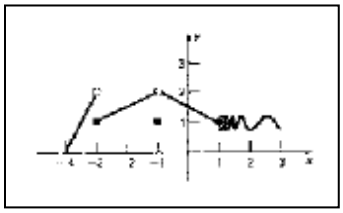
Since its introduction by the National Council of Teachers of Mathematics, the Rule of Four has become a component of the Reform Calculus movement as well as all secondary math curricula. The Rule of Four recommends that every topic should be presented numerically, graphically, symbolically, and verbally. Listed below are examples of tasks that AP Calculus students will encounter embracing this philosophy.

Numerically: Complete the table and use the results to estimate the limit. $\lim_{x\to 0}\frac{\cos x - 1}{x}$.

x	-0.1	-0.01	-0.001	0	0.001	0.01	.1
f(x)				---			

Graphically: Use the given graph to find the specified limit if it exist.

a. $\lim_{x\to -3} f(x)$ b. $\lim_{x\to -^{-}} f(x)$ c. $\lim_{x\to 1} f(x)$



Symbolically: Find the indicated limit or state that it does not exist.

a. $\lim_{x\to 6}(x-5)^{97}$ b. $\lim_{x\to 2}\frac{x^2-2x}{x^2-5x+6}$ c. $\lim_{x\to 0}\frac{(x+h)^2-x^2}{h}$

Verbally: Identify any vertical asymptotes or "holes" in the graph of the given function. Describe the behavior on each side of the asymptote or "hole". In your own words and symbols,

write a definition for a vertical asymptote. In your own words and appropriate symbols, write a definition for a "hole" in a graph. $f(x) = \frac{x^2 + x - 12}{x^2 - 9}$.

In addition to daily homework assignments, writing exercises, projects and/or portfolios will be assigned. While many projects will be incorporated in the study groups or other small groups, some will be individual completions. All projects will require presentation of results and conclusions. In the past, such assignments have included:

- Calculating the volume of clay in a terra cotta flower pot.
- Building representative models of solids with known cross sections and evaluating the volumes.
- A poster presentation showing why the Rule of 72 works.
- Biographical sketches of mathematicians who have contributed to the development of calculus.
- An opinion essay identifying the true father of Calculus (Newton or Liebniz).
- Development of an original game to review Calculus concepts.
- And countless (well maybe finite) other exercises gleaned from workshops, textbooks, and internet sources.

Expectations and grading rubrics will be discussed at the time of the assignment.

Year-End Portfolio: Each student is expected to maintain an AP Calculus Portfolio. Portfolio assignments will be given throughout the year. These assignments will offer students an opportunity to become familiar with the "AP style" questions and notations. It is recommended that students begin these assignments immediately and review the problems throughout the course. Portfolios should be bound in a 1-inch binder and will be reviewed and graded at least once each semester.

Tentative List of Portfolio contents: (Items may be deleted or added at the teacher's discretion.)

- College Board Topic List (available at apcentral.collegeboard.com/calculusab or apcentral.collegeboard.com/calculusbc). This should be downloaded and printed as soon as possible and be placed in the front of your portfolio for easy reference.
- Worksheets
  - ✓ $\varepsilon - \delta$ lab and worksheet
  - ✓ Derivatives using function notation
  - ✓ Pre-related Rates – Equation/Function rewrite
  - ✓ More Related Rates – Includes previous AP exam questions
  - ✓ Relationships of f, f ', and f "
  - ✓ f, f ', and f " graphing worksheet
  - ✓ Derivative Applications – Includes previous AP exam questions
  - ✓ Evaluating Definite Integrals by Numerical Approximations - Includes previous AP exam questions
  - ✓ Differential Equations Worksheet - Includes previous AP exam questions
  - ✓ Applications of Definite Integrals - Includes previous AP exam questions
  - ✓ Techniques of Integration, Answer Sheet, & Reflective Activity
  - ✓ Concept Map for Convergence Tests (BC only)
- Corrected Chapter Exams.
- Corrected Free-Response Exams (AP released exams will be used).
- Summary letter of advice to incoming AP students.
- Reflective letter to your teacher.

Chapter. Section	Topics	AB Timeline (days)	AB	BC Timeline (days)	BC
1.1	Preview of Calculus: Tangent Line Problem & Area Problem	1		1	
1.2	Limits Graphically & Numerically	2		1	
	$\varepsilon - \delta$ Definition of Limit	2		1	
1.3	Analytically Evaluation of Limits	2		1	
1.4	Continuity, One-sided Limits, and Intermediate Value Theorem	2		2	
1.5	Infinite Limits – Definition of a Vertical Asymptote	1		1	
2.1	Local Linearity, Tangent Line Problem, & the Derivative, Derivatives Defined as the Limit of the Difference Quotient, Slope of the Curve at a Point, Equation of the Tangent Line, Differentiability and Continuity	2		2	
2.2	Basic Differentiation Rules & Rates of Change	2		2	
2.3	Product and Quotient Rules and Higher Order Derivatives, Relationships between Position, Velocity, Speed, and Acceleration Functions	3		3	
2.4	Chain Rule	3		2	
2.5	Implicit Differentiation	2		1	
2.6	Application of Derivatives: Related Rates	5		3.5	
3.1	Extrema on an Interval: Including Definitions of Critical Numbers, Absolute and Relative Extrema, and Extreme Value Theorem	2		2	
3.2	Rolle's Theorem & Mean Value Theorem	2		1	
3.3	Increasing and Decreasing Functions and the First Derivative Test	4		4	
3.4	Concavity and Second Derivative Test, Identifying Points of Inflection	3		2	
3.5	Limits at Infinity – Definition of a Horizontal Asymptote	2		2	
3.6	Applications of Derivatives: Curve Sketching	1		.5	
3.7	Applications of Derivatives: Optimization problems	2		1.5	
3.8	Newton's Method for Approximating Real Zeros of a Function	1		1	
3.9	Differentials	2		1	
4.1	Antiderivatives and Indefinite Integration, Introduction to Differential Equations through Slope fields and Solution Curves	4		4	
4.2	Review of $\sum$ Notation and Numerical Approximation of the Definite Integral using Area of Inscribed & Circumscribed Rectangles.	3		3	
4.3	Numerical Approximation of the Definite Integral using Riemann Sums and Properties of Definite Integrals	3		2	
4.4	Fundamental Theorem of Calculus: Evaluation of Definite Integrals and Analysis of Functions Defined by a Definite Integral	5		3	
4.5	Integration by Substitution	3		2	
4.6	Numerical Approximation of the Definite Integral Using Trapezoidal Rule	1		1	
5.1	Differentiation of Natural Log Function	2		1	
5.2	Integration of Natural Log Function	1		1	
5.3	Inverse Functions & the Derivative of $f^{-1}(x)$	1		1	
5.4	Differentiation and Integration of Exponential functions	2		1	
5.5	Differentiation and Integration of Bases Other Than e	1		1	
5.6	Application of Differential Equations: Growth & Decay	2		1	
5.7	Differential Equations: Separable including Euler's Method	2		2	
5.8	Differentiation of Inverse Trigonometric Functions	1		1	
5.9	Integration of Inverse Trigonometric Functions	1		1	

1st 9 Weeks

2nd 9 Weeks

3rd 9 Weeks

1st 9 Weeks

2nd 9 Weeks

Chapter. Section	Topics	AB Timeline (days)	AB	BC Timeline (days)	BC
6.1	Area of a Region Between Two Curves Accumulation of Change Application of Definite Integrals: Accumulation of Change particularly attention to Total Distance Traveled contrasted with Displacement	2		1	
6.2	Application of Definite Integrals: Volumes of Solids with Known Cross Sections (Disk, Washer, and Slab Methods)	7		5	
6.3	Application of Definite Integrals: Volume of solids Using the Shell Method	4		2	
7.1	Review of Basic Integration Rules including Substitution of Variables	3		2	
7.2	Integration by Parts	3		2	
7.3	Trigonometric Integrals	4		3	
7.4	Integration by Trigonometric Substitution	3		2	
7.5	Integration by Partial Fractions	2		1	
7.6	Integration by Tables	2		1	
7.7	Indeterminate Forms and L'Hopital's Rule	3		2	
7.8	Definition and Evaluation of Improper Integrals	3		2	
8.1	Review of Sequences, Convergence, Divergence, Formulas for *n*th Term			1	
8.2	Series and Convergence			1.5	
8.3	Integral Test and p-series			1.5	
8.4	Comparisons of Series, Direct comparison & Limit comparison			2	
8.5	Alternating Series			2	
8.6	Ration and Root Tests for Convergence			2	
8.7	Taylor Polynomials and Approximations			3	
8.8	Power Series			2	
8.9	Representation of Functions by Power Series			2	
8.10	Taylor & MacLaurin Series			2	
9.1	Review of Conics and Calculus Applications including Tangent Line Equations, Area and Volume			1	
9.2	Review of Plane Curves and Parametric Equations including Curve Sketching and Elimination of the Parameter			2	
9.3	Parametric Equations and Calculus including Differentiation and the Tangent Line Equation as well as Integration and Area and Volume			2	
9.4	Polar Coordinates and Polar Graphs including Tangent Lines at the Pole			1	
9.5	Area of a Polar Region			2	
Supplemented	Introduction to Vector Functions and Space Curves			2	
Supplemented	Derivatives and Integrals of Vector Functions			3	
Supplemented	Motion in Space: Velocity and Acceleration			2	

The list above is a projected schedule. In addition to the topics in the College Board course outline, the teacher may choose to add topics such as $\varepsilon - \delta$ definitions, Newton's Method, the hyperbolic functions, and techniques of integration. The teacher may opt to extend or shorten the time spent on a particular topic or to rearrange the order of material. Such changes will be at the teacher's discretion and perception of the students' needs.