AP Calculus course

Brief Description of Course

Using the Finney, Demana, Waits, Kennedy Calculus – Graphical, Numerical, Algebraic textbook and following the AP curriculum guidelines, my course meets all of the goals of the new AP Calculus – AB course curriculum. My students learn the meaning of derivatives in terms of rate of change and local linear approximation. They use multiple approaches. They work with functions which are represented graphically, numerically, analytically, algebraically and are able to verbally write and speak (the rule of five) about the connection among these representations using appropriate mathematical language. My students learn the meaning of definite integral both as a limit of Riemann sums and as a net accumulation of a rate of change. My students learn the relationship between derivatives and the definite integral as expressed in the Fundamental Theorem of Calculus Parts I and II. They are asked to model problem situations with functions, differential equations and integrals. Additionally students represent differential equations with slope fields and solve separable differential equations analytically.

Embedded throughout the course are the appropriate applications of derivatives, integrals and antidifferentiation including, but not limited to, analysis of curves, optimization, rates of change, related rates, velocity, speed, acceleration, area, volume, average value, and exponential growth and decay using a variety of different methods with and without the use of the graphing calculator.

Technology:

Students use technology throughout this course making decisions as to when and where it is most appropriate. The ability to use graphing calculators is an essential part of the course and each student is required to have one for use in class as well as at home. They learn to use it as a tool to support their algebraic and/or analytical results. They are proficient with its many built-in functions. Through the use of the above stated textbook and their graphing calculators, students are given the opportunity to work in groups where they discover concepts, make connections, as well as explore, solve problems, work with data, and communicate and explain their solutions to each other and to me, as I monitor their work, orally and in writing, relative to the various topics throughout the curriculum. Every student is offered the opportunity to build their problem solving abilities.

Teaching Strategies:

Chapter 1 of the text is the summer assignment. This chapter reviews concepts that are taught in our Pre-Calculus class (prior year's class). I correct the summer assignment and address any misconceptions or problematic areas with the class. We delve immediately into chapter 2. Students are assigned problems either from the text or from relevant sources. We begin each class with a review of the prior night's assignment. Students are expected to volunteer to put the work on the board and to explain their solution to their fellow students. They are required to use multiple approaches whenever appropriate. They also entertain any relevant questions. This fosters mathematical communication and an in depth understanding of the concepts. Class lectures are enhanced by use of technology when it is appropriate. We actively use the graphing calculator, overhead projector, power point presentations, and computer programs that enhance the learning. Students are encouraged to ask any questions and to be active participants in the discussion at hand. Students are encouraged to be independent learners. They are encouraged to be creative and to think beyond the obvious. They are also encouraged to work collaboratively to

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complete assignments, collect data for labs and explore new concepts. Assistance and extra help are provided when necessary and appropriate. Students are encouraged to understand the math and not to merely memorize a series of facts. Memorization is of course necessary in many areas (derivatives, integrals, formulas). From the end of January until the A. P. Exam in May, my students meet weekly for an after school session where we review past topics using the released free response questions, released multiple choice questions and review sheets that I have made up. Attendance is mandatory at these sessions.
Projects, labs and explorations are woven in where appropriate throughout the school year and after the A.P. Exam providing students the opportunity to experience applications of their knowledge

Student Evaluation:
Students are graded through the use of collected homework assignments, quizzes, tests, projects, group work and a midterm exam. These assessments have Released A.P. free response questions. All of my quizzes, tests, and exams have a calculator component and a noncalculator component so that students can demonstrate to me that they are able to do the calculus of that section with and without a calculator. Students are expected to write sentence justifications on these assessments. Our school does not require students who take the AP Calculus Exam to take an additional final exam at the end of the year.

Sample of Projects:
Volume of a bundt pan
Maximize the volume of a box, cone - optimization problems
Murder Mystery - reviews many concepts
"More Ice Cream, Please", Volume review
"How Many Licks" - Tootsie Roll Pop lab - Related rates
"Is There No Limit to These Labs" - Limits
"The Game's Afoot" - Newton's Law of Cooling
Various explorations from workbook resources
Various projects that have been collected from NCTM Conferences

In summary, after having read the most recent AP Calculus AB Course Description, reviewed the course requirements and resource requirements, it is evident that this course covers ALL topics included in the Calculus AB topic outline as it appears in the AP Calculus Course Description, and meets all requirements, including a few additional topics that are covered after the AP Exam time permitting.

Chapter 1 - Prerequisites for Calculus is a chapter that all students are required to complete at home over the summer preceding their senior year at high school and before entering the AP Calculus course in the fall. The sections they must complete are:
1.1 Lines
1.2 Functions and Graphs
1.3 Exponential Functions
1.4 Parametric Equations
1.5 Functions and Logarithms
1.6 Trigonometric Functions

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In August when we return to school I spend a few days answering any questions relative to this material and we have a test on it before beginning Chapter 2. The timeframe is the summer to complete the chapter at home and about 6 days in school to review and test.

This is review of material that was covered in the course before, Pre-Calculus in our school, and I am asking the students to review the material over the summer to keep them from forgetting. They are given specific problems to do from each section and from the Chapter Review

Chapter 2 Limits and Continuity (13 days)
2.1 Rates of Change and Limits
- Average and Instantaneous Speed
- Definition of Limit
- Properties on Limits
- One-sided and Two-sided Limits
- Sandwich Theorem

2.2 Limits Involving Infinity
- Finite Limits as x approaches + and - infinity
- Sandwich Theorem revisited
- Infinite Limits as x approaches a
- End Behavior Models
- "Seeing" Limits as x approaches + and - Infinity

2.3 Continuity
- Continuity at a point
- Continuous Functions
- Algebraic Combinations
- Composites
- Intermediate Value Theorem for Continuous Functions

2.4 Rates of Change and Tangent Lines
- Average Rates of Change
- Tangent to a Curve
- Slope of a Curve
- Normal to a Curve

Speed Revisited

2.1
- Average and Instantaneous Speed
- Definition of Limit
- Properties on Limits
- One-sided and Two-sided Limits
- Sandwich Theorem

2.2
- Finite Limits as x approaches + and - infinity
- Sandwich Theorem revisited
- Infinite Limits as x approaches a
- End Behavior Models
- "Seeing" Limits as x approaches + and - Infinity

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2.3
- Continuity at a point
- Continuous Functions
- Algebraic Combinations
- Composites
- Intermediate Value Theorem for Continuous Functions

2.4
- Average Rates of Change
- Tangent to a Curve
- Slope of a Curve
- Normal to a Curve
- Speed Revisited

Chapter 3 Derivatives (28 days)

3.1 Derivative of a Function
- Definition of Derivative
- Notation
- Relationships between the graphs of f and f'
- Graphing the derivative from data
- One-sided Derivatives

3.2 Differentiability
- How f'(a) Might Fail to Exist
- Differentiability Implies Local Linearity
- Derivatives on a Calculator
- Differentiability Implies Continuity
- Intermediate Value Theorem for Derivatives

3.3 Rules for Differentiation
- Positive Integer Powers, Multiplies, Sums, and Differences
- Products and Quotients
- Negative Integer Powers of x
- Second and Higher Order Derivatives

3.4 Velocity and Other Rates of Change
- Instantaneous Rates of Change
- Motion along a Line
- Sensitivity to Change
- Derivatives in Economics

3.5 Derivatives of Trigonometric Functions
- Derivative of the Sine Function
- Derivative of the Cosine Function
- Simple Harmonic Motion
- Derivatives of the Other Basic Trigonometric Functions

3.6 Chain Rule
- Derivative of a Composite Function
- "Outside-Inside" Rule
- Repeated Use of the Chain Rule
- Power Chain Rule

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3.7 Implicit Differentiation
- Implicitly Defined Functions
- Lenses, Tangents, and Normal Lines
- Derivatives of Higher Order
- Rational Powers of Differentiable Functions

3.8 Derivatives of Inverse Trigonometric Functions
- Derivatives of Inverse Functions
- Derivative of the Arcsine
- Derivative of the Arctangent
- Derivative of the Arcsecant
- Derivatives of the Other Three

3.9 Derivatives of Exponential and Logarithmic Functions
- Derivative of e to the x
- Derivative of a to the x
- Derivative of lnx
- Derivative of log base a of x
- Power Rule for Arbitrary Real Powers

3.1
- Definition of Derivative
- Notation
- Relationships between the graphs of f and f'
- Graphing the derivative from data
- One-sided Derivatives

3.2
- How f'(a) Might Fail to Exist
- Differentiability Implies Local Linearity
- Derivatives on a Calculator
- Differentiability Implies Continuity

Intermediate Value Theorem for Derivatives

3.3
- Positive Integer Powers, Multiplies, Sums, and Differences
- Products and Quotients
- Negative Integer Powers of x
- Second and Higher Order Derivatives

3.4
- Instantaneous Rates of Change
- Motion along a Line
- Sensitivity to Change
- Derivatives in Economics

3.5
- Derivative of the Sine Function
- Derivative of the Cosine Function
- Simple Harmonic Motion
- Derivatives of the Other Basic Trigonometric Functions

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3.6
- Derivative of a Composite Function
- "Outside-Inside" Rule
- Repeated Use of the Chain Rule
- Power Chain Rule

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- Implicitly Defined Functions
- Lenses, Tangents, and Normal Lines
- Derivatives of Higher Order
- Rational Powers of Differentiable Functions

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- Derivatives of Inverse Functions
- Derivative of the Arcsine
- Derivative of the Arctangent
- Derivative of the Arcsecant
- Derivatives of the Other Three

3.9
- Derivative of e to the x
- Derivative of a to the x
- Derivative of lnx
- Derivative of log base a of x
- Power Rule for Arbitrary Real Powers

Chapter 4 - Applications of Derivatives (21 days)

4.1 Extreme Values of Functions
- Absolute (Global) Extreme Values
- Local (Relative) Extreme Values
- Finding Extreme Values

4.2 Mean Value Theorem
- Mean Value Theorem
- Physical Interpretation
- Increasing and Decreasing Functions
- Other Consequences

4.3 Connecting f' and f" with the Graph of f
- First derivative test for Local Extrema
- Concavity
- Points of Inflection
- Second Derivative Test for Local Extrema
- Learning about Functions from Derivatives

4.4 Modeling and Optimization
- Examples from Business and Industry
- Examples from Mathematics
- Examples from Economics
- Model Discrete Phenomena with Differentiable Functions

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4.5 Linearization and Newton's Method
- Linear Approximation
- Newton's Method
- Differentials
- Estimating Change with Differentials
- Absolute, Relative, and Percentage Change
- Sensitivity to Change

4.6 Related Rates
- Related Rate Equations
- Solution Strategy
- Simulating Related Motion

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- Absolute (Global) Extreme Values
- Local (Relative) Extreme Values
- Finding Extreme Values

4.2
- Mean Value Theorem
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- First derivative test for Local Extrema
- Concavity
- Points of Inflection
- Second Derivative Test for Local Extrema
- Learning about Functions from Derivatives

4.4
- Examples from Business and Industry
- Examples from Mathematics
- Examples from Economics
- Model Discrete Phenomena with Differentiable Functions

4.5
- Linear Approximation
- Newton's Method
- Differentials
- Estimating Change with Differentials
- Absolute, Relative, and Percentage Change
- Sensitivity to Change

4.6
- Related Rate Equations
- Solution Strategy
- Simulating Related Motion

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Chapter 5 - The Definite Integral (18 days)

5.1 Estimating with Finite Sums
- Distance Traveled
- Rectangular Approximation Method (RAM)
- Volume of a Sphere
- Cardiac Output

5.2 Definite Integrals
- Riemann Sums
- Terminology and Notation of Integration
- Definite Integral and Area
- Constant Functions
- Integrals on a Calculator
- Discontinuous Integrable Functions

5.3 Definite Integrals and Antiderivatives
- Properties of Definite Integrals
- Average Value of a Function
- Mean Value Theorem for Definite Integrals
- Connecting Differential and Integral Calculus

5.4 Fundamental Theorem of Calculus
- Fundamental theorem, Part 1
- Graphing the function "the integral of f(t) dt from a to x"
- Fundamental Theorem, Part 2
- Area Connection
- More Applications

5.5 Trapezoidal Rule
- Trapezoidal Approximations
- Other Algorithms
- Error Analysis

5.1
- Distance Traveled
- Rectangular Approximation Method (RAM)
- Volume of a Sphere
- Cardiac Output

5.2
- Riemann Sums
- Terminology and Notation of Integration
- Definite Integral and Area
- Constant Functions
- Integrals on a Calculator
- Discontinuous Integrable Functions

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- Properties of Definite Integrals
- Average Value of a Function
- Mean Value Theorem for Definite Integrals
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5.4
- Fundamental theorem, Part 1
- Graphing the function "the integral of f(t) dt from a to x"
- Fundamental Theorem, Part 2
- Area Connection
- More Applications

5.5
- Trapezoidal Approximations
- Other Algorithms
- Error Analysis

Chapter 6 - Differential Equations and Mathematical Modeling (16 days)

6.1 Antiderivatives and Slope fields
- Solving Initial Value Problems
- Antiderivatives and Indefinite Integrals
- Properties of Indefinite Integrals
- Applications

6.2 Integration by Substitution
- Power Rule in Integral Form
- Trigonometric Integrands
- Substitution in Indefinite Integrals
- Substitution in Definite Integrals
- Separable Differential Equations

6.3 Integration by Parts
- Product Rule in Integral form
- Solving for the Unknown Integral

6.4 Exponential Growth and Decay
- Laws of Exponential Change
- Continuously Compounded Interest
- Radioactivity - growth and decay
- Newton's Law of Cooling

6.5 Population Growth
- Exponential Model
- Logistic Growth Model
- Logistic Regression

6.1
- Solving Initial Value Problems
- Antiderivatives and Indefinite Integrals
- Properties of Indefinite Integrals
- Applications
- Slope fields - Students draw them by hand and investigate them graphically on their calculator. They study and investigate their connection to initial-value problems as well. I provide several additional worksheets down loaded from AP. Central and various other places as our textbook doesn't have many for the students to practice.

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6.2
- Power Rule in Integral Form
- Trigonometric Integrands
- Substitution in Indefinite Integrals
- Substitution in Definite Integrals
- Separable Differential Equations

6.3
- Product Rule in Integral form
- Solving for the Unknown Integral

6.4
- Laws of Exponential Change
- Continuously Compounded Interest
- Radioactivity - growth and decay
- Newton's Law of Cooling

6.5
- Exponential Model
- Logistic Growth Model
- Logistic Regression

Chapter 7 - Applications of Definite Integrals (18 days)

7.1 Integral as Net Change
- Linear Motion Revisited
- General Strategies for Modeling with Integrals
- Consumption Over Time
- Net Change From Data
- Work

7.2 Areas in the Plane
- Area Between Curves
- Area Enclosed by Intersecting Curves
- Boundaries With Changing Functions
- Integrating with Respect to y
- Saving time with Geometry Formulas

7.3 Volume
- Volumes as an Integral - Includes Cavalieri's Theorem
- Square Cross Sections
- Circular Cross Sections
- Other Cross Sections
- Washers, Disks, Cylindrical Shells

7.4 Length of Curves
- A Sine Wave
- Length of a Smooth Curve
- Vertical Tangents, Corners, and Cusps

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Chapter 7 - Applications of Definite Integrals

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- General Strategies for Modeling with Integrals
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- Square Cross Sections
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7.4

- Length of A Sine Wave
- Length of a Smooth Curve
- Vertical Tangents, Corners, and Cusps

Chapter 8 - L'Hopital's Rule, Improper Integrals, and Partial Fractions (4 days)

8.1 L'Hopital's Rule

- Indeterminate Form 0/0
- Indeterminate Forms - infinity/infinity, infinity times zero, infinity minus infinity, one to infinity power, zero to the zero power, infinity to the zero power

8.2 Relative Rates of Growth

- Comparing Rates of Growth - Faster, slower, same rate as x approaches infinity
- The rest of this chapter is beyond the scope of the AB Calculus AP test and is not covered before the AP test. At this point we begin to review for the AP test using practice released AP free response and multiple choice questions.

8.1

- Indeterminate Form 0/0
- Indeterminate Forms - infinity/infinity, infinity times zero, infinity minus infinity, one to infinity power, zero to the zero power, infinity to the zero power

8.2

- Comparing Rates of Growth - Faster, slower, same rate as x approaches infinity

The remainder of the year up to the A. P. Exam is dedicated to exam review including, but not limited to, taking practice timed test both free response and multiple choice. This is approximately a period of 3 to 4 weeks depending on the date of the exam, our April vacation, snow days and other factors relating to scheduling.

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This is our main textbook. This series comes with supplemental material including, but not limited to, a paperback book titled ADVANVED PLACEMENT CORRELATIONS AND PREPARATION CALCULUS, which I use to provide students with extra practice on particular concepts and group explorations of the topics that we cover.

TI-83 and TI-84 graphing calculators with the overhead component

Calculus in Motion - a program that allows students to have a visual representation of derivatives, integration, volume, related rate problems and more. The program is displayed on a projector attached to a laptop computer so that all students have a good visual.

I use a series of powerpoint presentation also shown on a projection devices allowing all students a good visual of the various topics

A Watched Cup Never Cools by Ellen Kamischkle This activity book of blackline masters has many experiments which allow my students to work in groups to investigate, explore, discuss and write about the topics we cover within the AP Calculus course. I list a few of the examples that we use here but this is just a sampling of them; we do, in fact use more. Some examples that we use are "More Ice Cream, Please", "How Many Licks" - Tootsie Roll Pop lab, "Is There No Limit to These Labs", "The Game's Afoot".

Volumes of Revolution with Regular Cross Sections - Student worksheets and accompany Volumes Transparency Sets 1, 2, and 3 - Published by Andco Educational Services - 800 Peachtree Street, NE, Unit 2503, Atlanta, GA

Released A.P. Free Response questions and released A.P. Multiple Choice Test

Calculus Explorations by Paul Foerester - Used to provide opportunities for students to have hands on practice with the concepts and techniques of Calculus - allows for student discovery and group work

Barron's How to Prepare for the AP Calculus Exam by Shirley Hockett - Used for practice test questions and review throughout the year