Dominican International School

AP CALCULUS BC

COURSE SYLLABUS

GRADE LEVEL: 12 SCHOOL YEAR: 2024-2025

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COURSE DESCRIPTION

Calculus is one of the most important areas of mathematics. This course is designed to help students build a solid foundation of math so that they will do well in the AP Exam and be better prepared for their future studies in colleges. Students will be introduced to the concepts and techniques of calculus through a comprehensive study of all of the topics outlined in the College Board's *Course and Exam Description: AP Calculus BC*.

TEACHING STRATEGIES

Classroom interaction is emphasized. Instead of one-way teaching, students will be challenged with problems and encouraged to come up with their own solutions. Group discussion will sometimes be organized and each group will then be invited to present the solution to the class. Students will be encouraged to discover the richness of meaning and idea behind an equation or problem solving technique. Each student will have the opportunity to present and explain her or his idea on the board to their classmates. When they present their ideas or solutions on the board, they will be communicating mathematics both verbally and in written sentences.

For student activities, students in each group work together and present their conclusions in a single paper that should emphasize justifications of the mathematics and quality of the presentation. The paper concludes with a student reflection on how confident they are in sharing their knowledge on these topics.

Through this kind of discussions and activities, students will have the opportunity to work with functions in a variety of ways - graphically, numerically, analytically and verbally. Most importantly, connections among these representations will be emphasized, and students will be expected to relate the various representations to each other. It's important for students to understand that graphs and tables are not always sufficient to prove an idea. Analytic argument is usually required for verification purpose.

STUDENT ACTIVITIES

Students will participate in classroom activities such as discussions and presentations. In addition, graphing calculators will be used by students to explore, discover, and reinforce the concepts of calculus. For example, the following sample activities demonstrate how calculators can be used to help students develop an intuitive feel for the concept of derivative.

1. **Solving problems**:
   Graph the function $y = \sin x$ in a standard viewing window, find the function value for a given x.

2. **Experiments**:
   Estimate the slope of tangent line at various x and plot the slope values as a function of x on the overhead screen. Students should be able to answer questions such as "What are the slope values at the turning points, and at the x-intercepts?"

3. **Interpret results**:
   Students should be able to see that the slope curve follows the path of the cosine function.

4. **Support conclusions**:
   To test the above conjecture, use calculator to graph the derivative of the sine. Then graph the cosine and note that the two graphs are superimposed. Students are demonstrated graphically before they are presented with the analytic proof of $\frac{d}{dx}(\sin x) = \cos x$.

ASSESSMENT

Students will be assessed with classroom participation, homework, quiz and quarter exams. Homework includes 5 to 10 problems per day during weekdays and 20 review problems for weekends. Weekly quizzes will help identify any weakness students may have, and which topics need additional enhancement. Quarter Exams will be given at the end of each quarter. To help students better prepared for the AP exam, old AP exam problems will be incorporated into homework and quarter exams.

PRIMARY TEXTBOOK & OTHER RESOURCES

Thomas, Hass, Heil, Weir, *Thomas' Calculus: Early Transcendentals*, 14th Edition, Pearson.

The required online textbook companion is the Pearson MyMathLab site:
https://www.pearsonmylabandmastering.com/northamerica/mymathlab/

College Board MyAP Practice: *https://myap.collegeboard.org/*

Finney, Demana, Waits, Kennedy, and Bressoud, *Calculus (AP* Edition) - Graphical, Numerical, Algebraic,* 5th edition, Pearson.

TECHNOLOGY RESOURCES – GRAPHING CALCULATOR

Graphing calculators, Ti-*nspire CX* (non-CAS), will be used to enhance the learning experience. Students will learn to use graphing calculators to help solve problems, interpret results, and support conclusions.

ADDITIONAL INFORMATION

Academic Dishonesty means employing a method or technique or engaging in conduct in an academic endeavor that contravenes the standards of ethical integrity expected at DIS. Academic dishonesty includes, but is not limited to, the following:

1. Purposely incorporating the ideas, words of sentences, paragraphs, or parts thereof without appropriate acknowledgment and representing the product as one's own work; and
   Representing another's intellectual work such as photographs, paintings, drawings, sculpture, or research or the like as one's own, including failure to attribute content to an AI.
2. Employing a tutor, making use of Artificial Intelligence without acknowledgement, getting a parent to write a paper or do an assignment, paying for an essay to be written by someone else and presented as the student's own work.
3. Committing any act that a reasonable person would conclude, when informed of the evidence, to be a dishonest means of obtaining or attempting to obtain credit for academic work.

Any act of academic dishonesty will result in an automatic zero on the entire assignment.

COURSE PLANNER

The following represents the topics covered in this course.

FIRST QUARTER

Limits and Continuity (15 days)

- Introducing Calculus: Can Change Occur at an Instant?
- Defining Limits and Using Limit Notation
- Estimating Limit Values from Graphs
- Estimating Limit Values from Tables
- Determining Limits Using Algebraic Properties of Limits
- Determining Limits Using Algebraic Manipulation
- Selecting Procedures for Determining Limits
- Determining Limits Using the Squeeze Theorem
- Connecting Multiple Representations of Limits
- Exploring Types of Discontinuities
- Defining Continuity at a Point
- Confirming Continuity over an Interval
- Removing Discontinuities
- Connecting Infinite Limits and Vertical Asymptotes
- Connecting Limits at Infinity and Horizontal Asymptotes
- Working with the Intermediate Value Theorem (IVT)

Differentiation: Definition and Basic Derivative Rules (10 days)

- Defining Average and Instantaneous Rates of Change at a Point
- Defining the Derivative of a Function and Using Derivative Notation
- Estimating Derivatives of a Function at a Point
- Connecting Differentiability and Continuity: Determining When Derivatives Do and Do Not Exist
- Applying the Power Rule
- Derivative Rules: Constant, Sum, Difference, and Constant Multiple
- Derivatives of cos x, sin x, e^x and ln x
- The Product Rule
- The Quotient Rule
- Finding the Derivatives of tan, cot, sec, and csc Functions

Differentiation: Composite, Implicit, and Inverse Functions (10 days)

- The Chain Rule
- Implicit Differentiation
- Differentiating Inverse Functions
- Differentiating Inverse Trigonometric Functions
- Selecting Procedures for Calculating Derivatives
- Calculating Higher-Order Derivatives

SECOND QUARTER

Contextual Applications of Differentiation (7 days)

- Interpreting the Meaning of the Derivative in Context
- Straight-Line Motion: Connecting Position, Velocity, and Acceleration
- Rates of Change in Applied Contexts Other Than Motion
- Introduction to Related Rates
- Solving Related Rates Problems
- Approximating Values of a Function Using Local Linearity and Linearization
- Using L'Hospital's Rule for Determining Limits of Indeterminate Forms

Analytical Applications of Differentiation (10 days)

- Using the Mean Value Theorem
- Extreme Value Theorem, Global Versus Local Extrema, and Critical Points
- Determining Intervals on Which a Function Is Increasing or Decreasing
- Using the First Derivative Test to Determine Relative (Local) Extrema
- Using the Candidates Test to Determine Absolute (Global) Extrema
- Determining Concavity of Functions over Their Domains
- Using the Second Derivative Test to Determine Extrema
- Sketching Graphs of Functions and Their Derivatives
- Connecting a Function, Its First Derivative, and Its Second Derivative
- Introduction to Optimization Problems
- Solving Optimization Problems
- Exploring Behaviors of Implicit Relations

Integration and Accumulation of Change (18 days)

- Exploring Accumulations of Change
- Approximating Areas with Riemann Sums
- Riemann Sums, Summation Notation, and Definite Integral Notation
- The Fundamental Theorem of Calculus and Accumulation Functions
- Interpreting the Behavior of Accumulation Functions Involving Area
- Applying Properties of Definite Integrals
- The Fundamental Theorem of Calculus and Definite Integrals
- Finding Antiderivatives and Indefinite Integrals: Basic Rules and Notation
- Integrating Using Substitution
- Integrating Functions Using Long Division and Completing the Square
- Integrating Using Integration by Parts
- Using Linear Partial Fractions
- Evaluating Improper Integrals
- Selecting Techniques for Antidifferentiation

Differential Equations (10 days)

- Modeling Situations with Differential Equations
- Verifying Solutions for Differential Equations
- Sketching Slope Fields
- Reasoning Using Slope Fields
- Approximating Solutions Using Euler's Method
- Finding General Solutions Using Separation of Variables
- Finding Particular Solutions Using Initial Conditions and Separation of Variables
- Exponential Models with Differential Equations
- Logistic Models with Differential Equations

THIRD QUARTER

Applications of Integration (15 days)

- Finding the Average Value of a Function on an Interval
- Connecting Position, Velocity, and Acceleration of Functions Using Integrals
- Using Accumulation Functions and Definite Integrals in Applied Contexts
- Finding the Area Between Curves Expressed as Functions of x
- Finding the Area Between Curves Expressed as Functions of y
- Finding the Area Between Curves That Intersect at More Than Two Points
- Volumes with Cross Sections: Squares and Rectangles
- Volumes with Cross Sections: Triangles and Semicircles
- Volume with Disc Method: Revolving Around the x- or y-Axis
- Volume with Disc Method: Revolving Around Other Axes
- Volume with Washer Method: Revolving Around the x- or y-Axis
- Volume with Washer Method: Revolving Around Other Axes
- The Arc Length of a Smooth, Planar Curve and Distance Traveled

Infinite Sequences and Series (25 days)

- Defining Convergent and Divergent Infinite Series
- Working with Geometric Series
- The *n*th Term Test for Divergence
- Integral Test for Convergence
- Harmonic Series and *p*-Series
- Comparison Tests for Convergence
- Alternating Series Test for Convergence
- Ratio Test for Convergence
- Determining Absolute or Conditional Convergence
- Alternating Series Error Bound
- Finding Taylor Polynomial Approximations of Functions
- Lagrange Error Bound
- Radius and Interval of Convergence of Power Series
- Finding Taylor or Maclaurin Series for a Function
- Representing Functions as Power Series

FORTH QUARTER

Parametric Equations, Polar Coordinates, and Vector-Valued Functions (12 days)

- Defining and Differentiating Parametric Equations
- Second Derivatives of Parametric Equations
- Finding Arc Lengths of Curves Given by Parametric Equations
- Defining and Differentiating Vector-Valued Functions
- Integrating Vector-Valued Functions
- Solving Motion Problems Using Parametric and Vector-Valued Functions
- Defining Polar Coordinates and Differentiating in Polar Form
- Find the Area of a Polar Region or the Area Bounded by a Single Polar Curve
- Finding the Area of the Region Bounded by Two Polar Curves

Review and AP Exam Preparation (8 days—Two complete practice tests and one mock exam)

- Concepts covered throughout the year
- Specific techniques expected to be mastered for the AP exam
- Requirements and expectations in taking the AP exam
- Previous AP exam problems
- Two complete practice tests
- One mock exam