AP Calculus Course Outline

I. Limits and Continuity

A. Calculate limits from graphs and tables
B. Calculate the limits of algebraic functions analytically
C. Prove basic limits with epsilons and deltas
D. Calculate the limits of trigonometric functions
E. Calculate limits at infinity and identify horizontal asymptotes
F. Identify vertical asymptotes and calculate positive or negative infinite limits
G. Identify the points at which a function is discontinuous and specify which parts of the definition of continuity are violated
H. Identify situations to which the Intermediate Value Theorem and the Extreme Value Theorem apply and use them to explain function behavior

II. Calculation of Derivatives

A. Calculate derivatives of low-degree polynomial functions using the limit definition of the derivative
B. Calculate derivatives using the power rule
C. Calculate higher-order derivatives
D. Calculate derivatives using the product and quotient rules
E. Calculate derivatives using the chain rule
F. Calculate the derivatives of implicitly defined functions and relations
G. Calculate the derivatives of trigonometric functions
H. Calculate the derivatives of inverse trigonometric functions
I. Calculate the derivatives of exponential and logarithmic functions
J. Prove basic identities involving hyperbolic trigonometric functions
K. Calculate the derivatives of hyperbolic trigonometric functions
L. Calculate the derivatives of inverse hyperbolic trigonometric functions

III. Applications of Derivatives

A. Find the equations of tangent and normal lines to given functions
B. Solve problems involving related rates of change
C. Analyze the motion of a particle given its position function
D. Analyze the features of a function using the properties of its first and second derivatives and sketch graphs of the curve and its derivatives
E. Solve problems involving the optimization of a function on an interval

IV. Calculation of Basic Integrals

A. Calculate the approximate area under a curve using left, right, or midpoint Riemann sums
B. Calculate definite integrals of low-degree polynomial functions using the limit definition of the definite integral

C. Explain the significance of the Fundamental Theorem of Calculus and use it to compute definite integrals of basic functions
D. Use the properties of definite integrals to find specified areas/integrals
E. Calculate basic indefinite integral/antiderivative formulas

V. Application s of Integrals

A. Calculate planar areas between given functions
B. Calculate the volumes of solids of revolution
C. Calculate the volumes of solids with known cross sections
D. Calculate the arc length of a specified curve
E. Analyze the motion of a particle given its velocity or acceleration
F. Calculate the surface area of a solid of revolution
G. Calculate the work done by variable forces
H. Calculate the work done on non-discrete objects
I. Calculate the fluid pressure on a specified object
J. Apply integrals to problems involving the accumulation of non-constant quantities

VI. Advanced Integration Techniques

A. Calculate integrals using the method of integration by parts
B. Calculate integrals involving powers and products of trigonometric functions
C. Calculate integrals involving trigonometric functions with different frequencies
D. Calculate integrals involving quadratic terms using trigonometric substitutions
E. Calculate integrals of rational functions using the method of partial fractions
F. Calculate intractable algebraic integrals using the tan(x/2) substitution
G. Use a systematic approach to identify and apply relevant integration techniques to given integrals

VII. Differential Equations

A. Sketch a slope field for a given first-order differential equation and approximate specified solution curves given initial conditions
B. Use Euler's method to calculate approximate points along the solution curve for a first-order differential equation
C. Solve separable differential equations analytically to obtain both general and particular solutions
D. Formulate and solve a rate problem using a differential equation

VIII. Polynomial Approximations

A. Calculate the terms in a Taylor series for a given function
B. Calculate the radius of convergence for a given power series
C. Test for endpoint convergence by testing series of constants for convergence

D. Estimate the error for a given number of terms or the number of terms needed to achieve a specified error tolerance for a power series
E. Manipulate known Taylor series to obtain new ones

IX. Vectors

A. Give a geometric interpretation of the sum, difference, dot product, and cross product of vectors in two-dimensions
B. Calculate the sum, difference, dot product, and cross product of vectors given in component form
C. Graph the position curve and direction of a two-dimensional vector function
D. Calculate the slope of a function defined parametrically
E. Analyze the motion of a particle in two dimensions given its position, velocity, or acceleration function
F. Calculate the arc length of a parametrically-defined function
G. Calculate the area enclosed by a two-dimensional parametrically-defined function

X. Polar Coordinates

A. Convert between polar and parametric representations
B. Graph a given polar function
C. Find the slope of a polar function at a specified point
D. Calculate the area enclosed by a polar function
E. Calculate the arc length of a polar function