

**Semester 1****I. Limits and Their Properties (2 weeks)**

- An intuitive understanding of the limiting process
- Find limits graphically and numerically
- Evaluate limits analytically
- An intuitive understanding of continuity
- Continuity and one-sided limits
- Intermediate Value Theorem
- Infinite limits and vertical asymptotes

**II. Differentiation (2-3 weeks)**

- The derivative and the tangent line problem
- Differentiability and continuity
- Basic differentiation rules and rates of change (average and instantaneous)
- Product and Quotient Rules and Higher Order derivatives
- The Chain Rule
- Implicit differentiation
- Related Rates

**III. Applications of Differentiation (3 weeks)**

- Extrema on an interval
- Rolle's Theorem and the Mean Value Theorem
- Increasing and decreasing functions
- The First Derivative Test
- Concavity and points of inflection
- The Second Derivative Test
- Limits at Infinity (horizontal asymptotes)
- Summary of Curve Sketching (including monotonicity)
- Optimization problems
- Business problems
- Newton's Method
- Differentials
- Linear (or tangent line) approximations

**IV. Introduction to Integral Calculus (3 weeks)**

- Antiderivatives and indefinite integration
- Position, velocity, acceleration
- Sigma Notation and concept of Area as the limit of a sum
- Riemann sums (including left, right, and midpoint evaluation points)
- Definite integrals solved using geometric formulas
- Properties of definite integrals
- Trapezoidal Rule
- The Fundamental Theorem of Calculus
- Average value of a function
- Second Fundamental Theorem of Calculus
- Integration using  $u$ -substitution
- Displacement and definite integrals

**V. Transcendental Functions (2-3 weeks)**

- The Natural Logarithmic Function and Differentiation
- The Natural Logarithmic Function and Integration
- Inverse Functions
- Exponential Functions: Differentiation and Integration
- Bases other than  $e$  and applications
- Inverse trigonometric functions and Differentiation
- Inverse trigonometric functions and Integration

**VI. Differential Equations (2 weeks)**

- Differential equations: Slope fields and Euler's Method
- Differential equations: Growth and decay
- Differential equations: Separation of variables and the Logistic Equation

**VII. Applications of Integration (1-2 weeks)**

- Area of a region between two curves
- Volume: Disk method
- Volume: Washer method
- Volume: Known cross-sections
- Arc Length and Surfaces of Revolution

**Semester 2****VIII. Integration Techniques (2-3 weeks)**

- Basic integration techniques
- Integration by parts
- Partial fractions
- Indeterminate forms and L'Hôpital's Rule
- Improper integrals

**IX. Infinite Series (5 weeks)**

- Sequences
- Series and convergence
- The Integral Test and  $p$ -Series
- Comparison of series
- Alternating series
- The Ratio and Root Tests
- Taylor Polynomials and Approximations
- Power series
- Representation of functions by power series
- Taylor and Maclaurin Series

**X. Parametric Equations and Polar Coordinates (2 weeks)**

- Plane curves and parametric equations
- Parametric equations and calculus
- Polar coordinates and polar graphs
- Area and Arc Length in polar coordinates

**XI. Vector-Valued Functions (1 week)**

- Vectors in a plane
- Vector-valued functions
- Differentiation and integration of vector-valued functions
- Velocity and acceleration

**XII. AP Exam Preparation (3 weeks)**

- Lederman's *Multiple-Choice Questions in Preparation for AP Exam*
- 1997, 1998, and 2003 AP Exams
- 2000 to present Free Response Questions