Math 2141: Calculus I

Credit hours: **4 credit hours**
Prerequisites: **Placement in ACCUPLACER Grid 8 or MATH 2111 with a grade of C or better**

Course Description

This course covers topics of differential and integral calculus including limits and continuity, higher-order derivatives, curve sketching, differentials, definite and indefinite integrals (areas and volumes), and applications of derivatives and integrals.

Course Objectives

1. Establish the fundamental theorems and applications of the calculus of single variable functions
2. Explore the concepts, properties, and aspects of the differential and integral calculus of single variable functions
3. Provide students with the mathematical tools necessary for more advanced STEM fields

Learning Outcomes

1. Calculate limits, derivatives, and indefinite integrals of various algebraic and trigonometric functions of a single variable
2. Apply the definition of continuity to pure and applied mathematics problems
3. Utilize the definition of the derivative to differentiate various algebraic and trigonometric functions of a single variable
4. Use the properties of limits and the derivative to analyze graphs of various functions of a single variable including transcendental functions
5. Employ the principles of the differential calculus to solve optimization problems, related rates exercises, and other applications
6. Calculate the area of regions in the plane with elementary Riemann sums
7. Utilize the Fundamental Theorem of Calculus and the techniques of integration, including u-substitution, to calculate the area of regions in the plane and the volume and surface area of solids of revolution

Course Topics

I. PRELIMINARY TOPICS
- A. Functions
- B. Classification of functions
- C. Operations on functions
- D. Composition of functions
- E. Inverse functions
- F. Trigonometric functions

II. THE LIMIT CONCEPT
- A. The definition of a limit at a point
  1. Intuitive approach
  2. Epsilon-Delta approach*
- B. Properties of limits
  1. Basic properties
  2. The Squeeze Theorem
  3. Important trigonometric limits
- C. One-sided limits

D. Infinite limits
E. Limits at infinity and asymptotes
F. Continuity
    1. Continuity at a point
    2. Continuity on an interval
    3. The Intermediate Value Theorem

III. THE DERIVATIVE
A. Slope of the secant line
B. Slopes of tangents and instantaneous rates
C. The definition of the derivative
    1. Terminology
    2. Notation
    3. Find derivatives using the limit definition
    4. Functions which are not differentiable (e.g. cusps and vertical asymptotes)
D. The Power Rule as it applies to integer and rational exponents
E. The Product Rule and the Quotient Rule
F. Higher order derivatives
G. Derivatives of elementary trigonometric functions
H. The Chain Rule
    1. Functions raised to exponents
    2. Trigonometric functions
I. Implicit Differentiation
    1. Related rates applications

IV. APPLICATIONS OF DIFFERENTIATION
A. Finding and graphing tangent lines
B. The Mean Value Theorem
C. Curve Sketching
    1. Absolute and relative extrema
    2. Increasing and decreasing intervals
    3. The First Derivative Test
    4. Concavity and inflection points
    5. The Second Derivative Test
    6. Intercepts, asymptotes and symmetry
    7. Generating graphs using topics 1 through 6
D. Optimization problems
E. Linear approximation and differentials
F. Newton's Method*

V. INTRODUCTION TO INTEGRATION
A. Antiderivatives
    1. The definition of an indefinite integral
    2. Antiderivative formulas
B. Summation notation
C. Area
    1. Rectangle approximations for area under the curve
    2. Riemann sums
D. The definition of a definite integral
    1. Terminology
    2. Notation
    3. Properties
E. The Fundamental Theorem of Calculus
F. Integration by Substitution

1. Functions raised to exponents
2. Trigonometric functions

VI. APPLICATIONS OF INTEGRATION
    A. Area
    B. The Mean Value Theorem for Integrals*
    C. Volume
        1. Disk and washer method
        2. Shell method
        3. Slice method*
    D. Arc length*
    E. Work*
    F. Liquid pressure and force*
    G. Center of mass*
    H. Centroid*

*Optional