*Montgomery College - Department of Mathematics*
*Germantown Campus*

# MA181 – Calculus I
# 4 Semester Hours

## Description

Intended primarily for students of the physical sciences, engineering, and mathematics. An introduction to major ideas of single variable calculus including limits, derivatives, and integrals of algebraic and transcendental functions; applications.

MA181 meets for 5 hours each week.

## Prerequisites

A grade of C or better in MA 180, appropriate score on mathematics assessment test, or consent of department.

Assessment levels: EN101/101A, RD120.

## Topics

I. Functions and Models
   1. Represent functions through the use of tables, graphs, formulas and verbal discussions.
   2. Classify basic functions and use them to create new functions by forming sums, differences, products, quotients, transformations, and compositions.
   3. Use a calculator to graph an arbitrary function; choose an appropriate window for the situation.
   4. Graph parametric curves and convert parametric equations to functions and vice-versa.
   5. Understand the behavior of exponential functions and compare growth rates of exponential and polynomial functions.
   6. Understand the concept of an inverse function.
   7. Define the logarithmic function as the inverse of the exponential function; use logarithms to solve equations involving exponentials.
   8. Fit a mathematical model to empirical data.

II. Limits and Derivatives
   1. Understand the concept of the tangent line as a limit of secant lines; determine the equation of a tangent line.
   2. Understand and be able to determine average and

instantaneous velocity.

3. Evaluate limits (including one-sided limits) intuitively by using graphs and calculators, and analytically by using properties of limits combined with algebraic manipulation.
4. Determine the discontinuities of a function from its graph.
5. Use the definition of continuity and/or continuity on an interval to determine whether a function is continuous at a point or on an interval.
6. Evaluate limits involving infinity; determine horizontal and vertical asymptotes.
7. Understand the concept of instantaneous rate of change as the limit of average rates of change.
8. Know the limit definition of the derivative; apply it to the concept of rate of change. Compute derivatives from the definition and from graphs and tables of values.
9. Understand the derivative function; sketch the graph of the derivative from the graph of the function.
10. Understand the concept of a differentiable function and how a function can fail to be differentiable.
11. Find and interpret the second derivative.
12. Relate the derivative to the concept of local linearity; use tangent line approximations.
13. Use the first and second derivatives to obtain information about the behavior of a function; sketch the graph of a function $f$ from the graph of $f'$ or from information about $f$, $f'$ and $f''$.

III. Differentiation Rules

1. Use analytical, graphical and geometric arguments to develop the rules of differentiation for derivatives of constants, linear functions, sums, differences, powers (including negative and fractional exponents), polynomials, exponential and logarithmic functions, products and quotients, and trigonometric functions; be able to use these rules to find derivatives.
2. Use the Chain Rule to extend these techniques of differentiation to composite functions.
3. Apply the Chain Rule to the process of finding derivatives implicitly; use implicit differentiation to develop differentiation formulas for the inverse trigonometric functions.
4. Extend the concept of the tangent line approximation by using rules for finding derivatives.

IV. Applications of Differentiation
   1. Solve related rates problems.
   2. Find critical numbers of a function; use derivatives to obtain information regarding the shape of a curve.
   3. Determine local and absolute extrema and points of inflection.
   4. Use analytic methods to refine and interpret graphs obtained by a graphing calculator.
   5. Solve problems involving optimization and modeling.
   6. Use Newton 's Method in approximation problems.
   7. Compute general antiderivatives and specific antiderivatives if initial conditions are given.
   8. Use antidifferentiation to solve problems involving rectilinear motion.

V. Integrals
   1. Estimate the area under a curve.
   2. Use a velocity function to estimate total distance traveled.
   3. Define the definite integral as a limit of Riemann Sums; use the definition to approximate the value of definite integrals.
   4. Develop and use the properties of the definite integral.
   5. Evaluate a definite integral by interpreting it in terms of area.
   6. Evaluate definite integrals by using the Evaluation Theorem (Fundamental Theorem of Calculus); determine total change from the rate of change of a function.
   7. Find general indefinite integrals.
   8. Interpret both parts of the Fundamental Theorem of Calculus including its implications for the relationship between integration and differentiation.

Text

*Calculus: Concepts and Contexts* (3rd edition), by James Stewart, Brooks-Cole, 2005.