Portland State UNIVERSITY

Fariborz Maseeh Department of Mathematics and Statistics

MTH 251: Calculus I

Updated Fall 2021

Course Description: Differential calculus of functions of a single variable, including limits, the definition and computation of the derivative, and applications of the derivative. This is the first course in a sequence of three: Mth 251, Mth 252, and Mth 253, which must be taken in sequence.

Credits: 4

Prerequisites: Completion of Mth 112 with a grade of C- or above within the last year, or passing at the necessary level on the mathematics placement test within the last year (https://www.pdx.edu/math/placement).

Course Objectives: The course focuses on the basic differential calculus of real-valued functions of a single variable. This includes limits, continuity, derivatives and applications of derivatives.

Student Learning Outcomes: Upon completion of this course students will be able to:

- Evaluate limits graphically, numerically, and symbolically.
- Analyze and describe functions with respect to continuity, asymptotes, and extreme values.
- Understand and apply the definition of the derivative, and be able to find derivatives using both this definition and the traditional differentiation rules.
- Recognize limits and derivatives in various settings and be able to use correct mathematical terminology, notation, and symbolic processes to meaningfully communicate mathematics accurately with others.
- Understand the basic relationships between functional behavior and associated properties of the first and second derivatives, including monotonicity and the Mean Value Theorem.
- Model and solve several types of applications using derivatives and linear approximations.
- Find indeterminate limits using L'Hôpital's Rule.
- Use implicit differentiation and apply these techniques to situations and applications involving related rates.

- Use the basic techniques of optimization and creatively apply these techniques to locate maxima and minima in applied contexts.

Topics:

1. *Limits and Continuity*: Understanding limits numerically, graphically, and algebraically, basic limit laws, continuity, trigonometric limits, limits at infinity, intermediate value theorem.

2. *Differentiation:* Definition of derivative, rates of change, product rule, quotient rule, chain rule, implicit differentiation, related rates, higher derivatives, derivatives of trigonometric functions, exponential functions, logarithmic functions.

3. *Applications of Differentiation:* Finding maxima/minima, applied optimization, mean value theorem, monotonicity, graph sketching, L'Hôpital's Rule, Newton's method, linear approximation.

Textbook:

Jon Rogawski, Colin Adams, and Robert Franzosa *Calculus: Early Transcendentals*, 4th ed., Freeman, W.H.& Company 2019.

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MTH 251 Textbook Mapping:

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The course uses an online homework system from Edfinity Courseware

1 Precalculus Review

1.1 Real Numbers, Functions, and Graphs

2 Limits

2.1 The Limit Idea: Instantaneous Velocity and Tangent Lines
2.2 Investigating Limits
2.3 Basic Limit Laws
2.4 Limits and Continuity
2.5 Indeterminate Forms
2.6 The Squeeze Theorem and Trigonometric Limits
2.7 Limits at Infinity
2.8 Intermediate Value Theorem

3 Differentiation

3.1 Definition of the Derivative
3.2 The Derivative as a Function
3.3 Product and Quotient Rules
3.4 Rates of Change
3.5 Higher Derivatives
3.6 Trigonometric Functions
3.7 The Chain Rule
3.8 Implicit Differentiation
3.9 Derivatives of General Exponential and Logarithmic Functions
3.10 Related Rates

4 Applications of the Derivative

4.1 Linear Approximation and Applications
4.2 Extreme Values
4.3 The Mean Value Theorem and Monotonicity
4.4 The Second Derivative and Concavity
4.5 L'Hôpital's Rule
4.6 Analyzing and Sketching Graphs of Functions
4.7 Applied Optimization
4.8 Newton's Method