

**Course Title:** Calculus I (IAI Code: MTH 901)

**Course Description:** *IAI Description:* Topics include (but are not limited to) the following: limits and continuity; definition of derivative: rate of change, slope; derivatives of polynomial and rational functions; the chain rule; implicit differentials; approximation by differentials; higher order derivatives; Rolle's Theorem: mean value theorem; applications of the derivative; anti-derivative; the definite integral; the fundamental theorem of calculus; area, volume, other applications of the integral; the calculus of the trigonometric functions; logarithmic and exponential functions; techniques of integration, including numerical methods; indeterminate forms: L'Hospital's rule; improper integrals; sequences and series, convergence tests, Taylor series; functions of more than one variable, partial derivatives; the differential, directional derivatives, gradients; double and triple integrals: evaluation and applications.

**Semester Credit Hours:** 4-5

**Prerequisite:** Successful Completion of College Algebra and Trigonometry or Precaclulus or Elementary Functions

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**Course Objectives/Standards:**

*based on the Illinois Mathematics Standards (IMS) for Teachers*

Upon completion of this course a student should be able to:

***Knowledge Objectives***

- Evaluate limits of functions. (IMS 3A, 5A)
- State and use the epsilon-delta definition of limit. (IMS 3A)
- Understand and apply the concept of continuity (including the Intermediate Value Theorem). (IMS 3A, 4B,5A)
- Understand and use the definition of derivative and interpret the derivative as an instantaneous rate of change and as the slope of the tangent line to a function at a point. (IMS 3A, 5A)
- Differentiate functions using the rules for differentiation: power, product, quotient, and chain rules. (IMS 3A)

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- Differentiate functions implicitly. (IMS 3A)
- Understand and apply Rolle's Theorem and the Mean Value Theorem. (IMS 4B)
- Locate extreme values, points of inflection, and asymptotes of graphs of functions. (IMS 3A, 5A)
- Solve applied maxima/minima problems. (IMS 2A, 3A, 4B, 5A)
- Solve related rate problems. (IMS 2A, 3A, 4B, 5A)
- Find and apply higher order derivatives and understand how they relate to the graph of a function. (IMS 3A, 5A)
- Understand and apply Newton's Method. (IMS 3A, 5A, 6B3)
- Know the development of and connections between exponential and logarithmic functions. (IMS 3A, 7A6)
- Apply calculus to transcendental functions. (IMS 3A)
- Find areas between curves. (IMS 3A, 5A)
- Use definite integrals to compute areas. (IMS 3A, 5A)
- Use definite integrals to solve problems involving work. (IMS 2A, 3A, 4B, 5A)

### ***Performance Objectives***

- Evaluate limits of functions. (IMS 3B, 6D1, 6D2, 7C8, 8C1, 8C2, 8C4, 8C5, 8C6)
- State and use the epsilon-delta definition of limit. (IMS 3B, 6D3, 8C4, 8C5, 8C6)
- Understand and apply the concept of continuity (including the Intermediate Value Theorem). (IMS 2C, 3B, 6D3, 8C5, 8C6)
- Understand and use the definition of derivative and interpret the derivative as an instantaneous rate of change and as the slope of the tangent line to a function at a point. (IMS 2C, 3B, 7C8, 8C5, 8C6)
- Differentiate functions using the rules for differentiation: power, product, quotient, and chain rules. (IMS 7C8, 8C5, 8C6)
- Differentiate functions implicitly. (IMS 8C5, 8C6)
- Understand and apply Rolle's Theorem and the Mean Value Theorem. (IMS 2C, 3B, 6D3, 7C8, 8C5, 8C6)
- Locate extreme values, points of inflection, and asymptotes of graphs of functions. (IMS 3B, 6C1, 6D1, 6D2, 7C8, 8C5, 8C6)
- Solve applied maxima/minima problems. (IMS 2C, 3B, 6C1, 6D1, 6D2, 7C8, 8C5, 8C6)
- Solve related rate problems. (IMS 2C, 3B, 6C1, 6C2, 6D1, 6D2, 7C8, 8C5, 8C6)
- Find and apply higher order derivatives and understand how they relate to the graph of a function. (IMS 2C, 3B, 6C1, 6D1, 6D2, 7C8, 8C5, 8C6)
- Understand and apply Newton's Method. (IMS 2C, 3B, 6C1, 6D3, 8C5, 8C6)
- Know the development of and connections between exponential and logarithmic functions. (IMS 3B, 7B6, 8C5, 8C6)
- Apply calculus to transcendental functions. (IMS 3B, 6D1, 6D2, 7B5, 7C8, 8C5, 8C6)

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- Find areas between curves. (IMS 3B, 6D1, 6D2, 7C8, 8C5, 8C6)
- Use definite integrals to compute areas. (IMS 3B, 6D1, 6D2, 7C8, 8C5, 8C6)
- Use definite integrals to solve problems involving work. (IMS 2C, 3B, 6D1, 6D2, 7C8, 8C5, 8C6)

### **Sample of Acceptable Course Assignments/Assessments/Artifacts**

*(by Standard and Indicator)*

#### 2A

- Evaluations of homework problems or class discussions or problem/project presentations or quizzes/exams;
- Computer/calculator programming exercise;
- Written analysis of videos modeling problem solving;
- Reflective writing on problem solving;
- Writing/analyzing multiple solution strategy problem solving;
- Peer tutoring on problem solving strategies.

#### 2C

- Evaluations of homework problems or class discussions or problem/project presentations or quizzes/exams that demonstrate the ability to generalize mathematical properties from specific cases/problems and formulate theorems or discover more general situations where such properties apply.

#### 3A

- Evaluations of homework problems or class discussions or problem/project presentations or quizzes/exams;
- Computer/calculator programming exercise;
- Reflective writing on reasoning;
- Completion of proofs;
- Peer tutoring on reasoning.

#### 3B

- Evaluations of homework problems or class discussions or problem/project presentations or quizzes/exams;
- Computer/calculator programming exercise;
- Reflective writing on reasoning with technology;
- Completion of proofs;
- Peer tutoring on reasoning with technology.

4B

- Evaluations of homework problems or class discussions or problem/project presentations or quizzes/exams;
- Computer/calculator programming exercise;
- Reflective writing on mathematics and how it relates to other disciplines.

5A

- Evaluations of appropriate use of technology on homework problems or class discussions or problem/project presentations or quizzes/exams requiring the use of technology: programming language or graphing calculator or mathematics software or internet resources or power point.

6B3

- Evaluations of ability to apply iteration to Newton's Method through homework problems or class discussions or problem/project presentations or quizzes/exams;
- Computer/calculator programming exercise;
- Reflective writing.

6C1 and 6C2

- Use number sense and proportional reasoning in the solving of calculus problems (finding extrema, points of inflections, asymptotes, max/min problems, related rates, Newton's Method) as evaluated by homework problems or class discussions or problem/project presentations or quizzes/exams;
- Computer/calculator programming exercise;
- Reflective writing;
- Peer tutoring on number sense and proportional reasoning.

6D1 and 6D2

- Evaluations of appropriate use of algorithms with or without technology to solve problems as evidenced by homework problems or class discussions or problem/project presentations or quizzes/exams;
- Computer/calculator programming exercise;
- Reflective writing;
- Peer tutoring on use of algorithms with or without technology to solve problems.

6D3

- Evaluations of ability to apply and use numerical integration to approximate results and solve problems as evidenced by homework problems or class discussions or problem/project presentations or quizzes/exams;
- Computer/calculator programming exercise;
- Reflective writing.

7A6 and 7B6

- Evaluations of homework problems or class discussions or problem/project presentations or quizzes/exams on logarithmic scale and finding derivatives and integrals of exponential/logarithmic functions including in application problems.

7C8

- Evaluations of homework problems or class discussions or problem/project presentations or quizzes/exams on modeling areas under curve as summation of rectangles and use of slices and shells to visualize volume.

8C1, 8C2, and 8C4

- Evaluations of homework problems or class discussions or problem/project presentations or quizzes/exams;
- Computer/calculator programming exercise;
- Reflective writing;
- Completion of proofs involving limits and how they relate to rates of change, distance, area, and volume.

8C5 and 8C6

- Evaluations of homework problems or class discussions or problem/project presentations or quizzes/exams;
- Computer/calculator programming exercise;
- Reflective writing;
- Completion of proofs on ALL aspects of calculus: derivatives, integrals, continuity, limits, applications.