MAT 150 Calculus I

Department of Mathematics
Southern Connecticut State University

I. Catalog Description

Functions, limits, differentiation of algebraic, trigonometric, exponential and logarithmic functions with applications, indeterminate forms, elementary integration, Riemann sums.

II. Purpose

The purpose of this course is to teach students the fundamentals of calculus in preparation for Calculus II and III, while also enhancing their quantitative reasoning skills. The primary goal of the course is to teach students the fundamental concepts and computational skills with regard to the topics of limits, derivatives and integrals while reinforcing their algebraic and trigonometry skills. A second goal for this course is that students learn how to apply the concepts introduced in Calculus I for modeling problems in the sciences as well as how to interpret those models.

III. Credit

(A) MAT 150 carries four semester-hours of university credit.

(B) MAT 150 is required of all mathematics majors.

(C) MAT 150 satisfies the Tier 1 Quantitative Reasoning requirement in the Liberal Education Program

(D) Students may earn 4 credits toward graduation from MAT 139 and MAT 150.

IV. Prerequisites

The student must satisfy one of the following two prerequisites:

- established a placement level appropriate for the course.
- passed MAT 122 with a grade of C- or better.

Specifically, students should have a background in trigonometry and experience solving problems and working with the following functions: polynomial, rational, exponential, logarithmic, trigonometric.

V. Format

MAT 150 is primarily a lecture-based course.

VI. Liberal Education Program

This course satisfies the University's Liberal Education Program (LEP) requirement in Quantitative Rea- soning (QR). It addresses the key elements of the QR requirement as indicated in Section VIII: Course Objectives. Further, as a Tier 1 LEP course, it will do the following:

(A) Address at least one *Area of Knowledge and Experience* through the choice of a variety of word problems that are applied to the sciences, *Natural World I: Physical Realm* or *Natural World II: Life and the Environment*. Nearly all application problems in calculus texts model phenomena in Physics, Chemistry, Biology or Environmental Science. There is also a strong focus on modeling position, velocity, and acceleration problems using both the derivative and the anti-derivative.

(B) Incorporate at least one *Discussion of Values*. *Rational Thought* is emphasized throughout the course by asking students to interpret and make predictions from a given mathematical model. For example, students might be asked to interpret the meaning of the derivative in the context of an application problem or they might be asked to explain how finding the area below a velocity curve relates to total distance traveled. *Environmental Awareness* could be discussed through finding the rate of change of a function that comes from an environmental issue such as global warming trends. *Civic Engagement* is another area that could be discussed by choosing to model data that directly affect students? local communities.

(C) Address at least one *Embedded Competency* in a significant manner. Instructors may choose to address this requirement by incorporating one of the following requirements into their course: *Oral Communication* by requiring students to present the results of their work through oral presentations, *Interpersonal Effectiveness* by requiring students to work in group settings, *Information Literacy* by requiring students to find and evaluate their own data for a project, or *Creative Thinking* by requiring students to create a model for a set of data or scenario in which they have not already been told what type of model is most appropriate.

(D) Present the Quantitative Reasoning aspects of Calculus in context. The key elements QR1-Quantitative Situations, QR2-Quantitative Data, QR3-Methods, QR4-Reliability of Data and Solutions, and QR5-Mathematical Process are addressed in the course objectives listed below.

VII. Quantitative Reasoning Key Elements

(A) **QR1:** Quantitative Situations - Identifying the essential quantitative elements in both routine and novel situations and understanding the relationships between those quantitative elements, and producing mathematical models appropriate for the intended analysis (e.g., writing equation(s) to rep- resent the situation).

(B) **QR2:** Quantitative Data - Representing quantitative information in both technical and common language by using symbolic, graphical, and tabular formats, and drawing correct inferences from quantitative information through the interpretations of such representations.

(C) **QR3:** Methods - Acquiring the tools and methods necessary to resolve both routine and novel quantitative questions, including a correct sequencing of procedures, and using them

appropriately, given the nature and constraints of a situation. In addition to using knowledge previously acquired in intermediate algebra, students will demonstrate proficiency with information presented in numerical or statistical form and mathematical concepts of growth and decay with their applications (e.g., linear, quadratic, exponential, etc.).

(D) **QR4:** Reliability of Data and Solutions - Correctly evaluating the level of accuracy stated or implied for given data, and assessing the correctness and accuracy of an analysis, including the assessment of the method and model used and the reasonableness of the solution.

(E) **QR5:** Mathematical Process - Using discovery (e.g., exploration and pattern-recognition), conjecture, and testing to develop mathematical formulas, theorems, and then giving persuasive mathematical arguments to establish their validity.

VIII. Course Objectives

In addition to satisfying LEP Tier 1 requirements, MAT 150 has specific course objectives. Students pass- ing MAT 150 should minimally be able to do each of the following tasks.

By hand (without the use of technology):

(a) Evaluate limits of simple functions (including rational functions) analytically and graphically. (QR3)

(b) Use L'Hôpital's Rule to compute limits.

(c) Compute $f'(x)$ using the definition for polynomials of degree ≤ 2. (QR3)

(d) Compute derivatives using a variety of differentiation methods. (QR3)

(e) State and apply the definition of continuity.

(f) Find asymptotes. (QR3)

(g) Apply the first and second derivative tests to find extrema and inflection points, both for graphs and in applications. (QR2, QR3)

(h) Find the antiderivative of basic functions. (QR3)

(i) Use the method of substitution to find antiderivatives. (QR3)

(j) Evaluate definite integrals. (QR3)

(k) Be able to state and carefully apply theorems such as the Mean Value Theorem, the Intermediate Value Theorem, Rolle's Theorem and the Fundamental Theorem of Calculus. (QR5)

(l) Be able to choose, use, and evaluate the results from an appropriate mathematical model for applica- tions (position/velocity/acceleration, related rates, optimization). (QR1, QR4)

Using technology:

(a) Estimate limits using graphs and tables. (QR2)

(b) Implement some numerical root-finding algorithm (e.g., Newton's method). (QR2, QR3, QR4)

(c) Graph a function and its derivative and exhibit knowledge of the relationship between the significant features of the graphs as it relates to calculus. (QR2, QR3)

(d) Estimate areas using a summation process. (QR2)

(e) Evaluate definite integrals using the numerical integration function.

IX. Outline

Instructors and students are expected to use technology such as the graphing calculator and/or computer to investigate and illustrate concepts from symbolic, graphical, and numerical points of view.

Limits (15%)

(a) Slope and the limit of the difference quotient

(b) Analytic methods for finding limits

(c) Infinite limits

(d) The ϵ–δ definition of limit (proofs at least for linear functions)

(e) Continuity

Derivatives with applications (40%)

(a) Definition and interpretation as a rate of change

(b) Differentiation rules

(c) The product and quotient rules

(d) The chain rule

(e) Maxima and minima of functions on closed intervals

(f) Applied optimization problems

(g) Derivatives of trigonometric and inverse trigonometric functions

(h) Derivatives of exponential and logarithmic functions

(i) Implicit differentiation and related rates

(j) Newton's method or any other root-finding algorithm

More applications of the derivative (20%)

(a) Increasing and decreasing functions

(b) The Mean Value Theorem

(c) The first derivative test and applications

(d) Simple curve sketching

(e) Higher order derivatives

(f) Curve sketching and asymptotes

(g) Indeterminate forms and L'Hôpital's Rule

(h) More indeterminate forms

The Integral (25%)

1. Antiderivatives
2. Elementary area computations
3. Riemann sums and the integral
4. Evaluation of integrals
5. The Fundamental Theorem of Calculus
6. Integration by substitution

X. Assessment

Individual instructors may vary assessment modes, but typically grades will be based on a combination of homework assignments, quizzes, and exams.

	QR 1 Quantitative Situations	QR 2 Quantitative Data	QR 3 Methods	QR 4 Reliability of Data and Solutions	QR 5 Mathematical Process
Homework	Individual instructors decide which QR will be assessed appropriately.				
Quizzes	Individual instructors decide which QR will be assessed appropriately.				
Tests	✓	✓	✓	✓	✓
Final Exam	✓	✓	✓	✓	✓

XI. Recommended Text

W. Briggs, L. Cochran, B. Gillett, *Calculus*, 3rd edition, Pearson.

Recommended sections:

- Chapter 1 : Sections 1.1–1.3.
- Chapter 2 : Sections 2.1–2.7.
- Chapter 3 : Sections 3.1–3.9.
- Chapter 4 : Sections 4.1– 4.7, 4.9.
- Chapter 5 : Sections 5.1–5.5.

XII. Waiver Policy

This course may be waived.

XIII. Preparation

- Prepared in February 2009 (Therese Bennett, Alain D'Amour, Emmett Dennis, John Scheuermann, Robert Vaden-Goad)
- Modified for the LEP in March 2014. (Therese Bennett, Klay Kruczek)
- Modified for the new textbook in October 2014.
- Approved by the Mathematics DCC on October 28, 2014.
- Revised by J. Hong, November 1, 2020.
- Approved by the MDCC, 9–0–0, November 10, 2020.
- Revised outline prepared by MDTC, November 17, 2020.