MAT 139 Short Course in Calculus

Department of Mathematics
Southern Connecticut State University

I. Catalog Description

A one-semester course emphasizing techniques and applications in business and the social sciences; functions and models, the derivative, exponential and logarithmic functions, integration.

II. Purpose

The purpose of the course is to provide students in Business, Economics, and Social Sciences and other related fields with essential ideas of applied calculus in one semester, 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 skills. A second goal for this course is that students learn how to apply the concepts introduced in this course for modeling problems in business and the social sciences.

III. Credit

(A) MAT 139 carries three semester-hours of university credit.

(B) MAT 139 is required for Economics, Finance, and Accounting majors, as well as Computer Information Systems majors.

(C) MAT 139 satisfies the Tier 1 Quantitative Reasoning requirement in the Liberal Education Program.

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

IV. Prerequisites

The student must satisfy one of the following two prerequisites:

- C- or better in MAT 120 or MAT 122 or MAT 124 or MAT 125
- establish a placement level appropriate for the course.

Specifically, student should have experience solving problems and working with the following functions: polynomial, rational, exponential, and logarithmic functions.

V. Format

MAT 139 meets for 3 contact hours per week throughout a standard academic semester and is conducted primarily in a lecture and discussion format.

VI. Liberal Education Program

This course satisfies the University's Liberal Education Program (LEP) requirement in Quantitative Reasoning (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 data sets or word problems that are applied to *American Experience* (for example, data measuring population changes in America and the Globalization of American Businesses) or *Global Awareness* (for example, viewing business trends in other countries, looking at rates of change of imports/exports.).

(B) Incorporate at least one *Discussion of Values*. For example, *Rational Thought* can be emphasized by asking students to interpret and make predictions from a given mathematical model. For example, students might be asked to interpret the meaning of slope in context or they might be asked about the limitations of the model. *Civic Engagement* is another area that could be discussed by choosing to model data that directly affects students? local communities and businesses.

(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 reason inductively to formulate appropriate and precise generalizations from given data/observations.

(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 represent 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 139 has specific course objectives. By the end of the course, a successful student should be able to do the following:

By hand (without the use of technology):

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

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

(c) Compute $f'(x)$ using differentiation rules (particularly the chain rule). (QR3)

(d) State and apply the definition of continuity.

(e) Find asymptotes. (QR3)

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

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

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

(i) Evaluate definite integrals. (QR3)

(j) Be able to state and carefully apply the Fundamental Theorem of Calculus. (QR5)

(k) Be able to choose, use, and evaluate the results from an appropriate mathematical model for applications (marginal cost/revenue/profit, related rates, optimization). (QR1, QR4)

(l) Be able to use integration by parts (QR3)

Using technology:

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

(b) 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)

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

(d) Approximate definite integrals using the numerical integration function.

IX. Outline

Instructors and students are expected to use technology to investigate and illustrate concepts from symbolic, graphical, and numerical points of view.

Functions, Limits, and Continuity (20%)

(a) Review of functions (equations, graphs, composite and inverse functions)

(b) Limit of a function

(c) Limits as x approaches infinity

(d) Continuity

The Derivative (25%)

(a) Instantaneous rate of change

(b) Geometric interpretation of the derivative

(c) Fundamental rules of differentiation

(d) The product and the quotient rule

(e) The chain rule

(f) Higher derivatives

Applications of the Derivative (25%)

(a) Maxima and minima

(b) Increasing and decreasing functions

(c) The first derivative test

(d) The second derivative test

(e) Optimization problems

(f) Curve sketching

(g) Elasticity of demand

Exponential and Logarithmic Functions (10%)

(a) Review of exponential and logarithmic functions

(b) Derivatives of exponential functions

(c) Derivatives of logarithmic functions

Integral Calculus (20%)

(a) Antiderivatives

(b) Summation notation

(c) The definite integral

(d) The Fundamental Theorem of Calculus

(e) The area between two curves

(f) Integration by substitutions

(g) Initial value problems using antiderivatives

(h) Consumer and producer surpluses

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 Texts

(A) Hoffman, Bradley, Sobecki, and Price, *Calculus For Business, Economics, and the Social and Life Sciences*,11th Edition, McGraw Hill, 2013.

Recommended sections:

- Chapter 1: Sections 1.1–1.6.
- Chapter 2: Sections 2.1–2.4, 2.6. (Instructors may wish to cover Marginal Analysis in 2.5 as well.)
- Chapter 3: Sections 3.1–3.4.
- Chapter 4: Sections 4.1–4.3, 4.4 (optional). (Topics can be chosen from different areas of applications.)
- Chapter 5: Sections 5.1–5.3. (Topics can be chosen from different areas of applications from 5.4 - 5.6.)
- Chapter 6: Sections 6.2–6.3.

(B) R. Larson, *Calculus : An Applied Approach*, 9th edition, Brooks Cole, 2013.

XII. Waiver Policy

This course may be waived. If a student receives AP credit for MAT 150, then the Mathematics Department will waive MAT 139 for that student.

XIII. Preparation

- Proposed outline prepared by K. Kruczek, March 2014.
- Approved by the MDCC, March 11, 2014.
- Revised outline prepared by J. Hong, November 1, 2020.
- Approved by the MDCC, 9–0–0, November 10, 2020.
- Revised outline prepared by MDTC, November 17, 2020.