MA141: Differential Calculus Syllabus

Kevin Bedoya

Spring 2026

Course Information

- **Course:** MA141 – Differential Calculus (MQR, 3 credits)
- **Section:** 12
- **Pre-requisite:** MATH 122 (Pre-Calculus)
- **Instructor:** Kevin Bedoya
- **Email:** kevin.bedoya32@qmail.cuny.edu
- **Lecture Times:** Mondays / Wednesdays, 10:45 AM – 12:00 PM
- **Location:** Kiely Hall 273
- **Office Hours:** Mondays / Wednesdays, 12:15 - 12:45 PM Kiely Hall 331
- **Tutoring Hours:** Tuesdays / Thursdays, 2:00 – 4:00 PM (Kiely Hall 331)
- **Primary Textbook:** *Essential Calculus*, 2nd Edition, James Stewart
- **Primary Communication Platform:** Discord

Queens College, CUNY
Department of Mathematics

Contents

Course Objectives

The objective of this course is to cement foundational understanding of real-valued functions by identifying their key characteristics and understanding their applications in mathematical modeling and problem solving. Students will rigorously construct tools and definitions for the analysis of functions, develop and apply limits to study function behavior, and tabulate significant limits associated with special functions.

Limits will be used to rigorously define the derivative. Students will develop rules for the computation of derivatives and apply these rules to elementary functions. Applications of derivatives will include related rates, approximations, and optimization problems.

Remark on the "140/150" Calculus Routes

Conventionally, the curriculum of Calculus I spans material up to the beginnings of integral calculus (approximately Chapter 4 of the primary textbook). In contrast, MA141 covers material through Chapter 3, culminating in optimization problems; as such, this course is strictly focused on differential calculus.

MA141 is the first course in a three-semester sequence:

- MA141: Differential Calculus (3 credits)
- MA142: Integral Calculus (3 credits)
- MA143: Series Calculus (3 credits)

An alternative two-semester route exists:

- MA151: Calculus I (4 credits)
- MA152: Calculus II (4 credits)

While the two-semester route is shorter, it is significantly denser, as three semesters of material are condensed into two. Students are strongly encouraged to follow the MA140 sequence in order to develop a steady and robust foundation in calculus. Mastery of differential calculus is critical for success in future coursework in applied mathematics and related disciplines. Students are advised to retain lecture notes, cheat sheets, and course materials for future reference.

Grading Metrics

Homework	18%
In-class Presentations	5%
Midterm Exam 1	16%
Midterm Exam 2	20%
Midterm Exam 3	16%
Final Exam	25%
Total	100%

Tentative Lecture and Exam Schedule (Spring 2026)

Chapter 1

- **(1/26/26) Lecture 1:** Classifying families of functions: polynomial, trigonometric, rational, special/arbitrary power, absolute value (distance), piecewise, products of functions, composition of functions, exponential, and logarithmic functions (exponential and logarithmic functions will not be covered in subsequent lectures). Properties and characteristics of each family, including domain and range. This lecture serves as a foundational review of pre-calculus.

- **(1/28/26) Lecture 2:** Formalization of functions and introduction to elementary set theory notation: definitions of sets, subsets, and unions. Functions and mappings defined in terms of sets. General definitions of domain, codomain, range, injective, surjective, and bijective functions.

- **(2/2/26) Lecture 3:** Studying distances on the Cartesian plane: interpretation of absolute value, properties of distances and inequalities, intervals, the triangle inequality, and the Pythagorean theorem (Euclidean distance). Graphical illustrations of inequalities, piecewise functions, and absolute value functions. Definition of singularities of real-valued functions.

- **(2/4/26) Lecture 4:** Introduction to the intuitive definition of the limit. Distinguishing numerical approximations from exact values. Numerical calculations of limits involving singularities. Directional (one-sided) limits. Formalizing limits using distances and inequalities. Introduction to the precise ε–δ definition of the limit.

- **(2/9/26) Lecture 5:** Computational properties of limits: the ten algebraic limit laws and the direct substitution property. Theorems involving limits, including the dual-sided equality theorem, upper-bound limit theorem, and the Squeeze Theorem. Trigonometric proof of $\lim_{x\to 0} \frac{\sin x}{x} = 1$, including the lemma: if $f(x)$ is even and $\lim_{x\to 0^+} f(x)$ exists, then $\lim_{x\to 0^-} f(x) = \lim_{x\to 0^+} f(x)$. Tabulation of significant trigonometric limits for later use.

- **(2/11/26) Lecture 6:** Returning to the precise definition of the limit from an elementary real analysis perspective. Interpreting the definition numerically and graphically. Applying the definition to prove the existence of limits. If time permits: application to one-sided limits and proofs of the sum, constant multiple, and product laws using the ε–δ definition.

- **(2/16/26)** Presidents' Day — No classes scheduled.

- **(2/18/26) Lecture 7:** Introduction to the intuitive and formal definitions of continuity. Pointwise continuity and continuity over intervals. Directional (one-sided) continuity. Algebraic properties of continuous functions. Determining intervals of continuity for different families of functions. Composition theorems for limits and continuity. The Intermediate Value Theorem.

- **(2/23/26) Lecture 8:** Review of vertical and horizontal asymptotes of rational functions. Reinterpretation of asymptotes using limits involving infinity. Introduction to convergence and divergence. Computing limits involving infinity. Situations in which limit laws fail when infinity is involved. Tabulation of useful limits involving infinity.

- **(2/25/26)** Midterm #1 Review Session: Students must bring questions from homework and lecture material. This class period is dedicated exclusively to problem solving.

- **(3/2/26) Midterm #1:** Chapter 1 material, Lectures 1–8, Homework 1–2.

Chapter 2

- **(3/4/26) Lecture 9:** Review of slopes of linear functions and their interpretation in mathematical modeling. Review of the difference quotient and its relationship to slope. Average rate of change. Velocity problems. Secant and tangent line problems. The derivative interpreted as instantaneous rate of change. Review of derivative notation (Leibniz and prime notation).
- **(3/9/26) Lecture 10:** The derivative as a function. The binomial theorem. Derivation of the power rule. Relationship between differentiability and continuity. Three cases of non-differentiability: (i) singularities of the parent function, (ii) corner points, and (iii) vertical tangents or asymptotic behavior. Computing higher-order derivatives.
- **(3/11/26) Lecture 11:** Algebraic properties of derivatives: sum and difference rules, derivatives of constants, and constant multiples. Generalization of the power rule to rational powers. The derivative as a functional operator. Generalization of the sum rule over arbitrary finite sums. Applications involving rates of change and higher derivatives.
- **(3/16/26) Lecture 12:** Review of trigonometric functions and identities. Differentiation of $\sin x$ and $\cos x$ using the definition of the derivative. Applications of trigonometric derivatives. Attempted differentiation of $\tan x$ using the limit definition.
- **(3/18/26) Lecture 13:** Derivation of the quotient rule. Applications to $\tan x$, $\sec x$, and rational functions. Derivation of the product rule from first principles. Interpretation of quotient differentiation via the product rule. Generalization of the product rule to arbitrary products.
- **(3/23/26) Lecture 14:** Introduction to the chain rule. Differentiation of semicircles and semiellipses. Chain rule combined with the power rule. If time permits: proof or derivation of the chain rule. Introduction to related rates.
- **(3/25/26) Lecture 15:** Review of standard equations of circles and ellipses. Introduction to implicit differentiation and its motivation. Implicit differentiation from an operator perspective. Continued applications to related rates.
- **(3/30/26) Lecture 16:** Returning to the tangent problem and the concept of locality. Linear approximation centered at a point. Numerical approximation via linearization. Introduction to differentials and applications to error propagation.
- **(4/1/26–4/12/26)** Spring Break — No classes scheduled.
- **(4/13/26)** Midterm #2 Review Session: Students must bring questions from homework and lecture material. This class period is dedicated exclusively to problem solving.
- **(4/25/26) Midterm #2:** Chapter 2 material, Lectures 9–16, Homework 3–4.

Chapter 3

- **(4/20/26) Lecture 17:** Introduction and motivation of optimization problems. Review of vertex form and extrema of quadratic functions. Absolute and local extrema. The Extreme Value Theorem. Fermat's Theorem and proof. Definition of critical values. Closed interval method for absolute extrema.

- **(4/22/26) Lecture 18:** Rolle's Theorem: statement, proof, and applications. Review of secant lines and motivation of the Mean Value Theorem. Geometric interpretation and proof of the Mean Value Theorem. Applications and corollaries.
- **(4/27/26) Lecture 19:** Increasing and decreasing functions. Proof and application of the Increasing/Decreasing Test. Interval tables. Concavity, inflection points, and the relationship to the second derivative. Concavity Test and Second Derivative Test.
- **(4/29/26) Lecture 20:** Guidelines for curve sketching. Mathematical modeling for optimization problems. First Derivative Test. Solving applied optimization problems.
- **(5/4/26) Lecture 21:** Continuation of optimization problems. If time permits: Newton's Method for root finding and an introduction to single-variable gradient descent.
- **(5/6/26)** Midterm #3 Review Session: Students must bring questions from homework and lecture material. This class period is dedicated exclusively to problem solving.
- **(5/11/26) Midterm #3:** Chapter 3 material, Lectures 17–21, Homework 5–6.
- **(5/13/26)** Final Exam Review: Emphasis on curve sketching and comprehensive problem solving.
- **(5/18/26)** Final Exam Review.
- **Final Exam:** TBA.

Math Lab and Tutoring Support

In addition to office hours, I will provide tutoring in the Queens College Math Lab (Kiely Hall 331) on Tuesdays and Thursdays from 2:00–4:00 PM. Students are strongly encouraged to attend tutoring sessions for additional support with lecture material and homework. While full solutions to homework problems will not be provided, guidance and conceptual clarification will be offered.

Course Policies

Homework

There will be six homework assignments throughout the semester. Each assignment is worth 3%, totaling 18% of the final course grade. Homework may include optional extra credit problems, allowing students to earn scores exceeding 100 points.

The method of submission will be clarified once the first assignment is released. Full credit requires sufficient completion of all required problems. Extra credit problems are optional. Points will not be deducted for incorrect final answers; however, incomplete or insufficient reasoning will be penalized.

Homework problems will be labeled *easy*, *medium*, or *hard*, reflecting the expected level of effort. Each assignment corresponds to four consecutive lectures (e.g., Homework 1 covers Lectures 1–4). Homework assignments are designed to prepare students for midterm examinations.

Plagiarism on homework assignments will result in a score of zero for the assignment.

Homework Lateness Policy

Late homework is penalized according to the formula:

$$M - 2^{n+1},$$

where M is the original homework score and n is the number of days late. Scores below zero are recorded as zero.

In-Class Presentations

Students are required to present solutions to homework problems twice during the semester. Up to three students may present during the first 15–20 minutes of class, subject to instructor approval. Correct solutions are not required for full credit; evaluation is based on effort and clarity of presentation.

Midterm and Final Exams

Each midterm exam covers material from eight lectures and two homework assignments. One midterm is administered per chapter. Exam structure will be announced in advance. Make-up exams are granted only with appropriate documentation due to emergencies.

Exam Day Procedure (Tentative)

On the day of an exam, students will be assigned seat numbers and must present a valid Queens College ID card. All prohibited technology must be silenced and stored away. Exams will begin once all students have received exam papers. The allotted exam time is 1 hour and 5 minutes.

Viewing Grades

Grades will be posted on Gradesly, an online platform developed and maintained by Professor Adam Kapelner (Department of Mathematics, Queens College). Login information will be provided at the beginning of the semester.

Additional Academic Support

Students are encouraged to take advantage of additional tutoring resources available through the Math Lab. Additional support is also available through the Learning Commons.

Required Texts and Course Materials

- *Essential Calculus*, 2nd Edition, James Stewart
- Discord (primary communication platform)
- Desmos, TI-84 calculator
- PyCharm (optional; used for in-class Python demonstrations)

Students are not responsible for writing or submitting code associated with computational demonstrations; only the mathematical concepts illustrated by these demonstrations are assessable.

Discord Communication Policy

Discord is to be used as a professional academic space for discussing lecture material, homework, and exams. Channels are organized by assignment and exam. Students must verify their identity upon joining by providing their full name and EMPLID. Access is restricted to enrolled students, and nicknames must be set to first and last names. Link to server **(it will expire on Saturday 1/31/26)**.

Important Academic Dates

A list of significant academic dates for the Spring semester is available at: Spring 2026 Academic Calendar

CUNY Policy on Academic Integrity

Academic integrity is a core value of the City University of New York. All forms of academic dishonesty—including cheating, plagiarism, fabrication, or facilitating academic misconduct—are prohibited and subject to disciplinary action. Sanctions may include failing grades, suspension, or expulsion.

Students are responsible for reviewing the official policy: CUNY Academic Integrity Policy

Students caught cheating on an exam will receive a score of zero and will be reported to the Department of Mathematics.

Reasonable Accommodations for Students with Disabilities

Students requiring accommodations must register with the appropriate campus office and submit documentation within the first week of the semester. For inquiries, contact QC.SPSV@qc.cuny.edu. Additional information is available at: https://www.qc.cuny.edu/sp/

Statement on Student Wellness

Students may experience personal or academic challenges that impact well-being and performance. Confidential mental health and wellness services are available at no cost to enrolled students. Information can be found at: https://www.qc.cuny.edu/cs/