NEW JERSEY CENTER
FOR TEACHING & LEARNING

Progressive Mathematics Initiative® (PMI®)
MATH6453: Learning and Teaching AP Calculus AB

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Course Credit: 4.0 NJCTL credits

Dates & Times:
This is a 4-credit, self-paced course, covering 17 modules of content. The exact number of hours that you can expect to spend on each module will vary based upon the module coursework, as well as your study style and preferences. You should plan to spend approximately 15 hours per credit working online, and up to 30 hours per credit working offline.

Graduate Student Handbook: www.njctl.org/graduate-handbook/

COURSE DESCRIPTION:
This course is for teachers to learn the content of PMI Calculus and how to teach that course to students. It introduces the study of limits, continuity, differentiation, and integration. Concepts are presented and explored from symbolic, algebraic, graphical, and numerical perspectives. Topics include Limits & Continuity; Derivatives; Applications of Derivatives; Analyzing Functions Using Derivatives, Integration; and 2D Applications of Integration.

STUDENT LEARNING OUTCOMES:
Upon completion of the course, the student will be able to:

1. Demonstrate an understanding of introductory calculus topics, detailed in the module learning outcomes below.
2. Integrate PMI materials (including presentations, labs, practice problems, etc.) to support student learning and deliver effective instruction.
3. Create a social constructivist learning environment through the use of formative assessment questions, interpreting the results of this assessment to effectively facilitate student-led discussions that support deeper understanding of the content.
4. Integrate multiple attempts to demonstrate student mastery of content knowledge, as encouraged/fostered by the PMI pedagogy.

5. Implement learning plans that are aligned to advanced placement standards and allow for differentiation based on the needs of learners.
6. Implement learning plans that are aligned to advanced placement standards, incorporate literacy strategies and allow for differentiation.

TEXTS, READINGS, INSTRUCTIONAL RESOURCES:
Required Texts:

- This course uses a free digital textbook accessible at: https://moodle.njctl.org/course/view.php?id=198
- Participants will download SMART Notebook presentations, homework files, labs, and teacher resources.

Recommended Readings:

- Related articles within discussion prompts

COURSE REQUIREMENTS:
In order to receive a Passing grade, the participant must complete the following course requirements:

1. Activities: A number of different learning activities will ensure participant engagement and learning in the course. These include:
   - Engage in video module lessons which demonstrate minimized direct instruction followed by frequent formative assessment.
   - Completion of formative assessments aligned to learning objectives which include detailed analysis when answered incorrectly.
   - Interaction with module discussion boards that allow conversation with peers and course instructors about the module's content, delivering that content to students. Discussion boards also serve as a place to ask and answer questions related to the module's content.
2. Short Answer Assignment: Each module requires one (1) original response to a given prompt. These prompts are typically based upon course lessons and require teachers to analyze, reflect, and make connections between the module's content and their own classroom practice.
3. Mastery Exercises: For each module, these multiple-choice question quizzes assess the content knowledge gained in a module. Participants have the opportunity to retake; random questions are pulled from a larger question bank on each attempt ensuring varied questions.
4. Virtual Labs: In each module, a virtual lab write-up will be submitted. Virtual labs are interactive lab simulations that promote discovery-based student learning through real-world applications and analysis.
5. Module Exam: One is completed at the end of each module. It is a culminating exam consisting of multiple choice and free response questions aligned to the standards and objectives of the module.
6. Reflection Paper: At the end of the course, participants are required to reflect on the knowledge taught in the course, make connections, and compare/contrast their current pedagogy with new strategies gained in this assignment.

7. Final Exam: At the end of the course, a comprehensive exam consisting of Multiple Choice and Free Response questions assesses the content knowledge learned throughout the course.

GRADE DISTRIBUTION AND SCALE:

Grade Distribution:

Module Exams	70%
Final Exam	10%
Labs	6%
Short Answer Assignments	6%
Mastery Exercises	6%
Reflection Paper	2%

Grade Scale:

A	93 – 100
A-	90 – 92
B+	86 – 89
B	83 – 86
B-	80 – 82
C+	77 – 79
C	73 – 76
C-	70 – 72
D	60.0 – 69.9
F	59.9 or below

GRADING RUBRIC:

The following rubric is used to score:

- Short Answer Assignment – 6% of grade
- Reflection Paper – 2% of grade

The minimum possible score for this rubric is 4 points, and the score will be converted to the minimum grade available in this module (which is zero unless the scale is used). The maximum score of 25 points will be converted to the maximum grade.

Intermediate scores will be converted respectively and rounded to the nearest available grade. If a scale is used instead of a grade, the score will be converted to the scale elements as if they were consecutive integers.

	Meets Expectation	Approaches Expectation	Below Expectation	Limited Evidence
	7 points	***5 points***	***3 points***	***1 point***
Content	• Demonstrates excellent knowledge of concepts, skills, and theories relevant to topic.	• Demonstrates fair knowledge of concepts, skills, and theories.	• Demonstrates incomplete or insubstantial knowledge of concepts, skills, and theories.	• Demonstrates little or no knowledge of concepts, skills, and theories.
Depth of Reflection	• Content is well supported and addresses all required components of the assignment.	• Content is partially supported; addresses most of the required components of the assignment.	• Content contains major deficiencies; addresses some of the required components of the assignment.	• Content is not supported and/or includes few of the required components of the assignment.
Evidence and Practice	• Response shows strong evidence of synthesis of ideas presented and insights gained throughout the entire course. The implications of these insights for the respondent's overall teaching practice are thoroughly detailed, as applicable.	• Writing is mostly clear, concise, and well organized with good sentence/paragraph construction. Thoughts are expressed in a coherent and logical manner. There are no more than five spelling, grammar, or syntax errors per page of writing.	• Response is missing some components and/or does not fully meet the requirements indicated in the instructions. Some questions or parts of the assignment are not addressed. Some attachments and additional documents, if required, are missing or unsuitable for the purpose of the assignment.	• Response excludes essential components and/or does not address the requirements indicated in the instructions. Many parts of the assignment are addressed minimally, inadequately, and/or not at all.
	4 points	***3 points***	***2 points***	***1 point***
Writing Quality	• Writing is well-organized, clear, concise, and focused; no errors.	• Some minor errors or omissions in writing organization, focus, and clarity.	• Some significant errors or omissions in writing organization, focus, and clarity.	• Numerous errors in writing organization, focus, and/or clarity.

The following rubric is used to score:

- Labs – 6% of grade

The minimum possible score for this rubric is 2 points, and the score will be converted to the minimum grade available in this module (which is zero unless the scale is used). The maximum score of 14 points will be converted to the maximum grade.

Intermediate scores will be converted respectively and rounded to the nearest available grade. If a scale is used instead of a grade, the score will be converted to the scale elements as if they were consecutive integers.

	Meets Expectation	**Approaches Expectation**	**Below Expectation**	**Limited Evidence**
	7 points	***5 points***	***3 points***	***1 point***
Completeness	• Lab write-up is complete with no missing fields.	• Lab write-up has 1-2 missing fields.	• Lab write-up has 3-5 missing fields.	• There are more than 5 missing fields on the lab write-up.
Calculations	• All answers are calculated correctly.	• Most answers are calculated correctly, but there are 1-2 minor calculation errors.	• Most answers are calculated correctly, but there are multiple minor calculation errors, or 1-2 gross miscalculations.	• There are calculation errors throughout the lab.

The remaining types of assignments are not scored using a rubric. These assignments are scored using percentage correct to assign a letter grade. The assignments in this manner are as follows:

- Mastery Exercises – 6% of grade
- Module Exams – 70% of grade
- Final Exam – 10% of grade

Mastery Exercises can be retaken as many times as desired to ensure a high score. Due to the nature of these assignments, each time they are taken, they will be composed of unique questions pulled randomly from a larger question bank.

Module and Final Exams are scored using a curve, which allows us to keep content exams rigorous. Module Exams can be retaken one time. Final Exams cannot be retaken.

ACADEMIC STANDING:

NJCTL has established standards for academic good standing within a student's academic program. Students enrolled in any NJCTL online course must receive an 80 or higher to successfully complete a course and receive credit for that course. An 80 is equivalent to a GPA

of 2.7 or B-. Additionally, students in an endorsement program must receive a cumulative GPA of 3.0 for all courses combined in order to successfully complete the program.

ACADEMIC INTEGRITY:
Students must assume responsibility for maintaining honesty in all work submitted for credit and in any other work designated by the instructor of the course. Academic dishonesty includes cheating, fabrication, facilitating academic dishonesty, plagiarism, reusing /repurposing your own work, unauthorized possession of academic materials, and unauthorized collaboration.

CITING SOURCES WITH APA STYLE:
All students are expected to follow proper writing and APA requirements when citing in APA (based on the APA Style Manual, 6th edition) for all assignments.

DISABILITY SERVICES STATEMENT:
We are committed to providing reasonable accommodations for all persons with disabilities. Any student with a documented disability requesting academic accommodations should contact the Dean of Students, Melissa Axelsson, for additional information to coordinate reasonable accommodations for students with documented disabilities (melissa@njctl.org).

NETIQUETTE:
Respect the diversity of opinions among the instructor and classmates and engage with them in a courteous, respectful, and professional manner. All posts and classroom communication must be conducted in accordance with the student code of conduct. Think before you push the Send button. Did you say just what you meant? How will the person on the other end read the words?

Maintain an environment free of harassment, stalking, threats, abuse, insults or humiliation toward the instructor and classmates. This includes, but is not limited to, demeaning written or oral comments of an ethnic, religious, age, disability, sexist (or sexual orientation), or racist nature; and the unwanted sexual advances or intimidations by email, or on discussion boards and other postings within or connected to the online classroom.

If you have concerns about something that has been said, please let your instructor know.

CLASS SCHEDULE:

Module	Module Learning Outcomes	Assignments
1 – Limits & Continuity Part 1	● Interpret the rate of change at an instant in terms of average rates of change over intervals containing that instant. ● Represent limits analytically using correct notation. ● Interpret limits expressed in analytic notation. ● Estimate limits of functions.	● Mastery Exercises ● Short Answer Assignment

2 – Limits & Continuity Part 2	• Determine the limits of functions using limit theorems. • Determine the limits of functions using equivalent expressions for the function or the squeeze theorem. • Justify conclusions about continuity at a point using the definition. • Determine intervals over which a function is continuous. • Determine values of x or solve for parameters that make discontinuous functions continuous, if possible. • Interpret the behavior of functions using limits involving infinity. • Determine limits of functions that result in indeterminate forms.	• Mastery Exercises • Short Answer Assignment
3 – Limits & Continuity Part 3	• Justify conclusions about continuity at a point using the definition. • Determine intervals over which a function is continuous. • Determine values of x or solve for parameters that make discontinuous functions continuous, if possible. • Explain the behavior of a function on an interval using the Intermediate Value Theorem.	• Mastery Exercises • Short Answer Assignment • Lab • Module Exam (Calculator & Non-Calculator)
4 – Derivatives Part 1	• Determine average rates of change using difference quotients. • Represent the derivative of a function as the limit of a difference quotient. • Estimate derivatives. • Interpret a limit as a definition of a derivative. • Explain the relationship between differentiability and continuity. • Calculate derivatives of familiar functions. • Determine higher order derivatives of a function.	• Mastery Exercises • Short Answer Assignment • Lab
5 – Derivatives Part 2	• Calculate derivatives of products and quotients of differentiable functions. • Calculate derivatives of compositions of differentiable functions.	• Mastery Exercises • Short Answer Assignment
6 – Derivatives Part 3	• Approximate a value on a curve using the equation of a tangent line. • Approximate a value on a curve using the equation of a normal line. • Calculate derivatives of inverse and inverse trigonometric functions. • Determine the equation of a line tangent to a curve at a given point. • Apply the rules of derivatives to solve various problems.	• Mastery Exercises • Short Answer Assignment • Module Exam (Calculator & Non-Calculator)

7 – Applications of Derivatives Part 1	• Interpret the meaning of a derivative in context. • Calculate rates of change in applied contexts. • Interpret rates of change in applied contexts. • Calculate related rates in applied contexts. • Interpret related rates in applied contexts. • Calculate derivatives of implicitly defined functions.	• Mastery Exercises • Short Answer Assignment • Lab
8 – Applications of Derivatives Part 2	• Make connections between position, velocity and acceleration functions. • Approximate a value on a curve using the equation of a tangent line. • Apply rules of differentiation to solve real world applications.	• Mastery Exercises • Short Answer Assignment • Module Exam (Calculator & Non-Calculator)
9 - Analyzing Functions using Derivatives Part 1	• Justify conclusions about functions by applying the Extreme Value Theorem. • Justify conclusions about the behavior of a function based on the behavior of its derivatives. • Calculate minimum and maximum values in applied contexts or analysis of functions. • Interpret minimum and maximum values calculated in applied contexts.	• Mastery Exercises • Short Answer Assignment • Lab
10 -Analyzing Functions using Derivatives Part 2	• Justify conclusions about functions by applying the Mean Value Theorem over an interval. • Justify conclusions about the behavior of a function based on the behavior of its derivatives. • Calculate minimum and maximum values in applied contexts or analysis of functions. • Interpret minimum and maximum values calculated in applied contexts. • Determine critical points of implicit relations. • Justify conclusions about the behavior of an implicitly defined function based on evidence from its derivatives. • Apply function analysis to solve optimization problems.	• Mastery Exercises • Short Answer Assignment • Module Exam (Calculator & Non-Calculator)
11 - Integration Part 1	• Interpret the meaning of areas associated with the graph of a rate of change in context. • Approximate a definite integral using geometric and numerical methods. • Interpret the limiting case of the Riemann sum as a definite integral. • Represent the limiting case of the Riemann sum as a definite integral.	• Mastery Exercises • Short Answer Assignment • Lab

12 - Integration Part 2	• Represent accumulation functions using definite integrals. • Calculate a definite integral using areas and properties of definite integrals. • Evaluate definite integrals analytically using the Fundamental Theorem of Calculus. • Determine antiderivatives of functions and indefinite integrals, using knowledge of derivatives.	• Mastery Exercises • Short Answer Assignment
13 - Integration Part 3	• Find integrals using u-Substitution. • Apply the mean value theorem to integrals. • Apply the average value theorem to integrals. • Evaluate definite integrals analytically using the Fundamental Theorem of Calculus.	• Mastery Exercises • Short Answer Assignment • Module Exam (Calculator & Non-Calculator)
14 - Applications of Integration Part 1	• Determine the average value of a function using definite integrals. • Determine the average value of a function using definite integrals. • Interpret the meaning of a definite integral in accumulation problems. • Determine net change using definite integrals in applied contexts. • Calculate areas in the plane using the definite integral.	• Mastery Exercises • Short Answer Assignment
15 - Applications of Integration Part 2	• Find the volume of a solid of revolution using the disc method. • Find the volume of a solid of revolution using the washer method. • Find the volume of a solid of revolution using the known cross-sections method.	• Mastery Exercises • Short Answer Assignment • Lab • Module Exam (Calculator & Non-Calculator)
16 - Differential Equations	• Use slope fields to determine derivatives or original function. • Create slope fields of derivatives. • Verify solutions to differential equations. • Estimate solutions to differential equations. • Determine general solutions to differential equations. • Determine particular solutions to differential equations. • Interpret the meaning of a differential equation and its variables in context. • Determine general and particular solutions for problems involving differential equations in context.	• Mastery Exercises • Short Answer Assignment • Lab • Module Exam (Calculator & Non-Calculator)
17 – Reflection & Final Exam	• Prepare for exam through discussion board and/or meeting with professor	• Reflection Paper • Final Exam