Techniques of Calculus
Math 110, Sections 001 and 002

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Text: *Brief Calculus, An Applied Approach, 7th Edition*, R. Larson and B. Edwards, Houghton-Mifflin, Boston New York, 2006.

Calculator: Calculators are not allowed for any in-class assessment such as the final, midterms or in-class quizzes.

Grades: The grading scheme is the following:

Lecture notes	3/week	**no re-grade**	125pts (total)
WeBWorK	2 or 3 per week	**retry-able**	125pts (total)
Midterm 1	Thursday, February 8	**re-grade**	100pts
Midterm 2	Thursday, March 8	**re-grade**	100pts
Midterm 3	Thursday, April 12	**re-grade**	100pts
Final Exam	Regularly scheduled times and days	**no re-grade**	150pts
Total			**700**pts

Class Format The course is about problem solving, so that means the format is as follows:

1. You must read the appropriate section of the text *before* the class when it is to be covered.

2. You must write up your own notes on the section of material and bring them to class - these are to be a resource for you during the course.

3. You should start the WeBWorK assignment for the section *before* the class and bring your WeBWorKassignment to class (along with your work).

4. The class will begin with a brief lecture by of the most important points on the material (approximately $15 \sim 20$ minutes), after which the class will break up into groups. The groups will work together on WeBWorKproblems for the remainder of the period. I will be available for help during that time and I'll try to spend some time with each group.

5. The last $5 \sim 10$ minutes might consist of a summary by me of points that have come up repeatedly during period.

6. The lecture notes are to be handed in at the end of the class.

Re-Grades: There are no re-grades for lecture notes or the final exam. There are however re-grades for the midterm exams. The re-grades are entirely optional. To make sure that your re-grade is considered, you should follow these steps.

1. Each question you want to get re graded should be on a **separate** page or pages. Multi-part questions can go on the same page.

2. Show **all** your work for the question.

3. Attach all the re-grade pages together using either staples or a paper-clip and slip the re-grade into the exam.

4. You **must** include your original exam. No original, no re-grade.

If your re-grade is entirely correct, then you can receive 50% of the points remaining for the question. Thus, a question that you originally got 4 for would (if you did the re-grade correctly) get $4 + 1/2 \times (10 - 4)/10 = 7/10$ points after the re-grade.

The Course: This course is a designed as a first course in calculus. The course begins with the definition of limits and continuity including the various consequences such as the Intermediate Value and Extreme Value Theorems. After that we come to the definition of the derivative and the various methods for computing the derivative such as the product, quotient and chain rules. We also touch on the derivatives of the transcendental functions such as the exponential, logarithmic, sine, cosine and tangent functions as well. Applications to finding the derivative of functions defined as the solution of some equation in two variables (implicit functions) as well as to physics, economics and biology via the interpretation of the derivative as the rate of change are introduced.

More challenging applications folloow with the Mean Value and Fermat's Theorems which form the basis for using calculus to solve problems in optimization. Convexity and concavity are introduced as a further application of the Mean Value Theorem and as an aid to optimization. Curve sketching is also discussed using the geometric information gleaned from the first and second derivatives.

Moving to antiderivatives, we introduce the Reimman sum and the definite integral. The relation to the derivative is provided through the Fundamental Theorem of Calculus. Extensions via the Substitution Rule aare used to derive some of the properties of the logarithm.

The last section of the course deals with applications of integration to area and volume problems, including volumes of revolution, work and averages

Course Objectives:
At the end of this course you should be able to:

- Use the definition of a limit to verify that a given number is a limit of a given function at a given point
- Verify that a given function is continuous either at a given point or on a given domain
- Find approximate solutions to an equation by using the Intermediate Value Theorem.
- Find the derivative of a function by using the sum, difference, power, product, quotient or chain rules as appropriate, starting from the derivatives of the powers of x, the exponential or logarithmic functions.
- Use the chain rule to find the derivative of an implicitly defined function.
- Find the higher derivatives of a function.
- Use Fermat's Theorem to find the critical points of a function.
- Use the first derivative test to find where a function is increasing or decreasing and so to categorize critical points as local extrema or points of inflection.
- Use the second derivative test to categorize critical points as extrema and to find intervals where the function is concave up or concave down.
- Solve optimization problems using these techinques
- Sketch graphs of functions using these techniques
- Use the Riemann integral to express various quantities in terms of definite integrals.
- Use the Fundamental Theorem of Calculus to compute definite integrals for polynomial, exponential and simple rational functions
- Use the Substitution Rule to calculate indefinite and definite integrals.
- Use definite integrals to compute areas between curves
- Use the method of integration by parts to compute integrals and solve problems involving compound interest and revenue and payment streams.

Lecture Outline: The tentative schedule for the semester is:

Week 1: 01/17, 01/18, 01/19

Wednesday: Introduction to the syllabus and WeBWorK demonstration

Thursday: Modelling the lecture notes (I)

Friday: Modelling the lecture notes (II)

Week 2: 01/22, 01/24, 01/25, 01/26, 01/27

Monday: 1.1 The Cartesian Plane and the Distance Formula

Wednesday: 1.2 Graphs of Equations

Thursday: Problems/Review
WeBWorK 1.1 The Cartesian Plane and the Distance Formula due

Friday: 1.3 Lines in the Plane and Slope

Saturday: WeBWorK 1.2 Graphs of Equations due

Week 3: 01/29, 01/31, 02/01, 02/02

Monday: 1.4 Functions Functions
WeBWorK 1.3 Lines in the Plane and Slope due

Wednesday: 1.5 Limits (I)

Thursday: Problems/Review
WeBWorK 1.4 Functions due

Friday: 1.5 Limits (II)/1.6 Continuity (I)

Week 4: 02/05, 02/07, 02/08, 02/09

Monday: 1.6 Continuity (II)
WeBWorK 1.5 Limits due

Wednesday: Review

Thursday: Exam 1
WeBWorK 1.6 Continuity due

Friday: 2.1 The Derivative and the Slope of a Graph

Week 5: 02/12, 02/14, 02/15, 02/16, 02/17

Monday: 2.2 Some Rules for Differentiation
WeBWorK 2.1 The Derivative and the Slope of a Graph due

Wednesday: 2.3 Rates of Change: Velocity and Marginals

Thursday: Problems/Review
WeBWorK 2.2 Some Rules for Differentiation due

Friday: 2.4 The Product and Quotient Rules (I)

Saturday: WeBWorK 2.3 Rates of Change: Velocity and Marginals due

Week 6: 02/19, 02/21, 02/22, 02/23, 02/24

Monday: 2.4 The Product and Quotient Rules (II)/2.5 The Chain Rule (I)
WeBWorK due

Wednesday: 2.5 The Chain Rule (II)

Thursday: Problems/Review
WeBWorK 2.4 The Product and Quotient Rules due

Friday: 2.6 Higher-Order Derivatives

Saturday: WeBWorK 2.5 The Chain Rule due

Week 7: 02/26, 02/28, 03/01, 03/02, 03/03

Monday: 2.7 Implicit Differentiation (I)
WeBWorK 2.6 Higher-Order Derivatives due

Wednesday: 2.7 Implicit Differentiation (II)/2.8 Related Rates (I)

Thursday: Problems/Review

Friday: 2.8 Related Rates (II)

Saturday: WeBWorK 2.7 Implicit Differentiation due

Week 8: 03/05, 03/07, 03/08, 03/09

Monday: 3.1 Increasing and Decreasing Functions
WeBWorK 2.8 Related Rates due

Wednesday: Review

Thursday: Exam 2
WeBWorK 3.1 Increasing and Decreasing Functions due

Friday: 3.2 Extrema and First-Derivative Test

Week 9: 03/19, 03/21, 03/22, 03/23, 03/24

Monday: 3.3 Concavity and the Second-Derivative Test
WeBWorK 3.2 Extrema and First-Derivative Test due

Wednesday: 3.4 Optimization Problems

Thursday: Problems/Review
WeBWorK 3.3 Concavity and the Second-Derivative Test due

Friday: 3.5 Business and Economics Applications

Saturday: WeBWorK 3.4 Optimization Problems due

Week 10: 03/26, 03/28, 03/29, 03/30, 03/31

Monday: 3.6 Asymptotes
WeBWorK 3.5 Business and Economics Applications due

Wednesday: 3.7 Curve Sketching

Thursday: Problems/Review
WeBWorK 3.6 Asymptotes due

Friday: 3.8 and Marginal Analysis

Saturday: WeBWorK 3.7 Curve Sketching due

Week 11: 04/02, 04/04, 04/05, 04/06, 04/07

Monday: 4.1 Exponential Functions
WeBWorK 3.8 Differentials and Marginal Analysis due

Wednesday: 4.2 Derivatives of Exponential Functions

Thursday: Problems/Review
WeBWorK 4.1 Exponential Functions due

Friday: 4.3 Logarithmic Functions

Saturday: WeBWorK 4.2 Derivatives of Exponential Functions due

Week 12: 04/09, 04/11, 04/12, 04/13

Monday: 4.4 Derivatives of Logarithmic Functions
WeBWorK 4.3 Logarithmic Functions due

Wesnesday: Review

Thursday: Exam 3
WeBWorK 4.4 Derivatives of Logarithmic Functions due

Friday: 4.5 Exponential Growth and Decay

Week 13: 04/16, 04/18, 04/19, 04/20, 04/21

Monday: 5.1 Antiderivatives and Indefinite Integrals
WeBWorK 4.5 Exponential Growth and Decay due

Wednesday: 5.2 The General Power Rule

Thursday: Problems/Review
WeBWorK 5.1 Antiderivatives and Indefinite Integrals due

Friday: 5.3 Exponential and Logarithmic Integrals

Saturday: WeBWorK 5.2 The General Power Rule due

Week 14: 04/23, 04/25, 04/26, 04/27, 04/28

Monday: 5.4 Area and the Fundamental Theorem of Calculus
WeBWorK 5.3 Exponential and Logarithmic Integrals due

Wednesday: 5.5 The Area of a Region Bounded by Two Graphs

Thursday: Problems/Review
WeBWorK 5.4 Area and the Fundamental Theorem of Calculus due

Friday: 5.6 The Definite Integral as the Limit of a Sum

Saturday: WeBWorK 5.5 The Area of a Region Bounded by Two Graphs due

Week 15: 04/30, 05/02, 05/03, 05/04, 05/05

Monday: 6.1 Integration by Substitution
WeBWorK 5.6 The Definite Integral as the Limit of a Sum due

Wednesday: 6.2 Integration by Parts and Present value
WeBWorK 6.1 Integration by Substitution due

Thursday: Review

Friday: Review

Saturday: WeBWorK 6.2 Integration by Parts and Present value due

Week 16: 05/07, 05/08

Monday: Final, Section 001

Tuesday: Final, Section 002

Attendance: Experience has shown that if you miss more than 10% or so of the lectures, you're likely to fail.

Cell Phones: Cell phones are to be turned *off* during class and are not permitted under *any* circumstances during an evaluative situation such as a quiz, midterm or final. Not only is it rude to use them in class, it leaves you open to a charge of violating the academic integrity code.

Snow Days: See my webpage or call my phone for a recorded message to see if class is cancelled. It is highly unlikely that I will cancel but the University won't.

Academic Integrity Defintion and Expectations: Academic integrity is the pursuit of scholarly activity in an open, honest and responsible manner. Academic integrity is a basic guiding principle for all academic activity at The Pennsylvania State University, and all members of the University community are expected to act in accordance with personal integrity, respect other students' dignity, rights and property, and help create and maintain an environment in which all can succeed through the fruits of their efforts.

Academic integrity includes a commitment not to engage in or tolerate acts of falsification, misrepresentation or deception. Such acts of dishonesty violate the fundamental ethical principles of the University community and compromise the worth of work completed by others. (*Policies and Rules for Students, Section 49-20.*)

Consequences of academic dishonesty: The instructor may assign an academic sanction ranging from a warning to failure on an assignment or in the course or to removal from the course. (Note that a failure in a course may affect a student's status in a program and/or in the University.) The instructor reportseach academic sanction to the Office of Judicial Affairs, which keeps a record. Students can appeal academic sanctions to the Committee on Academic Integrity through the Office of Academic Affairs. In more serious cases of academic sanctions of academic dsihonesty, the Office of Judicial affairs may

apply disciplinary sanctions in addition to the academic sanctions. These may range from a warning to probation, suspension or expulsion from the University. An "XF"grade is a formal University disciplinary sanction indicating on the student's transcript that failure in a course was due to a serious act of academic dishonesty. (*Policies and Rules for Students, Section 49-20 and Academic Integrity Procedure G-9.*)