

**SALEM STATE UNIVERSITY
MATHEMATICS DEPARTMENT
COURSE SYLLABUS
MAT 220, Calculus I**

Course Description: An introduction to the differential calculus of real-valued functions of one real variable. Limits, derivatives and their applications will be studied in a context that includes polynomial, rational, trigonometric, exponential, and logarithmic functions.

Prerequisite: Completion of the Basic College Mathematics Competency Requirement and MAT 202N or an in-depth knowledge of trigonometric and logarithmic functions.

Suggested Texts:

Stewart, James, *Calculus - Early Transcendentals*, 5th edition, Thomson, Brooks/Cole, 2003
Thomas, George B., *Calculus*, 11th edition, Pearson, Addison Wesley, 2005.

Global Goals: This course is intended to:

- Introduce the fundamental theories and techniques of differential calculus.
- Teach students to communicate mathematics clearly, both verbally and in writing.
- Teach students to use mathematics to solve problems requiring creativity and insight, as well as those using algorithms.
- Teach students to assess the reasonableness of their solutions.
- Expose students to applications of mathematics from other disciplines.

Instructional Objectives: The student will be able to:

- Represent a functional relationship algebraically, graphically and using tables.
- Estimate limits through numerical tables and graphs.
- Calculate limits precisely using algebraic manipulation and limit theorems.
- Use mathematical models involving exponential and logarithmic functions.
- Use the derivative to find instantaneous rates of change.
- Find derivatives of functions defined explicitly and implicitly.
- Solve optimization problems using derivatives.
- Use linearizations to approximate values of nonlinear function.
- Use derivatives to sketch key features of a function.
- Calculate elementary antiderivatives.

Course Outline:

I. Functions and their Graphs.

Week 1	<ul style="list-style-type: none">• Definition of function; numerical, algebraic, and graphical analysis of functions; functional notation
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	<ul style="list-style-type: none"> • Domains and ranges • Linear functions, polynomials, and rational functions • The absolute value and square root function
Week 2	<ul style="list-style-type: none"> • Combinations of functions—arithmetical and compositions • Inverse functions

II. Limits.

Week 3	<ul style="list-style-type: none"> • Intuitive limits, numerical and graphical analysis of limits • Limit Theorem and applications
Week 4	<ul style="list-style-type: none"> • Limits by factoring and canceling • One-sided limits and limits of piecemeal functions
Week 5	<ul style="list-style-type: none"> • Horizontal and vertical asymptotes • The Squeeze Theorem • Continuity

III. Derivatives.

Week 6	<ul style="list-style-type: none"> • Definition of $f'(a)$, meaning as slope of tangent line, calculations of $f'(a)$ from definition
Week 7	<ul style="list-style-type: none"> • Sum, difference, product, and quotient rules with some proofs
Week 8	<ul style="list-style-type: none"> • Review of trigonometric functions • $\lim_{x \rightarrow 0} \sin x/x$, and $\lim_{x \rightarrow 0} (1 - \cos x)/x$ • Derivatives of trig functions • The Chain Rule, implicit differentiation
Week 9	<ul style="list-style-type: none"> • Review of logarithmic and exponential functions • Derivatives of logs and exponentials • Exponential growth and decay • Linearization and differentials

IV. Applications of derivatives.

Week 10	<ul style="list-style-type: none"> • Local and absolute extrema, Extreme Value Theorem, Critical Point Theorem • MVT with proof
Week 11	<ul style="list-style-type: none"> • Analyzing direction using the first derivative • Analyzing concavity using the second derivative

Week 12	<ul style="list-style-type: none"> • Rectilinear Motion • Optimization Problems
Week 13	<ul style="list-style-type: none"> • L'Hopital's Rule and Indeterminate forms of type $\frac{0}{0}$ and $\frac{\infty}{\infty}$
Week 14	<ul style="list-style-type: none"> • Antiderivatives including u-substitution

Grading:

A possible grading scheme is:

Grades will be based on three exams and a mandatory final exam. Each will count as 25% of the grade.

University Policy Statement:

Salem State University is committed to providing equal access to the educational experience for all students in compliance with Section 504 of the Rehabilitation Act and the Americans with Disabilities Act and to providing all reasonable academic accommodations, aids, and adjustments. Any student who has a documented disability requiring an accommodation, aid or adjustment should speak with the instructor immediately. Students with disabilities who have not previously done so should provide documentation to and schedule an appointment with the office for Students with Disabilities and obtain appropriate services.

Bibliography:

H. Anton, *Brief Calculus*, 7th edition, Hoboken, N.J.: John Wiley & Sons, Inc., 2002.

C. Clements, R. Pantozzi, and S. Steketee, *Exploring Calculus with The Geometer's Sketchpad*, Emeryville, C.A.: Key Curriculum Press, 2002.

M.Cohen, E. D. Gaughan, A.Knoebel, D.S. Kurtz, D. Pengelley, *Student Research Projects in Calculus*, Mathematical Association of America, 1991.

A. Crannell, G. Larose, T. Ratliff, and E. Rykken, *Writing Projects for Mathematics Courses*, Mathematical Association of America, 2004.

G. R. Woods, *Calculus Mysteries and Thrillers*, Mathematical Association of America, 1998.

Justification for Q Designation for MAT 220, Calculus I:

1. Interpret and/or predict trends:

Students in MAT 220, Calculus I, interpret and/or predict trends when the concept of a limit is introduced. Students use numerical tables and/or graphs to estimate limits.

Example: Find the limit: $\lim_{x \rightarrow 0} \frac{\sin x}{x}$.

Students generate values of the function $f(x) = \frac{\sin x}{x}$ and make tables like the one shown here:

After examining the table of values, students can then predict that as the

x values approach zero, the $f(x)$ values approach one.

2. Collect, manipulate, plot and analyze data with or without technical equipment:

In MAT 220, Calculus I, students collect data to estimate limits, as seen above in #1.

x	$f(x) = \frac{\sin x}{x}$
.1	.998334166
.01	.999983333
.001	.999998333
.0001	.999999998
.00001	.999999999
-.1	.998334166
-.01	.999983333
-.001	.999998333
-.0001	.999999998
-.00001	.999999999

Students also plot data when they sketch the graphs of functions. Derivatives, the central tool of Calculus I, are used to predict a function's behavior.

Example:

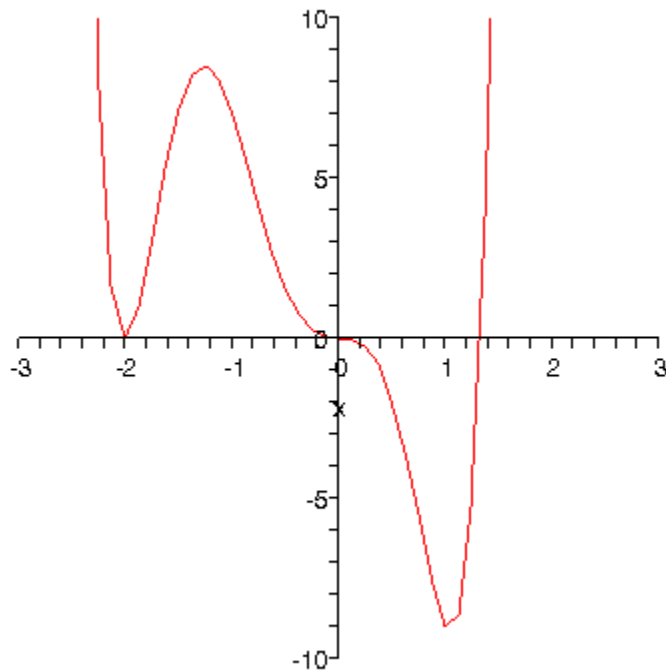
Make a conjecture about the behavior of the graph of:

$$y = x^3 - 4x^2 + 2x$$

in the vicinity of its x -intercepts, and test your conjecture by generating the graph.

Source: *Brief Calculus*, Anton, 7th edition, pg. 260.

Students set the function above equal to zero to find that the x -intercepts occur at $x = 0, \frac{4}{3}$ and -2 . They use information from the derivative to quickly analyze what the graph of the function should look like near each of those points. They then plot the function either by hand, with a graphing calculator or using Maple software in our Mathematics Lab.



3. Use a model, theory or principle to analyze quantitative problems; and at least one of the following:

- a. Use mental estimates to quantify, interpret, and check information.
- b. Recognize when approximation is more appropriate than a precise answer.
- c. Discern the quantitative versus the qualitative issues from a problem situation.

In MAT 220, Calculus I, students use exponential models to analyze population change. Depending on the context of the problem, students find either an exact numerical answer or an approximation.

Example:

Suppose that the spread of the flu virus on a college campus is modeled by the function

$$y(t) = \frac{100}{1 + 9e^{-t}}$$

where $y(t)$ is the number of infected students at time t (in days, starting with $t=0$). Use a graphing utility to estimate the day on which the virus is spreading most rapidly.

Source: *Brief Calculus*, Anton, 7th edition, pgs. 476-7.
