



COURSE SYLLABUS

Course: Calculus I
Number: MAT 2610
Credit-Hours: 4 Credits

Course Description: A brief review of algebra and trigonometry; coordinate systems, analytical geometry, the derivative using the definition, limits, continuity, techniques of differentiation; Mean Value theorem and its application, Applications of differentiation to extreme value problems, curve sketching and related rates problems, the integral and its properties, applications of the integral for finding area under a curve, antiderivatives, the Fundamental Theorem of Calculus.

Prerequisite: MAT 1140 (Precalculus with Trigonometry or equivalent)

Detailed Syllabus:

0. Getting Started

1. Email and Chat
2. Learning About the Course
3. Required Hardware
 - i. Relatively new computer (Windows XP or Mac OSX 10.3 or higher)
 - ii. USB scanner
 - iii. Adjustable Webcam
 - iv. High-speed internet connection
4. Software
 - i. LiveMath Maker
 - ii. QuickTime/iTunes

Comprehensive Precalculus Review

e-Text: *The Primitives of Precalculus* by Robert Curtis

1. The Big Picture

1. Solving (easy) equations in 1 variable.
2. What if you can't solve for x?
3. Finding solutions numerically
4. Finding solutions graphically
5. Solving equations of more than 1 variable

2. Functions

1. Function notation.
2. Data sets
3. Graphing functions
4. Data sets and smooth curves
5. Domain and Range
6. Algebraic combinations of functions

3. Linear Functions

1. Algebraic definition
2. Slope
3. Graphing linear functions by hand
4. Properties of linear functions
5. Linear data sets

4. Quadratic Functions

1. Algebraic definition
2. Graphing and Properties of Quadratic Functions
3. Solving quadratic equations algebraically: Factoring
4. Solving quadratic equations algebraically: Quadratic formula
5. Solving quadratic equations numerically and graphically
6. Complex Numbers
7. Quadratic data sets

5. Power and Polynomial Functions

1. Algebraic definition
2. Graphing and Properties of Polynomial Functions
3. Solving polynomial equations algebraically: factoring
4. Solving polynomial equations numerically and graphically
5. Fundamental Theorem of Algebra
6. Radicals and fractional exponents

6. Rational Polynomial Functions

1. Algebraic definition
2. Graphing and Properties of Rational Polynomial Functions
3. Solving rational polynomial equations algebraically: factoring
4. Solving rational polynomial equations numerically and graphically

7. Exponential Functions

1. Algebraic definition
2. Graphing and Properties of Exponential Functions
3. Solving exponential equations numerically and graphically
4. Exponential Growth and Applications
5. Data sets and exponential functions.

8. Logarithmic Functions

1. Inverse Functions
2. Algebraic Definition
3. Graphing and Properties of Logarithmic Functions
4. Solving exponential and logarithmic equations algebraically
5. Solving logarithmic equations numerically and graphically
6. Logarithmic Growth and Applications
7. Data sets and logarithmic functions.

9. Modern Motivations for Calculus

1. Analysis of Graphical Data: Live Stock Price Data
2. Predicting: Using small changes in price to predict
3. Limits & Continuity: Is the stock price being nice and calm?
4. Concavity: Buy low, sell high.
5. Accumulation: How much money did we make?
6. Classical Motivations
 - a. Position, Velocity, Acceleration
 - b. Slope of Tangent Line at a Point on Function Plot
 - c. Area Under a Function Plot

Calculus&LiveMath by *Davis/Porta/Uhl* e-Textbook

10. Growth: Preparing for the Derivative

1. Growth of Linear Functions
2. Growth of Power Functions
3. Growth of Exponential Functions
4. Dominance of Growth of Functions
5. Percentage Growth of Functions
6. Global Scale: Infinite Limits
7. Data Functions and Interpolation
8. Approximation of Functions by Linear Functions
9. Growth of Trigonometric Functions

11. Continuity

1. Limits
2. Continuous Functions
3. Jump Discontinuities
4. Piecewise Functions and Continuity
5. Limit Rules

12. Exponential Functions and Natural Logarithms

1. e
2. Natural Logarithm
3. Growth Analysis
4. Applications: Carbon Dating
5. Percentage Growth and Steady Growth of Exponential Functions
6. Data Functions and Logarithmic Analysis
7. Inverse Functions
8. Applications: Compound Interest and Finance
9. Applications: World Population

13. The Derivative

1. Instantaneous Growth Rates
2. Definition of the Derivative
3. Computing the Derivative Graphically
4. Computing the Derivative Algebraically
5. Computing the Derivative Numerically
6. Average Growth Rate vs. Instantaneous Growth Rate
7. Applications of the Derivative: Spread of Disease
8. Finding Maxima and Minima of Functions
9. Relating a Function and Its Derivative
10. Approximating functions using trigonometric functions.

14. Computing Derivatives

1. Sum, Difference, Product, Quotient Rule
2. Chain Rule
3. Logarithmic Differentiation
4. Instantaneous Percentage Growth
5. Growth Dominance
6. Applications: Linear Dimensions

15. Using Derivatives

1. Finding Maxima and Minima
2. Finding Good Representative Plots
3. Applications: Maximizing Volume
4. The Second Derivative
5. Applications: The Space Shuttle Challenger

16. Introduction to Differential Equations

1. Basic Linear Differential Equations
2. Logistic Growth
3. Logistic Differential Equation
4. Applications: Pollution
5. Applications: Business Growth and Limitations
6. Applications: Radioactive Decay
7. The Race Track Principal
8. Predator-Prey Model

17. Parametric Plots

1. Standard Examples in 2D and 3D
2. The Cycloid
3. Derivatives of Parametric Functions
4. Applications: Projectile Motion
5. Applications: Predator-Prey

18. Integration

1. Measuring Area Under a Curve
2. Definition of the Integral
3. Properties of Integrals, Symmetry
4. Integrals of Data Functions
5. Numerical Methods: Rectangles, Trapezoids
6. Undefined Integrals
7. Numerical Calculation of Integrals

19. Fundamental Theorem of Calculus

1. Derivative of an Integral
2. Integral of a Derivative
3. Fundamental Formula
4. Distance, Velocity, and Acceleration
5. Improper Integrals
6. More Properties of Integrals
7. Applications: Measure Accumulation Totals
8. Indefinite Integrals and Antiderivatives

20. Measurements via Slicing

1. Measuring Area via Slicing
2. Measuring Volume via Slicing
3. Density and Mass
4. Accumulation
5. Arc Length

“That DANG Calculus!” by Robert Curtis E-Textbook Optional Topics

A. Numerical Derivatives

1. Delta Y: Measuring Output Change: Raw & Percent
2. Comparing Output Change
3. Describing Change
4. Delta X: Varying Input Change: Non-Uniform Inputs
 - a. Application: E-Bay auctions
5. Largest Increment vs Smallest Increment
6. Rates of Change
7. Comparing Rates of Change

B. The Derivative

1. Geometry of Rates of Change
2. Left, Right, & Centered Derivatives
3. Collecting Data in Virtual Experiments
 - a. Vertical Projectile Flight
 - b. Foxes and Rabbits (dynamic system)
 - c. Interest Rate fluctuations
 - d. Business Application: Analyzing a Coffeehouse Operation
 - e. Instantaneous Velocity: The Radar Gun and the Speeding Car

C. Relationship Between Data Function and Its Derivative

1. Linear growth, exponential growth
2. Derivative Changing Signs: Extrema
3. Graphical Derivatives
 - a. Given Graph, Draw Derivative
 - b. LiveMath Slope Finder
 - c. Manually with Ruler
4. Drawing Estimates for Derivatives
 - a. Find where derivative changes signs
5. Increasing Resolution: Better Data?
6. Graphical Second Derivative
 - a. Placing Approximating Parabolas
 - b. Derivative of Data Derivative
 - c. Concavity & Inflection Points
7. Data & Continuity: Infinite Data Samples?

D. Algebraic Derivatives

1. Infinitely-Precise Resolution
2. Going from Algebra to Data
3. Going from Data to Algebra
4. Limits
 - a. Data Derivative with Increasing Resolution
 - b. Finite to Infinite Jump
 - c. Algebraic Simplifications Allowing Limit Calculations
 - d. Algebraic Limits & Continuity
5. Algebraic Miracles: The Simplicity of the Algebraic Derivative Calculus
6. Derivative Calculus: Sum, Difference, Product, Quotient, Chain Rules
7. Manual Computations

E. Classical Derivative Problems

1. Limits
2. First Derivative Test
3. Curve Sketching
4. Maximizing Functions
5. Velocity, Speed & Acceleration
6. Related Rates
7. Second Derivative Test
8. Logarithmic Differentiation
9. Mean Value Theorem
10. Applications

F. Modern Derivative Problems

1. Steady State (Infinite Limits)
2. Percentage Growth Rates
3. Data, Interpolate, Differentiate, Predict
4. Dominance of Growth
5. Logarithmic Analysis of Data
6. Differential Equations

G. Numerical Accumulation

1. Accumulating Rates: Car Gas Mileage
2. Numerical Integral
3. Derivative of Numerical Integral

H. Graphical Accumulation

1. Area Accumulation
2. Graphical Integral
3. Graphical Relationships

I. Algebraic Integration

1. Numerical Integral Miracles
2. Integral Calculus (Easy Functions)
3. Properties of Integrals
4. Fundamental Theorem of Calculus: Antiderivatives
5. Integral and Integrable Functions
6. Undefined Integrals
7. Improper Integrals

J. Classical Integration Problems

1. Area
2. Distance, Velocity, Acceleration
3. Arc Length
4. Differentials

K. Modern Integration Problems

1. Numerical Integration Methods
2. Integral Functions
3. Non-Integrable Functions
4. Data, Interpolate, Integrate, Predict