COURSE OUTLINE

Course Number	Course Title	Credits
MAT151	**Calculus I for the Mathematical and Physical Sciences**	**4**

Hours: Lecture/Lab/Other	Co- or Pre-requisite	Implementation Semester & Year
4 lecture	**MAT146: Precalculus with a minimum of a C or better**	**Spring 2022**

Catalog description:
First course in the standard integrated calculus sequence. Topics include differentiation of algebraic, exponential, logarithmic, trigonometric, hyperbolic, and inverse trigonometric functions. Applications include curve sketching, related rates, maxima, minima, and approximations as well as integration and applications of the definite integral.

General Education Category:
Goal 2: Mathematics

Course coordinator:
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Required texts & Other materials:
Calculus: Volume 1, Edwin Herman and Gilbert Strang
https://openstax.org/details/books/calculus-volume-1

Course Student Learning Outcomes (SLO):

Upon successful completion of this course the student will be able to:

1. Find limits of functions including finding limits of indeterminate form. [Supports ILG #2, 11, PLO #1 - 4]
2. Understand that graphically the derivative may be thought of as the slope of a tangent line and that the derivative is the instantaneous rate of change of one variable with respect to another variable. [Supports ILG #2, 11, PLO #1 - 4]
3. Find the derivative of various kinds of functions and use the derivative to solve related rate, optimization, and other kinds of problems. [Supports ILG #2, 11, PLO #1 - 4]
4. Graph functions using the first derivative and second derivative to find extrema and inflection points. [Supports ILG #2, 11, PLO #1 - 4]
5. Find antiderivatives of simple functions understanding that applications and other methods of integration will follow in the next course. [Supports ILG #2, 11, PLO #1 - 4]
6. Understand the concept of integration and visualize an integral as an area under a curve. [Supports ILG #2, 11, PLO #1 - 4]
7. Use the Fundamental Theorem of Calculus to find definite integrals. [Supports ILG #2, 11, PLO #1 - 4]
8. Evaluate definite integrals using substitution. [Supports ILG #2, 11, PLO #1 - 4]

Course-specific Institutional Learning Goals (ILG):

Institutional Learning Goal 2. Mathematics. Students will use appropriate mathematical and statistical concepts and operations to interpret data and to solve problems.

Institutional Learning Goal 11. Critical Thinking: Students will use critical thinking skills to understand, analyze, or apply information or solve problems.

Program Learning Outcomes for Mathematics AS (PLO)

1. Apply a range of mathematical skills spanning fundamental concepts to more advanced mathematical concepts.
2. Apply quantitative knowledge, including the required technological skills and theoretical knowledge.
3. Demonstrate critical thinking skills to solve real world problems using mathematical modeling.
4. Communicate methods of solutions and results to problems using mathematical language and notation.

Units of study in detail – Unit Student Learning Outcomes:

Unit I Limits [Supports Course SLO #1]

Learning Objectives

The student will be able to:

- Determine one-sided and two-sided limits of various functions from their graphs.
- Determine infinite limits and limits at $\pm\infty$ from graphs.
- Use various theorems on limits to calculate limits of functions algebraically.
- Use the delta-epsilon definition of limit to determine delta when given epsilon, or to prove the truth of a given limit.
- Define continuity and be able to determine points of discontinuity, if they exist, for given functions, and be able to describe discontinuites as removable, jump, or infinite.
- Determine vertical and horizontal asymptotes, if they exist, for a given function.
- Explain how limits can fail to exist.
- State and use the Intermediate Value Theorem to approximate roots.
- Find limits and determine points of discontinuity of trigonometric functions using $\lim_{x\to 0} \frac{\sin x}{x} = 1$ and $\lim_{x\to 0} \frac{1-\cos x}{x} = 0$.
- State and use the Squeezing Theorem to find limits.

Unit II Derivatives [Supports Course SLOs #2, 3]

Learning Objectives

The student will be able to:

- Determine average versus instantaneous velocity using the slope of the secant line through two points and the slope of the tangent line through a given point on the position function.
- Calculate the instantaneous rate of change of *y* with respect to *x* and distinguish this from average rate of change of *y* with respect to *x* for a given function
- Define the derivative, $f'(x)$, $\frac{dy}{dx}$, or y', to be
$$f'(x) = \lim_{h\to 0} \frac{f(x+h)-f(x)}{h} = \lim_{\Delta x\to 0} \frac{f(x+\Delta x)-f(x)}{\Delta x}$$
and be able to find the derivative and the equation of the tangent line to $y = f(x)$ at a given point $x = a$.
- Use the theorems on techniques of differentiation to find the derivatives of constant, polynomial, product, quotient, exponential, logarithmic, trigonometric, inverse trigonometric, and hyperbolic functions.

- Find higher order derivatives ($y'', y''', \ldots$) of functions.
- Use the Chain Rule to find derivatives of composite functions.
- Use differentials to approximate changes in function values and to find the local linear approximation of f at a using $f(x) \approx f(a) + f'(a)(x - a)$.
- Find dy for a given function.
- Use differentiation with respect to time, t, to solve related rates problems.
- Apply the concept of rate of change to solve problems in natural and social science problems.
- Define and use properly in written and oral communication all of the vocabulary presented in this unit.

Unit III **Analysis of Functions and Their Graphs [Supports Course SLOs #3, 4, 5]**

Learning Objectives

The student will be able to:

- Determine intervals where a function is increasing, decreasing, or constant by analyzing its first derivative.
- Use the Extreme Value Theorem to find absolute extrema of a function, if they exist, and define and find critical points.
- Use the first and second derivative tests to find intervals of increase, decrease, upward and/or downward concavity.
- Analyze other limits of indeterminate forms such as $0 \cdot \infty, \infty - \infty, 0^0, \infty^0, 1^\infty$ to see if they can be found or if L' Hospital's Rule should be applied to find the limit.
- Define and locate inflection points for a function.
- Graph functions using knowledge learned in precalculus courses as well as the tools of calculus such as limits, first derivative, and second derivative.
- Know, understand its shortcomings, and be able to apply Newton's Method to find zeros of functions.
- Solve optimization problems.
- State Rolle's Theorem and the Mean Value Theorem and use them to solve problems.
- Find antiderivatives for simple polynomial, exponential, and trigonometric functions.
- Define and use properly in written and oral communication all of the vocabulary presented in this unit.

Unit IV **Integrals [Supports Course SLOs #6, 7, 8]**

Learning Objectives

The student will be able to:

- Associate integration with finding the area under a curve.
- Define and be able to find a definite integral.
- State and apply the Fundamental Theorem of Calculus.
- Use integration techniques to determine velocity and position functions when given an acceleration function.
- Use a substitution to find an indefinite integral and, when given conditions, evaluate the constant of integration.
- Use substitution to rewrite an integral and redefine its bounds to evaluate composite function integrals.

Evaluation of student learning:

Tests, quizzes, homework assignments and projects may be used in evaluating the students' progress throughout the course depending on the individual instructor. It is suggested that three tests and a final exam be used in evaluating the students' progress. A suggested day-by-day schedule and suggested homework problems should be available to the students. A cumulative final exam must be given in the course.

Tests	55%
Cumulative Final Exam	30%
Quizzes, Homework, Projects	15%