LEARNING OUTCOMES
FOR
MATH 12002 – CALCULUS I

The successful Calculus I student should be able to apply the following competencies to a wide variety of functions, including piecewise, polynomial, rational, algebraic, trigonometric, inverse trigonometric, exponential, and logarithmic.

LIMITS AND CONTINUITY

Learning Outcome	Sample Assessment Item	"A" Expectation	"C" Expectation	"F" Expectation
Determine the existence of, estimate numerically and graphically, and find algebraically the limits of functions.	Evaluate: $$\lim_{x\to 2}\frac{x^2-16}{x^2-3x-4}$$	Factors, simplifies, and evaluates limit correctly.	Incorrect answer due to algebraic errors.	States that the limit is $\frac{0}{0}$ or does not exist.
Recognize and determine infinite limits and limits at infinity and interpret with respect to asymptotic behavior.	Evaluate: $$\lim_{x\to 2^+}\frac{x-4}{x-2}$$ $$\lim_{x\to +\infty}\frac{7x^5-3x^2+5\sqrt{x}}{4-9x^5}$$	Recognizes that the limit is infinite. Determines correct sign with justification. Determines correct value of the limit at infinity. Provides appropriate justification.	Recognizes that the limit is infinite. does not determine correct sign or justification is insufficient. Determines correct value of the limit at infinity but does not provide appropriate justification, or has only minor errors.	Does not recognize that limit is infinite or says limit does not exist. Fails to determine limit at infinity.
Determine continuity at a point or on intervals and distinguish between the types of discontinuities at a point.	Determine if the following is continuous at $x = 4$: $$f(x)=\begin{cases}\dfrac{x^2-16}{x^2-3x-4} & \text{if } x\neq 4\\ 8/5 & \text{if } x=4\end{cases}$$	Uses limit definition of continuity correctly to determine whether continuous.	Correctly determines whether continuous but without sufficient justification, or uses correct method with minor errors.	Fails to determine whether continuous or has correct guess with no justification.

DERIVATIVES

Learning Outcome	Sample Assessment Item	"A" Expectation	"C" Expectation	"F" Expectation
Determine the derivative of a function using the limit definition. Interpret the derivative as the slope of a tangent line to a graph, the slope of a graph at a point, and the rate of change of a dependent variable with respect to an independent variable.	Find $f'(4)$ if $f(x) = x^2 - 6x + 2$ using *only* the limit definition of the derivative; find the equation of the tangent line to the graph of $f(x)$ where $x = 4$.	Correctly sets up and evaluates the limit of the difference quotient to compute the derivative.	Correctly sets up the difference quotient but does not determine the correct limit.	Does not set up correct difference quotient or evaluate limit.
Determine the derivative and higher derivatives of a function explicitly using differentiation formulas.	Find the derivatives: 1. $f(x) = 4x^4 + \frac{1}{x^4} + 3\sqrt[4]{x} + 3^4$ 2. $f(x) = (6x^7 + x)\sin 3x$ 3. $f(x) = \frac{x^5 + \sec x}{5 - \cos x}$ 4. $f(x) = (\ln(x^8+5))\sec^{-1}(4x)$ 5. $f(x) = \frac{e^{x^4+5}}{x^3 + \ln x}$	Uses differentiation formulas to compute derivatives correctly.	Uses correct differentiation formulas but has significant errors in the computations.	Uses inappropriate differentiation formulas (e.g., product rule instead of chain rule) or incorrect formulas (e.g., product of derivatives instead of product rule).
Determine derivatives implicitly.	Find y' (the derivative of y with respect to x) if $x^2 + y^3 + \tan y + x^4y^5 = 6.$	Succesfully differentiates implicitly and solves for y' in terms of x and y.	Differentiates implicitly but with significant errors (e.g., does not use product rule for x^4y^5) and solves for y', or differentiates correctly but does not solve for y'.	Neither differentiates correctly nor solves for y'.

APPLICATIONS OF DERIVATIVES

Learning Outcome	Sample Assessment Item	"A" Expectation	"C" Expectation	"F" Expectation
Solve related rates problems.	A rocket, rising vertically, is tracked by a radar station on the ground 9 miles from the launch pad. When the rocket is 12 miles high, it is rising at 1050 miles per hour. How fast is the distance from the radar station to the rocket increasing at that time?	Draws appropriate diagram, defines and relates variables, differentiates to relate rates of change, correctly determines requested rate.	Draws diagram, incorrectly labels or relates variables but differentiates and solves, or relates variables but fails to to relate rates and find the requested rate.	Only draws a diagram or unrelated picture (e.g., of a llama).
Determine absolute extrema for a continuous function on a closed interval. Use these and other appropriate techniques to solve optimization problems.	1. Find the absolute maximum and absolute minimum values of the function $f(x) = 5x^2 - 2x^3$ on the closed interval $[-1, 2]$. 2. A rectangular box is to be constructed with a square base and open top, and a volume of 32 cubic feet. Find the dimensions of the box that will minimize the amount of material used.	Correctly sets up function to optimize, finds critical number(s), determines optimum value, verifies that it is optimum.	Sets up incorrect function and finds optimum value, or sets up correct function but fails to determine correct optimum value.	Does not set up correct function to optimize; does not differentiate.
Use the first and second derivatives to analyze and sketch the graph of a function, including asymptotes, intervals on which the graph is increasing, decreasing, concave up, or concave down, and any local extrema and inflection points.	Analyze this: $$f(x) = \frac{x^2}{(x+2)^2}$$	Determines correct intervals from derivatives, determines local extrema and inflection points, and accurately sketches graph including asymptotes.	Determines only some correct information from derivatives; fails to sketch graph compatible with information.	Does not determine correct information or graph.

INTEGRATION

Learning Outcome	Sample Assessment Item	"A" Expectation	"C" Expectation	"F" Expectation
Determine antiderivatives and indefinite integrals and integrate by substitution.	Compute the following indefinite integrals. 1. $\int \left(\frac{1}{\sqrt[5]{x^3}} + 4\cos x - 9 \right) dx$ 2. $\int (x^3+3x^2)(x^4+4x^3+4)^7\, dx$	Makes appropriate substitution and evaluates integral correctly using integration formulas.	Makes appropriate substitution but fails to correctly evaluate integral.	Does not make appropriate substitution; uses incorrect integration formulas (e.g., product of integrals instead of substitution).
Use the Fundamental Theorem of Calculus to evaluate definite integrals.	Evaluate: 1. $\int_1^3 \left(\frac{3}{x^2} + 4x^2 \right) dx$ 2. $\int_0^{\pi/2} \cos^8 x \sin x\, dx$	Uses appropriate substitution and integration formulas to determine antiderivative and correctly evaluates definite integral.	Determines correct antiderivative but fails to evaluate definite integral correctly, or evaluates definite integral but with incorrect antiderivative.	Neither determines correct antiderivative nor evaluates definite integral correctly.
Use definite integrals to find areas of planar regions.	Find the area of the region bounded by the curves $y = x^2 + 2x$ and $y = 4 - x^2$ and the lines $x = 0$ and $x = 3$.	Sets up correct definite integral representing area and correctly evaluates definite integral to find area.	Sets up correct integral but fails to evaluate definite integral to find area, or sets up incorrect integral representing area but evaluates definite integral correctly.	Does not set up correct integral or evaluate correctly.