MAT 141 Basic Calculus I, Fall 2025-2026 Recitation #3

Q 1. *Find the derivatives of the following functions:*

a) $y = (x^2 + 3e^x + 1)(\sec x + 5 + \dfrac{1}{x})$

b) $x = \dfrac{t^2 - \tan t}{t + sin(t) - 2}$

Q 2. ***Free fall from the Tower of Pisa*** *Had Galileo dropped a cannonball from the Tower of Pisa,* $56m$ *above the ground, the ball's height above the ground* t *seconds into the fall would have been* $s = 56 - 4.9t^2$

a) *What would have been the ball's velocity, speed, and acceleration at time* t*?*

b) *About how long would it have taken the ball to hit the ground?*

c) *What would have been the ball's velocity at the moment of impact?*

Q 3. *By computing the first few derivatives and looking for a pattern, find the following derivative:*

$$\frac{d^{73}}{dx^{73}}(x \sin x).$$

Q 4. *For the given* $y = f(u)$ *and* $u = g(x)$*, find* $dy/dx = f'(g(x))g'(x)$.

a) $y = -\sec u, u = \frac{1}{x} + 7x$

b) $y = e^u, u = 4\sqrt{x} + x^2$

Q 5. *Find the first and second derivatives of the following function:*

$$y = \left(1 + tan^2\left(\frac{t}{12}\right)\right)^3$$

Q 6. *Consider the function*

$$f(x) = \begin{cases} x \sin\left(\frac{1}{x}\right), & x > 0 \\ 0, & x \leq 0 \end{cases}$$

a) *Show that f is continuous at $x = 0$.*

b) *Determine f' for $x \neq 0$.*

c) *Show that f is not differentiable at $x = 0$.*

Q 7. *Use implicit differentiation to find dy/dx and then d^2y/dx^2. Write the solutions in terms of x and y only.*

a) $\sin y = x \cos y - 2$

b) $e^{x^2 y} = 2x + 2y$

Q 8. *Find equations for the tangent line and the normal line to the cissoid of Diocles*

$$y^2(2 - x) = x^3$$

at $(1, 1)$.

Q 9. *Let $f(x) = x^3 - 3x^2 - 1$, $x \geq 2$. Find the value od df^{-1}/dx at the point $x = -1$.*

Q 10. *Suppose that the differentiable function $y = f(x)$ has an inverse and that the graph of f passes through the point $(2, 4)$ and has a slope of $1/3$. Find the values of df^{-1}/dx at $x = 4$.*