Instructions:
Write the answers and show all your work in the blue books. There are 6 problems. Make sure you do all 6. No books, notes, or collaboration with others.

Problem 1. (4 points) Use the limit definition of the derivative to find $f'(x)$ if $f(x) = 3x^2 - 2x$.

Problem 2. (18 points) Find the indicated derivatives and simplify:

\[
\frac{dy}{dx} \text{ if } y = \frac{1 - x}{(1 + x)^2}.
\]

\[
f'(\theta) \text{ if } f(\theta) = \frac{\cos \theta}{1 - \sin \theta}.
\]

\[
\frac{dy}{dx} \text{ if } y = x^{\sqrt{2}}.
\]

\[
\frac{d}{du}(\tan(u^3)).
\]

\[
\frac{dy}{dz} \text{ if } y = z^5 \ln(1 + z).
\]

\[
f''(16) \text{ if } f(x) = x^{\frac{4}{3}}.
\]

Problem 3. (5 points) A Conchoid of de Sluze has equation

\[(x - 1)(x^2 + y^2) = 2x^2.\]

Find the equation of the tangent line to this curve at (2,2). (Use implicit differentiation to find the slope.)

Problem 4. (4 points) A computer user resizes an on-screen window by dragging its corner with her mouse. If this is done in such a way that the height is always half the width, and so that the width increases at a constant rate of 2 inches per second, at what rate is the area of the window growing at the instant when it is 5 inches wide?
Problem 5. (5 points) A ball is thrown downward from a height of 100 feet with initial speed 64 feet per second and is moving at a speed of 160 feet per second by the time it strikes the ground. How long must it have taken the ball to reach the ground? (Recall that the equation giving the height, $h(t)$, as a function of time, $t$, is the one discovered by Galileo: $h(t) = h_0 - v_0 t - 16t^2$, where $h_0$ is the initial height, and $v_0$ is the initial speed.)

Problem 6. (4 points) Sketch a plausible graph for a function $f$ having the following properties (different $f$ in parts (a) and (b).)

(a.) $f < 0, \quad f' < 0, \quad f'' < 0$.

(b.) $f > 0, \quad f' < 0, \quad f'' > 0$. 