1. [5 pts] Find the derivative of \( f(x) = \frac{3(x^2 + 1)}{e^{x^2}} \).

(a) \( f'(x) = \frac{2x(2-x)}{e^{x^2}} \)

(b) \( f'(x) = \frac{3(x + 1)^2}{e^{x^2}} \)

(c) \( f'(x) = \frac{6x}{e^{x^2}} \)

(d) \( f'(x) = \frac{-6x^3}{e^{x^2}} \)

(e) none of these

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2. [5 pts] Let \( f(x) = (1 + x^2)^{\frac{3}{2}} \). Find \( f''(0) \).

(a) 0

(b) 3

(c) \( \frac{3}{4\sqrt{2}} \)

(d) \( \frac{3}{4} \)

(e) none of these
3. [5 pts] Find the derivative of \( f(x) = \sqrt{x} \sin(3x) \).

(a) \( f'(x) = \frac{3 \cos(3x)}{2\sqrt{x}} \)

(b) \( f'(x) = \frac{\sin(3x)}{2\sqrt{x}} + \sqrt{x} \cos(9x) \)

(c) \( f'(x) = \frac{\sin(3x)}{2\sqrt{x}} + \sqrt{x} \cos(3x) \)

(d) \( f'(x) = \frac{\sin(3x) + 6x \cos(3x)}{2\sqrt{x}} \)

(e) none of these

4. Find the derivative of \( f(x) = \ln(\sqrt{x^2 - 1}) \).

(a) \( f'(x) = \frac{2x}{\sqrt{x^2 - 1}} \)

(b) \( f'(x) = \frac{x}{x^2 - 1} \)

(c) \( f'(x) = \frac{x}{\ln(x^2 - 1)^2} \)

(d) \( f'(x) = \frac{1}{4x \ln(x^2 - 1)} \)

(e) none of these
5. [5 pts] If \( f(x) = x^{\tan x} \), find \( f'(x) \).

(a) \( f'(x) = x^{\tan x} \left( \sec^2 x \ln x + \frac{\tan x}{x} \right) \)

(b) \( f'(x) = \tan x x^{\tan x - 1} \sec^2 x \)

(c) \( f'(x) = x^{\tan x} \ln x \)

(d) \( f'(x) = x^{\tan x} \left( \sec^2 x + \ln x \right) \)

(e) none of these

6. [5 pts] Evaluate the expression \( \sin \left( \cos^{-1} \left( \frac{4}{5} \right) \right) \).

(a) \( \frac{1}{2} \)

(b) \( \frac{3}{4} \)

(c) \( \frac{\sqrt{3}}{2} \)

(d) \( \frac{\sqrt{2}}{2} \)

(e) none of these
7. [5 pts] Let \( f(x) = 3 + x + e^x \). Compute \( \frac{df^{-1}}{dx}(4) \).

(a) 0

(b) \( \frac{1}{2} \)

(c) \( \frac{3}{4} \)

(d) 1

(e) none of these

8. [5 pts] If \( g(x) = xf(x^3) \), \( f(2) = 4 \), \( f(8) = 3 \), \( f'(8) = -1 \) and \( f'(2) = -2 \), what is \( g'(2) \)?

(a) -24

(b) -12

(c) -16

(d) -21

(e) none of these
9. Suppose $W(t)$ denotes the amount of a radioactive material left after time $t$ (measured in days). Assume that the half-life of the material is 3 days. Find the differential equation for the radioactive decay function $W(t)$.

(a) \[ \frac{dW}{dt} = \frac{\ln 2}{3} W(t) \]

(b) \[ \frac{dW}{dt} = -\frac{\ln 2}{3} W(t) \]

(c) \[ \frac{dW}{dt} = \frac{\ln 3}{2} W(t) \]

(d) \[ \frac{dW}{dt} = -\frac{\ln 3}{2} W(t) \]

(e) none of these

10. What values of $m$ and $a$ make \[ f(x) = \begin{cases} ax^2, & x > 2 \\ mx + 4, & x \leq 2 \end{cases} \] continuous and differentiable everywhere?

(a) \( a = -1, m = 2 \)

(b) \( a = -2, m = -4 \)

(c) \( a = -1, m = -4 \)

(d) \( a = -2, m = -1 \)

(e) none of these
11. [7 pts] A car moves along a straight road. Its location at time $t$ is given by $s(t) = \frac{1}{6}t^3$, where $t$ is measured in hours and $s(t)$ is measured in kilometers.

(a) Graph $s(t)$ for $0 \leq t \leq 3$.

(b) Find the average velocity of the car between $t = 0$ and $t = 3$. Illustrate (clearly) the average velocity of your graph of $s(t)$.

(c) Find the instantaneous velocity of the car at time $t = 1$. Illustrate (clearly) the instantaneous velocity on the graph of $s(t)$.

12. [9 pts.] (a) Find the linear approximation of $f(x) = \sqrt{1 + 6x}$ at $x = 4$.

(b) Use part (a) to approximate $\sqrt{19}$. 
13. [8 pts.] Find \( \frac{d^2y}{dx^2} \) when \( x^4 + y^4 = 1 \).

14. [8 pts.] Given \( f(x) = \frac{(x+5)^5}{(1-3x)^4} \), find all values of \( x \) where the function has horizontal tangent lines.
15. [9 pts] Find the equation(s) of the line(s) tangent to the curve given by \( y^2 + xy = 8 \) at \( x = -2 \).
16.  [9 pts.] A balloon is released from the ground 4 meters from a stationary observer. If the balloon rises vertically at a constant rate of 1 meter per second, how fast is the distance between the observer and the balloon changing when balloon has risen 3 meters?
Clearly mark answers to the multiple choice problems on your paper and your scantron.

In order to obtain full credit for partial credit problems, all work must be shown. Credit will not be given for an answer not supported by work.

"An Aggie does not lie, cheat or steal or tolerate those who do."