1. (15 pts.) (a) State the limit definition of derivative.
(b) Let \( f(x) = 3x - 2x^2 + 1 \). Find \( f'(x) \) using the limit definition.

2. (20 pts.) Find the derivatives of the following:
(a) \( \sqrt{x^2 + 5} \)  
(b) \( \tan^2(3x - 7) \)  
(c) \( x^4 \sec(\sqrt{x}) \)  
(d) \( \frac{\cos(2x)}{x} \)

3. (15 pts.) Let \( f(x) = \begin{cases} 
\frac{x^2 - 9}{x - 3} & x < 3 \\
5 & x = 3 \\
2x & x > 3 
\end{cases} \)

(a) Find \( \lim_{x \to 3^-} f(x) \).
(b) Does \( \lim_{x \to 3^+} f(x) \) exist? Why or why not?
(c) Is \( f(x) \) continuous at \( x = 3 \)? Why or why not?

4. (10 pts.) Find the tangent line to the curve \( y + x^3 + y^3 = 38 \) at the point (2, 3).

5. (15 pts.) Find the maximum value of \( x^2y \) if \( x \) and \( y \) are positive and \( x + y = 10 \).

6. (10 pts.) A ball throw upward on planet X has height \( x = -5t^2 + 20t + 2 \) meters after \( t \) seconds. How fast, and in which direction, is the ball moving at \( t = 3 \) seconds?

7. (10 pts.) Use linear approximation or differentials to estimate \( \sqrt{25.04} \).

8. (15 pts.) What is the area of the region between the curves \( y = x^2 + x \) and \( y = 2 \)?

9. (28 pts.) Let \( f(x) = \frac{1}{4 + x^2} \).

(a) On what interval(s) is \( f(x) \) increasing?
(b) On what interval(s) is \( f(x) \) concave down?
(c) Does \( f(x) \) have any local extrema? If so, where?
(d) Does \( f(x) \) have any inflection points? If so, where?

10. (12 pts.) Use Riemann sums with \( n = 3 \) rectangles and left-hand endpoints to estimate \( \int_{0}^{\pi/2} \cos x \, dx \). Is this an overestimate or an underestimate?

11. (15 pts.) An inverted conical tank of water is 10 ft. tall and has an upper radius of 2 ft. Water is entering at the rate of 10 ft³/min. How fast is the water level changing when it is 5 ft. deep? The volume of a cone is \( V = \frac{1}{3} \pi r^2 h \).

12. (35 pts.) Calculate the following integrals
(a) \( \int_{-1}^{1} 4x^2 - 3x \, dx \)  
(b) \( \int \frac{x^2 + 3}{\sqrt{x}} \, dx \)  
(c) \( \int x \sec^2(x^2) \, dx \)  
(d) \( \int_{0}^{1} \sin(\pi x) \, dx \)

(e) \( \int_{0}^{1} \frac{x^2}{(x^3 + 1)^2} \, dx \)