1. **(25 pts.)** Find the derivative of each of the following functions: (Do not simplify)

(a) \( f(x) = \frac{3}{x^5} - \sqrt{3x - 1} \)

(b) \( f(x) = e^x (x^5 + 2x^3)^3 \)

(c) \( f(x) = (2x^3 + e^{-5x+2})^5 \)

(d) \( f(x) = \left(\frac{1}{x} + x\right) \cdot \ln(5 - 2x^2) \)

(e) \( f(x) = \frac{2x^2 + 3x}{x^3 + 2} \)
2. (20 pts.) Find the following limits algebraically (if exists)

(a) \( \lim_{x \to 2} \frac{x^2 - x - 2}{x^2 - 4} \)

(b) \( \lim_{x \to 0} \frac{2x^3 + 3x - 10}{x^4 + x^2 + 5} \)

(c) \( \lim_{x \to 0} \frac{\sqrt{x + 4} - 2}{x} \)

(d) \( \lim_{x \to \infty} \frac{2x^3 - 3x^2 + 2}{3x^3 + 2x - 1} \)

3. (10 pts.) Find the equation of the tangent line to the graph of \( f(x) = 5x^3 + 2 \) at \( x = 2 \).
4. (20 pts.) Let \( f(x) = \frac{4x^2 + 4}{x^2 - 1} \), \( f'(x) = \frac{-16x}{(x^2 - 1)^2} \), and \( f''(x) = \frac{16(1 + 3x^2)}{(x^2 - 1)^3} \).

(a) Find horizontal asymptotes of \( f(x) \).

(b) Find vertical asymptotes of \( f(x) \).

(c) Find all the intervals where \( f(x) \) is increasing and all the intervals where \( f(x) \) is decreasing.

(d) Find all the intervals where \( f(x) \) is concave up and all the intervals where \( f(x) \) is concave down.

5. (15 pts.) Find the absolute maximum and minimum of the function \( f(x) = x + \frac{16}{x} \) on the interval \([1,5]\).
6. (15 pts.) A construction company is constructing a closed top, square-based, rectangular metal tank that will have a volume 64 cubic ft. What dimensions yield minimum surface area?

7. (15 pts.) A certain bacteria culture grows at a rate proportional to its size and it becomes 4 times its size in every 6 hours. Find the growth rate.
8. (10 pts.) The decay rate of zirconium is 1.05% per day. What is its half life?

9. (15 pts.) An airconditioning company determines that the marginal cost of producing the $x$th airconditioner is given by

$$C'(x) = -.2x + 500,$$

and that $C(0) = 100$.
Find the total cost of producing 100 airconditioners.
10. (20 pts.) Evaluate the following integrals:

(a) \[ \int \left( \frac{2}{x^3} + \sqrt{x} - e^{-2x} + \frac{3}{x} \right) \, dx \]

(b) \[ \int \frac{(x + 1)}{(x^2 + 2x)} \, dx \]

(c) \[ \int x e^{3x^2 + 1} \, dx \]

(d) \[ \int_1^5 e^{5x} \, dx \]

11. (10 pts.) Let the cost of producing \( x \) units be

\[ C(x) = 20xe^{-0.01x} \] dollars.

and the revenue from the sale of \( x \) units be

\[ R(x) = 30xe^{-0.01x} \]

(a) Find the profit function.
(b) What production level will maximize the profit?

12. \textbf{(15 pts.)} Find the area of the region bounded by

\[ y = 2x^2 - x + 3 \text{ and } y = x + 3. \]
13. (10 pts.) Using the limit definition of derivative, find $f'(x)$ where $f(x) = \frac{1}{2x}$. 