1. For a certain product, weekly demand quantity, \( x \), is 250 when the price, \( p \), is $100. Each decrease of $1 in the price increases demand quantity by 10 units. The weekly fixed cost of production is $1200 and each unit costs an additional $50 to produce. Find the profit function.

2. A person invested $1500 at annual interest rate \( r \) compounded continuously. After 10 years the value of the account was $2500. Find the interest rate, \( r \). Express the answer in percent form rounded to 3 decimal places.

3. A substance decays at a rate proportional to the amount present. The initial amount was 15 g. The amount after 400 years is 10g. Find the number of years past the initial time when the amount is 5g.

4. Solve for \( x \) if \( \log_3 (x - 3) + \log_3 (x + 4) - \log_3 2 = 2 \).

5. Evaluate each limit or state DNE (does not exist).

\[
a) \lim_{x \to 4} \frac{3(x^2 - 16)}{x^2 - 3x - 4} \quad b) \lim_{x \to \infty} \frac{3(x^2 - 16)}{x^2 - 3x - 4}
\]

6. Determine the \( x \)-values where the function is not continuous. At each discontinuity, indicate which of the statements i and/or ii makes the function discontinuous.

\[
i) \lim_{x \to a} f(x) \text{ does not exist.} \quad ii) \lim_{x \to a} f(x) \neq f(a)
\]

\[
f(x) = \begin{cases} 
1 & x = -3 \text{ or } x = 3 \\
12x - 36 & x \neq -3 \text{ or } x \neq 3 \\
\frac{x^2 - 9}{x^2 - 9} & x = -3 \text{ or } x = 3
\end{cases}
\]

7. Determine all \( x \)-values where the function is not differentiable.

\[
f(x) = \begin{cases} 
12x^{1/3} & x < 1 \\
5x + 7 & 1 \leq x
\end{cases}
\]
8. \( f(x) = \begin{cases} 
\frac{x + 3}{x^2 + 5x + 6} & x < 0 \\
\frac{x + 1}{2} & 0 \leq x
\end{cases} \)

a) For what values of \( c \) does \( \lim_{x \to c} f(x) \) not exist?

b) At what \( x \)-value(s) is \( f(x) \) not continuous?

c) At what \( x \)-value(s) is \( f(x) \) not differentiable?

9. A profit function is \( P(x) = -0.3x^2 + 40x - 800 \). Use the marginal profit to approximate the change in profit if \( x \) increases from 100 to 101.

10. \( f'(x) = (x - 2)(x + 3)^2 \) is the derivative of \( f(x) \).

At what \( x \)-value if any does \( f(x) \) have a relative minimum?

At what \( x \)-value if any does \( f(x) \) have a relative maximum?

At what \( x \)-value(s) if any does \( f(x) \) have an inflection point?

11. The instantaneous rate of change, with respect to \( x \), of \( f(x) \) is 6 when \( x=3 \) and \( f(3)=5 \). Find the equation of the tangent line to \( f(x) \) at \( x=3 \).

12. \( f(x) = (x + 1)^2 e^{(4x - 8)} \)

a) At what \( x \)-value(s) is the tangent line to \( f(x) \) horizontal?

b) Find an equation of the tangent line to \( f(x) \) at \( x=2 \).

13. Find the derivative with respect to \( x \) of each function.

a) \( g(x) = \ln \left( \frac{x^2 + 5}{\sqrt{x^4 + 9}} \right) \)

b) \( f(x) = 7 \left( e^{6x} + x^5 \right)^{1/2} + 30 \)
14. The demand quantity for a product at price, \( p \), is \( f(p) = 400 - 40\sqrt{p} \).

a) Find the elasticity function, \( E(p) \).

b) Is demand elastic or inelastic at \( p=64 \)?

c) Find the approximate percent change in demand if \( p \) is increased from $64 to $72. Will revenue increase or decrease under this price increase?

15. A person will enclose a rectangular area of 540 square feet. The material for the front side costs $20 per foot. The material for the other three sides costs $12 per foot. (Assume the costs are for horizontal linear feet of a certain determined height.) Find the dimensions that will minimize the cost of the fence.

16. If the person of problem 15 wants to enclose a rectangular area of unknown size and wants to spend a total of $3200, what is the maximum area he can enclose?

17. Find each antiderivative.

\[
\begin{align*}
\int \frac{x^2}{x^3 + 6} \, dx & \quad b) \quad \int \frac{x}{\sqrt{x} + 3} \, dx \\
\int \frac{e^{\sqrt{x}}}{\sqrt{x}} \, dx & \quad d) \quad \int \frac{5}{2x + 1} + 3xe^x \, dx \\
\int \frac{x^5 - 3}{x^2} \, dx & \quad f) \quad \int \frac{e^{2x}}{e^{2x} + 5} \, dx
\end{align*}
\]

18. Approximate the value of \( \int_{0}^{2} 9^x \, dx \) using a right hand Riemann sum with 4 equal subintervals.

19. The demand supply prices at quantity, \( x \), are given by

\( D(x) = \sqrt{105 - 0.2x} \) \quad \( S(x) = \sqrt{45 + 0.3x} \)

a) Find the consumer surplus at equilibrium.

b) Find the producer surplus at equilibrium.
20. a) Find \( \int_{0}^{3} f(x) \, dx \) for the function, \( f(x) \), in the graph.

b) Find the average value of \( f(x) \) over the interval \([0, 3]\).

c) Find \( \int_{0}^{3} |f(x)| \, dx \).

21. Shown is the graph of \( F'(t) = f(t) \). If \( F(1) = 2 \), find \( F(8) \).
22. A marginal average cost function is given by \( MAC = 0.25 - \frac{144}{x^2} \).

a) At what quantity, \( x \), is average cost at a minimum?

b) What is the average cost function of the average cost per unit for 40 units is $26?

c) Find the total cost function and the average value of the total cost over \([0, 40]\).

23. The derivative of \( f(x) \) is \( f'(x) = \frac{x - 2}{(x + 1)^2} \). Assume \( f(x) \) is continuous except at \( x = -1 \).

At what \( x \)-value(s) does \( f(x) \) have an inflection point? On what interval(s) is \( f(x) \) concave up?

24. \( f(x, y) = -3x^2 + 2xy - y^2 + 6x + 4y \)

Find the critical point and classify it using the 2nd derivative test.

25. Find and all critical points and classify each using the 2nd derivative test or state that the test fails.

a) \( f(x, y) = 3xy^2 - 4x^3 - 6y^2 \)

b) \( f(x, y) = 3x^2 - 2y^3 - 12xy + 36x \)

c) \( f(x, y) = e^{xy} + y \)