1. Compute the following limits:
   
   (a) \( \lim_{x \to \pi/2} \cot x \csc x \)
   
   (b) \( \lim_{x \to 0^+} \left( \frac{1}{\sqrt{x}} - \frac{1}{\sqrt{x^2 + x}} \right) \)
   
   (c) \( \lim_{x \to -1} \cos^{-1} \left( \frac{x}{8} \right) \)
   
   (d) \( \lim_{x \to 0} \frac{\tan x}{x} \)
   
   (e) \( \lim_{x \to 0} \frac{e^x - 1}{\sin x} \)
   
   (f) \( \lim_{x \to \infty} x^{1/x} \)
   
   (g) \( \lim_{x \to 1} \frac{e^x - e}{\ln x} \).

2. For the function \( f(x) = \begin{cases} 
   x^2 + c, & x < 3 \\
   2x - c, & x \geq 3 
\end{cases} \), determine the value of \( c \) that makes the function continuous.

3. Use the definition of derivative to find \( f'(x) \) for \( f(x) = \frac{1}{\sqrt{x} + 3} \).

4. Find the derivative of the following functions:
   
   (a) \( f(x) = x^2 e^{-x^2} \)
   
   (b) \( f(x) = e^{-3x} \sin 2x \)
   
   (c) \( g(x) = (2x + 1)^4(x^3 - x + 2)^5 \)
   
   (d) \( f(x) = \sin^{-1}(2x + 1) \)
   
   (e) \( f(x) = x^{\cos^{-1} x} \)
   
   (f) \( g(x) = e^{\tan^{-1} x} \)
   
   (g) \( f(x) = \log_4(x^2 - 5) \)
   
   (h) \( f(x) = x \ln(e^x + 1) \)
   
   (i) \( f(x) = 7^{1-x^2} \)

5. Find all points on the graph of \( y = \frac{\cos(x)}{2 + \sin(x)} \) at which the tangent line is horizontal.

6. Find an equation of the tangent line to the curve \( y = \frac{x}{1 + x^2} \) at \( x = 2 \).

7. Calculate the first and second derivatives of each of the following functions. It is not necessary to simplify your answers.
   
   (a) \( f(x) = e^x \cos(x) \)
   
   (b) \( g(x) = x^{-3/4} - 4x^7 + x^{1/2} \)
   
   (c) \( h(x) = x^3 \sin(x) \)
   
   (d) \( k(x) = (x^2 + x) \tan(x) \)

8. Use implicit differentiation to find \( \frac{dy}{dx} \):
   
   (a) \( x^2 - 2xy + y^3 = 3 \)
   
   (b) \( y \sin(x^2) = x \sin(y^2) \)

9. Use logarithmic differentiation to find the derivative of the following functions:
   
   (a) \( y = \frac{\sqrt{x + 5} \cdot (x - 2)^3}{e^{x^2}(x^3 + 1)^4} \)
   
   (b) \( y = (\sin x)^x \)

10. A plane is flying horizontally at an altitude of 2 miles and a speed of 500 mi/h passes directly over a radar station. Find the rate at which the distance from the plane to the station is increasing when it is 4 miles away from the station.

11. A boat is pulled into a dock by a rope attached to the bow of the boat and passing through a pulley on the dock that is 1m higher than the bow of the boat. If the rope is pulled in at a rate of 1 m/s, how fast is the boat approaching the dock when it is 8m from the dock?
12. Find the linearization at $x = 1$ of $y = e^x \ln x$.

13. Find the maximum and minimum values of the function on the given interval:

$$f(x) = \frac{1 - x}{x^2 + 3x}, \quad [1, 4]$$

14. Find the critical points and the intervals on which the function is increasing or decreasing, and apply the First Derivative Test to each critical point to determine whether it is a local maximum, a local minimum, or neither. Additionally, find the intervals on which the function is concave up or down, and any point of inflection:

$$y = \theta + \cos \theta, \quad [0, 2\pi].$$

15. The graph of the derivative $f'$ of a continuous function $f$ is shown below:

(a) On what intervals is $f$ increasing or decreasing?

(b) At what values of $x$ does $f$ have a local maximum or minimum?

(c) On what intervals is $f$ concave upward or downward?

(d) State the $x$–coordinates of the points of inflection.

(e) Assuming that $f(0) = 0$, sketch a possible graph of $f$.

16. Sketch the graph of the following functions. Indicate the asymptotes, the local extrema and points of inflection:

(a) $f(x) = x - 2\ln(x^2 + 1)$

(b) $f(x) = \frac{x}{\sqrt{x^2 + 1}}$

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19. Consider the graph of the function $f(x) = \frac{x^3}{1 + x^2}$.

(a) Find a formula for the slope of the secant line between $(x, f(x))$ and $(-x, f(-x))$.

(b) At what point $x$ is the slope in part a) maximized? Make sure to explain why this point is a global maximum.