1. Compute the following limits:

   (a) $\lim_{x\to\frac{\pi}{2}} \frac{\cot x}{\csc x}$ (b) $\lim_{x\to 0^+} \left(\frac{1}{\sqrt{x}} - \frac{1}{\sqrt{x^2+x}}\right)$ (c) $\lim_{x\to 4} \cos^{-1}\left(\frac{x}{8}\right)$ (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) $f(x) = x\ln(e^x + 1)$ (j) $f(x) = 7^{1-x^3}$

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) $k(x) = \left(x^2 + x\right)\tan(x)$

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 $y = e^x \ln x$.

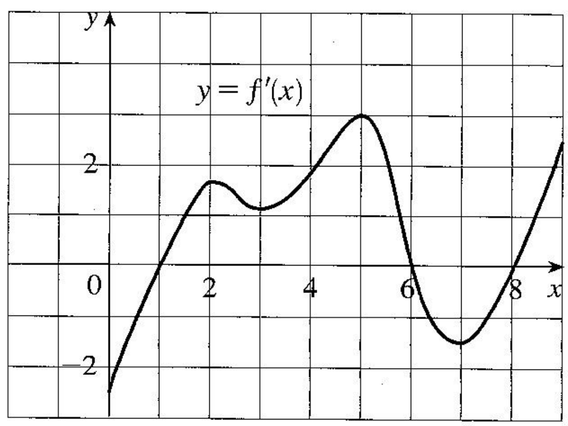
13. Find the maximum and minimum values of the function on the given interval:

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

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:

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

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

17. Problem 8, p. 265.

18. Problem 10, p. 265.

19. Consider the graph of the function $f(x) = \dfrac{x^3}{1+x^4}$.

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.

20. Problem 31, p. 267.