You must show appropriate work to receive credit.

1. (15) Evaluate each of the following limits.

(a) \( \lim_{x \to 3} \frac{2x^2 - 5x - 3}{x^2 - 9} \)

(b) \( \lim_{x \to \infty} \frac{2 + 6x + 7x^2}{5x^2 + 1} \)

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

2. (10) Use the limit definition of the derivative to verify that \( f'(x) = 8x - 3 \) when \( f(x) = 4x^2 - 3x \).

3. (10) If \( f(x) = 2x^3 + 5x^3 - 1 \), find an equation of the tangent line to the curve at the point where \( x = 1 \).
4. (35) Differentiate the following functions. You need not simplify.

(a) \( f(x) = \frac{5}{x^3} + 12\sqrt[3]{x^2} \)

(b) \( g(x) = \frac{\sin \sqrt{x}}{x} \)

(c) \( y = e^{2x} \ln 3x \)

(d) \( h(x) = \tan^2 7x \)

(e) \( F(x) = \int_1^x (t+1)^3 \, dt \)

5. (5) If \( g(x) \) is the inverse of \( f(x) = \ln x + 3x - 1 \), find \( g'(2) \).

6. (5) Sketch a graph of a function that satisfies all of the following.

\[
\begin{align*}
 f(0) &= 4 & f(2) &= 2 \\
 f'(0) &= 0 & f'(2) &= 0 \\
 \lim_{x \to -\infty} f(x) &= 5 & \lim_{x \to \infty} f(x) &= -\infty
\end{align*}
\]
7. (10) If \( y \) is defined implicitly by \( (y+1)^8 + xy = x^2 \), find \( \frac{dy}{dx} \).

8. (10) A fisherman is pulling in a fish from the deck of a boat 6 meters above the water. The line attached to the fish is being reeled in at a rate of 0.8 meters per second. Assuming that the fish remains at water level, at what rate is the fish getting closer to the boat (horizontal speed) when there is 10 meters of line out?

9. (10) If \( f(x) = x \ln x - 2x \) on the interval \( 1 \leq x \leq e^2 \), then find the absolute extrema.

The absolute maximum value is _______
The absolute minimum value is _______
10. (10) If \( f(x) = x^4 - 4x^3 \), find each of the following, if they exist. If something does not exist, write DNE.

(a) The x-coordinate of local maximum, \( x = \) 

(b) The x-coordinate of the local minimum, \( x = \) 

(c) The x-coordinate(s) of the inflection point(s), \( x = \) 

11. (10) A box with a square base and open top is to be constructed from a 6 ft by 6 ft piece of cardboard by cutting equal squares from each corner and folding up the sides. Find the x-value that results in the largest possible volume of the box.

12. (5) The acceleration of an object is given by \( a(t) = 24t + 6 \). Find its displacement function \( s(t) \), if \( v(0) = 0 \) and \( s(1) = 9 \) meters.
13. (35) Integrate.

(a) \( \int \left( x^3 + \frac{1}{x^2} - 5 \right) dx \)

(b) \( \int \sin^2 \theta \cos \theta \, d\theta \)

(c) \( \int x e^x \, dx \)

(d) \( \int \frac{8x^3}{x^4 + 5} \, dx \)

(e) \( \int_0^\pi \sec^2 x \, dx \)

14. (10) A force of 80 N is required to hold a spring stretched 2 meters beyond its natural length. Find the work done in stretching this spring 3 meters beyond its natural length.
15. (10) Sketch and shade in the region in the first quadrant bounded by the parabolas $y = 3x^2$ and $y = 24 - 3x^2$. Find the area of this region.

16. (10) The region below is formed by $y = 6x - x^2$ and the x-axis.

(a) Set-up the integral you would use to find the volume of the solid generated by revolving this region about the x-axis. Do not evaluate; just set-up the integral.

(b) Set-up the integral you would use to find the volume of the solid generated by revolving this region about the y-axis. Do not evaluate; just set-up the integral.