Show all work for full credit. You may not use notes or books. You may use calculators (such as the TI-83, TI-84, TI-85 or TI-86) to check your work and help with arithmetic. You may not use the TI-89 or higher.

(10 pts) 1. Let \( f''(x) = e^x + 2x \), \( f(0) = 0 \) and \( f(1) = e + 1 \). Find \( f(x) \).

(10 pts) 2. Find the absolute maximum and absolute minimum values of \( f(x) = x^3 - 3x + 1 \) on \([0, 2] \).
(30 pts) 3. Evaluate the integrals.

(a) \( \int_{1}^{9} \frac{1}{x} \, dx \)

(b) \( \int_{0}^{\pi/2} \cos \theta (\sin^2 \theta + 2) \, d\theta \)

(c) \( \int_{1}^{3} \frac{2 + \sqrt{x}}{\sqrt{x}} \, dx \)
(d) \[ \int \sqrt{2 - t} \, dt \]

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

(f) \[ \int x e^{2x^2} \, dx \]
(10 pts) 4. The graph of $y = f(x)$ is shown in the picture.

(a) Use three rectangles to find estimates of each type for the area under the given graph of $f$ from $x = 0$ to $x = 6$.

(i) $L_3$ (use left endpoints).

(ii) $R_3$ (use right endpoints).

(iii) $M_3$ (use midpoints).

(b) Explain which of the numbers $L_3$, $R_3$, $M_3$ gives the best estimate of the area under $y = f(x)$. 
(10 pts) 5. Sketch the region enclosed by the curves $y = x^2 - 3$ and $y = -2x^2$ and find the area of the region. Sketch an approximating rectangle and label its height and width. Please label the graph clearly.
(10 pts) 6. Find the volume of the solid obtained by rotating the region bounded by the curves \( y = e^x, \ y = 0, \ x = 0, \) and \( x = 2 \) about the \( x \)-axis. Sketch the region and the solid. Please label the graph clearly. Please give the exact answer for volume.
(10 pts) 7(a) Let \( f(x) = 3\sqrt{x} \). Find the average value of the function on \([0, 4]\).

(b) Find \( c \) such that \( f_{\text{ave}} = f(c) \), \((f_{\text{ave}} \) is the number you found in part (a)).

(c) Sketch the graph of \( f \) and a rectangle whose area is the same as the area under the graph of \( f \). Please label the graph clearly.
(21 pts) 8. Evaluate the following limits. If the limit does not exist, explain why.

(a) \( \lim_{x \to 4} 3 + \frac{2x}{9} \)

(b) \( \lim_{x \to 4} \frac{x^2 + x - 12}{x + 4} \)

(c) \( \lim_{x \to 7} \frac{x^2 - 49}{\sqrt{x} - \sqrt{7}} \)

(d) \( \lim_{x \to 0} \frac{|x|}{x} \)
(e) \( \lim_{x \to 0} \frac{3x}{\sin \pi x} \)

(f) \( \lim_{x \to 1} \frac{x^{14} - 1}{x^3 - 1} \)

(g) \( \lim_{x \to 3^+} \frac{2}{x - 5} \)
(10 pts) 9. Evaluate \( \int_0^6 f(x) \, dx \) by interpreting it in terms of areas, where

\[
f(x) = \begin{cases} 
|x - 2|, & \text{if } 0 \leq x \leq 4 \\
2, & \text{if } 4 < x \leq 6
\end{cases}
\]

Hint: Sketch the graph.
10. The graph of \( y = f(x) \) is shown in the picture.

(a) State the intervals on which \( f \) is continuous.

(b) Find, or state that it does not exist.

\[
\lim_{x \to 5^-} f(x) = \quad \lim_{x \to 5^+} f(x) =
\]

(c) Is \( f \) differentiable at \( x = 1? \quad x = 4? \quad x = 5? \)

(d) Find:

\[
f'(3.5) = \quad f''(3.5) =
\]

(e) Find the limit \( \lim_{h \to 0} \frac{f(1 + h) - f(1)}{h} = \)

(f) Does \( \lim_{h \to 0} \frac{f(4 + h) - f(4)}{h} \) exist? Explain.
(10 pts) 11. Use logarithmic differentiation to find the derivative of the function $y = x^{2x}$.

(10 pts) 12. Find $\frac{dy}{dx}$ by implicit differentiation: $x^3 - 2xy + y^2 = 5$.

(10 pts) 13. Find the equation of the line tangent to the curve $y = 2x^2 + \sin 2x + 3$ at $(0, 3)$. 
(10 pts) 14. John rented 100 apartments for $400 monthly rent. He noticed that for each $20 increase in rent, 10 fewer apartments would be rented. What should he charge for rent to maximize revenue? Hint: First, find the price function $p(x)$. You may assume it is linear.
(20 pts) 15. Differentiate the function. No simplification is required.

(a) \[ y = \ln(x^2 \cos x) \]

(b) \[ y = \frac{x^2 + 2}{7x - 1} \]

(c) \[ y = e^{x^2+3} + e^{-5x} \]

(d) \[ y = (x^2 + 3)(x^{2/3} - 5) \]