1. [35 pts] Consider the function \( f(x) = x^4 - 6x^2 \).
   
   (a) [2 pts] What is the domain of \( f(x) \)?
   
   (b) [3 pts] Is \( f(x) \) odd, even or neither? Justify your answer algebraically.
   
   (c) [3 pts] Find all the \( x \)-intercepts and \( y \)-intercepts of \( f(x) \), if any.
   
   (d) [2 pts] Find all the asymptotes of \( f(x) \), if any.
   
   (e) [2 pts] Find \( \lim_{x \to \infty} f(x) \) and \( \lim_{x \to -\infty} f(x) \).
   
   (f) [2 pts] Find \( f'(x) \). Check your answer very carefully before proceeding.
   
   (g) [2 pts] Find \( f''(x) \). Check your answer very carefully before proceeding.
   
   (h) [3 pts] Where is \( f(x) \) increasing and where is \( f(x) \) decreasing? Write your answer using interval notation.
   
   (i) [3 pts] Find all local extrema of \( f(x) \), if it possesses any.
   
   (j) [3 pts] Where is \( f(x) \) concave up and where is \( f(x) \) concave down? Write your answer using interval notation.
   
   (k) [3 pts] Find all inflection points of \( f(x) \), if it possesses any.
   
   (l) [7 pts] Sketch the graph of \( f(x) \). Label all intercepts, relative extrema (if any) and inflection points (if any).

2. [18 pts] Consider the function \( p(x) = x^3 - 3x + 4 \).
   
   (a) Write the equation that uses Newton’s method to find the root(s) of \( p(x) \).
   
   (b) Using your answer to part (a), if \( x_1 = 0 \), find \( x_2 \).
   
   (c) Suppose \( x_1 \) is chosen such that \( x_2 = -1 \). What is \( x_3 \) in this case? Explain briefly.

3. [15 pts] The following problems are unrelated.
   
   (a) If \( f(x) = 10 - x^2 \), \( 1 \leq x \leq 5 \), evaluate the Riemann sum with \( n = 4 \), taking the sample points to be right endpoints.
   
   (b) Evaluate \( \int_2^{10} |x - 7| \, dx \) by interpreting it in terms of areas.
   
   (c) Evaluate \( \lim_{n \to \infty} \sum_{i=1}^{n} \frac{3}{n} \left( \frac{i}{n} \right)^2 \).

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4. [12 pts] If 1200 cm$^2$ of material is available to make a box with a square base and an open top, find the largest possible volume of the box. Be sure to show that this is the maximum volume.

5. [20 pts] The following problems are unrelated.

(a) [6 pts] Let $g(x) = \frac{x}{x^2 + 1}$. Noting that $g'(x) = \frac{1 - x^2}{(x^2 + 1)^2}$ and $g''(x) = \frac{2x(x^2 - 3)}{(x^2 + 1)^3}$, use the second derivative test to classify the relative extrema of $g(x)$.

(b) [6 pts] Find the most general antiderivative of $f(w) = \frac{5}{\sqrt{w^2}} + \frac{2}{\sqrt{w^3}}$.

(c) [8 pts] A particle is moving with an acceleration $a(t) = 10 \sin t + 3 \cos t$. When time $t = 0$, the particle’s position is 0 and when $t = 2\pi$ its position is 12. Find its position when $t = 5\pi/2$.

Potentially helpful formulas

\[ \sum_{i=1}^{n} i = \frac{n(n+1)}{2} \quad \sum_{i=1}^{n} i^2 = \frac{n(n+1)(2n+1)}{6} \quad \sum_{i=1}^{n} i^3 = \left[ \frac{n(n+1)}{2} \right]^2 \]