1. [10] What is the definition of a critical point of a function?
2. [10] Find the absolute extrema of \( f(x) = e^{x/\sqrt{x^4+1}} \).
3. [10] Find where the graph of \( f(x) = x^5 - 5x^4 + 5x^3 - 15 \) is increasing, decreasing, concave up and down; find extrema and inflection.
4. [10] You have to design an open-top rectangular stainless-steel vat. It is to have a square base and a volume of 32 ft\(^3\), to be welded from quarter-inch plate, and weigh no more than necessary. What quantity must you calculate in order to minimize the weight of the vat? What dimensions should you use?
5. [10] How accurately must you measure the edge of a cube in order to be able to calculate the surface area with an error of less than 2%? Suppose that you have measured the edge with the required accuracy. How accurately can the volume be calculated from the edge measurement? To find out, estimate the percentage error on the volume calculation that may arise from the error in the edge measurement.
6. [10] Find all local extrema of the function \( f(x) = 3x - x^3 \), and determine where it is increasing and decreasing. Use this information to determine how many roots \( f \) has in the range \( 1 \leq x \leq 2 \). Use the Newton—Raphson formula:

\[
x_{n+1} = x_n - \frac{f(x_n)}{f'(x_n)}
\]

to find all the roots in that range.
7. [10] Solve the initial value problem \( \frac{dy}{dx} = \cos x + \sin x \), \( y(\pi) = 1 \).
8. [10] Find the indefinite integral \( \int \frac{2}{\sqrt{1 - x^2}} - \frac{1}{x^{1/4}} \, dx \).
9. [10] Use integration by substitution to find the indefinite integral \( \int \frac{\sin x}{2 - \cos x} \, dx \).