Instructions:

Write the answers and show all your work in the blue books. There are 5 problems. Make sure you do all 5. No books, notes, or collaboration with others.

Problem 1. (4 points) Suppose

\[ f(x + h) = x^2 + 2hx + h^2 \]

for all \( x \) and all \( h \). Use this information and the limit definition to find the derivative function \( f'(x) \). (Make sure your solution includes a clear statement of the limit definition.)

Problem 2. (12 points) Find the indicated derivatives:

\[ \frac{dy}{dx} \quad \text{if} \quad y = \sin \left( \frac{1 + x}{1 - x} \right). \]

\[ f'(x) \quad \text{if} \quad f(x) = \sqrt{\tan 2x}. \]

\[ D_{\theta}(\sin \theta \sec^2 \theta). \]

\[ \frac{d^2y}{dx^2} \quad \text{if} \quad y = (3x + 2)^{20}. \]

Problem 3. (5 points) Use implicit differentiation to find \( \frac{dy}{dx} \mid_{x=1} \) if \( y^2x + x^2y = 2, y > 0. \)

Problem 4. (5 points) If a cube grows in such a way that its surface area increases at a constant rate of 20 square inches per second, at what rate is the volume growing at the instant when the surface area reaches 600 square inches? (Suggestion: Express both area and volume as a function of \( x \), the length of a side. Determine the rate of change of \( x \) using the given information about the surface area.)
Problem 5. (12 points)  A body moves along the $x$ axis in such a way that its coordinate at time $t$ is $x = \frac{t^4}{4} - t^3 - 2t^2 + 5, t \geq 0$.

a. Where was the particle at time zero?

b. What was the velocity at time zero?

c. In what interval of times is the particle moving to the left?

d. In what interval of times is the velocity decreasing?

e. In what interval of times is the speed decreasing?