

Read each problem carefully. Please show all your work for each problem! Use only those methods discussed thus far in class. No calculators!

1. (20 points) Differentiate:

$$(a) f(x) = x^3 + 1, \quad (b) g(t) = t^2(2 + t),$$
$$(c) h(z) = \frac{z^2}{3 - z}, \quad (d) u(x) = \sqrt{x + \sqrt{x}}.$$

2. (20 points) Compute the following limits (whether finite or infinite):

$$(a) \lim_{x \rightarrow -2^-} \frac{x^2}{2 + x}, \quad (b) \lim_{t \rightarrow 2} \frac{2t - 4}{t^2 + 3t - 10},$$
$$(c) \lim_{\theta \rightarrow 0} \frac{2\theta^2}{\cos 2\theta - 1}, \quad (d) \lim_{x \rightarrow 0^-} \frac{3x}{|x|}.$$

3. (10 points) The length of the side of a square decreases at a rate of 3 cm/s. What is the rate of change of its area, when the area is equal to 16 cm²?
4. (20 points) Find the equations of the tangent line and the normal line to the curve

$$y = \frac{x - 1}{x - 2}$$

at the point (3, 2). Draw a *detailed* sketch showing the curve and these two lines.

5. (15 points) Use the definition of the derivative to find $f'(x)$, if

$$f(x) = \frac{2}{x + 1}.$$

Compare your answer with that obtained using the rules of differentiation.

6. (15 points) For each function below, determine for which values of x these functions are continuous, and if not, whether the discontinuity is removable or not, and explain why:

$$(a) f(x) = x^2 + 2x + 3, \quad (b) g(x) = \frac{1 - \sqrt{x}}{1 - x}, \quad (c) h(x) = \frac{x}{\sin x}.$$