

Name: \_\_\_\_\_

Each problem is worth 30 points. Complete at least five problems; you may complete the sixth for extra credit. Show all your work.

1. State the constant multiple rule, and prove the rule using the definition of the derivative.

2. Find  $\frac{d}{dx} \frac{\sqrt[3]{x}}{\sqrt{x^7}}$  using the definition of the derivative. Check your work using differentiation rules.

3. Approximate the slope of the graph of  $f(x) = \sin(\pi \sin(x))$  at  $x = \pi$ , and use your approximation to find a formula for the tangent line to the graph of  $f(x)$  at  $x = \pi$ .

4. Find

$$\frac{d}{dx} \sqrt{x} e^x$$

5. Suppose the number of UT students infected with a mutant strain of the H5N1 virus  $t$  weeks after delivery of an contaminated shipment of poultry is given by

$$I(t) = \frac{25,000t^2}{50 + t^2}$$

Determine when the infection is speeding up and slowing down.

6. For the function  $f(x)$  pictured below, sketch  $f'(x)$  and a possible antiderivative  $F(x)$ . Justify each of your graphs by writing a sentence relating the sign, slope, and concavity of the graph of  $f(x)$  with the relevant features of your graphs.

