1.) Compute the indicated derivative of each of the following functions. [20]

a.) \( f(x) = x^5 - \sqrt{x} + \pi^6 + \frac{3}{x^2} \), \( \text{Find } f'(x) \)

b.) \( w(t) = \tan^{-1} t \), \( \text{Find } w'(3) \)

c.) \( y = \frac{e^x}{1+3x} \), \( \text{Find } \frac{dy}{dx} \)

d.) \( g(x) = \ln x \), \( g''(x) \)

e.) \( r(\theta) = \sin \theta \), \( \text{Find } r^{(25)}(\theta) \)
2.) Find the equation of the tangent line to the curve \( x^2 + \frac{2}{\pi} \cos(\pi y) + 4xy = 3 \) at the point \( (1, \frac{1}{2}) \).

3.) A cylindrical tank with radius 5 m is being filled with water at a rate of 3 \( m^3/min \). How fast is the height of the water increasing?
4. Find the derivative $f'(x)$ for each of the following. *You need not simplify answers.*

a.) $f(x) = \ln(1 + 3x^2)$

b.) $f(x) = e^x(x^3 - x)^{12}$

c.) $f(x) = \sin(\cos(\tan x))$
5.) Find the linearization of the function \( f(x) = \sqrt{x + 99} \) at \( a = 1 \). Use this to approximate \( \sqrt{102} \).

6.) The half-life of the element anteatertonium is 50 years. Suppose that we have a 1024 mg sample of anteatertonium.

   a.) Find the mass of anteatertonium remaining after 150 years.

   b.) How long would it take the original anteatertonium sample to decay to 1 mg?

7.) Suppose \( C(s) \) is the total cost (in dollars) of building a home with \( s \) square feet of space.

   a.) What are the units of \( C'(s) \)?

   b.) What is the practical meaning of \( C'(s) \) for this problem?

   c.) Is \( C'(s) \) positive or negative? Why?