1. Find $dy/dx$ for each of the following.

(a) $y = x^2 + 2x + e^2 + e^{2x} + \ln 2 + \ln (2x) + \arctan 2$

(b) $y = \sqrt{x} \cdot \arctan (5x)$

(c) $y = \ln(\tan(2^x \cos(x^2)))$

(d) $y = \frac{x + e^\pi}{\cos 4 + \sin^6(6x)}$

2. Consider the curve defined by $x^3 + y^3 = \frac{9}{2}xy$ (known as the Folium of Descartes).

(a) Find $dy/dx$.

(b) Verify that the point (1,2) is on the curve above.

(c) Find the equation of the tangent line at the point (1,2).
3. Evaluate the following limits.

(a) \( \lim_{x \to 1} \frac{x^3 - 1}{7 - 7x} \)

(b) \( \lim_{x \to 0} \frac{1 - \cos 2x}{3x} \)

(c) \( \lim_{x \to 0^+} x^2 \ln x \)

(d) \( \lim_{x \to 0} \frac{1 - \cos 4x}{5x^2} \)

(e) \( \lim_{x \to \infty} \frac{x^2}{2x} \)

4. Suppose that \( y = f(t) \) is a solution to the differential equation \( y' = \frac{1}{\pi} \arcsin t + y^2 \) and that \( f \left( \frac{\sqrt{2}}{2} \right) = \frac{1}{2} \). Find the equation of the tangent line to \( f \) at \( \left( \frac{\sqrt{2}}{2}, \frac{1}{2} \right) \).

5. Find the following.

(a) an antiderivative of \( y = \frac{5}{\sqrt{1 - 9x^2}} + x^3 + \cos(2x) + e^3 \)

(b) \( \tan(\arccos x) \) (rewritten as an algebraic expression - no trigonometric functions)
6. Consider the function \( f(x) = x^4 e^x \) with domain all real numbers.

(a) Find the \( x \)-value(s) of all roots (\( x \)-intercepts) of \( f \).

(b) Find the \( x \)- and \( y \)-value(s) of all critical points and identify each as a local max, local min, or neither.

(c) Find the \( x \)- and \( y \)-value(s) of all global extrema and identify each as a global max or global min.

(d) Find the \( x \)-value(s) of all inflection points.

(e) Sketch \( f \).

7. How would your answers to the previous question change if the domain of \( f \) were \([-10, 10]\)?
8. Use Newton’s Method with an initial guess of $x_0 = -1$ to find the next three approximations to a solution of $x^3 + x + 1 = 0$. Then test your final approximation to see if it appears to be close to a root.

9. The rate of change of a population $P(t)$ of eels is proportional to the size of the population. When the population is 40000, it is growing at a rate of 400 eels per year. At time $t = 0$, the population is 10000.
   (a) Write a differential equation whose solution is $P(t)$.

   (b) Solve your differential equation.

   (c) When will the population reach 60000?

10. You are planning to build a box-shaped aquarium with no top and with two square ends. Your budget is $288. If the glass for the sides costs $12 per square foot and the opaque material for the bottom costs $3 per square foot, what dimensions will maximize the volume? Be sure to show how you know you have found the maximum.