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

1. (15 points) Differentiate:
   (a) \( f(x) = e^{2x} \sin 3x \),
   (b) \( g(y) = \frac{\ln(y^2)}{y} \),
   (c) \( h(z) = \log_x(2x) \).

2. (15 points) Integrate:
   (a) \( \int x \cdot 3^x \, dx \),
   (b) \( \int \frac{\log_4 x}{x} \, dx \),
   (c) \( \int \frac{e^{2x}}{3 + e^{2x}} \, dx \).

3. (15 points) Evaluate the following limits:
   (a) \( \lim_{x \to 0} \frac{\tan 3x}{\tan 5x} \),
   (b) \( \lim_{x \to \infty} (x^2 + 2x + 3)e^{-x} \),
   (c) \( \lim_{x \to 0} \frac{1 - \cos x}{\ln(1 - x^2)} \).

4. (15 points) Evaluate the following limits:
   (a) \( \lim_{x \to 0^+} x^{\sqrt{x}} \),
   (b) \( \lim_{z \to \infty} \left(1 + \frac{1}{2z}\right)^z \),
   (c) \( \lim_{t \to \infty} \frac{\ln t}{t^{0.01}} \).

5. (14 points) Find the length of a curve
   \( y = \frac{x^2}{2} - \frac{\ln x}{4} \), \( 2 \leq x \leq 4 \).

6. (12 points) Find the area of the surface of revolution obtained by revolving the curve
   \( y = \left(x - \frac{4}{9}\right)^{3/2} \), \( 1 \leq x \leq 4 \),
   around the y-axis.

7. (14 points) How much work is needed to fill a spherical tank of radius 20 ft with its center 30 ft above the ground, with water \( (\rho = 63 \text{ lb/ft}^3) \) from the ground level?