1. (15 pts.) Find the derivatives of the following functions. Do not simplify the answers.

(a) \( f(x) = 5e^{(x^2+1)} - 2e^{3x} + \ln(2x + 1) \)

(b) \( f(x) = \ln \sqrt{\frac{(3x + 1)^3}{e^{3x}(x^2 + x)}} \)

(c) \( f(x) = x^3 \sqrt{e^{2x} + 1} \)
2. (15 pts.) Find the maximum value of $f(x) = x^2 e^{-x}$ on the interval $[0, 4]$. Be sure to justify your answer.

3. (15 pts.) A population of bacteria is growing at a rate of 2% per hour. How long does it take the population to double in size?
4. (15 pts.) The level of a pollutant in a lake is decreasing according to the exponential decay model. Initially the pollutant level is 10 ppm (parts per million) and after two weeks the pollutant level is 8 ppm. When will the pollutant level be 1 ppm?
5. (15 pts.) Evaluate the following indefinite integrals.

(a) \[ \int \left( x^3 - 2x^2 + 3e^{2x} \right) \, dx \]

(b) \[ \int \left( 3\sqrt{x} - \frac{2}{\sqrt{x}} - \frac{4}{x} \right) \, dx \]

(c) \[ \int \frac{3x^2 + 2x - 4}{x} \, dx \]
6. (10 pts.) Find the function \( f(x) \) for which \( f'(x) = x^2 + 2 \) and \( f(1) = 2 \).

7. (15 pts.)

(a) Find the area under the curve \( y = x + 1 \) over the interval \([1, e]\).

(b) Is the area greater than 5? Explain how you know.