1. (10 points each) Please find the following indefinite and definite integrals.

(a) \[ \int x \cos(x^2) \, dx \]

(b) \[ \int \frac{\ln x}{x} \, dx \]
(c) \( \int_0^1 \frac{1}{3 - 2x} \, dx \)

(d) \( \int_{-1}^1 x^2 e^{2x^3} \, dx \)
2. (12 points) Solve the initial value problem below.

\[
\frac{dy}{dt} = -2ty^2 \\
y(0) = 4
\]

3. (8 points) Determine if the function given below has an inverse. You must justify your answer.

\[f(x) = \sqrt{x^5 + 2x^3 + x}\]
4. (5 points each) In the unfortunate event of a nuclear explosion the radioactive isotope of strontium, $^{90}\text{Sr}$, is released. This isotope has a half-life of approximately 28 years.

(a) What is the decay constant for $^{90}\text{Sr}$?

(b) Suppose 3.5 kg of $^{90}\text{Sr}$ are produced as a result of an explosion, how many kg will remain after 100 years?

(c) If the area of the explosion cannot be safely inhabited by people until the amount of $^{90}\text{Sr}$ falls below 0.001 kg, how long after the explosion will the area remain uninhabitable?
5. (10 points) Use logarithmic differentiation to find the derivative of the following function.

\[ f(x) = \frac{(x^2 + 7x)^5 \sqrt{\sin x}}{e^{x^2}} \]
6. (15 points) At the moment the engine of a car is switched off, the temperature of the coolant is 200°F. The temperature of the environment is 75°F. Five minutes after the car is switched off the temperature of the coolant is 180°F. If it is not safe to drain the coolant until it reaches a temperature of 100°F, how long must a mechanic wait to drain the coolant?