1. An element decays at a rate that is proportional to the amount present. There is initially 50 grams of the element present, and it is observed that 90% of the original amount remains after 2 hours.

   a.) Write a differential equation for the rate of change of the mass of the element. Make sure to identify all constants and variables. (10 pts)

   b.) Solve the differential equation in Part 1a. (15 pts)
2.) Solve the following initial value problem. (25 pts)

\[ \frac{dy}{dt} + \frac{y}{t} = \frac{1}{t^2} , \quad y(1) = 1 \]
3.) Find the general solution to the following 2\textsuperscript{nd} order differential equation. **(25 pts)**

\[
\frac{d^2x}{dt^2} - 2 \frac{dx}{dt} + 10x = 10
\]
4.) Solve the following initial value problem. (25 pts)

\[
\begin{align*}
\frac{dx}{dt} &= 7x + y \\
\frac{dy}{dt} &= -4x + 3y
\end{align*}
\]

\[
\begin{pmatrix} x(0) \\ y(0) \end{pmatrix} = \begin{pmatrix} 2 \\ -5 \end{pmatrix}
\]