1. Find the general solution to \( \frac{d^2y}{dx^2} - 6 \frac{dy}{dx} + 9y = -12e^{3x} + 2 - 12x + 9x^2 \).
2. Find the general solution to $x^2 y'' + xy' + 4y = \sec(2 \ln(x))$. Note that, by using the substitution $u = 2 \ln(x)$, one finds
\[
\int \frac{\tan(2 \ln(x))}{x} \, dx = -\frac{1}{2} \ln \left| \cos(2 \ln(x)) \right|
\]

3. Given $y = \frac{\sin(x^2)}{x}$ is a solution of $x^3 y'' + x^2 y' + (4x^5 - x)y = 0$, find the general solution of this differential equation.
4. A solution to $y'' + 10y' + 89y = 267$ is $y = 3$.

A solution to $y'' + 10y' + 89y = 89x^3 - 59x^2 - 14x - 2$ is $y = x^3 - x^2$.

Find the general solution to $y'' + 10y' + 89y = 271 - 178x^3 + 118x^2 + 28x$.

5. Solve the system of equations:

\[
\begin{align*}
\frac{dx}{dt} &= 9x + 8y \\
\frac{dy}{dt} &= -3x - 5y.
\end{align*}
\]
6. A 32 lb weight stretches a spring 32/5 ft. This weight is then lifted 5 ft above equilibrium and given a downward velocity of 29 ft/s. There is damping in this system that is equal to twice the instantaneous velocity.

(a) Write down the governing differential equation and initial conditions for the motion of the weight. DO NOT SOLVE THE EQUATION.

(b) The answer to the above differential equation \( x(t) = c_1 e^{-t} \cos(2t) + c_2 e^{-t} \sin(2t) \). Find \( c_1 \) and \( c_2 \).

(c) Determine the first two times when the weight passes through the equilibrium position. For each time, state whether the time corresponds to motion up or down.

(d) SET UP BUT DO NOT SOLVE the mathematical expression you would use to determine the time \( T \) such that \( |x(t)| < 0.01 \) for all \( t > T \).