You must show your work to receive credit.

1. Consider the linear system $\vec{Y}' = A\vec{Y}$ where

$$A = \begin{pmatrix} -3 & 0 \\ -2 & -3 \end{pmatrix}$$

Find the general solution. Solve for $Y_1(0) = 1, Y_2(0) = 0$. 
2. Consider the linear system $\vec{Y}' = A\vec{Y}$ where

$$A = \begin{pmatrix} -3 & -3 \\ -2 & 2 \end{pmatrix}$$

Find the eigenvalues, eigenvectors and sketch the phase plane.
3. Consider the linear system \( \ddot{\vec{Y}} = A\dot{\vec{Y}} \) where

\[
A = \begin{pmatrix}
-3 & 2 \\
-2 & -3 \\
\end{pmatrix}
\]

(a) Compute the eigenvalues of \( A \).

(b) Classify the equilibrium at the origin. Sketch the phase plane and classify as source, sink, saddle.

(c) find the solution for the initial value problem \( Y_1(0) = 1, Y_2(0) = 0. \)
4. Find the solution for the problem $y'' + 2y' + 5y = 4 \sin(t) + 2 \cos(t), y(0) = 1, y'(0) = 2$
5. Find the general solution for the problem $y'' + 2y' + y = e^{-t}$. Solve with initial conditions $y(0) = 0, y'(0) = 1$. 
6. Find the general solution for the problem $y'' + 9y = \sin(2t)$. Find the solution for the initial value problem $y(0) = 0, y'(0) = 0$. 
7. Find the general solution for the problem \( y'' + 9y = \sin(3t) \). Find the solution for the initial value problem \( y(0) = 0, y'(0) = 0 \).