

1. [12 points] Suppose we are solving the linear system  $\mathbf{x}' = \mathbf{A}\mathbf{x} + \begin{pmatrix} 0 \\ 8 \end{pmatrix}$ .

a. [4 points] If  $\mathbf{A} = \begin{pmatrix} -3 & 1 \\ 1 & -3 \end{pmatrix}$ , find all critical points for the system.

b. [5 points] If the eigenvalues and eigenvectors of  $\mathbf{A}$  are  $\lambda_{1,2} = -4, -2$  with  $\mathbf{v}_1 = \begin{pmatrix} -1 \\ 1 \end{pmatrix}$  and  $\mathbf{v}_2 = \begin{pmatrix} 1 \\ 1 \end{pmatrix}$ , sketch a phase portrait for the system.

c. [3 points] For a different  $\mathbf{A}$ , could a solution to the system be  $x = e^{-3t} \sin(t)$ ,  $y = e^{-3t} \cos(t)$ ? Explain.