

1. Which of the following best describes the phase portrait

of $\vec{x}' = \begin{bmatrix} 0 & 1 \\ -5 & 4 \end{bmatrix} \vec{x}$?

- (A) Center point
- (B) Spiral source
- (C) Spiral sink
- (D) None of the above

2. For which of the following ODEs is it the case that all three of the functions $x_1(t) = \cos(t)$, $x_2(t) = \sin(t)$ and $x_3(t) = e^t$ are solutions?

(A) $x''' + x'' + x' + x = 0$

(B) $x''' + x'' - x' - x = 0$

(C) $x''' - x'' + x' - x = 0$

(D) None of the above

If an object of mass $m > 0$ is attached to a wall by a spring of stiffness $k > 0$ and slides around on a frictionless surface, then a combination of Newton's Law and Hooke's Law says that the displacement x of the object is governed by the ODE $mx'' = -kx$.

3. If we rewrite this ODE as a first order linear system

$$\vec{x}' = A\vec{x} \text{ where } \vec{x} = \begin{bmatrix} x \\ x' \end{bmatrix},$$

what can we say about the eigenvalues of A ?

- (A) There is only one real eigenvalue.
- (B) There are two distinct real eigenvalues.
- (C) There are two distinct complex eigenvalues.