1. If we rewrite the second order linear ODE

$$y'' - 3y' - 4y = 0$$
  
as a linear system  $\frac{d\vec{u}}{dt} = A\vec{u}$  where  $\vec{u} = \begin{bmatrix} y \\ y' \end{bmatrix}$ , what is A?  
(A)  $\begin{bmatrix} 0 & 1 \\ 4 & 3 \end{bmatrix}$   
(B)  $\begin{bmatrix} 0 & 1 \\ 3 & 4 \end{bmatrix}$   
(C)  $\begin{bmatrix} 0 & 4 \\ 1 & 3 \end{bmatrix}$   
(D) None of the above

2. True or False?

The characteristic polynomial of 
$$\begin{bmatrix} 0 & 1 \\ b & a \end{bmatrix}$$
 is

$$\lambda^2 - a\lambda - b.$$

3. True or False?

The characteristic polynomial of 
$$\begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ c & b & a \end{bmatrix}$$
 is

$$-(\lambda^3-a\lambda^2-b\lambda-c).$$

4. Let x and y denote the quantities of salt in two interconnected 100 L tanks A and B, respectively, and suppose water flows between the two tanks as depicted below, where the input to tank A is pure water.



The system of ODEs that relates dx/dt and dy/dt to x and y is..

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- (A) linear and homogeneous.
- (B) linear but not homogeneous.
- (C) nonlinear.



5. True or False? The system has the following phase portrait.



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This is the real phase portrait.



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6. Almost the same setup as the previous problem, except now the input to tank A has a salt concentration of 0.2 kg/L.



The system of ODEs that relates dx/dt and dy/dt to x and y is..

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- (A) linear and homogeneous.
- (B) linear but not homogeneous.
- (C) nonlinear.