

## 8.1 Preliminary Theory – Linear Systems

Supplemental Instruction  
Iowa State University

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1. Write the following linear systems in matrix form

a.  $\frac{dx}{dt} = 3x - 5y$

$$\frac{dy}{dt} = 4x + 8y$$

b.  $\frac{dx}{dt} = -3x + 4y - 9z$

$$\frac{dy}{dt} = 6x - y$$

$$\frac{dz}{dt} = 10x + 4y + 3z$$

2. Write the given system without using matrices

a.  $X' = \begin{pmatrix} 4 & 2 \\ -1 & 3 \end{pmatrix} X + \begin{pmatrix} 1 \\ -1 \end{pmatrix} e^t$

b.  $\frac{d}{dt} \begin{pmatrix} x \\ y \\ z \end{pmatrix} = \begin{pmatrix} 1 & -1 & 2 \\ 3 & -4 & 1 \\ -2 & 5 & 6 \end{pmatrix} \begin{pmatrix} x \\ y \\ z \end{pmatrix} + \begin{pmatrix} 1 \\ 2 \\ 2 \end{pmatrix} e^{-t} - \begin{pmatrix} 3 \\ -1 \\ 1 \end{pmatrix} t$

3. Verify that the vector  $X$  is a solution of the given system

a.  $\frac{dx}{dt} = 3x - 4y$

$$\frac{dy}{dt} = 4x - 7y$$

$$X = \begin{pmatrix} 1 \\ 2 \end{pmatrix} e^{-5t}$$

b.  $X' = \begin{pmatrix} -1 & \frac{1}{4} \\ 1 & -1 \end{pmatrix} X$

$$X = \begin{pmatrix} -1 \\ 2 \end{pmatrix} e^{\frac{-3t}{2}}$$

$$\text{c. } X' = \begin{pmatrix} 1 & 2 & 1 \\ 6 & -1 & 0 \\ -1 & -2 & -1 \end{pmatrix} X$$

$$X = \begin{pmatrix} 1 \\ 6 \\ -13 \end{pmatrix}$$