HOMEWORK # 9
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This is a very short homework that covers some of the discussed topics from Module 9. Due date of the homework is: **Friday, May 1, 2020, @ 11:59pm**.

Solve the following problems.

1. For the given third order system given by the following ODE

$$y^{(3)}(t) + 6\ddot{y}(t) + 11\dot{y}(t) + 6y(t) = 6u(t),$$

find (a) the transfer function and then (b) the state-space representation in the controllable, observable and diagonal canonical forms. Assume zero initial conditions for the system's inputs and outputs.

2. A state-space representation is defined by the following matrices:

$$\boldsymbol{A} = \begin{bmatrix} 1 & 2 \\ -4 & 3 \end{bmatrix}, \boldsymbol{B} = \begin{bmatrix} 1 \\ 2 \end{bmatrix}, \boldsymbol{C} = \begin{bmatrix} 1 & 1 \end{bmatrix}, \boldsymbol{D} = 0.$$

From this representation (which is not like any canonical form), obtain/transfer the above system to the controllable canonical form. You might find the equation which transforms state-space to transfer function useful.

3. Find the eigenvalues, eigenvector, and the diagonal form of $\boldsymbol{A} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix}$. Then from that, obtain $e^{\boldsymbol{A}t}$.

4. Using the solution of the previous problem, solve for $x(t) = \begin{bmatrix} x_1(t) \\ x_2(t) \end{bmatrix}$ given that

$$\dot{x}(t) = \boldsymbol{A}x(t)$$

$$x(0) = \begin{bmatrix} -1 \\ 3 \end{bmatrix},$$

where $\boldsymbol{A}$ is the matrix given in the previous problem.

5. Solve Problem 4 if the input is $u(t) = 2 + 5e^{-t}$ and $\boldsymbol{B} = \begin{bmatrix} 1 \\ 2 \end{bmatrix}$. Verify your solutions on MATLAB, and show the MATLAB code.