EE 310 - LAB 4

Question:

a) The following state space model is given;

$$\dot{x} = Ax + bu \qquad y = C^T x + du$$

$$\dot{x} = \begin{bmatrix} 0 & -2 \\ 2 & -k \end{bmatrix} x + \begin{bmatrix} 0 \\ 4 \end{bmatrix} u \qquad y = \begin{bmatrix} 1 & 0 \end{bmatrix} x \qquad (1)$$

In order to obtain the transfer function, the following formula will be used:

$$G(s) = C^T \left(sI - A \right)^{-1} b + d \qquad (2)$$

By using equation (2) for the state space model in (1), we have;

$$G(s) = \frac{-8}{s^2 + ks + 4} \qquad (3)$$

Verify equation (3) by hand calculation.

b) We observe that we found a second-order lag transfer function. Hence, we should compare the following:

$$s^2 + 2D\omega_n s + \omega_n^2 = s^2 + ks + 4 \qquad (4)$$

From equation (4), we can obtain the following:

$$\omega_n = 2$$
$$D = \frac{k}{4} \qquad (5)$$

Verfiy the results in (5) by hand calculation.

c) When $D \geq 1$, there are no oscillations. Hence $k \geq 4$. Apply Simulink solution to this problem.

d) When $0 < D < 1$, we have decreasing oscillations. Hence $0 < k < 4$. Apply Simulink solution to this problem.

e) When $D < 0$, we ahve increasing oscillations. Hence $k < 0$. Apply Simulink solution to this problem.