Ex/PG/ME/T/128A/2019

MME Second semester Examination, 2019

Principles & Applications of Linear Control Theory

Time: Three hours

Answer any five questions 20 x 5 = 100

1 Question 1.

Find out the transfer functions of the following systems :-

1. An inductive-capacitive-resistive circuit
2. An integrating amplifier
3. A spring-damper system

2 Question 2.

1. Comment on the stability of the following equation using Routh's criteria

$$s^4 + 2s^3 + 5s + 7 = 0$$

2. Sketch the root locus plot for the following open loop transfer function :-

$$\frac{1}{s(s^2 + 5s + 6)}$$

3 Question 3.

Sketch the Bode plot of the following system using asymptotes

$$\frac{20\,(s+1)}{s\,(s+2)\,(s+3)}$$

4 Question 4.

1. What is phase margin and gain margin ?
2. Consider an open loop control system

$$\frac{10}{(s+1)}$$

Using Bode plot, discuss the effect of adding an integrator to the system

5 Question 5.

1. Considerthe following input-output transfer function of a SISO system

$$\frac{K\,(s+1)}{(s+2)\,(s+3)}$$

Convert it into a state spece representation

2. Considerthe following state space representation of a SISO system

$$\begin{bmatrix}\dot{Z}_1\\ \dot{Z}_2\end{bmatrix} = \begin{bmatrix}0 & 1/C\\ -1/L & -R/L\end{bmatrix}\begin{bmatrix}Z_1\\ Z_2\end{bmatrix} + \begin{bmatrix}0\\ 1/L\end{bmatrix}u(t)$$

$$y(t) = \begin{bmatrix}1 & 0\end{bmatrix}\begin{bmatrix}Z_1\\ Z_2\end{bmatrix}$$

Find out the transfer function from the state space representation

6 Question 6.

Consider the following system:-

$$A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -1 & -5 & -6 \end{bmatrix} \; B = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} \; C = \begin{bmatrix} 1 & 0 & 0 \end{bmatrix} \; D = \begin{bmatrix} 0 \end{bmatrix} \tag{1}$$

The eigenvalues are $\lambda_1 = -0.3080, \lambda_2 = -0.6431, \lambda_2 = -5.0489$

1. Compute the Vandermonde matrix and show that it diagonalises the $[A]$ matrix
2. What will be state-space representation for the system in canonical form?
3. Discuss on the controllability and observability of the system

7 Question 7.

Consider the system of Question 6

1. What do you understand by full state feedback control? Draw the block diagram for a regulator with full state feedback.
2. Consider the system specified in the previous question (Question 6). Compute the full state feedback matrix for the system using the direct method. The desired poles are at

$$\lambda_1 = -3 - j4, \lambda_2 = -3 + j4, \lambda_3 = -10$$