Code : 031815

B.Tech. 8th Semester Exam., 2017

Modern Control Theory

Time : 3 hours *Full Marks : 70*

Instructions :

(i) The marks are indicated in the right-hand margin.

*(ii) There are **NINE** questions in this paper.*

*(iii) Attempt **FIVE** questions in all.*

(iv) Questions No. 1 is compulsory.

1. Answer any seven questions of the following: 2×7=14

(a) What are the drawbacks in transfer function model analysis?

(b) What is state and state variable?

(c) What is the need for state observer?

(d) Explain Eigen vector.

(e) What is pole placement by state feedback?

(f) Explain backlash.

(g) Write any two properties of eigenvalues.

(h) What is a dominant pole?

(i) What are phase variables?

(j) What is state observer?

P.T.O.

2. (a) Derive the solution of homogeneous state equations. 7

(b) Draw the state variable diagram for the given transfer function. 7

$$\frac{C(s)}{R(s)} = \frac{5s}{3s^2+3s+1}$$

3. (a) A system is characterize by the transfer function.

$$\frac{Y(s)}{U(s)} = \frac{s+2}{s^3+3s^2+2s+10}$$ 7

Find the state and output equations.

(b) A system is described by the equations as 7

$$\dot{x}(t) = \begin{bmatrix} -1 & 1 \\ 0 & 2 \end{bmatrix} x(t) + \begin{bmatrix} 1 & 0 & 1 \\ 0 & 1 & 1 \end{bmatrix} u$$

$$y = \begin{bmatrix} 1 & 2 \\ 1 & 0 \\ 1 & 1 \end{bmatrix} x(t)$$

Determine the transfer function.

4. Define controllability and observability. Comment on observability and controllability of the system described by the following state variable model. 14

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -6 & -5 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u$$

$$y(t) = [2 \;\; 1] \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

5. (a) Define the describing function. Derive the describing function for backlash or relay with dead zone. 8

(b) Discuss the stability analysis with describing function. 6

6. Write the properties of state transition matrices. Compute e^{At} when.. 14

$$A = \begin{bmatrix} 0 & 1 \\ -3 & -4 \end{bmatrix}$$

7. Given the plant G(s) = 20(s+5)/s(s+1)(s+2), design the phase variable feedback gains to yield 9.5% overshoot and a settling time of 0.74 second. 14

8. (a) Discuss common non-linearities present in a system. 7

(b) Discuss the state variable approach for optimal control problem. 7

9. Write short notes on any two of the following. 2×7

a. Liapunov's stability analysis

b. State observer design

c. Stability from phase plane

d. Dead-zone

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