Code: 9A02803

R09

B.Tech IV Year II Semester (R09) Regular & Supplementary Examinations April 2016

MODERN CONTROL THEORY

(Electrical & Electronics Engineering)

Time: 3 hours Max. Marks: 70

Answer any FIVE questions
All questions carry equal marks

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1 (a) Define state transition matrix and give its properties.

(b) An n[th] order liner differential equation relating the output z(t) to the input u(t) is given by:

$$z^n + a_1 z^{n-1} + \cdots + a_{n-1} z^2 + a_n z = b_0 u^m + b_1 u^{m-1} + \cdots + b_{m-1} u^2 + b_m u$$

Where a_i's and b_j's are constants and the super scripts indicate the order of the derivation, obtain its phase variable canonic form.

2 Consider the state model of a system which is given by:

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -2 & -4 & -3 \end{bmatrix} \begin{bmatrix} x_1(t) \\ x_2(t) \\ x_3(t) \end{bmatrix} + \begin{bmatrix} 1 & 0 \\ 0 & 1 \\ -1 & 1 \end{bmatrix} u(t)$$

$$z(t) = \begin{bmatrix} 0 & 1 & -1 \\ 1 & 2 & 1 \end{bmatrix} \begin{bmatrix} x_1(t) \\ x_2(t) \\ x_3(t) \end{bmatrix}$$

Convert the state model to observable phase variable form.

3 (a) Explain the effect of state feedback on controllability and observability.

(b) Find the a reduced order observer for a given state model whose Eigen values are $-2, -3$

$$\dot{X} = \begin{bmatrix} 1 & -2 & -2 \\ 0 & -1 & 1 \\ 1 & 0 & -1 \end{bmatrix} X + \begin{bmatrix} 2 \\ 0 \\ 1 \end{bmatrix} u$$

$$y = \begin{bmatrix} 1 & 1 & 0 \end{bmatrix} X$$

4 (a) What are the various types of non-linearities that occur in control systems? What are the characteristics and effects on the operations of a control system?

(b) Explain describing function analysis of saturation non-linearity.

5 (a) What are singular points? Explain how they can be classified with the help of neat diagrams.

(b) Describe how method of isoclines construction is used for phase plane trajectory for a system described by: $\frac{d^r x}{dt^2} + n - \phi(v)\ where\ v = \frac{dx}{dt}$.

6 (a) Consider a non-linear system described by the equation: $\dot{X}_1 = X_2,\ \dot{X}_2 = -(1 - |X_1|)X_2 - X_1$. Find the region in the state plane for which equilibrium state of the system is asymptotically state.

(b) State and prove the Liapunov's stability theorem for linear time invariant systems.

7 (a) Explain how to formulate optimal control problem.

(b) Discuss infinite time regulator problem.

8 (a) Explain the fixed end point problem and derive the Euler-Lagrange equation.

(b) Explain about minimum principle with suitable example.

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