R09

Code: 9A02803

B.Tech IV Year II Semester (R09) Advanced Supplementary Examinations, July 2013

MODERN CONTROL THEORY

(Electrical and Electronics Engineering)

Time: 3 hours Max. Marks: 70

Answer any FIVE questions

All questions carry equal marks

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1 (a) Construct state model and state diagram for the differential equation:

$$\frac{d^3y}{dt^3} + 6\frac{d^2y}{dt^2} + 11\frac{dy}{dt} + 6y + u = 0.$$

(b) State and prove that the state model is non-unique.

2 For the state model: $\dot{X} = \begin{bmatrix} 0 & 0 & 1 \\ -2 & -3 & 0 \\ 0 & 2 & -3 \end{bmatrix} X + \begin{bmatrix} 0 \\ 2 \\ 0 \end{bmatrix} U;\ Y = \begin{bmatrix} 1 & 0 & 0 \end{bmatrix} X$, find Jordan canonical form and hence deduce the controllability of the model.

3 For the system: $\dot{X} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 0 & 3 \end{bmatrix} X + \begin{bmatrix} 1 & 0 \\ 0 & 1 \\ 1 & 1 \end{bmatrix} U$, design a linear state variable feedback such that the closed loop poles are located at -1, -2 and -3.

4 (a) What is meant by describing function? Explain.

(b) Derive the describing function for saturation non-linearity.

5 Draw the phase trajectory of the system described by the equation $\ddot{X} + \dot{X} + X^2 = 0$. Comment on the stability of the system.

6 State and prove the Lyapunov's stability and instability theorems.

7 Discuss the following in detail with suitable examples:

(a) Minimum energy problem.

(b) Minimum time problem.

8 For the system $\dot{x}_1 = x_2 + u_1$, $\dot{x}_2 = u_2$, find the optimal control u*(t) for the functional $J = \frac{1}{2}\int_0^4 (u_1^2 + u_2^2)dt$. Given $x_1(0) = x_2(0) = 1$; $x_1(4) = 0$.

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