Total No. of Questions : 10]

SEAT No. :

P2982

[Total No. of Pages : 3

[5058]-374

T.E. (Instrumentation and Control)
CONTROL SYSTEM DESIGN
(2012 Course) (Semester - I) (306264)

Time : 2½ Hours] *[Max. Marks : 70*

Instructions to the candidates:

1) *Neat diagrams must be drawn wherever necessary.*
2) *Figures to the right side indicate full marks.*
3) *Use of Calculator is allowed.*
4) *Assume Suitable data if necessary.*
5) *All questions are compulsory.*

Q1) a) Derive the transfer function for electrical lead network. **[6]**

b) Explain effect of addition of poles on stability of system using root locus approach. **[4]**

OR

Q2) a) Find out damping ratio, frequency of natural oscillation, velocity error constant if system with transfer function $G(s)=\frac{4}{s(s+2)}$ is compensated using lead compensator with transfer function $G_c(s)=4.7\frac{s+2.9}{s+5.4}$. **[6]**

b) Compare the features of Lead and Lag compensator **[4]**

Q3) a) Explain P, I and D control action with controller settings and their effect on stability of system. **[4]**

b) Explain direct synthesis method of controller design for first order system with and without delay time in brief. **[6]**

OR

Q4) The forward path transfer function of unity feedback control systems is given as $G(s)=\frac{100}{(s+1.5)(s+4)(s+8)}$ if e_{ss} = 0.1 for unit ramp input, the dominant closed loop pole located at -1 ± 2.5 j. Design a PID controller. **[10]**

P.T.O.

Q5) a) Obtain state model in three different canonical form for system with transfer function. **[12]**

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

b) Explain advantages of state space representation over classical representation. **[6]**

OR

Q6) a) Find out transfer function of system from state model. **[12]**

and $\dot{x} = \begin{bmatrix} 0 & 0 & -20 \\ 1 & 0 & -24 \\ 0 & 1 & -9 \end{bmatrix} x + \begin{bmatrix} 3 \\ 1 \\ 0 \end{bmatrix} u$ and $y = \begin{bmatrix} 0 & 0 & 1 \end{bmatrix} x$.

b) Explain the terms state, state variable, state vector and state space. **[6]**

Q7) a) Determine state transition matrix using Cayley Hamilton theorem for following plant matrix $A = \begin{bmatrix} -4 & 3 \\ -6 & 5 \end{bmatrix}$. **[8]**

b) Determine controllability and observability of system of following state model. **[8]**

$$\dot{x} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & -11 & -6 \end{bmatrix} x + \begin{bmatrix} 1 \\ 0 \\ 1 \end{bmatrix} u \text{ and } y = \begin{bmatrix} 10 & 5 & 1 \end{bmatrix} x$$

OR

Q8) a) Obtain output response of following system with unit step input and initial condition as $x(0) = \begin{bmatrix} 1 \\ 1 \end{bmatrix}$. **[10]**

$$\dot{x} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} x + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u \text{ and } y = \begin{bmatrix} 1 & 0 \end{bmatrix} x$$

b) Determine whether following system is state controllable and state observable or not? **[6]**

$$\dot{x}=\begin{bmatrix}-2 & 0\\ 0 & -1\end{bmatrix}x+\begin{bmatrix}3\\ 1\end{bmatrix}u \text{ and } y=\begin{bmatrix}1 & 0\end{bmatrix}x$$

Q9) Find state feedback gain matrix for the system to place the desired closed loop poles at location $s = -2 + 2j$, $s = -2 -2j$. **[16]**

$$\dot{x}=\begin{bmatrix}0 & 1\\ 0 & -1\end{bmatrix}x+\begin{bmatrix}0\\ 1\end{bmatrix}u \text{ and } y=\begin{bmatrix}1 & 0\end{bmatrix}u$$

OR

Q10) Design a Full order observer for the system defined by following state equation

$$\dot{x}=\begin{bmatrix}0 & 1\\ 0 & -1\end{bmatrix}x+\begin{bmatrix}0\\ 1\end{bmatrix}u \text{ and } y=\begin{bmatrix}1 & 0\end{bmatrix}u$$

Given the set of desired poles for the observer $s = -8, -8$. **[16]**

☛ ☛ ☛