Total No. of Questions : 10]

SEAT No. :

P4543

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T.E. (Instru.)

CONTROL SYSTEM DESIGN

(2012 Pattern)

Time : 2 $\frac{1}{2}$ Hours] *[Max. Marks : 70*

Instructions to the candidates :-

1) ***All questions are compulsory.***
2) ***Neat diagram must be drawn wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of logarithmic tables, electronic pocket calculator and steam table is allowed.***
5) ***Your answer will be valued as a whole.***
6) ***Assume suitable data, if necessary.***

Q1) a) Discuss the selection of compensator as per required specification. **[4]**

b) Draw lead compensator and find it's transfer function. **[6]**

OR

Q2) Design a lag compensator for the system whose open-loop transfer function is

$$G(s)H(s) = \frac{4}{s(2s+1)}$$

So that the phase margin will be 40° without sacrificing K_V. Also compute network component. **[10]**

Q3) a) A process cycles at proportional gain of 20 with period of oscillation is 5sec in close loop. Determine tuning constants of PID controller. **[8]**

b) Write equations for PI controller. **[2]**

OR

Q4) Design a PD controller such that dominant roots of characteristics equation is loacated at s = –1.2 + j102. The forward transfer function of unity gain feedback control system is given by **[10]**

$$G(s) = \frac{30}{s(s+1)(s+3)}.$$

P.T.O.

Q5) a) Convert following state space model into controllable phase variable canonical form. **[8]**

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

Y = [0 0 1]x

b) Convert the state model given below in to transfer function. **[8]**

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

Y = [1 0 1]x + 5u

OR

Q6) The transfer function of system is given by

$$\frac{y(s)}{u(s)} = \frac{s+1}{s^\wedge 2 + 9s + 20}$$

a) Convert transfer function into canonical state model. **[8]**

b) Convert transfer function into observable canonical state model. **[8]**

Q7) a) Determine whether following system is controllable and observable or not

$$\dot{x} = \begin{bmatrix} 1 & 2 & 0 \\ 1 & -1 & -3 \\ 0 & 2 & 0 \end{bmatrix} x + \begin{bmatrix} 2 \\ 1 \\ 1 \end{bmatrix} u$$ **[9]**

Y = [1 0 1] x

b) Convert following state space model in to canonical form using diagonalisation method **[9]**

$$\dot{x} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & -11 & -6 \end{bmatrix} x + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u$$

Y =[1, 2, 2] x

OR

Q8) a) Obtain response if no input is applied **[9]**

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

b) Give derivation to find solution of state space model. **[9]**

Q9) a) Consider a system having transfer function **[8]**

$$G(s)=\frac{1}{s^2+5s+4}$$

b) Find the state space model of the given transfer function. Verify that the system is controllable, If so, Design a state feedback controller using Ackerman's method such that closed - loop poles are at s1 = –3, s2 = –6. **[8]**

OR

Q10) a) A consider a system having transfer function **[8]**

$$G(s)=\frac{3}{s^2+8s+15}$$

b) Find the state space model of the given transfer function. Verify that the system is observable, If so, determine the observer gain matrix using Ackerman's method to place the observer poles at s1 = –5 and s2 = –7. **[8]**