TE / V / Control System Design / INST / 07·12·15

QP Code : **5696**

(3 Hours) [Total Marks :80

N.B. : (1) Question no. **1** is **compulsory.**
(2) Attempt any **three** questions from remaining **five** questions.
(3) **Assume** suitable **data** if **needed.**

1. Answer the following:- 20
   (a) Explain the need of compensator.
   (b) State advantages of modern control over traditional cntrol system.
   (c) Obtain transfer function using state model.

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

   (d) Derive the transfer function of lead compensator

2. (a) Construct state models of the following 10

   (i) $T(S) = \dfrac{S+2}{S^3+5S^2+6S+7}$

   (ii) $\dfrac{d^3y}{dt^3} + 5\dfrac{d^2y}{dt^2} + 7\dfrac{dy}{dt} + 4y = 3\dfrac{du}{dt} + 4u$

   (b) Explain design steps of lag compensator using root locus. 10

3. (a) A unity feedback type 2 system with $G(S) = \dfrac{K}{S^2}$. It is desired to Compensate the system so as to meet the following transient specifications. 10

$t_s \leq 4$ sec

$\%\ Mp \leq 20\%$

   (b) State controllability and observability. Check following system is controllable or observable? 10

$$\dot{x} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & -2 & -3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u$$

$$y = \begin{bmatrix} 3 & 4 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$$

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$$\dot{x} = \begin{bmatrix} 1 & 2 & 0 \\ 3 & -1 & 1 \\ 0 & 2 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 2 \\ 1 \\ 1 \end{bmatrix} u$$

$$y = \begin{bmatrix} 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$$

The desired poles are $-4, -3 \pm j$ 10

(b) Find STM where, $A = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix}$ and obtain homogeneous response when initial conditions $X_0 = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$ 10

5. (a) For the plant $G(S) = \dfrac{10(S+10)}{S(S+3)(S+12)}$

Give steps to be used to design the phase variable feedback gain to yield 5% over shoot and peak time 0.3 sec. Find the state feedback gain vector. 10

(b) A unity feedback system with an open loop T.F. $G(S) = \dfrac{k}{S(S+1)}$ where 10

$K_v = 12$ / sec

$\Phi_m = 40^0$

Design suitable compensator.

6. (a) Explain design steps for lead compensator using bode plot. 10

(b) Design PID controller for the system 10

$$G(S) = \frac{K}{S(S+1)(s+2)}$$

Determine compensated block $G_c(S)$

Course: T.E. (SEM.-V) (REV. -2012) (CBSGS) (INSTR. ENGG.) (Prog-T3425)

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Correction:

Following line is not printed in first line of of second page of QP 5696. Read as follows:

Q. 4. (a) Design state observer for the system which is given as:

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