INS 1

_28/05/2015_

SEM V / Control Syst. Design

QP Code : 3340

(3 Hours) [**Total Marks : 80**

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

1. Attempt the following :– 20
  (a) State the advantages of modern control theory over conventional theory.
  (b) Obtain the transfer function of the system.
  $$\dot{x}_1 = -2x_1 - x_2 + u$$
  $$\dot{x}_2 = -3x_1 - x_2 + u$$
  $$y = x_1$$
  (c) Compare lead / lag / lag-lead compensator. Also draw poles & zeros plot of all.
  (d) What is caley Hamilton theorem? Explain the steps to solve for STM using the Caley Hamilton theorem.

2. (a) Derive the transfer function of lag-lead compensator. 10
  (b) Obtain diagonalized matrix (M) for siven system matrix :
  $$A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -1 & -3 & -3 \end{bmatrix}$$

3. (a) For the unity feedback control system with PID controller is used to control the system. The plant transfer function is 10
  $$G(s) = \frac{K}{s(s+1)(s+5)}$$
  Determine PID controller.
  (b) An open loop control system with : 10
  $$G(s) = \frac{K}{s^2}$$
  The system is compensated to meet the following specifications using lag compensator
  $$K_v = 5/sec$$

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4. (a) Determine the state transition matrix for the system :   **10**

$$A = \begin{bmatrix} -2 & 1 \\ -2 & -3 \end{bmatrix}$$ also find the response if the initial condition is

$$x(0) = \begin{bmatrix} 1 \\ 2 \end{bmatrix}$$

   (b) Explain the design steps of lag compensator using Bode plot   **10**

5. (a) Design an observer for the plan   muADDA.com   **10**

$$G(s) = \frac{10(s+2)}{s(s+4)}$$

Desired observer poles are at −5, −5

   (b) Check the following systems are completely controllable & observable: **10**

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

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

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

        $y = \begin{bmatrix} 1 & -1 \end{bmatrix} x$

6. (a) Consider a plant transfer function   **10**

$$G(s) = \frac{10}{(s+1)\ (s+5)}$$

Design state feedback gain matrix to meet the following specifications:
$\xi = 0.5$
$w_n = 5$ rad/sec

   (b) For a unity feedback system   **10**

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

Design a suitable compensator with the following specifications :−
$K_v = 12$/sec
Phage margin = 40°

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