SEM V/Control Syst. Design

K.G.C.E. EXAM KARJAT, RAIGAD

INST

28/05/2015

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 **10**

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

Desired observer poles are at –5, –5

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

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

$y=[1 \quad 0]\ x$

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

$y=[1 \quad -1]\ x$

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

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

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**

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

Design a suitable compensator with the following specifications :–

$K_v = 12$/sec

Phage margin = 40°

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