B.E.(with Credits)-Regular-Semester 2012 - Instrumentation Engineering Sem VI

IN603 - Control System Design

P. Pages : 2 **GUG/W/16/5388**

Time : Three Hours * 3 5 5 7 * Max. Marks : 80

Notes :
1. Same answer book must be used for each question.
2. All questions carry marks as indicated.
3. Assume suitable data wherever necessary.
4. Illustrate your answers wherever necessary with the help of neat sketches.

1. Consider a plant with transfer function **16**

$$G(S) = \frac{4}{S(S+0.5)}$$

Design a cascade lead compensator to meet following specifications.

i) Damping ratio of dominant closed -loop poles, ξ =0.5

ii) Undamped natural frequency of dominant closed loop poles, $W_n = 5 rad/sec$.

iii) Velocity error constant = $80 sec^{-1}$.

OR

2. Design a lag compensator for the system with an open loop transfer function of **16**

$$G(S) = \frac{K}{S(S+1)(S+4)}$$

The system is to be compensated to meet following specifications:

i) Damping ratio $\mathcal{J}$=0.5

ii) Setting time t_s =10 sec.

iii) Velocity error constant $K_v \geq 5 sec^{-1}$.

3. Design a phase lag compensation for the system having a unity feedback, with open loop transfer function. **16**

$$G(S) = \frac{K}{S(S+1)(0.25+1)}$$

in order to achieve following specification.

i) Velocity error constant K_v =8

ii) Phase Margin = 40º

OR

4. Consider an unity feedback control system with open loop transfer function. **16**

$$G(S) = \frac{K}{S^2(0.25+1)}$$

Design a phase lead compensator to meet following specification.

i) Acceleration error constant K_a =10

ii) Phase Margin $\geq 35^o$

5. a) Consider the plant model as given below **8**

$$\dot{x}(t) = A\ x(t) + bu(t)$$

$$y(t) = c\ x(t) \qquad ;\ \text{with}$$

$$A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & -1 & 1 \\ 0 & -1 & -10 \end{bmatrix};\quad b = \begin{bmatrix} 0 \\ 0 \\ 10 \end{bmatrix};\quad c = [1\ \ 0\ \ 0]$$

Convert this state model in to transfer function.

b) Consider a system with the transfer function $G(S) = \dfrac{S+3}{S^3 + 9S^2 + 24S + 20} = \dfrac{Y(S)}{U(S)}$ obtain the Jordan canonical form. **8**

OR

6. a) Consider the system. $\dot{x} = \begin{bmatrix} 1 & 1 & 0 \\ 0 & -2 & 1 \\ 0 & 0 & -1 \end{bmatrix} x + \begin{bmatrix} 0 \\ 1 \\ -2 \end{bmatrix} u;\quad y = [1\ \ 0\ \ 0]\, x$ Find the eigen values of 'A' and determine the stability of the system. **8**

b) Determine the controllability and observability of the following system. **8**

$$A = \begin{bmatrix} -1 & 0 \\ 0 & -2 \end{bmatrix};\quad b = \begin{bmatrix} 2 \\ 5 \end{bmatrix};\quad c = [0\ \ 1]$$

7. a) Using ISE as an objective function how the gain settings of the PID controllers can be optimized? Explain in detail using parseval theorem. **10**

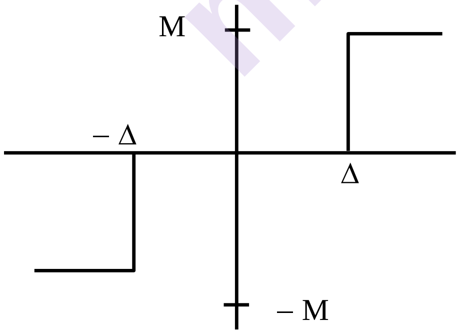
b) Compare optimal control and non optimal control system. **6**

OR

8. a) Explain the parameter optimization subject to constraints. **10**

b) Write a short note on ITAE (Integral Time Absolute Error) **6**

9. Obtain the Describing Function for following non linearity. **16**



OR

10. a) A nonlinear system is described by **10**

$$\dot{x}_1 = -3x_1 + x_2$$

$$\dot{x}_2 = x_1 - x_2 - x_2^3$$

Identify all singular points of the system.

b) Write short note on Liapunov stability criterion. **6**

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