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BT-7/M-20 37019

LINEAR CONTROL SYSTEM

ELE-403-E

Time : Three Hours] [Maximum Marks : 100

Note : Attempt *Five* questions in all, selecting at least *one* question from each Unit. Use semi log Graph papers wherever necessary.

Unit I

1. (a) Discuss with typical illustrations, the merits and demerits of close loop control system over open loop control system. **10**

(b) Write notes on the following : **5+5**

(i) Sample data digital control system

(ii) Multivariable control system.

2. (a) For a mechanical system shown in Fig. 1, find overall transfer function of the system. Also find its force-voltage and force-current analogies. **14**

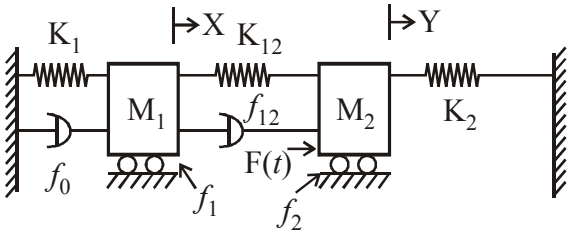

Fig. 1

where F(t) is force, M_1 and M_2 are masses.

(b) Describe the characteristics of feedback control system. **6**

Unit II

3. (a) Define the various time domain specifications of second order system. Derive the expressions for rise time, t_r, peak of overshoot, m_p, peak time, t_p, setting time, t_s and steady state error e_{ss} for second order control system subjected to unit step input. **5+10**

(b) A unity feedback system is characterized by an open loop transfer function (O.L.T.F.),

$$G(s) = \frac{10}{s(0.2s+1)}$$

Determine steady state error to unit step, unit ramp, unit parabolic and unit impulse inputs. **5**

4. (a) Point out the limitation of Routh-Hurwitz stability criterion. Define the relative stability of a control system. Determine the range values of K(K > 0) for stability for the system whose characteristic equation is given by : **8**

$$q(s) = s^3 + 3Ks^2 + (K+2)s + 4 = 0$$

(b) Sketch root locus plot as 'K' varied from 0 to ∞ for the feedback system whose O.L.T.F. **12**

$$GH(s) = \frac{K}{s(s+4)\left(s^2+4s+20\right)}$$

Find the range value of 'K' for which the system is stable. What is the highest value of K which can be used before continuous oscillations occur ? Also determine the frequency of continuous oscillations.

Unit III

5. (a) Compare time and frequency domain approaches for analysis of a control system. Derive the expression for resonant peak. **8**

(b) The O.L.T.F. of a unit feedback system is : **12**

$$G(s) = \frac{K}{s(s+2)(s+20)}$$

Sketch Bode plot and determine the following :

(i) Limiting value of 'K' for the system to be stable.

(ii) Value of 'K' for GM to be 10 db, and 'K' for PM to be 50^0 db.

6. (a) Sketch Nyquist plot for unit feedback control system characterized by an open loop transfer function (O.L.T.F.) **12**

$$G(s) = \frac{K}{s(0.2s+1)(0.05s+1)}$$

Find :

(i) GM and PM for K = 1

(ii) Range values of 'K' for which the system is stable.

(iii) Value of 'K' for GM to be 20 db,

(iv) Value of 'K' for PM to be 40^0.

(b) Sketch Bode plot of a control system whose O.L.T.F. **8**

$$G(s) = \frac{Ke^{-0.1s}}{s(s+1)(0.1s+1)}$$

Determine the gain K for the gain crossover frequency to be 5 rad/sec. Given that :

$$< e^{-0.1s} = -5.73w^0$$

Unit IV

7. (a) Explain a method for determining the solution of state equation. A system is described by : **14**

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 1 \\ 1 \end{bmatrix} U,$$

U is unit step function. Compute the solution of this state equation assuming :

$$X(0) = [10]^T$$

(b) Compare state variable analysis techniques with other analysis techniques of control system. **6**

8. (a) Explain the concept the controllability and observability of a control system. Derive the necessary and sufficient conditions for the controllability and observability. Examine the controllability and observability for the following system : **15**

$$\frac{Y(s)}{U(s)} = \frac{8}{s^3 + 6s^2 + 11s + 6}$$

(b) Prove that state models are not unique but the number of state variables are unique. **5**