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Question Paper Code : 80554

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2016.

Fifth Semester

Electrical and Electronics Engineering

IC 6501 — CONTROL SYSTEMS

(Common to Electronics and Instrumentation Engineering/Instrumentation and Control Engineering)

(Regulations 2013)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Why negative feedback is preferred in control systems?

2. What are the differences between a Synchro transmitter and a Synchro control transformer?

3. Give the relation between static and dynamic error coefficients.

4. State the basic properties of root locus.

5. What does a gain margin close to unity or phase margin close to zero indicate?

6. What are the effects and limitations of phase-lag control?

7. What are two notions of system stability to be satisfied for a linear time-invariant system to be stable?

8. Why frequency domain compensation is normally carried out using the Bode plots?

9. For a first order differential equation described by $\dot{x}(t) = a\,x(t) + b\,u(t)$, draw the block diagram form of state diagram.

10. State the limitations of state variable feedback.

PART B — (5 × 16 = 80 marks)

11. (a) Write the differential equations governing the mechanical system shown in Fig. Q 11(a). Draw the force-voltage and force-current electrical analogous circuits. (16)

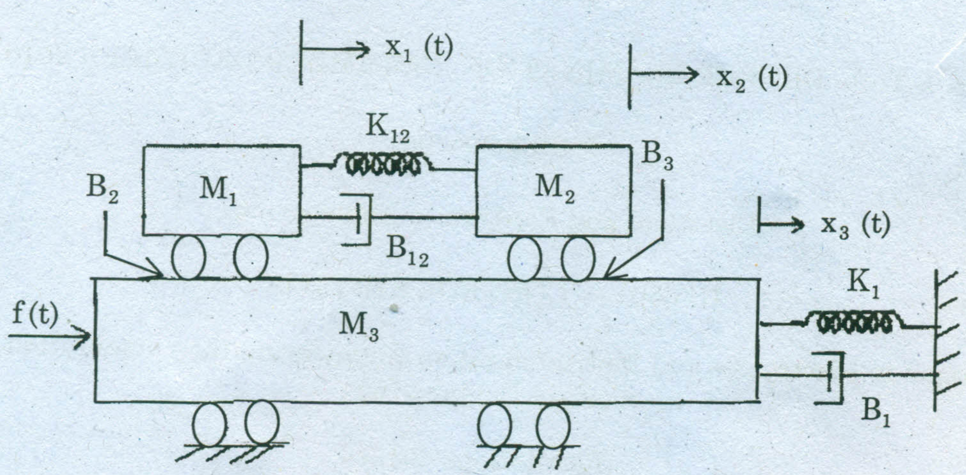

Fig. Q 11 (a)

Or

(b) (i) Derive the transfer function of AC servomotor. (8)

(ii) Construct a block diagram for the simple electrical network shown in Fig. Q 11 (b) (ii) and hence, obtain the signal flow graph and the transfer function $\frac{E_0(s)}{E_i(s)}$. (8)

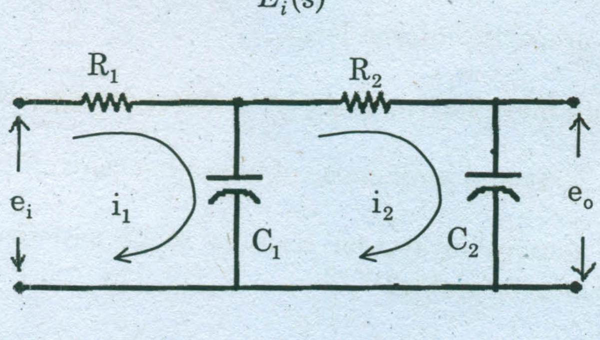

Fig. Q 11 (b) (ii)

12. (a) Draw the root locus for a system is given by $G(s) = \dfrac{K(s+1)}{s(s^2+5s+20)}$. (16)

Or

(b) (i) The overall transfer function of a control system is given by $\dfrac{C(s)}{R(s)} = \dfrac{16}{(s^2+1.6s+16)}$. It is desired that the damping ratio be 0.8. Determine the derivative rate feedback constant K_t and compare rise time, peak time, maximum overshoot and steady state error for unit ramp input function without and with derivative feedback control. (10)

(ii) Compare P, I and D controller.

13. (a) The open loop transfer function of a unity feedback system is given by $G(s) = \dfrac{1}{s(s+1)(2s+1)}$. Sketch the polar plot and determine the gain margin and phase margin. (16)

Or

(b) Draw the Bode plot for the transfer function $G(s) = \dfrac{1}{s(s^2+3s+5)}$. Determine the gain margin and phase margin. (16)

14. (a) (i) Determine the range of values of K for which the system described by the following characteristic equation is stable. (10)

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

(ii) State and explain Nyquist stability criterion. (6)

Or

(b) Design a lead compensator for a unity feedback system with an open loop transfer function $G(s) = \dfrac{K}{s(s+1)}$ for the specifications of $K_v = 10\,\text{sec}^{-1}$ and phase margin $\phi_m = 35°$. (16)

15. (a) Obtain the time response of the system described by

$$[\dot{x}(t)] = \begin{bmatrix} 0 & 1 \\ -1 & -2 \end{bmatrix} \begin{bmatrix} x_1(t) \\ x_2(t) \end{bmatrix} + \begin{bmatrix} 1 \\ -1 \end{bmatrix} u(t)$$

with the initial conditions $\begin{bmatrix} x_1(0) \\ x_2(0) \end{bmatrix} = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$; $y(t) = \begin{bmatrix} 0 & 1 \end{bmatrix} \begin{bmatrix} x_1(t) \\ x_2(t) \end{bmatrix}$. (16)

Or

(b) Determine whether the system described by the following state model is completely controllable and observable (16)

$$[\dot{x}(t)] = \begin{bmatrix} 0 & 0 & 1 \\ -2 & -3 & 0 \\ 0 & 2 & -3 \end{bmatrix} \begin{bmatrix} x_1(t) \\ x_2(t) \\ x_3(t) \end{bmatrix} + \begin{bmatrix} 0 \\ 2 \\ 0 \end{bmatrix} u(t);\ y(t) = \begin{bmatrix} 1 & 0 & 0 \end{bmatrix} \begin{bmatrix} x_1(t) \\ x_2(t) \\ x_3(t) \end{bmatrix}.$$
