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Question Paper Code : 27300

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2015.

Fifth Semester

Electrical and Electronics Engineering

IC 6501 – CONTROL SYSTEMS

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

(Regulations 2013)

Time : Three hours

Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Draw the electrical analog of a thermometer.
2. What is electrical zero position of a synchro transmitter?
3. For the system described by $\frac{C(s)}{R(s)} = \frac{16}{s^2 + 8s + 16}$; find the nature of the time response.
4. Why is the derivative control not used in control systems?
5. Draw the approximate polar plot for a Type 0 second order system.
6. What is the basis for the selection of a particular compensator for a system?
7. How are the roots of the characteristic equation of a system related to stability?
8. Draw the electric lag network and its pole-zero plot.
9. What is meant by 'State' of a dynamic system?
10. When do you say that a system is completely state controllable?

PART B — (5 × 16 = 80 marks)

11. (a) (i) Explain open loop and closed loop control systems with examples. (8)
- (ii) Derive the transfer function of an armature controlled DC servomotor. (8)

Or

- (b) (i) For the mechanical system shown in Fig. Q 11(b)(i).
- (1) Draw the mechanical network diagram and hence write the differential equations describing the behaviour of the system. (6)
- (2) Draw the force-voltage and force-current analogous electrical circuits. (4)

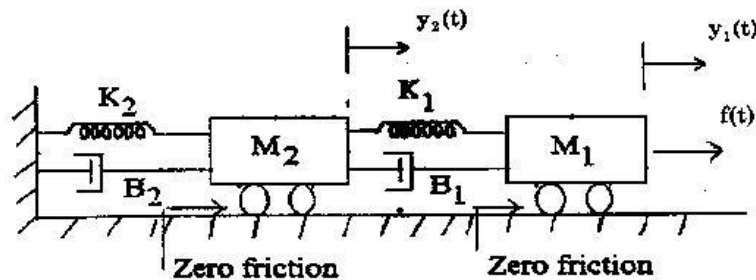


Fig. Q 11(b)(i)

- (ii) For a nonunity negative feedback control system whose open loop transfer function is $G(s)$ and feedback path transfer function is $H(s)$, obtain the control ratio using Mason's gain formula. (6)
12. (a) (i) Derive the expressions for the unit step response of a second order
- (1) underdamped, and
- (2) undamped systems (8+4)
- (ii) Explain briefly the PID controller action with block diagram and obtain its transfer function model. (4)

Or

- (b) (i) The open loop transfer function of a unity feedback system is given by $G(s) = \frac{1}{s(1+s)}$. The input to the system is described by $r(t) = 4 + 6t$. Find the generalized error coefficients and steady state error. (6)

- (ii) Explain the rules to construct root locus of a system. (10)

13. (a) Construct Bode plot for the system whose open loop transfer function is given below and determine (i) the gain margin, (ii) the phase margin, and (iii) closed-loop system stability.

$$G(s) = \frac{4}{s(1 - 0.5s)(1 + 0.08s)} \quad (16)$$

Or

- (b) (i) Explain the use of Nichol's chart to obtain closed loop frequency response from open loop frequency response of a unity feedback system. (8)

- (ii) Describe the correlation between time and frequency domain specifications. (8)

14. (a) (i) By use of the Nyquist stability criterion, determine whether the closed-loop system having the following open-loop transfer function is stable or not. If not, how many closed-loop poles lie in the right-half s-plane.

$$G(s)H(s) = \frac{s+2}{(s+1)(s-1)} \quad (6)$$

- (ii) Explain the procedure for the design of a lead compensator using Bode plot. (10)

Or

- (b) (i) The open loop transfer function of a unity feedback system is given by $G(s)H(s) = \frac{K}{(s+2)(s+4)(s^2+6s+25)}$. By applying the Routh criterion, find the range of values of K for which the closed loop system is stable. Determine the values of K which will cause sustained oscillations in the closed loop system. What are the corresponding oscillation frequencies? (10)

- (ii) Derive the transfer function of the lag-lead compensator. (6)

15. (a) (i) Obtain the state model of the mechanical system shown in Fig.Q11(b)(i) in which $f(t)$ is the input and $y_2(t)$ is the output. (10)

- (ii) State and prove the properties of State Transition Matrix. (6)

Or

- (b) Check for controllability and observability of a system having following coefficient matrices. (8+8)

$$A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & -11 & -6 \end{bmatrix}; B = \begin{bmatrix} 1 \\ 0 \\ 1 \end{bmatrix}; C^T = \begin{bmatrix} 10 \\ 5 \\ 1 \end{bmatrix};$$