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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.

(2) Draw the force-voltage and force-current analogous electrical circuits. (6+4)

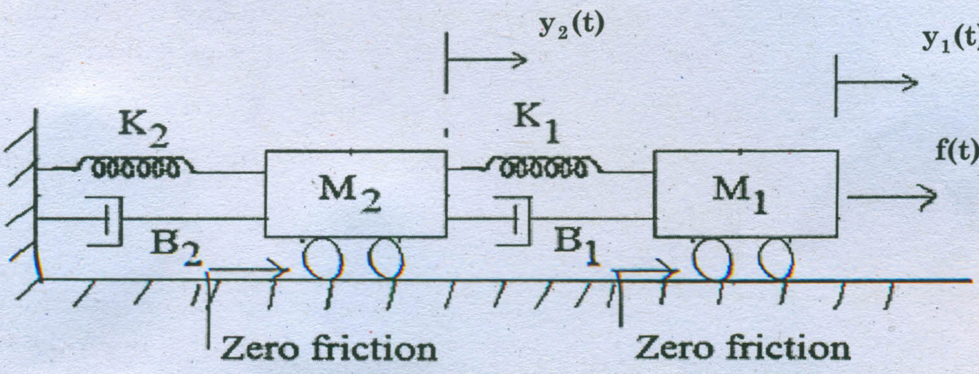

Fig. Q 11(b)(i)

(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.

$$G(s) = \frac{4}{s(1+0.5\,s)(1+0.08s)}$$ (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.

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

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