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Question Paper Code : 71732

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2017

Fourth Semester

Electronics and Communication Engineering

EC 6405 — CONTROL SYSTEM ENGINEERING

(Common to Mechatronics Engineering and Medical Electronics Engineering)

(Regulations 2013)

Time : Three hours

Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. State Mason's gain formula.
2. Differentiate closed loop and open loop control system.
3. Define steady state error.
4. Draw the transfer function model for PID control.
5. What is meant by gain margin?
6. What is the necessity of compensators?
7. What are the advantages of Routh Hurwitz stability criterion?
8. Define Nyquist stability criterion.
9. List some advantages of sampled data control systems.
10. State sampling theorem.

PART B — (5 × 13 = 65 marks).

11. (a) Draw the equivalent electrical analogous circuit for the mechanical system shown below force-voltage analogy.

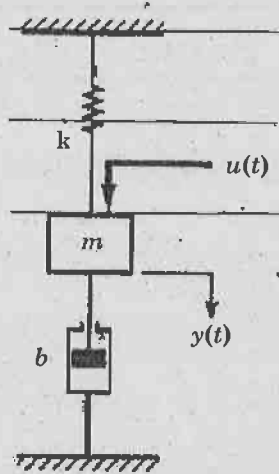


Fig. Q. 11 (a)

Or

- (b) Simplify the following diagram using block diagram reduction method. Also derive the transfer function of the same using signal flow graph.

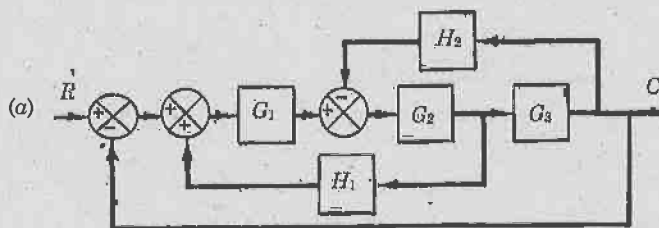


Fig. Q. 11 (b)

12. (a) The unity feedback system is characterized by an open loop transfer function $G(s) = K/s(s+10)$. Determine the gain K , so that the system will have a damping ratio of 0.5 for this value of K . Determine settling time, peak overshoot and peak time for a unit step input.

Or

- (b) Explain about briefly the operation of P, PI and PID control compensation using simple MATLAB programs.

13. (a) Plot the polar plot for the following transfer function

$$G(S) = \frac{15}{(s+1)(s+3)(s+6)}$$

Or

- (b) Discuss briefly about the lag; lead and lag-lead compensator with examples.

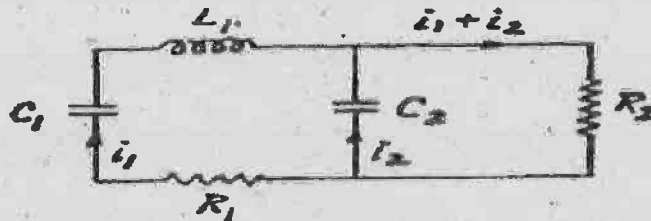
14. (a) Determine the range of K for stability of unity feedback system using Routh stability criterion whose transfer function

$$\frac{C(s)}{R(s)} = \frac{K}{s(s^2 + s + 1)(s + 2) + K}$$

Or

- (b) Explain briefly about the steps to be followed to construct a root locus plot of a given transfer function.

15. (a) Construct the state model of the following electrical system.



Or

- (b) A system is characterized by transfer function $\frac{Y(s)}{U(s)} = \frac{2}{s^3 + 6s^2 + 11s + 6}$. Find the state and output equation in matrix form and also test the controllability and observability of the system.

PART C — (1 × 15 = 15 marks)

16. (a) For a system represented by state equation $\dot{X}(t) = AX(t)$. The response is $X(t) = \begin{bmatrix} e^{-2t} \\ -2e^{-2t} \end{bmatrix}$ when $X(0) = \begin{bmatrix} 1 \\ -2 \end{bmatrix}$ and $X(t) = \begin{bmatrix} e^{-t} \\ -e^{-t} \end{bmatrix}$ when $X(0) = \begin{bmatrix} 1 \\ -1 \end{bmatrix}$. Determine the system matrix A and the state transition matrix.

Or

- (b) Draw the root locus diagram for a system open loop transfer function and then determine the value of k such that the damping ratio of the dominant closed loop poles is 0.4.

$$\text{Open-loop transfer function} = \frac{20}{s(s+1)(s+4) + 20ks}$$