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Question Paper Code : 52914

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2019.

Fourth Semester

Electronics and Communication Engineering

EC 6405 — CONTROL SYSTEM ENGINEERING

(Common to Mechatronics Engineering and Medical Electronics Engineering)

(Regulation 2013)

Time : Three hours | Maximum : 100 marks

(Provide Semilog sheet, Polar graph and ordinary graph sheet)

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What is a control system?

2. List the basic elements of translational mechanical systems.

3. List the standard test signals used in time domain analysis.

4. State the effect of PI compensation in system performance.

5. What is meant by gain margin?

6. What is the necessity of compensators?

7. Find the range of K for closed loop stable behavior of system with characteristic equation $2s^4 + 12s^3 + 22s^2 + 12s + K$ using Routh Hurwitz stability criterion.

8. What is the value of gain K at any given point on root locus?

9. What are state variables?

10. Draw the Sampler and hold circuits.

PART B — (5 × 13 = 65 marks)

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

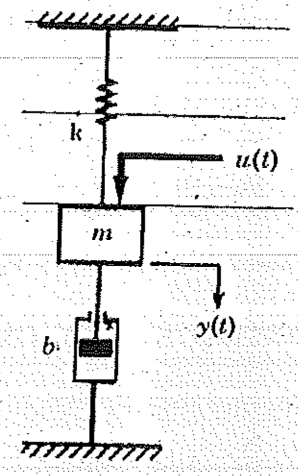

Fig. Q. 11(a)

Or

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

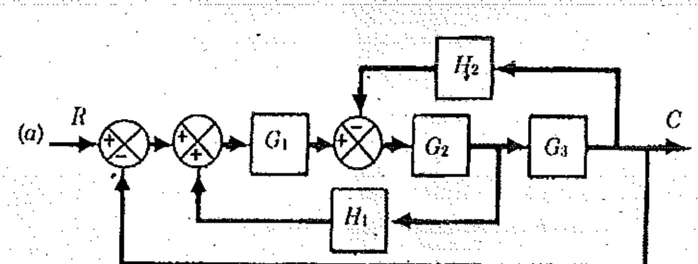

Fig. Q. 11(b)

12. (a) (i) Derive the time response analysis of a first order system for step and ramp input. (11)

(ii) What are the time domain specifications? Define any two. (2)

Or

(b) (i) Determine the type and order of the system with following transfer functions.

(1) $\dfrac{s+4}{(s-2)(s+3)}$ (2)

(2) $\dfrac{10}{s^3(s^2+2s+1)}$ (2)

(ii) With a neat diagram, explain the function of PID compensation in detail. (9)

13. (a) Sketch the Bode plot for the following transfer function and determine the system gain K for the gain cross over frequency to be 5 rad/sec.

$G(s) = Ks^2/[(1+0.2s)(1+0.02s)]$

Or

(b) (i) Write short notes on series compensation. (4)

(ii) Write down the procedure for designing Lead compensator using Bode plot. (9)

14. (a) (i) State Nyquist stability criterion and explain the three situations while examining the stability of the linear control system. (3)

(ii) Construct R-H criterion and determine the stability of a system representing the characteristic equation.

$s^5+s^4+2s^3+2s^2+3s+5=0$. Comment on location of the roots of the characteristics equation. (10)

Or

(b) With neat steps write down the procedure for construction of root locus. Each rule give an example.

15. (a) Consider a system with state-space model given below.

$$x = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -1 & -5 & -1 \end{bmatrix} X + \begin{bmatrix} 0 \\ 5 \\ -24 \end{bmatrix} u; y = [1 \quad 0 \quad 0]x + [0]u;$$

verify that the system is observable and controllable.

Or

(b) Explain the functional modules of closed loop sampled data system and compare its performance with open loop sampled data system.

PART C — (1 × 15 = 15 marks)

16. (a) For a system represented by state equation $\dot{X}(t) = AX(t)$. The response is

$$X(t) = \begin{bmatrix} e^{-2t} \\ -2e^{-2t} \end{bmatrix} \text{ when } X(0) = \begin{bmatrix} 1 \\ -2 \end{bmatrix} \text{ and } X(t) = \begin{bmatrix} e^{-t} \\ -e^{-t} \end{bmatrix} \text{ when } X(0) = \begin{bmatrix} 1 \\ -1 \end{bmatrix}$$

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.

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