Question Paper Code : 91721

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2019

Fifth Semester

Instrumentation and Control Engineering

IC 6501 – CONTROL SYSTEMS

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

(Regulations 2013)

(Also Common to PTIC 6501 – Control Systems for B.E. Part time for Third Semester – Electrical and Electronics Engineering – Regulations 2014)

Time : Three Hours   Maximum : 100 Marks

Answer ALL questions

PART – A   (10×2=20 Marks)

1. List the characteristics of negative feedback in control system.

2. Write the expression for Mason's gain formula.

3. Distinguish between type and order of a system.

4. What is the effect on system performance when a proportional controller is introduced in a system ?

5. Why frequency domain analysis is needed ?

6. Show the shape of the polar plot for the transfer function $K/s\,(1 + sT_1)\,(1 + sT_2)$.

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 space ?

10. When a system is said to be completely observable ?

PART – B **(5×13=65 Marks)**

11. a) i) Explain open loop and closed loop systems with suitable examples. **(6)**

ii) Derive the transfer function for an armature controlled DC motor. **(7)**

(OR)

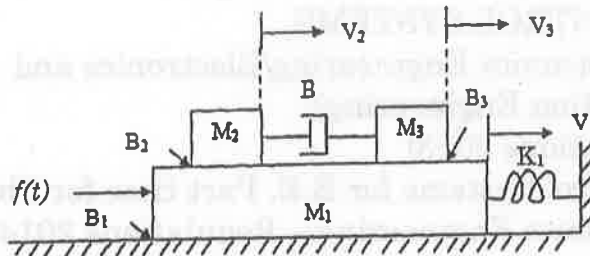b) Obtain the transfer function of the mechanical systems shown in the following Figure 11 (b). **(13)**

Figure 11 (b)

12. a) Derive the time domain specifications of a second order system.

(OR)

b) i) For a Unity feedback control system, the open loop transfer function is given by $G(S) = \dfrac{10(S+2)}{S^2(S+1)}$

1) Find the position, velocity and acceleration error co-efficients.

2) Also find the steady state error when the input is

$R(S) = \dfrac{3}{S} - \dfrac{2}{s^2} + \dfrac{1}{3s^3}$. **(8)**

ii) With a neat diagram explain the effect of PD controller in detail. **(5)**

13. a) Sketch the Bode plot and hence find Gain cross over frequency. Phase cross over frequency, gain margin and phase margin for the function

$G(s) = \dfrac{10(s+3)}{s(s+2)(s^2+4s+100)}$.

(OR)

b) Sketch the polar plot for the following transfer function and find Gain cross over frequency, phase cross over frequency, gain margin and phase margin for $G(s) = 400/s(s+2)(s+10)$.

14. a) i) Use the routh stability criterion, determine the range of K for stability of unity feedback system whose open loop transfer function is

$G(s) = \dfrac{K}{s(s+1)(s+2)}$. **(10)**

ii) State Routh stability criterion. **(3)**

(OR)

b) Design a lead compensator for a unity feedback system with open loop transfer

function, $G(s) = \dfrac{K}{s\,(s+1)\,(s+5)}$ to satisfy the following specifications

   i) Velocity error constant, $K_v \geq 50$

   ii) Phase margin ≥ 20 degrees.   **(13)**

15. a) i) Obtain the state model of the mechanical system shown in Fig. 11 (b) (i) in which f(t) is the input and $y_2(t)$ is the output.   **(8)**

     ii) State and prove the properties of State Transition Matrix.   **(5)**

(OR)

b) Check for controllability and observability of a system having following coefficient matrices.

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

PART – C   **(1×15=15 Marks)**

16. a) Draw the signal flow graph and find the closed loop transfer function of a system whose block diagram is shown in Figure 16 a).   **(15)**

Figure 16 a)

(OR)

b) The open loop transfer function of a unity feedback system is given by $G(s) = K/[s(1 + 0.2s)\,(1 + 0.05s)]$. Construct Nyquist plot and find the range of K for stability.   **(15)**

b) Design a lead compensator for a unity feedback system with open loop transfer function, $G(s) = \dfrac{K}{s(s+1)(s+8)}$ to satisfy the following specifications:

   i) Velocity error constant, $K_v \geq 20$

   ii) Phase margin = 50 degrees. [13]

15. a) Obtain the state model of the mechanical system shown in Fig. 15 (a) in which f(t) is the input and y(t) is the output. [8]

   a) State and prove the properties of State Transition Matrix. [8]

OR

b) Check for controllability and observability of a system having following coefficient matrices:

$$A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & -11 & -6 \end{bmatrix} \quad B = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} \quad C^T = \begin{bmatrix} 10 \\ 8 \\ 1 \end{bmatrix}$$

PART – C (2×15=15 Marks)

16. a) Draw the signal flow graph and find the overall loop transfer function of a system whose block diagram is shown in Figure 16 (a). [15]
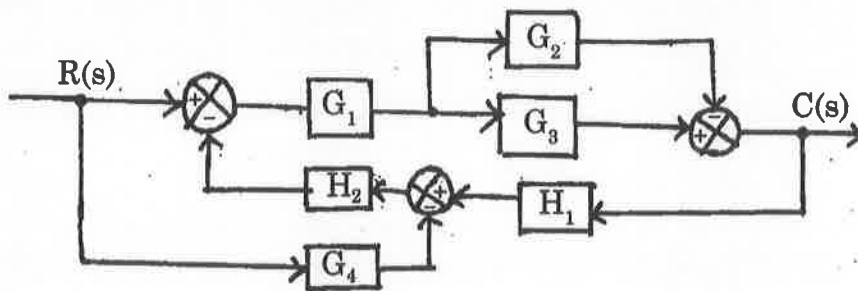

Figure 16 (a)

OR

b) The open loop transfer function of a unity feedback system is given by $G(s) = K[s(1 + 0.5s)(1 + 0.05s)]$. Construct Nyquist plot and find the range of K for stability. [15]