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15EC43

**Fourth Semester B.E. Degree Examination, Feb./Mar. 2022**  
**Control Systems**

Time: 3 hrs.

Max. Marks: 80

**Note: Answer any FIVE full questions, choosing ONE full question from each module.**

**Module-1**

- 1 a. Distinguish between Open loop and Closed loop system with suitable examples. (04 Marks)
- b. Write the differential equations for mechanical system shown in Fig. Q1(b) and write FV Analogous Electrical circuit. (06 Marks)

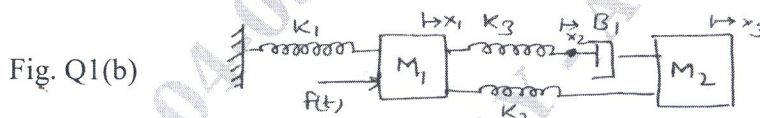


Fig. Q1(b)

- c. For the signal flow graph, shown in Fig. Q1(c), determine the Transfer function  $\frac{C(s)}{R(s)}$ , using Mason's Gain formula. (06 Marks)

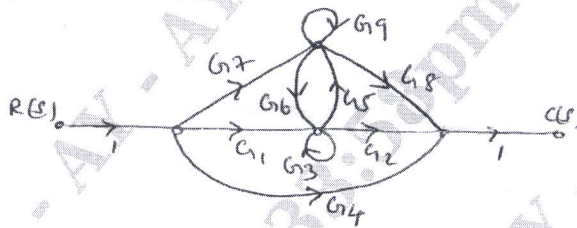


Fig. Q1(c)

**OR**

- 2 a. Draw the Mechanical network. Write differential equations of performance and also draw the Torque Current Analogous circuit for Fig. Q2(a). (06 Marks)

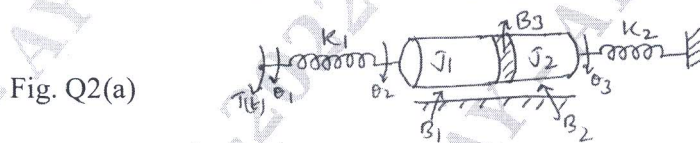


Fig. Q2(a)

- b. Obtain  $\frac{C(s)}{R(s)}$  of the system shown in Fig. Q2(b) by using block diagram Reduction method. (06 Marks)

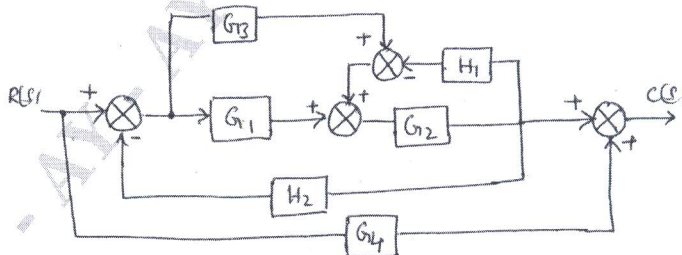


Fig. Q2(b)

- c. Illustrate how to perform the following connection with block diagram Reduction technique.
  - i) Shifting a Takeoff point after a block
  - ii) Shifting a Summing point after a block.
 (04 Marks)

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.  
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8=50, will be treated as malpractice.

**Module-2**

- 3 a. A negative feedback system is characterized by an Open loop system  $G(s)H(s) = \frac{10}{s(s+2)}$ . If the system is subjected to a step input of IV. Find the following time domain specifications : i) Delay time ii) Rise time iii) Peak time iv) Peak overshoot. (08 Marks)
- b. For a system  $G(s)H(s) = \frac{K}{s^2(s+2)(s+3)}$ . Find the value of K to limit steady state error to 10 when input to system is  $1 + 10t + \frac{40}{2}t^2$ . (08 Marks)

OR

- 4 a. Comment on the following statement : An increase in damping ratio increases the rise time. (04 Marks)
- b. For a unity feedback control system with  $G(s) = \frac{64}{s(s+9.6)}$ . Write the output response to a unit step input. Determine i) The response at  $t = 0.1$  sec. ii) Maximum value of the response and time at which it occurs. (08 Marks)
- c. Explain Proportional + Integral + Differential controller and their effect on Stability. (04 Marks)

**Module-3**

- 5 a. Explain briefly the Routh - Hurwitz criterion and use it to determine the roots i) in RHS ii) LHS iii) On  $j\omega$  axis of S plane for the Polynomial.  $P(s) = s^6 + s^5 + 5s^4 + s^3 + 2s^2 - 2s - 8$ . (08 Marks)
- b. The Open Loop Transfer function of a Single loop, unity feedback control system is given by  $G(s) = \frac{K(s+13)}{s(s+3)(s+7)}$ .  
i) Find the value of K for which the Closed loop system is stable.  
ii) Find the value of K for which the Closed loop poles are more negative than -1. (08 Marks)

OR

- 6 a. Following all the steps, draw the root locus diagram for the Transfer function  $G(s)H(s) = \frac{K}{s(s^2 + 8s + 17)}$ . From the diagram evaluate the value of K for a system damping ratio of 0.5. (14 Marks)
- b. List the advantages of Root locus. (02 Marks)

**Module-4**

- 7 a. Find the Transfer function which has the Asymptotic Bode magnitude plot shown in Fig. Q.7(a). (08 Marks)

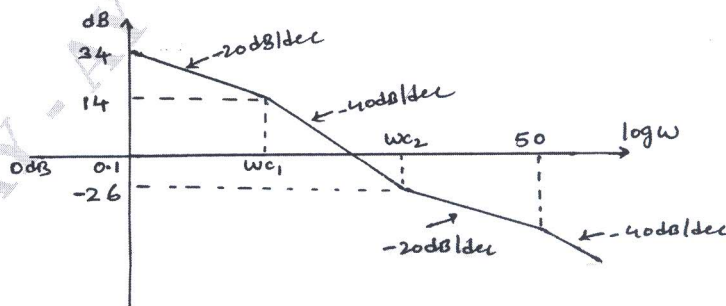


Fig. Q.7(a)

- b. A -Ve Feedback control system is characterized by an Open Loop Transfer function  

$$G(s)H(s) = \frac{10}{(s+1)(s+2)}$$
 investigate the closed loop stability of the system using Nyquist stability criterion. (08 Marks)

OR

- 8 a. The Open Loop Transfer function of unity feedback system is  

$$G(s) = \frac{K}{s(1+0.02s)(1+0.05s)}$$
 Draw the Asymptotic Bode plot and hence find the value of K for which gain margin is 10dB, what is corresponding phase margin. (12 Marks)
- b. State and explain "Nyquist Stability Criterion". (04 Marks)

**Module-5**

- 9 a. Explain Signal reconstruction scheme using sample and hold circuit. (04 Marks)
- b. Obtain state model for system represented by differential equation.

$$\frac{d^3y}{dt^3} + 3\frac{d^2y}{dt^2} + 6\frac{dy}{dt} + 7y(t) = 2u(t). \quad (06 \text{ Marks})$$

- c. Obtain Transfer function of system having state model.

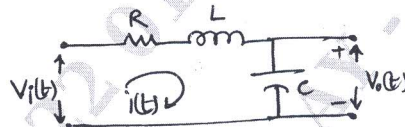
$$\dot{X}(t) = \begin{bmatrix} -5 & -1 \\ 3 & -1 \end{bmatrix} X(t) + \begin{bmatrix} 2 \\ 5 \end{bmatrix} U(t).$$

$$Y(t) = [1 \ 2] X(t). \quad (06 \text{ Marks})$$

OR

- 10 a. Discuss the advantages and limitations of State Variable approach. (03 Marks)
- b. Find the State space representation of circuit shown in Fig. Q10(b). (06 Marks)

Fig. Q10(b)



- c. Find State transition matrix for  $A = \begin{bmatrix} 0 & -1 \\ +2 & -3 \end{bmatrix}$ . (07 Marks)

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