



# CBCS SCHEME

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15EC43

## Fourth Semester B.E. Degree Examination, Dec.2019/Jan.2020 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. Compare open loop and closed loop control system. (05 Marks)
- b. Find the transfer function  $\frac{C(S)}{R(S)}$  for the signal flow graph shown in Fig.Q.1(b). (05 Marks)

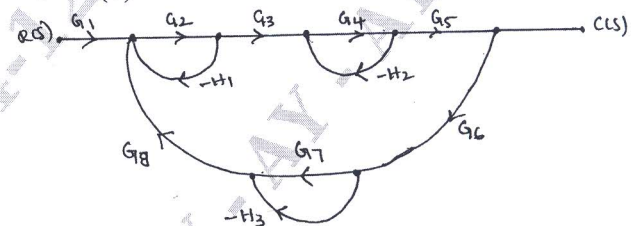


Fig.Q.1(b)

- c. For the Mechanical system shown in Fig.Q.1(c):
  - i) Draw the mechanical network
  - ii) Write the differential equation
  - iii) Draw the force-voltage analogous electrical network. (06 Marks)

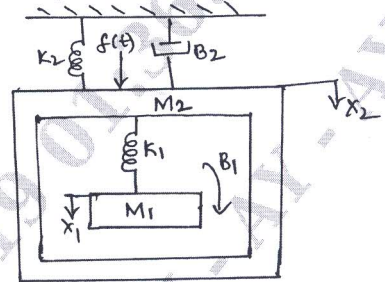


Fig.Q.1(c)

OR

- 2 a. Obtain the transfer function  $\frac{\theta_2(s)}{T(s)}$  for the system shown in Fig.Q.2(a). (05 Marks)

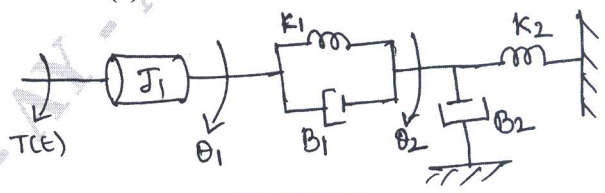


Fig.Q.2(a)

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.

- b. Obtain the transfer function  $\frac{C(s)}{R(s)}$  of the system shown in Fig.Q.2(b) by using block diagram reduction technique. (05 Marks)

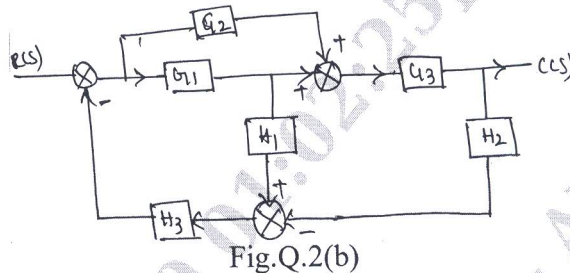


Fig.Q.2(b)

- c. For the network shown in Fig.Q.2(c) construct the signal flow graph and obtain the transfer function using Mason gain formula. Given  $R_1 = 100K\Omega$ ,  $R_2 = 1M\Omega$ ,  $C_1 = 10\mu f$ ,  $C_2 = 1\mu f$ . (06 Marks)

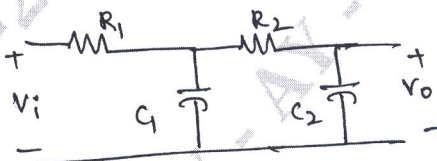


Fig.Q.2(c)

**Module-2**

- 3 a. Derive the expression for unit step response of under damped second order system. (08 Marks)
- b. For a unity feedback control system with  $G(S) = \frac{10(S+2)}{S^2(S+1)}$ . Find the static error coefficients and steady state error when input transform is  $R(S) = \frac{3}{S} + \frac{2}{S^2} + \frac{1}{3S^3}$ . (04 Marks)
- c. A units feedback control system has  $G(S) = \frac{K}{S(S+10)}$  determine the gain K for  $\xi = 0.5$ . Also find rise time, peak time, peak overshoot and settling time. Assume system is subjected to a step of 1v. (04 Marks)

OR

- 4 a. Show that the steady state error  $e_{ss} = \lim_{s \rightarrow 0} \frac{S.R(s)}{1+G(s).H(s)}$  using simple closed loop system with negative feedback. (04 Marks)
- b. For a spring-mass damper system shown in Fig.Q.4(b), an experiment was conducted by applying a force of 2 Newtons to the mass. The response  $x(t)$  was recorded using xy plotter and experimental result is as shown in Fig.Q.4(b) below. Find the value of M, K, B. (07 Marks)

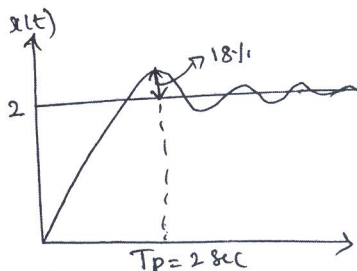
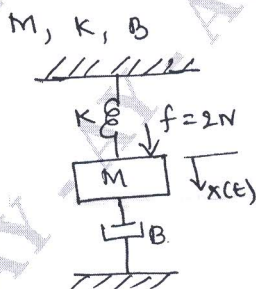


Fig.Q4(b)

- c. A signal is represented by the equation  $\frac{d^2\theta}{dt^2} + 10\frac{d\theta}{dt} = 150e$  where  $e = (r - \theta)$  is the actuating signal, calculate the value of damping ratio, undamped and damped frequency of oscillation. Also draw the block diagram and find its closed loop transfer function. (05 Marks)

### Module-3

- 5 a. Explain the concept of Routh Hurwitz criterion. What are the necessary and sufficient conditions for the system to be stable as per Routh-Hurwitz criteria? (05 Marks)
- b. Comment on the stability of a system using Routh's stability criteria whose characteristic equation is  $s^4 + 2s^3 + 4s^2 + 6s + 8 = 0$ . How many poles of systems lie in right half of s plane? (04 Marks)
- c. Construct the root locus and show that part of the root locus is circle. Comment on stability of open loop transfer function given by  $G(s) = \frac{K(s+2)}{s(s+1)}$ . (07 Marks)

### OR

- 6 a. Determine the range of K such that the characteristic equation.  $S^3 + 3(k+1)S^2 + (7K+5)S + (4K+7) = 0$  has roots more negative than  $S = -1$ . (07 Marks)
- b. A feedback control system has open loop Transfer function  $G(S)H(S) = \frac{K}{S(S+4)(S^2+4S+20)}$  plot the root locus for  $K = 0$  to  $\infty$ . Indicate all the points on it. (09 Marks)

### Module-4

- 7 a. Explain Nyquist stability criterion. (04 Marks)
- b. Sketch the Nyquist plot for open loop transfer function  $G(S)H(S) = \frac{K}{S(S+1)(S+2)}$ . Find the range of K for closed loop stability. (08 Marks)
- c. For the log magnitude diagram shown in Fig.Q.7(c) find the transfer function. (04 Marks)

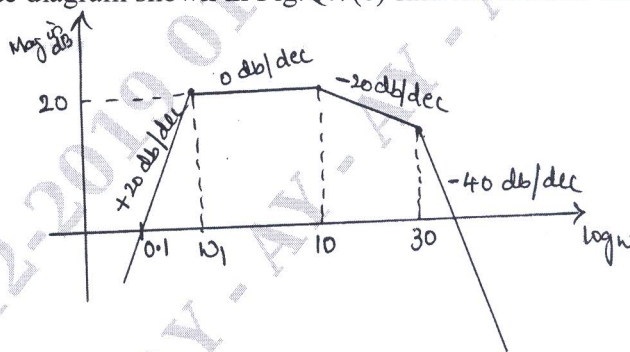


Fig.Q.7(c)

### OR

- 8 a. Define Gain Margin and phase Margin. Explain how these can be determined using Bode plot. (04 Marks)
- b. Construct the Bode magnitude and phase plot for  $G(s)H(s) = \frac{100(0.1s+1)}{s(s+1)^2(0.01s+1)}$ . Find Gain margin and phase Margin. (06 Marks)

- c. The polar plot of open loop transfer function of unity feedback system is shown in Fig.Q.8(c). None of the  $G(s)H(s)$  functions have poles on RHS.
- Complete the Nyquist path
  - Is the system stable
  - What is the system TYPE number?
- (06 Marks)

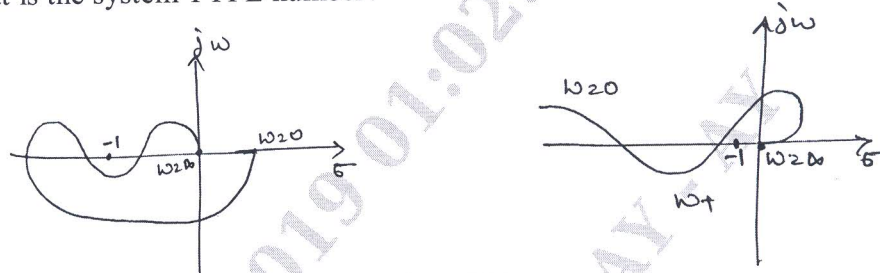


Fig.Q.8(c)

**Module-5**

- 9 a. List the properties of state transition matrix. (04 Marks)
- b. Obtain an appropriate state model for a system represented by an electric circuit as shown in Fig.Q.9(b). (06 Marks)

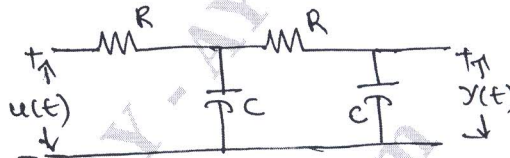


Fig.Q.9(b)

- c. Find the state transition matrix for a system whose system matrix is given by

$$A = \begin{bmatrix} 0 & 1 \\ -8 & -6 \end{bmatrix}$$

(06 Marks)

OR

- 10 a. Draw and explain the block diagram of sample data control system. (04 Marks)
- b. The transfer function of a control system is given by  $\frac{y(s)}{u(s)} = \frac{s^2 + 3s + 4}{s^3 + 2s^2 + 3s + 2}$  obtain a state model using signal flow graph. (08 Marks)
- c. Obtain the state model of the system shown in Fig.Q.10(c). (04 Marks)

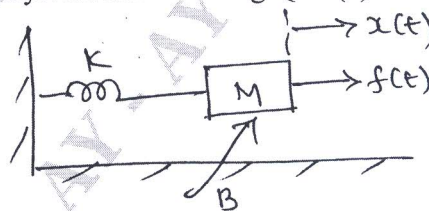


Fig.Q.10(c)

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