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)**

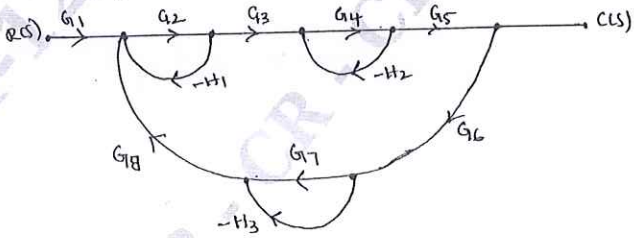


Fig.Q.1(b)

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)**

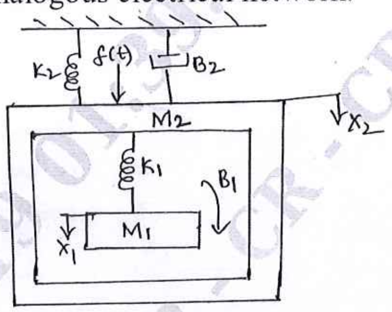


Fig.Q.1(c)

OR

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

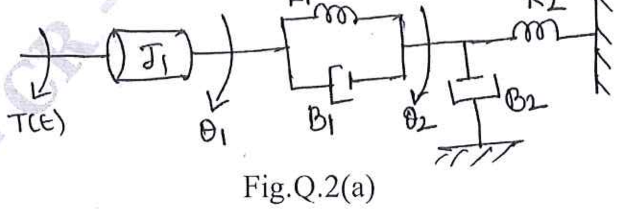


Fig.Q.2(a)

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)**

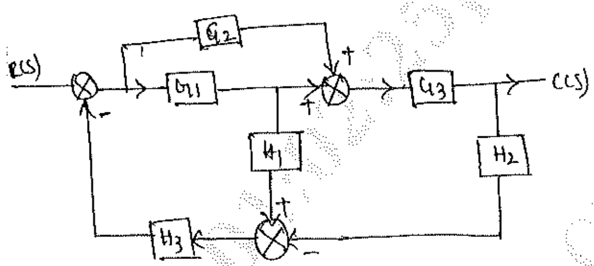


Fig.Q.2(b)

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)**

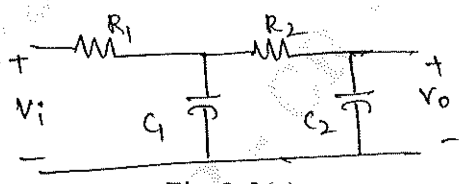


Fig.Q.2(c)

Module-2

3 a. Derive the expression for unit step response of under damped second order system. **(08 Marks)**

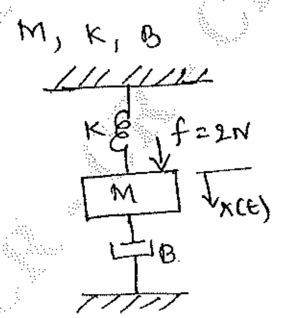
b. For a unity feedback control system with $G(S) = \frac{10(S+2)}{S^2(S+1)}$. Find the static error coefficients and steady state error when input transform is $R(S) = \frac{3}{S} + \frac{2}{S^2} + \frac{1}{3S^3}$. **(04 Marks)**

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 $e_{ss} = \lim_{s \to o} \frac{S.R(s)}{1+G(s).H(s)}$ 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)**



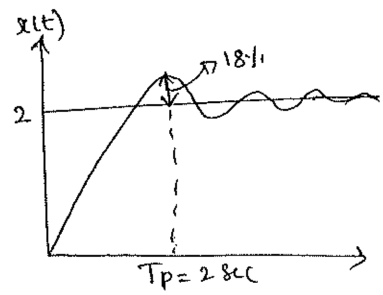


Fig.Q4(b)

c. A signal is represented by the equation $\frac{d^2\theta}{dt^2} + 10\frac{d\theta}{dt} = 150e$ where e = (r - θ) 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 creterio. 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 ∞. 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)**

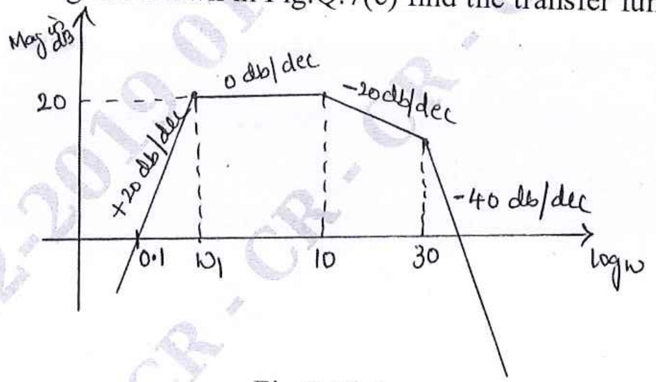


Fig.Q.7(c)

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.
   i) Complete the Nyquist path
   ii) Is the system stable
   iii) What is the system TYPE number? **(06 Marks)**

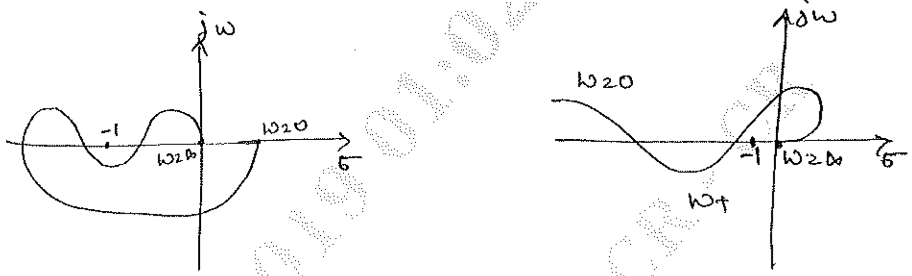


Fig.Q.8(c)

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)**

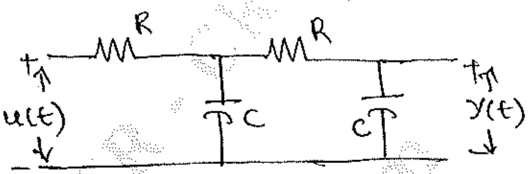


Fig.Q.9(b)

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)**

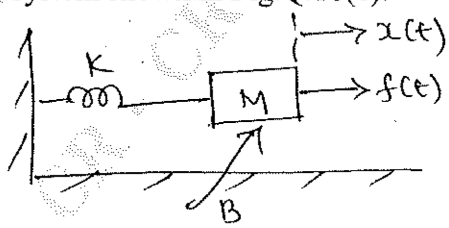


Fig.Q.10(c)

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