CBCS SCHEME

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17EE61

Sixth Semester B.E. Degree Examination, July/August 2021
Control Systems

Time: 3 hrs. Max. Marks: 100

Note: Answer any FIVE full questions.

1 a. Distinguish between open loop and closed loop control system, with example. **(06 Marks)**

b. A mechanical system shown in Fig.Q.1(b):

i) Obtain the differential equations describing the system.

ii) Sketch the analogous electrical circuit based on force-voltage analogy. **(08 Marks)**

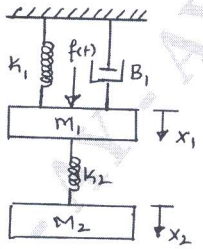


Fig.Q.1(b)

c. Obtain the transfer function of an armature controlled D.C. servomotor. **(06 Marks)**

2 a. For the mechanical system shown in Fig.Q.2(a)

i) Draw the mechanical equivalent network

ii) Write the performance equation

iii) Draw the analogous electrical network based on torque-current analogy. **(08 Marks)**

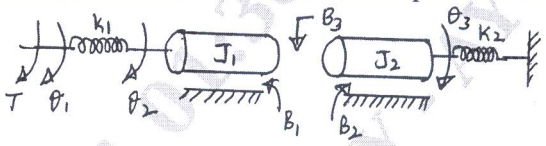


Fig.Q.2(a)

b. For the electrical network shown in Fig.Q.2(b) obtain the transfer function $\frac{E_o(s)}{E_i(s)}$. **(06 Marks)**

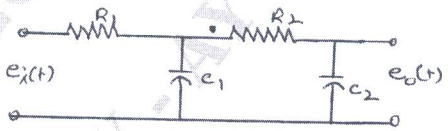


Fig.Q.2(b)

c. For the electrical network shown in Fig.Q.2(c) obtain translational mechanical system. **(06 Marks)**

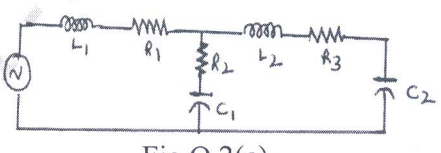
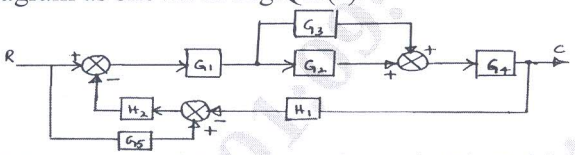


Fig.Q.2(c)

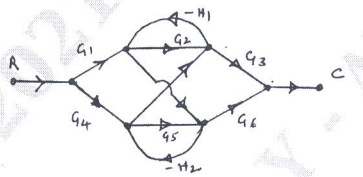
3 a. Using block diagram reduction technique, find the closed loop transfer function of the system whose block diagram as shown in Fig.Q.3(a). **(10 Marks)**

Fig.Q.3(a)



b. Find C/R for the signal flow graph of the system shown in Fig.Q.3(b). Apply Masson's gain formula. **(10 Marks)**

Fig.Q.3(b)



4 a. A system is described by the following set of linear algebraic equations:

$x_2 = a_{12}x_1 + a_{22}x_2 + a_{32}x_3$

$x_3 = a_{23}x_2 + a_{43}x_4$

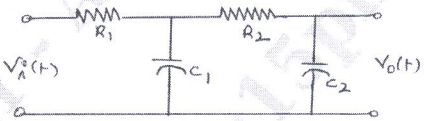
$x_4 = a_{24}x_2 + a_{34}x_3 + a_{44}x_4$

$x_5 = a_{25}x_2 + a_{45}x_4$

Draw the signal flow graph and obtain the transfer function. **(10 Marks)**

b. Determine transfer function by using block diagram reduction technique for the electrical network shown in Fig.Q.4(b). **(10 Marks)**

Fig.Q.4(b)



5 a. A unity feedback control system has an open loop transfer function $G(s) = \frac{5}{s(s+1)}$.

Find the rise time, percentage overshoot, peak time and settling time for a step input of 10 units. Also determine the peak overshoot. **(10 Marks)**

b. The open loop transfer function of a unity feedback control system is given by

$$G(s) = \frac{K}{s(1+s\tau)}$$

i) By what factor the amplifier gain 'K' should be multiplied so that the damping ratio is increased from 0.2 to 0.8?

ii) By what factor the time constant T should be multiplied so that the damping ratio is reduced from 90% to 30%? **(10 Marks)**

6 a. A unity feedback control system has $G(s) = \frac{K(s+13)}{s(s+3)(s+7)}$ using RH criterion, calculate the range of 'K' for which the system is (i) stable (ii) Has its closed loop more negative than -1. **(06 Marks)**

b. Determine the stability of the system represent by the following characteristics equation:

$s^5 + s^4 + 2s^3 + 2s^2 + 3s + 5 = 0$ **(06 Marks)**

c. Investigate the stability of the system given by characteristics equation.

$s^6 + 3s^5 + 5s^4 + 9s^3 + 8s^2 + 6s + 4 = 0$

How many poles are i) On the LHS ii) On the imaginary axis iii) On the RHS of s-plane. **(08 Marks)**

7 a. Sketch the complete root locus of the system having $G(s)H(s) = \frac{K}{s(s+2)(s^2+4s+13)}$ comment on stability. **(10 Marks)**

b. Draw the Bode plot for the system having open loop transfer function

$$G(s)H(s) = \frac{K}{s(1+0.1s)(1+0.05s)}$$

Find the value of 'K' for a given gain margin of 10db. **(10 Marks)**

8 a. Sketch the root locus plot for a closed loop system having an $G(s)H(s) = \frac{k(s+2)}{s(s+1)}$ for all value of 'K' from 0 to ∞. Comment on stability of the system. Also show that a part of the root locus is a circle. **(08 Marks)**

b. Find the open loop transfer function of a system whose approximate plot is shown in Fig.Q.8(b). **(06 Marks)**

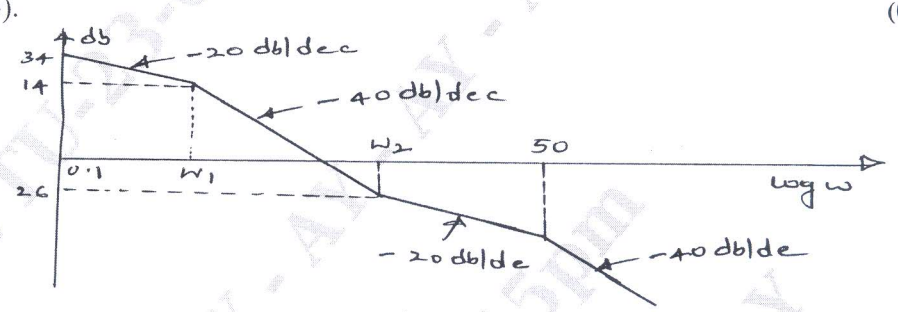


Fig.Q.8(b)

c. A negative feedback control system is characterized by $G(s) = \frac{k}{s(s+\alpha)}$, $H(s) = 1$

i) Find the value of 'k' and 'α' so that $M_r = 1.04$ and $W_r = 11.55$ rad/sec.

ii) For the value of 'k' and 'α' formed in part (i). Calculate the settling time and Bandwidth of the system. **(06 Marks)**

9 a. For a certain control system $G(s)H(s) = \frac{k}{s(s+2)(s+10)}$ sketch the Nyquist plot and hence calculate the range of 'k' for stability. **(10 Marks)**

b. Explain the step by step procedure of Lag compensating network. **(10 Marks)**

10 a. With neat block diagram, explain the PI, PD and PID controller. Also explain the effect of each controller. **(10 Marks)**

b. The open loop transfer function of unity feedback system is $G(s) = \frac{K}{s(s+1)}$. It is desired to have the velocity error constant $K_v = 12\text{sec}^{-1}$ and phase margin as 40°. Design a lead compensator to meet the above specifications. **(10 Marks)**

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