CBCS SCHEME

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18EE61

Sixth Semester B.E. Degree Examination, Jan./Feb. 2023
Control Systems

Time: 3 hrs. Max. Marks: 100

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

Module-1

1 a. What are the properties of good control system? **(04 Marks)**

b. Obtain the transfer function of an armature controlled DC servomotor. **(08 Marks)**

c. Construct mathematical model for the mechanical system shown in Fig.Q1(c). Draw its electrical equivalent circuit based on F-V analogy.

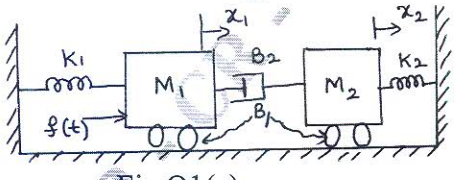

Fig.Q1(c) **(08 Marks)**

OR

2 a. Draw the block diagram of open loop and closed loop system. List any two merits and demerits of closed loop system over the open loop system. **(06 Marks)**

b. Obtain the electrical F-I analogy for the system shown in Fig.Q2(b).

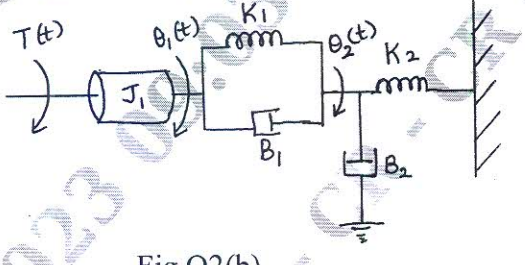

Fig.Q2(b) **(07 Marks)**

c. Show that the two systems in Fig.Q2(c) are analogous by comparing the transfer function.

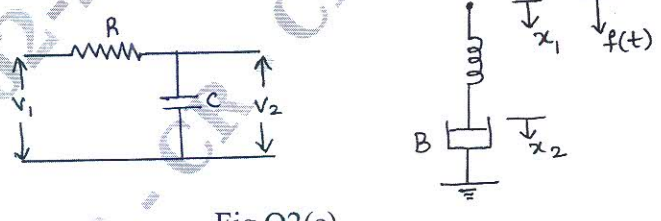

Fig.Q2(c) **(07 Marks)**

Module-2

3 a. Define the following terms related to signal flow graph:
(i) Forward path
(ii) Feedback loop
(iii) Self loop
(iv) Source node. **(04 Marks)**

b. Obtain the transfer function for the block diagram shown in Fig.Q3(b) using Mason's gain formula.

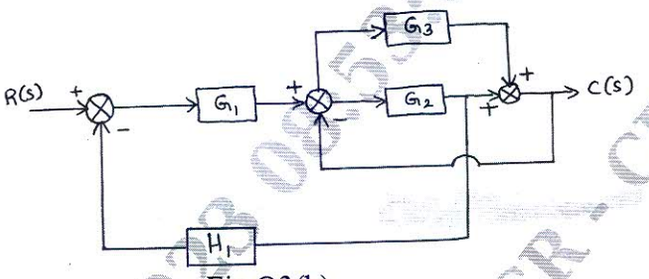

Fig.Q3(b) **(08 Marks)**

c. Find the transfer function for the network shown in Fig.Q3(c) using signal flow graph.

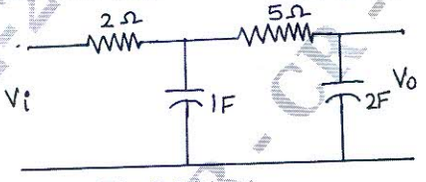

Fig.Q3(c) **(08 Marks)**

OR

4 a. Obtain the expression for closed loop transfer function for a negative feedback system. **(04 Marks)**

b. Obtain the transfer function for the block diagram shown in Fig.Q4(b) using block diagram reduction method.

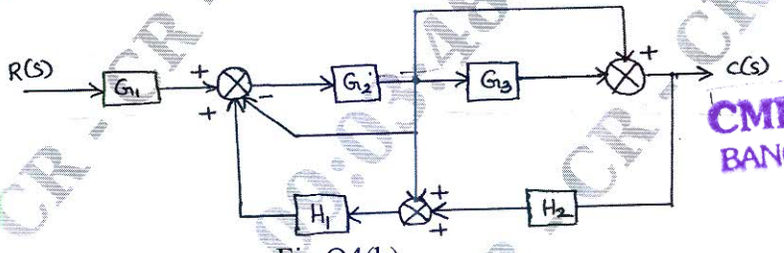

Fig.Q4(b) **(08 Marks)**

c. For the signal flow graph shown in Fig.Q4(c), determine the transfer function C(s)/R(s) using Mason's gain formula.

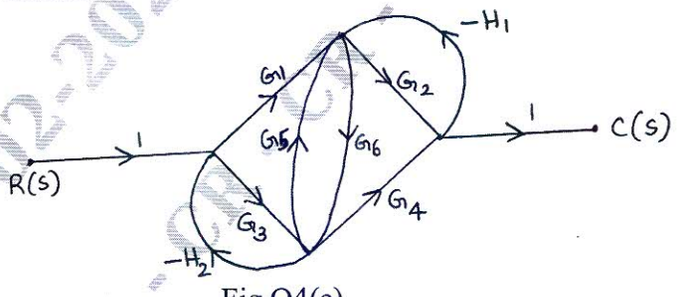

Fig.Q4(c) **(08 Marks)**

Module-3

5 a. Define and derive the expression for (i) Rise time (ii) Peak overshoot of an underdamped second order control system subjected to step input. **(08 Marks)**

b. An unity feedback system has $G(s) = \frac{20(1+s)}{s^2(2+s)(4+s)}$, find (i) The static error coefficients (ii) Steady state error when the input is $r(t) = 40 + 2t + 5t^2$. **(06 Marks)**

c. For a unity feedback system, $G(s) = \frac{k(s+4)}{s(s+1)(s+2)}$. Using RH criterion find the following :

(i) The range of k that keeps the system stable.
(ii) The value of k that makes the system oscillate.
(iii) The frequency of oscillation, when k is set to the value that makes the system oscillate. **(06 Marks)**

OR

6 a. Explain Routh-Hurwitz criterion for determining the stability of the system and mention its limitations. **(06 Marks)**

b. Find the range of k for which the system, whose characteristics equation is given below is stable.

$$F(s) = s^3 + (k + 0.5)s^2 + 4ks + 50$$ **(06 Marks)**

c. For an unity feedback system with $G(s) = \frac{50}{s(s+5)}$, find :

(i) Percentage overshoot for unit step input
(ii) Settling time
(iii) Static error coefficients
(iv) Steady state error when input is $r(t) = 6t^2 + 4t + 2$ **(08 Marks)**

Module-4

7 a. Sketch the root locus for unity feedback having

$$G(s) = \frac{k(s+1)}{s(s+2)(s^2+2s+2)}$$

Determine the range of k for the system stability. **(14 Marks)**

b. Define the following terms:
(i) Resonant peak (ii) Resonant frequency (iii) Bandwidth (iv) Cut-off frequency.
Give any two correlation between time and frequency responses. **(06 Marks)**

OR

8 a. Construct the Bode plot for a unity feedback control system with

$$G(s) = \frac{10(s+10)}{s(s+2)(s+5)}$$

Find its (i) Gain crossover frequency (ii) Gain margin (iii) Phase crossover frequency (iv) Phase margin. Comment on the stability. **(14 Marks)**

b. Define the following as applied to bode plots:
(i) Gain margin (ii) Phase margin (iii) Gain cross over frequency. **(06 Marks)**

Module-5

9 a. Sketch the Nyquist plot of a unity feedback control system having the open loop transfer function $G(s) = \frac{5}{s(1-s)}$. Determine the stability of the system using Nyquist stability criterion. **(14 Marks)**

b. Write short notes on PID controller. **(06 Marks)**

OR

10 a. State and explain Nyquist stability criterion. **(08 Marks)**

b. Explain the P-I controller on a second order system. **(06 Marks)**

c. What are the limitations of single stage phase lead control? **(06 Marks)**

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