

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. (08 Marks)

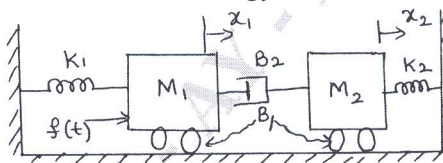


Fig.Q1(c)

(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). (07 Marks)

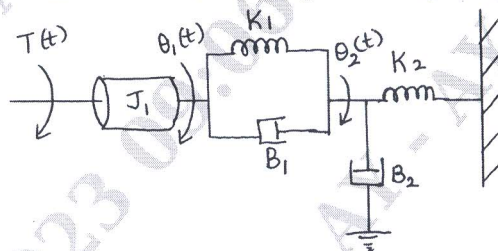


Fig.Q2(b)

(07 Marks)

- c. Show that the two systems in Fig.Q2(c) are analogous by comparing the transfer function. (07 Marks)

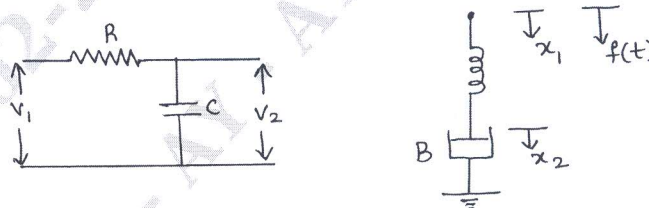


Fig.Q2(c)

(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)

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

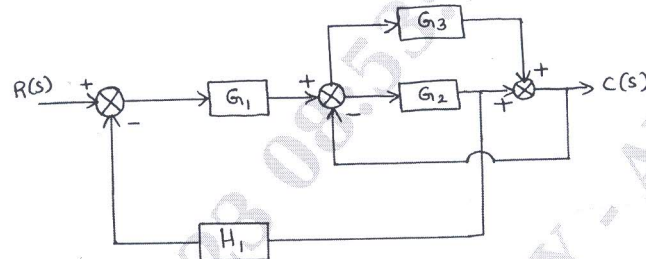


Fig.Q3(b)

(08 Marks)

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

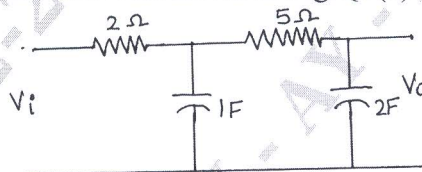


Fig.Q3(c)

(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.

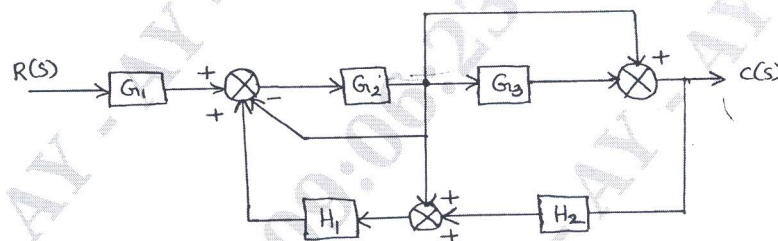


Fig.Q4(b)

(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.

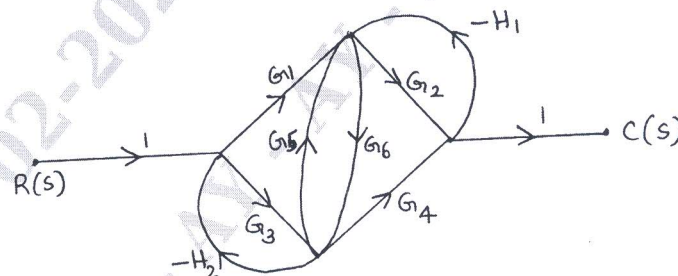


Fig.Q4(c)

(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 :
- The range of k that keeps the system stable.
 - The value of k that makes the system oscillate.
 - 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 :
- Percentage overshoot for unit step input
 - Settling time
 - Static error coefficients
 - 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:
- Resonant peak
 - Resonant frequency
 - Bandwidth
 - 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:
- Gain margin
 - Phase margin
 - 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. (08 Marks)
- c. What are the limitations of single stage phase lead control? (04 Marks)
