CBCS SCHEME

Fourth Semester B.E. Degree Examination, Dec.2023/Jan.2024
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. Define control system. Write the differences between open loop control system and closed loop control system.   **(08 Marks)**

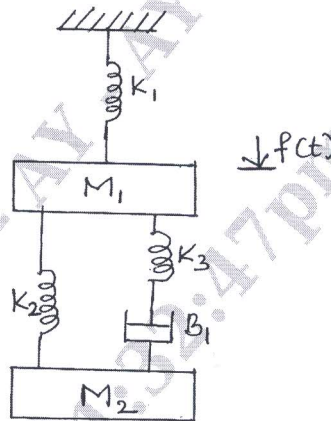   b. For the mechanical system shown in Fig.Q1(b). Obtain the analogous electrical network based on F-V analogy.

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

OR

2 a. Define transfer function. derive an expression for the transfer function of a closed loop, negative feedback system.   **(04 Marks)**

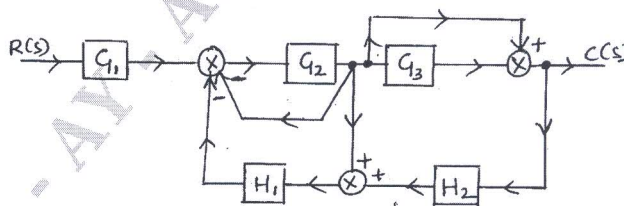   b. Reduce the block diagram shown in Fig.Q2(b) using block diagram reduction rules and obtain C(S)/R(S).

Fig.Q2(b)   **(06 Marks)**

   c. Find $\dfrac{C(S)}{R(S)}$ using Mason's gain formula.   **(06 Marks)**

Module-2

3 a. List the standard test inputs used in control system and write their Laplace transform.

        (04 Marks)

  b. Find K_p, K_v, K_a and steady state error for a system with open loop transfer function as

$$G(s)H(s) = \frac{10(s+2)(s+3)}{s(s+1)(s+4)(s+5)}$$

where the input is $r(t) = 3 + t + t^2$.

        (06 Marks)

  c. For the system shown in Fig.Q3(c), obtain closed loop transfer function, damping ratio natural frequency and expression for the output response if subjected to unit step input.
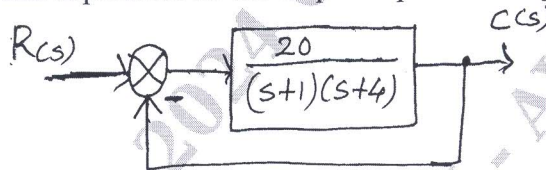

Fig.Q3(c)

        (06 Marks)

OR

4 a. Define rise time and maximum overshoot and write their formula.   **(04 Marks)**

  b. For a given system $G(s)H(s) = \dfrac{K}{s^2(s+2)(s+3)}$. Find the value of K to limit steady state error to 10 when input to system is $1 + 10t + 20t^2$.

        (06 Marks)

  c. For a unity feedback control system with $G(s) = \dfrac{64}{s(s+9.6)}$. Write the output response to a unit step input. Determine:

      i) The response at $t = 0.1$ sec.

      ii) Settling time for $\pm 2\%$ of steady state.   **(06 Marks)**

Module-3

5 a. Explain basic concept of Root locus.   **(03 Marks)**

  b. The open loop T.F of unity feedback system is given by

$$G(s) = \frac{K(s+3)}{s(s^2+2s+3)(s+5)(s+6)}$$

Find the value of K of which closed loop system is stable.   **(07 Marks)**

  c. A unity feedback control system is described by the characteristic equation $s^6 + 2s^5 + 8s^4 + 12s^3 + 20s^2 + 16s + 16 = 0$. Find its stability using R-H criterion.   **(06 Marks)**

OR

6 a. Explain R-H criterion for determining the stability of a system and mention its limitations.

        (04 Marks)

  b. A feedback control system has an open loop transfer function,

$$G(s)H(s) = \frac{K}{s(s+3)(s^2+2s+2)}$$

Draw the root locus as K varies from 0 to ∞.   **(12 Marks)**

Module-4

7 a. Sketch the bode plot for the transfer function :

$$G(s) = \frac{ks^2}{(1+0.2s)(1+0.02s)}$$

Determine the value of k for the gain cross-over frequency to be 5 rad/sec.   **(10 Marks)**

  b. Define : i) Gain margin ii) Phase margin iii) Gain cross-over frequency.   **(06 Marks)**

OR

8   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 values of k for system stability.
(10 Marks)

   b.   State and explain the Nyquist stability criterion. (06 Marks)

Module-5

9   a.   Explain the sampling process with the help of unit impulse train. (06 Marks)

   b.   What is diagonalization of a matrix explain with suitable example? (05 Marks)

   c.   Obtain the state model of the system represented by the differential equation :

$$\frac{d^3y(t)}{dt^3} + 6\frac{d^2y(t)}{dt^2} + 11\frac{dy(t)}{dt} + 10y(t) = 3u(t)$$

(05 Marks)

OR

10   a.   Define the following terms:
   i)   State variable
   ii) State space
   iii) State trajectory. (06 Marks)

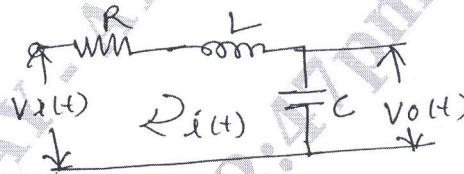   b.   Obtain the state model of the given electrical system for the Fig.Q.10(b).

Fig.Q.10(b) (06 Marks)

   c.   State the advantages and disadvantages of digital control system. (04 Marks)

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