CBCS SCHEME

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15EC43

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.

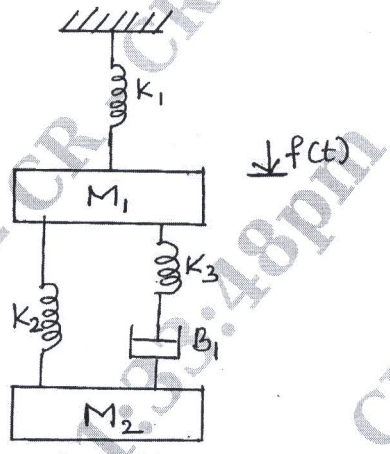

Fig.Q1(b) **(08 Marks)**

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).

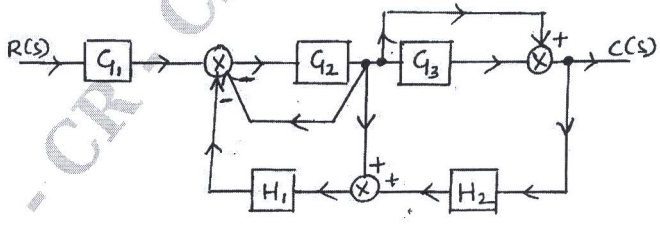

Fig.Q2(b) **(06 Marks)**

c. Find $\frac{C(S)}{R(S)}$ 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.

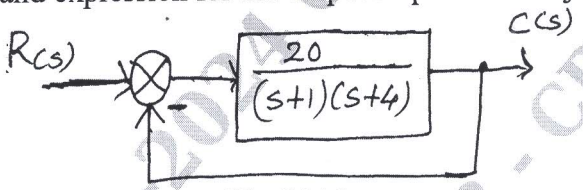

Fig.Q3(c) **(06 Marks)**

OR

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

b. For a given system $G(s)H(s) = \frac{K}{s^2(s+2)(s+3)}$. 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 $G(s) = \frac{64}{s(s+9.6)}$. Write the output response to a unit step input. Determine:

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

ii) Settling time for ± 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).

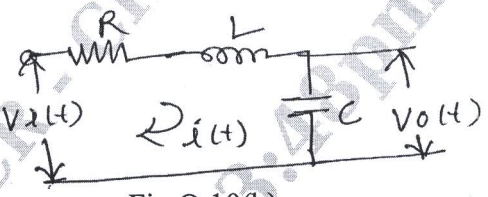

Fig.Q.10(b) **(06 Marks)**

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

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