CBCS SCHEME

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18MT34

Third Semester B.E. Degree Examination, June/July 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. Explain open loop control system and closed loop control system with an example. **(10 Marks)**

b. For the mechanical system shown in Fig.Q1(b).

i) Obtain the equations of motion for masses M_1 and M_2.

ii) Find the transfer function $\frac{X_2(s)}{F(s)}$.

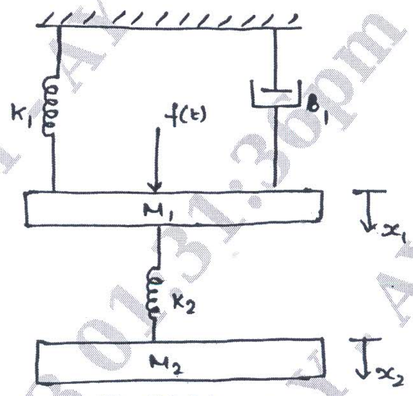

Fig.Q1(b) **(10 Marks)**

OR

2 a. Differentiate between open loop control system and closed loop control system. **(07 Marks)**

b. For the rotational mechanical system Fig.Q2(b), draw the electrical networks based on torque current analogy. Give all the relevant equations.

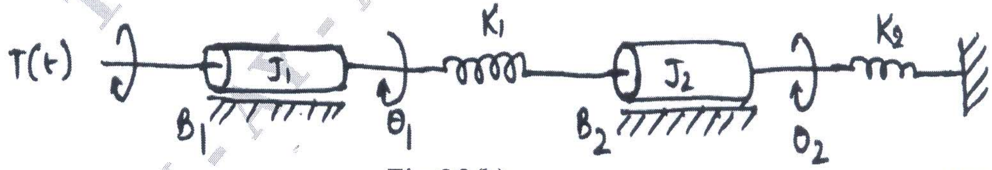

Fig.Q2(b) **(10 Marks)**

c. What are the advantage of analog electric circuits. **(03 Marks)**

Module-2

3 a. Define the following :

i) Forward path and forward path gain
ii) Loop and loop gain
iii) Non-touching loops
iv) Input node
v) Output node. **(08 Marks)**

b. Find C/R for the graph shown below Fig.Q3(b) using Mason's gain formula.

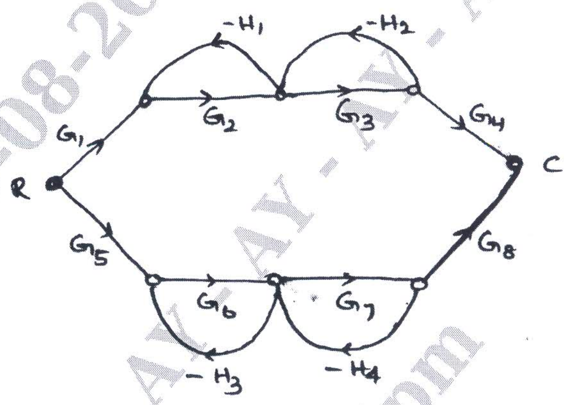

Fig.Q3(b) **(12 Marks)**

OR

4 a. Find the step response of second order systems for underdamped case. (Refer Fig.Q4(a)).

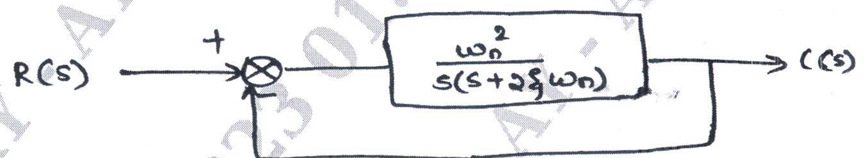

Fig.Q4(a) Second order reference system. **(14 Marks)**

b. Refer the system shown in Fig.Q4(b). Find the following :

i) System type
ii) Static error constants K_p, K_v and K_a
iii) The steady – state for an input r(t) = 5u(t).

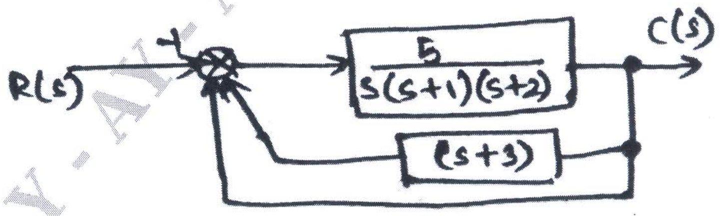

Fig.Q4(b) **(06 Marks)**

Module-3

5 a. A negative feedback control system is characterized by

$$G(s)H(s) = \frac{Ke^{-s}}{s(s^2+5s+9)}.$$

Determine the maximum value of K for stability. **(10 Marks)**

b. Investigate the stability of a closed loop system whose characteristics equation is given by $s^5 + s^4 + 2s^3 + 2s^2 + 3s + 5 = 0$. **(10 Marks)**

OR

6 a. A negative feedback system is represented by the equation : $F(s) = s^3 + 10s^2 + 29s + K$ shift the vertical axis to the right by 2 by using $s = s_1 - 2$ and determine the value of gain K so that the complex roots are $s = -2 \pm 1j$. **(08 Marks)**

b. A positional servomechanism is characterized by an open loop transfer function :

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

Determine :

i) The value of the gain K when and of the closed loop roots is equal at 0.707

ii) The value of the gain K when the closed loop system has two roots on the jω axis. **(12 Marks)**

Module-4

7 Sketch the root locus plot for a negative feedback control system having an open loop transfer function :

$$G(s)H(s) = \frac{K}{s(s+1)(s+2)}.$$

(20 Marks)

OR

8 Construct the bode plot for a unity feedback system with

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

And find gain margin, phase margin and comment on stability. **(20 Marks)**

Module-5

9 a. Define state and state variables. List the properties of state transition matrices. **(08 Marks)**

b. Represent the electrical circuit shown in Fig.Q9(b) by a state model.

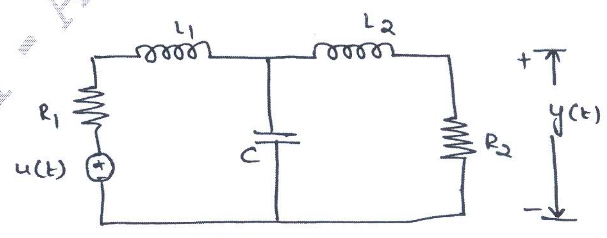

Fig.Q9(b) **(12 Marks)**

OR

10 a. Obtain an appropriate state model for a system represented by an electric circuit as shown n Fig.Q10(a).

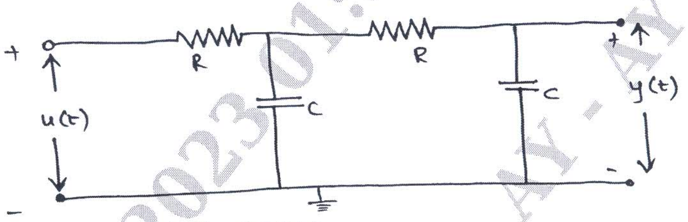

Fig. Q10(a) **(12 Marks)**

b. Obtain the state–transistion matrix $\phi(t)$ of the following system :

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

Also, obtain the inverse of state–transistion matrix $\phi^{-1}(t)$. **(08 Marks)**

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