CBCS SCHEME

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17EC43

Fourth 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.***

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.

Module-1

1 a. Define control system. Briefly explain the requirements of a control system. **(04 Marks)**

b. For the mechanical system shown n Fig.Q1(b). Draw :
i) Mechanical network
ii) Write the differential equations
iii) Force-voltage analog
iv) Force-current analog.

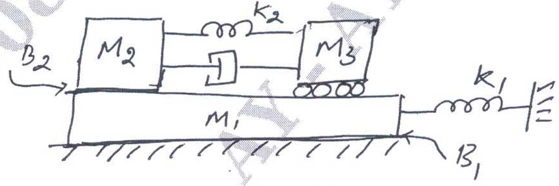

Fig.Q1(b) **(10 Marks)**

c. For the signal flow graph shown in Fig.Q1(c). Find the closed loop transfer function : $\frac{C(s)}{R(s)}$.

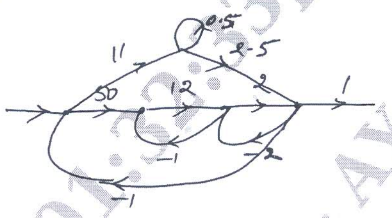

Fig.Q1(c) **(06 Marks)**

OR

2 a. Distinguish between open loop and closed loop control system with an example for each. **(06 Marks)**

b. For the figure shown in Fig.Q2(a). Find the transfer function $\frac{Q_2(s)}{T(s)}$.

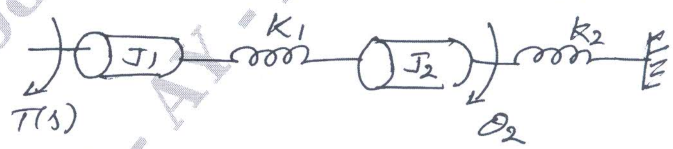

Fig.Q2(b) **(08 Marks)**

c. The system block diagram is given Fig.Q2(c), find $\frac{C(s)}{R(s)}$.

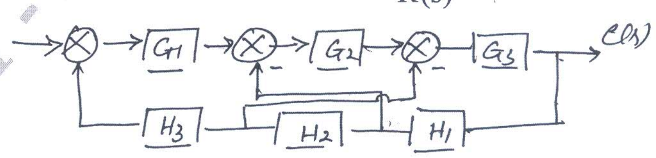

Fig.Q2(c) **(06 Marks)**

Module-2

3 a. Derive an expression for the underdamped response of a second order feedback control system for step input. **(06 Marks)**

b. A system is given by differential equation $\frac{d^2y(t)}{dt^2}+0.2\frac{dy(t)}{dt}+y(t)=x(t)$. determine time domain specifications for limit step input. **(08 Marks)**

c. For a units feedback system having open loop transfer function :

$$G(s)=\frac{120}{s^2(s+2)(s+3)}$$

Determine steady state error for an input $r(t) = 1 + 2 + 3t^2$. **(06 Marks)**

OR

4 a. For a unity feedback system shown in Fig.Q4(a) find :

i) Percent over shoot for step input

ii) Settling time for step input

iii) Steady state error for input $r(t) = 2 + 4t + 6t^2$.

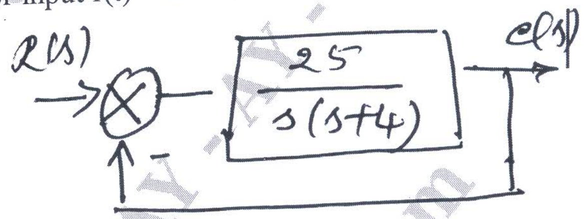

Fig.Q4(a) **(08 Marks)**

b. Find K and T for the system shown in Fig.Q4(b) such that the output response with unit step input.

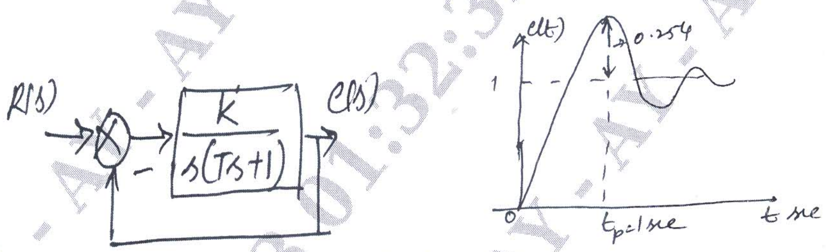

Fig.Q4(b) **(06 Marks)**

c. Write a note on PID controllers. **(06 Marks)**

Module-3

5 a. A feedback control system has characteristics equation $s^5-s^4-2s^3+2s^2-8s+8=0$. How many poles are

i) Left half of s-plane

ii) On imaginary axis

iii) On the right half of s-plane. **(05 Marks)**

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

$$G(s)H(s)=\frac{K}{s(s^2+6s+10)}$$

Sketch the root locus as K is varied from 0 to ∞. **(10 Marks)**

c. Show that the root locus with $G(s)H(s)=\frac{K(s+3)}{s(s+2)}$ is a circle having center (–3, 0) and radius $\sqrt{3}$. **(05 Marks)**

OR

6 a. For a system equation $s^4 + 2s^3 + (4+k)s^2 + 9s + 25 = 0$. Determine the K for system to be stable. **(05 Marks)**

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

$$G(s)H(s) = \frac{K}{s(s+4)(s^2+4s+20)}$$

Sketch the root locus as K is varied from 0 to ∞. **(10 Marks)**

c. A feedback control system has an open loop transfer function :

$$G(s)H(s) = \frac{K}{s(s+3)(s^2+3s+11.25)}$$

Check if $s = -1.5$ and $s = -1.5 + 1.8375j$ is on the root locus. Use angle condition. **(05 Marks)**

Module-4

7 a. A unity feedback system is shown in Fig.Q7(a) find resonant peak, resonant frequency and phase shift.

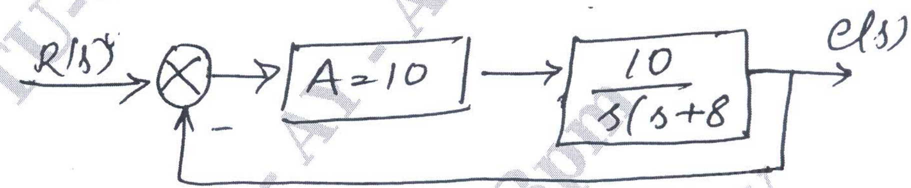

Fig.Q7(a) **(05 Marks)**

b. Draw the polar plot whose open loop transfer function is :

$$G(s)H(s) = \frac{1}{1+0.1s}.$$ **(05 Marks)**

c. The open loop transfer function :

$$G(s)H(s) = \frac{K}{s(1+0.02s)(1+0.05s)}$$

Draw the bode plot and from the diagram find the value of K for gain margin = 10dB. **(10 Marks)**

OR

8 a. Explain lead-lag compensator networks. **(05 Marks)**

b. Using Nyquist stability investigate the closed loop stability for open loop transfer function:

$$G(s)H(s) = \frac{100}{(s+1)(s+2)(s+3)}$$ **(07 Marks)**

c. The open loop transfer function $G(s)H(s) = \frac{100}{s(s+5)(s+10)}$. Draw the bode plot and from the diagram obtain gain margin and phase margin. **(08 Marks)**

Module-5

9 a. Define :

i) State
ii) State variable
iii) State space
iv) State transition matrix

(06 Marks)

b. Find the state transition matrix of $A = \begin{bmatrix} 0 & -1 \\ 2 & -3 \end{bmatrix}$. (08 Marks)

c. Obtain the transfer function form the state model.

$$\begin{bmatrix} \dot{x}_1(t) \\ \dot{x}_2(t) \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -6 & -5 \end{bmatrix} \begin{bmatrix} x_1(t) \\ x_2(t) \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(t) \text{ and } y(t) = [8 \;\; 1] \begin{bmatrix} x_1(t) \\ x_2(t) \end{bmatrix}.$$

(06 Marks)

OR

10 a. State the properties of state transition matrix. (06 Marks)

b. Obtain the state model for the system refer Fig.Q10(b).

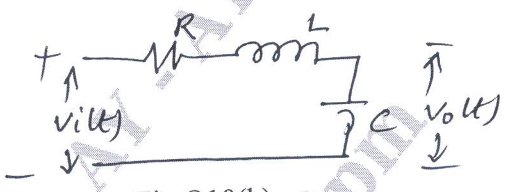

Fig.Q10(b)

(08 Marks)

c. Represent the differential equation given below in a state model :

$$\frac{d^3y(t)}{dt^3} + 3\frac{d^2y(t)}{dt^2} + \frac{6dy(t)}{dt} + 7y(t) = 2u(t).$$

(06 Marks)

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