CBCS SCHEME

USN | | | | | | | | | | |

18EI/BM44

Fourth Semester B.E. Degree Examination, July/August 2022
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. Obtain mathematical model for the following SMD system as shown in Fig.Q1(a) based on force-voltage analogy. Draw the corresponding electrical analogous system.

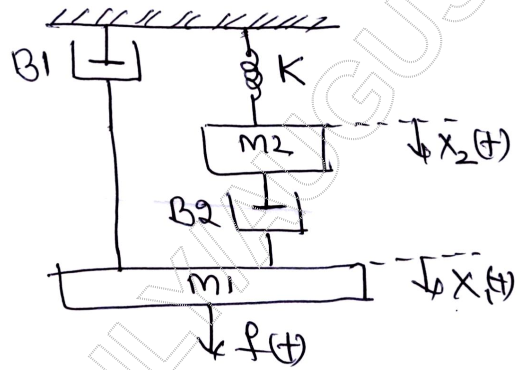

Fig.Q1(a) **(10 Marks)**

b. Reduce the following block diagram as shown in Fig.Q1(b) using block diagram reduction techniques. Hence obtain final system transfer function.

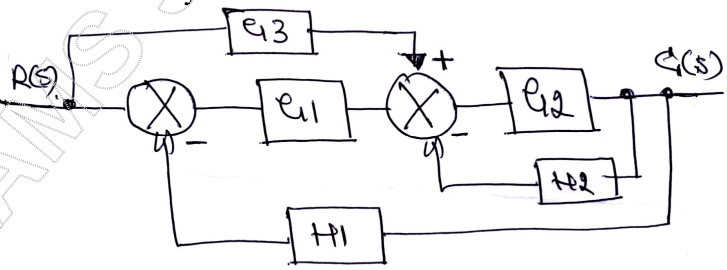

Fig.Q1(b) **(10 Marks)**

OR

2 a. Obtain mathematical model for the following SMD system as shown in Fig.Q2(a) based on force-current analogy. Draw the corresponding electrical analogous system.

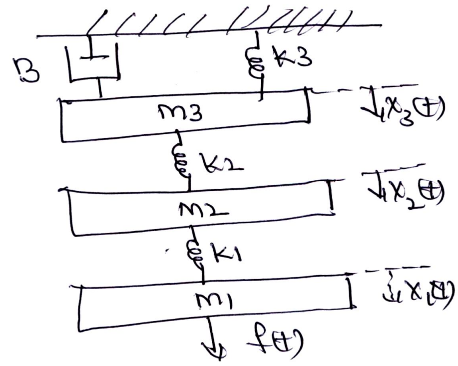

Fig.Q2(a) **(10 Marks)**

b. Reduce the following block diagram shown in Fig.Q2(b) using block diagram reduction techniques. Hence obtain final system transfer function.

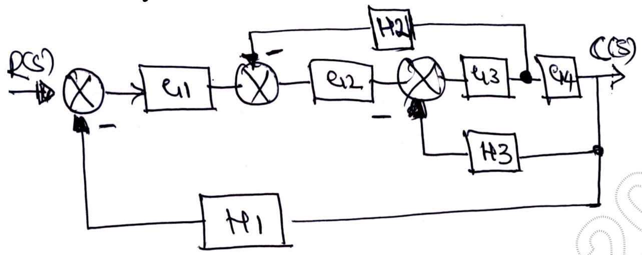

Fig.Q2(b) **(10 Marks)**

Module-2

3 a. Define Mason's gain formula. Convert the following block diagram as shown in Fig.Q3(a) into a signal flow graph. Hence obtain final system transfer using Mason's gain formula only.

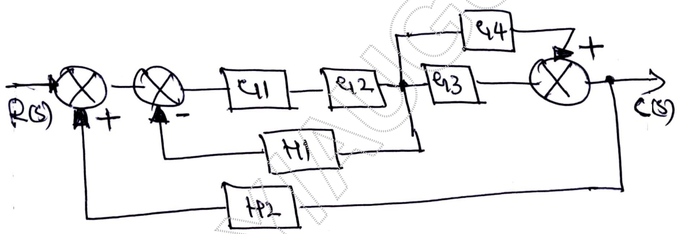

Fig.Q3(a) **(10 Marks)**

b. Define all time domain specifications. Draw a neat second-order underdamped system response sketching all time domain specifications. Derive an equation for:
(i) Rise time (ii) Maximum peak overshoot **(10 Marks)**

OR

4 a. Consider the following signal flow graph as shown in Fig.Q4(a). Obtain final system transfer function using Mason's gain formula.

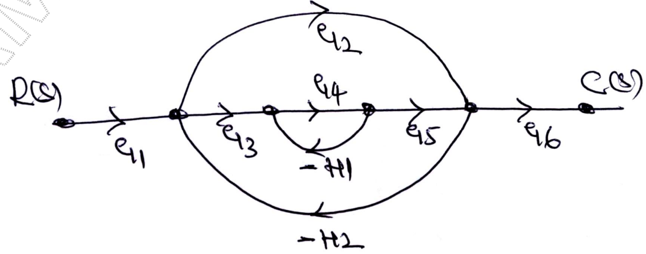

Fig.Q4(a) **(10 Marks)**

b. What do you mean by steady state errors? Derive an equation for steady state error (e_{ss}) as well as error constants (K_p, K_v and K_a) for step, ramp and parabolic inputs. **(10 Marks)**

Module-3

5 a. Define R-H criterion. Explain concept of stability. Determine whether the following characteristic equation represents a stable system using RH criterion.

$$F(s) = s^8 + 5s^6 + 2s^4 + 3s^2 + 1 = 0$$ **(07 Marks)**

b. Find range of values of K so that system with following characteristic equation will be stable

$$F(s) = s(s^2 + s + 1)(s + 4) + K = 0$$ **(07 Marks)**

c. Consider the following characteristic equation:

$$F(s) = s^4 + 22s^3 + 10s^2 + s + K = 0$$

Find out marginal value of K (K_{mar}) and frequency of oscillations 'W' at K_{mar}. **(06 Marks)**

OR

6 a. Consider the following unity feedback system transfer function given by

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

Sketch the root locus. Draw all salient points on the root locus. Comment on stability for the given transfer function. **(10 Marks)**

b. For the following unity feedback system given by

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

Sketch the root locus. Draw all salient points on the root locus. Comment on stability for the given transfer functions. **(10 Marks)**

Module-4

7 a. What is need of frequency domain analysis and what are its advantages? Enlist and explain all frequency domain specifications. **(10 Marks)**

b. Derive an equation for correlation between time domain and frequency domain specifications in terms of : (i) Resonant Peak (M_r) ; (ii) Bandwidth (W_c) **(10 Marks)**

OR

8 a. Consider a second order system with unity feedback given by

$$G(s) = \frac{200}{s(s+8)}$$

Find Resonant Peak (M_r) and cut-off bandwidth (W_c). **(07 Marks)**

b. What is a polar plot? How would you determine stability using polar plots? **(07 Marks)**

c. Draw the polar plot for the transfer function given by

$$G(s) = \frac{5}{s(s+1)}$$

Comment on stability. **(06 Marks)**

Module-5

9 a. Define state, state variables, state vector and state space. Describe general structure of state model. **(10 Marks)**

b. For the circuit as shown in Fig.Q9(b), find state model using physical variables for state variables.

Fig.Q9(b) **(10 Marks)**

OR

10 a. Obtain the state model for the system represented by

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

Draw the state diagram. **(10 Marks)**

b. Consider a system having state model

$$\begin{bmatrix} \dot{X}_1 \\ \dot{X}_2 \end{bmatrix} = \begin{bmatrix} -2 & -3 \\ 4 & 2 \end{bmatrix}\begin{bmatrix} X_1 \\ X_2 \end{bmatrix} + \begin{bmatrix} 3 \\ 5 \end{bmatrix}U \quad \text{and} \quad Y = \begin{bmatrix} 1 & 1 \end{bmatrix}\begin{bmatrix} X_1 \\ X_2 \end{bmatrix}$$ with D = 0, obtain its transfer function. **(10 Marks)**