CBCS SCHEME

USN | | | | | | | | | | 17EC43

Fourth Semester B.E. Degree Examination, Dec.2023/Jan.2024
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. Define and compare open loop control system with closed loop control system with an example. **(04 Marks)**

b. For the mechanical system shown in Fig. Q1 (b), find the transfer function $\frac{X_1(s)}{F(s)}$.

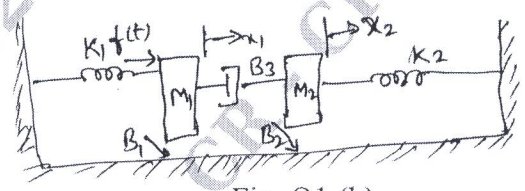

Fig. Q1 (b) **(08 Marks)**

c. Refer Fig. Q1 (c), (i) Draw the mechanical network. (ii) Draw the electrical network based on torque-currents analogy. Give all the relevant performance equations.

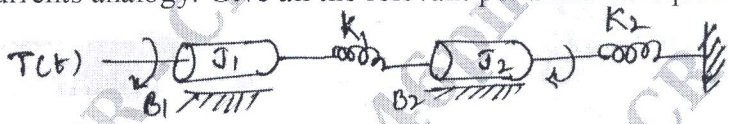

Fig. Q1 (c) **(08 Marks)**

OR

2 a. Refer the mechanical system in Fig. Q2 (a). If mass M is subjected to sudden force of 1 N, what is the final displacement of mass M? Consider : K = 1 N/m ; B = 0.2 N-S/m and M = 1 kg.

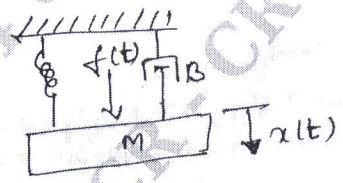

Fig. Q2 (a) **(06 Marks)**

b. Find $M = \frac{Y}{R}$ for the block diagram shown below in Fig. Q2 (b).

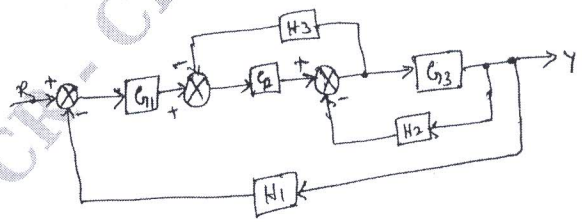

Fig. Q2 (b) **(08 Marks)**

c. Find $\frac{Y_5}{Y_1}$ and $\frac{Y_2}{Y_1}$ in the signal flow graph shown in Fig. Q2 (c).

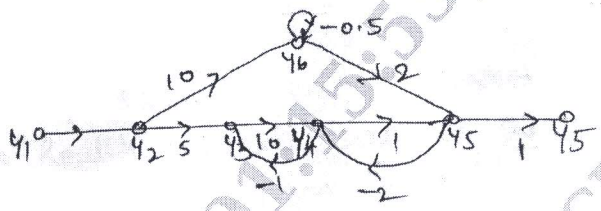

Fig. Q2 (c) **(06 Marks)**

Module-2

3 a. Explain the following time domain specification of a 2nd order system :
(i) Rise time (ii) Delay time (iii) Peak time (iv) Peak overshoot. **(08 Marks)**

b. Obtain the time response of a 1st order system subjected to unit step input. Plot the response. **(06 Marks)**

c. A unity feedback control system is characterized by an open loop transfer function, $G(s)H(s) = \frac{K}{s(s+10)}$. Determine the system gain K, so that the system will have a damping ratio of 0.5. For this value K, find the rise time, peak time, settling time and peak over shoot. Assume that the system is subjected to a step of 1 V. **(06 Marks)**

OR

4 a. Obtain the steady error E_{SS} of Type – 0, Type – 1 and Type – 2 systems for the standard inputs. **(12 Marks)**

b. Explain the effect of PI and PD controller on the performance of a second order control system. **(08 Marks)**

Module-3

5 a. Find the range of K for the system to be stable using RH criterion. $G(s)H(s) = \frac{K(1-s)}{s(s^2+5s+9)}$. **(06 Marks)**

b. A unity feedback control system has $G(s) = \frac{K(s+13)}{s(s+3)(s+7)}$ using Routh's criterion calculate the range of K for which the system is (i) Stable (ii) has its closed loop, poles more negative than -0.5 for $K = 1$. **(08 Marks)**

c. Explain the angle and magnitude conditions of root locus and explain their use with suitable example. **(06 Marks)**

OR

6 a. Explain the various rules for the construction of the root locus of a feedback control system. **(08 Marks)**

b. For a unity feed back control system $C(s) = \frac{K}{s(s+1)(s+2)}$. Sketch the root locus showing all the details in it. **(12 Marks)**

Module-4

7 a. Define the following terms : (i) Phase margin (ii) Phase cross over frequency (iii) Gain margin (iv) Gain cross over frequency. **(08 Marks)**

b. A unity Feed back control system has $G(s)=\frac{80}{s(s+2)(s+20)}$. Draw the Bode plot. Determine GM, PM, W_{gc} and W_{pc}. Comment on stability. **(12 Marks)**

OR

8 a. State and explain Nyquist stability criterion. **(08 Marks)**

b. 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 stability. **(12 Marks)**

Module-5

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

b. Draw the block diagram of a typical system with Digital Controller and explain. **(06 Marks)**

c. Draw and explain the block diagram of sampled data system and digital data system. **(08 Marks)**

OR

10 a. Obtain the state model of the mechanical system in Fig. Q10 (a).

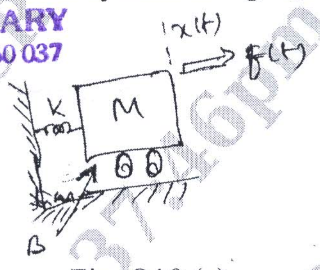

Fig. Q10 (a) **(10 Marks)**

b. Construct the state model for a system characterized by differential equation,

$$\frac{d^3y}{dt^3}+6\frac{d^2y}{dt^2}+11\frac{dy}{dt}+6y=5u$$ **(10 Marks)**

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