CBCS SCHEME

USN

18MT34

Third Semester B.E. Degree Examination, Aug./Sept. 2020
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. Distinguish between open loop and closed loop control system. Describe two example for each. **(10 Marks)**

b. For the mechanical system shown in Fig. Q1 (b). Find the transfer function $\frac{X_1(s)}{F(s)}$. **(10 Marks)**

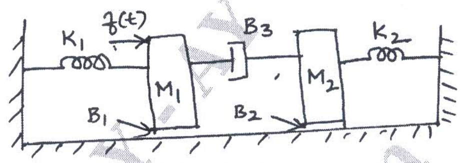

Fig. Q1 (b)

OR

2 a. Refer Fig. Q2(a), draw the mechanical network. Draw the electrical network based on torque-current anology. Give all the relevant performance equations. **(10 Marks)**

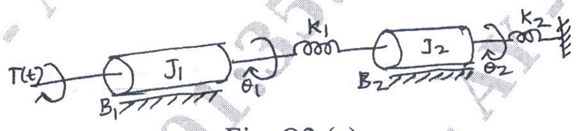

Fig. Q2 (a)

b. Reduce the block diagram to its simple form and hence obtain $\frac{C(s)}{R(s)}$. Refer Fig. Q2 (b). **(10 Marks)**

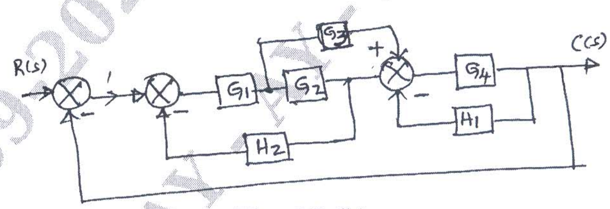

Fig. Q2 (b)

Module-2

3 a. Define the following terms related to signal flow graph :
(i) Source node (ii) Sink node (iii) Forward path and its gain
(iv) Feed back loop and its gain (v) Non-touching loops. **(10 Marks)**

b. A unity feedback system is characterized by open loop transfer function $G(s) = \frac{K}{s(s+10)}$.

Find the value of K so that the system will have a damping ratio of 0.5. For this value of K, determine the settling time, peak over shoot and time to peak overshoot for unit step input. **(10 Marks)**

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.

OR

4 a. Find $\frac{C}{R}$ for the graph shown in Fig.Q4(a) using Mason's gain formula: **(10 Marks)**

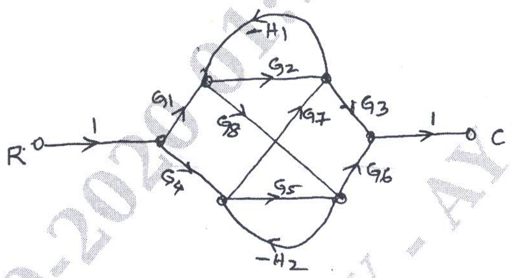

Fig. Q4 (a)

b. Obtain an expression for the time response of second order system for underdamped condition. **(10 Marks)**

Module-3

5 a. State and explain the Routh-Hurwitz criterion of stability. What are its limitations? **(10 Marks)**

b. Refer the characteristic equation by $s^4 + 25s^3 + 15s^2 + 20s + K = 0$. Determine (i) the range of value of K so that the system is asymptotically stable and (ii) the value of K so that the system is marginally stable and the frequencies of sustained oscillations if applicable. **(10 Marks)**

OR

6 a. For the characteristic equation given by $s^4 + Ks^3 + 2s^2 + (K+1)s + 10 = 0$, determine (i) the range of K so that the system is stable and (ii) the value of 'K' so that the system is marginally stable and the frequencies of sustained oscillations if any. **(10 Marks)**

b. A positional servomechanic is characterized by an open loop transfer function, $G(s)H(s) = \frac{K(s+2)}{s(s-1)}$. Determine (i) The value of 'K' when and of the closed loop roots is equal at 0.707 and (ii) the value of the gain 'K' when the closed loop system has two roots on the jw-axis. **(10 Marks)**

Module-4

7 a. Describe briefly the procedure to construct root locus diagram of a linear control system. Mention all important rules. **(06 Marks)**

b. Plot the Bode diagram for the open-loop transfer function of a unity feedback system given below:

$$G(s) = \frac{4}{(0.1s+1)^2(0.01s+1)}.$$ **(14 Marks)**

OR

8 Sketch the root locus plot for a closed loop having an open loop transfer function, $G(s)H(s) = \frac{k(s+2)}{s(s+1)}$ for all the values of k from 0 to ∞. Comment on the stability of the system. Also show that a part of the root locus is a circle. **(20 Marks)**

Module-5

9 a. Develop the state equations for the network shown in Fig. Q9(a). **(10 Marks)**

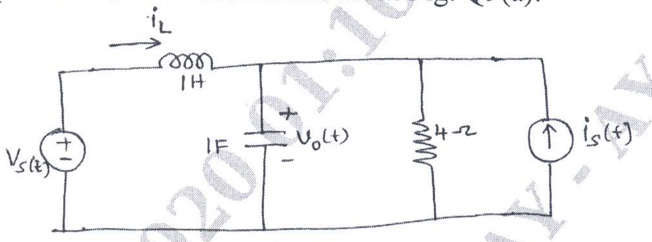

Fig. Q9(a)

b. Find the state transition matrix for a system whose system matrix is given by, $A = \begin{bmatrix} 0 & 1 \\ -2 & -2 \end{bmatrix}$. **(10 Marks)**

OR

10 a. Obtain the time-response for the following system:

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

where u(t) is the unit step function. **(10 Marks)**

b. Represent the differential equation given below in a state model.

$$\frac{d^3y}{dt^3} + 3\frac{d^2y}{dt^2} + 6\frac{dy}{dt} + 7y(t) = 2u(t).$$ **(10 Marks)**

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