CBCS SCHEME

USN | | | | | | | | | |

15MT34

Third Semester B.E. Degree Examination, Jan./Feb. 2023
Control Systems

Time: 3 hrs. Max. Marks: 80

Note: 1. ***Answer any FIVE full questions, choosing ONE full question from each module.***
2. ***Write neat sketches wherever required.***

Module-1

1 a. Distinguish between open loop and closed loop control systems and given one practical example of each. **(06 Marks)**

b. For the system shown in Fig.Q1(b).
i) Draw the mechanical network
ii) Write the differential equations
iii) Draw torque-voltage analogous electric network. **(10 Marks)**

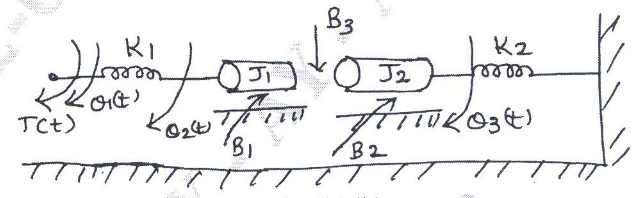

Fig.Q1(b)

OR

2 a. Define transfer function and what are its properties. **(06 Marks)**

b. Obtain the transfer function for the block diagram shown in Fig.Q2(b). Using block diagram reduction method. **(10 Marks)**

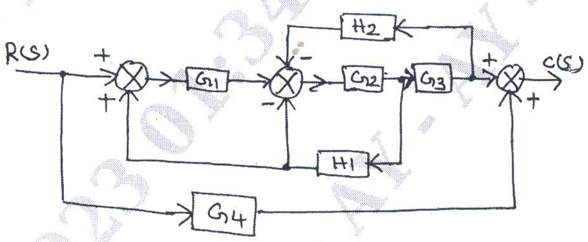

Fig.Q2(b)

Module-2

3 a. What is signal–flow graph representation? Briefly explain the properties of signal flow graph. **(06 Marks)**

b. Obtain the closed loop transfer function $\frac{C(s)}{R(s)}$ for the signal flow graph of a system show in Fig.Q3(b) using Mason's gain formula. **(10 Marks)**

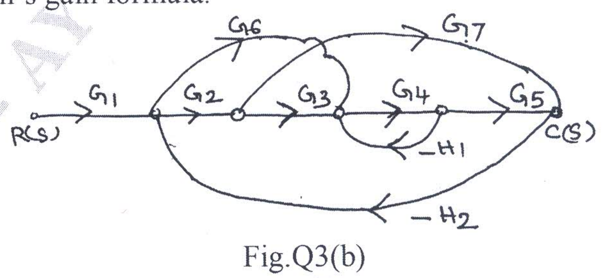

Fig.Q3(b)

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. Derive expressions for peak time t_p and peak over shoot M_p of an under damped second order control system subjected to step input. **(06 Marks)**

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

Determine the gain K so that the system will have a damping ratio of 0.5. For this value of K determine the peak time and peak overshoot for a unit step input. **(06 Marks)**

c. For a unity feedback control system with $G(S) = \frac{40(S+2)}{S(S+1)(S+4)}$. Determine all static error coefficients **(04 Marks)**

Module-3

5 a. Find the number of roots of this equation with positive real part, zero real part and negative real part. $S^6 + 4s^5 + 3s^4 - 16s^2 - 64s - 48 = 0$. **(08 Marks)**

b. For unity feedback system $G(s) = \frac{k}{s(1+0.4s)(1+0.25s)}$. Find range of value of k, marginal value of k and frequency of sustained oscillation. **(08 Marks)**

OR

6 a. Explain the terms : i) Asymptotes ii) Centroid iii) break-way point. **(08 Marks)**

b. A feedback control system has open loop transfer function $G(s)H(s) = \frac{k}{s(s+4)(s^2+4s+20)}$ plot the root locus for k = 0 to ∞. Indicate all the point on it. **(08 Marks)**

Module-4

7 a. A system of third order shows resonance peak of 2 and resonance frequency of 3 rad/sec. Determine the transfer function of equivalent second order system and hence find T_r, T_p, T_s and % overshoot. **(08 Marks)**

b. For a particular unity feedback, $G(s) = \frac{242(s+5)}{s(s+1)(s^2+5s+121)}$. Sketch the bode plot. Find ω_{gc} and ω_{pc}. G.M, P.M. **(08 Marks)**

OR

8 a. Consider type2 system with transfer function $G(s)H(s) = \frac{1}{s^2(1+T_s)}$. Obtain its polar plot. **(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. **(08 Marks)**

Module-5

9 a. Obtain the state model of the electrical network shown in Fig Q9(a) in the standard form. Given $t = t_0$, $i(t) = i(t_0)$ and $v_0(t) = v_0(t_0)$.

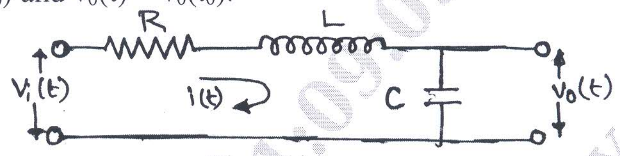

Fig Q9(a) **(08 Marks)**

b. Consider a system having state model

$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix} = \begin{bmatrix}-2 & -3\\ 4 & 2\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix} + \begin{bmatrix}3\\ 5\end{bmatrix}u \text{ and } Y = [1 \ \ 1]\begin{bmatrix}x_1\\ x_2\end{bmatrix}$$, with D = 0. Obtain its transfer function.

(08 Marks)

OR

10 a. Obtain the complete time response of the systems given by $\dot{x}(t) = \begin{bmatrix}0 & 1\\ -2 & 0\end{bmatrix}x(t)$ where $x(0) = \begin{bmatrix}1\\ 1\end{bmatrix}$ and $Y(t) = [1 \ \ -1]\,x(t)$. **(10 Marks)**

b. Find the state transition matrix of the state equation $\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix} = \begin{bmatrix}1 & 0\\ 0 & 1\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix} + \begin{bmatrix}1\\ 1\end{bmatrix}U$, using the inverse transform method. **(06 Marks)**

* * * * *