CBCS SCHEME

USN

17EC43

Fourth Semester B.E. Degree Examination, July/August 2022
Control Systems

Time: 3 hrs. Max. Marks: 100

Note: 1.Answer any FIVE full questions, choosing ONE full question from each module.
2.No Handbook, No Charts, No Tables permitted.

Module-1

1 a. Define control system. Compare open loop and closed loop system. **(06 Marks)**

b. Find the transfer function $\frac{X(s)}{E(s)}$ for a electrochemical system shown in Fig.Q1(b).

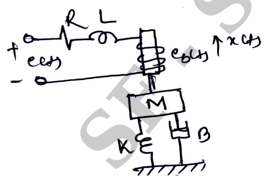

Fig.Q1(b) **(06 Marks)**

c. The system block diagram is shown in Fig.Q1(c). Find C(s)/R(s).

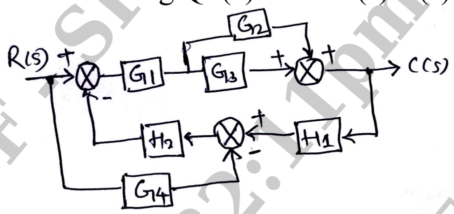

Fig.Q1(c) **(08 Marks)**

OR

2 a. Define the signal flow graph and list the properties of signal flow graph. **(06 Marks)**

b. Find C(s)/R(s) by Mason's gain formula shown in Fig.Q2(b).

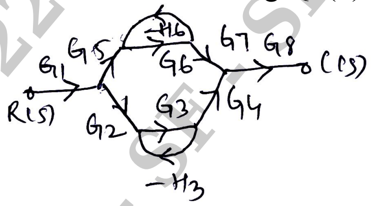

Fig.Q2(b) **(08 Marks)**

c. For the mechanical system shown in Fig.Q2(c)
(i) Draw the mechanical network (ii) Draw force – voltage analogous electric network.

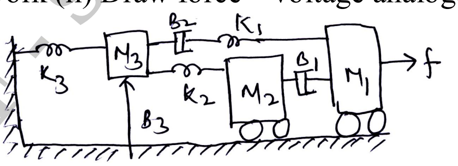

Fig.Q2(c) **(06 Marks)**

Module-2

3 a. Define the following time response specifications for an underdamped 2[nd] order system:
(i) Rise time t_r (ii) Peak time t_p (iii) Peak overshoot M_p (iv) Settling time t_s **(04 Marks)**

b. For the system shown in the Fig.Q3(b) obtain the closed loop transfer function damping ratio natural frequency and expression for the output response if subjected to unit step input.

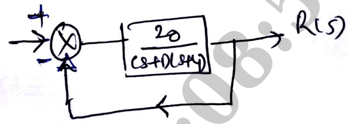

Fig.Q3(b) **(08 Marks)**

c. The response of servo mechanism is $c(t) = 1 + 0.2e^{-60t} - 1.2e^{-10t}$ when subjected to a unit step input, obtain an expression for the closed loop transfer function. Determine natural frequency and damping ratio. **(08 Marks)**

OR

4 a. Explain the PID controller and its effect. **(04 Marks)**

b. For a unity feedback control system with $G(s)=\dfrac{10(s+2)}{s^2(s+1)}$, find

(i) The static error coefficients

(ii) Steady state error when the input transform is $R(s) = 3/s + 2/s^2 + 1/3s^3$. **(08 Marks)**

c. A unity feedback system has $G(s) = \dfrac{40(s+2)}{s(s+1)(s+4)}$

(i) Determine All error coefficient (ii) Error for ramp input and magnitude of 4. **(08 Marks)**

Module-3

5 a. State and explain Routh's stability criterion for determining stability of the system. **(04 Marks)**

b. A unity feedback control system has $G(s) = 20k / [s(s+1)(s+5)+20]$, where $r(t) = 2t$

It is desired that for ramp input $e_{ss} \le 1.5$. What minimum value must k have for this condition to be satisfied? With this k, is the system stable? **(08 Marks)**

c. A unity feedback system has $G(s)=\dfrac{k(s+13)}{s(s+3)\times(s+1)}$, 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 –1. **(08 Marks)**

OR

6 a. Derive the condition used to determine the trajectories of the root loci in the S-plane. **(04 Marks)**

b. For a system having $G(s)H(s)=\dfrac{k}{s(s+3)(s^2+3s+11.25)}$

Find the valid break away points and angle of departure. **(08 Marks)**

c. Sketch the rough nature of the root locus of a certain control system whose characteristics equation is given by $s^3 + 9s^2 + Ks + K = 0$. Comment on stability. **(08 Marks)**

Module-4

7 a. Derive the expression for resonant peak M_r and resonant frequency W_r for a standard second order system in terms of ξ and ω_n. **(06 Marks)**

b. The closed loop transfer function of a feedback system is given by

$$T(s) = 1000/(s+22.5)(s^2 + 2.45s + 44.4)$$

Determine

(i) resonance peak M_r and resonant frequency (W_r) of the system by drawing the frequency response curve.

(ii) What should be values of damping ratio (ξ) and undamped natural frequency (ω_n) of an equivalent 2nd system which will produce the same M_r and W_r as determined in part (i)

(iii) Determine the bandwidth of the equivalent 2nd order system. **(14 Marks)**

OR

8 a. Sketch the Bode plot for the transfer function

$$G(s) = ks^2 / (1 + 0.2s)(1 + 0.2s)$$

Determine the value of 'k' for the gain cross-over frequency to be 5 Rad/sec. **(10 Marks)**

b. What is polar plot and list its applications. **(04 Marks)**

c. State the effects of lag and lead compensating networks. **(06 Marks)**

Module-5

9 a. Explain the terms (i) State (ii) State variable (iii) State vector (iv) State space **(04 Marks)**

b. Obtain the state equation and output equation of the electric network as shown in Fig.Q9(b).

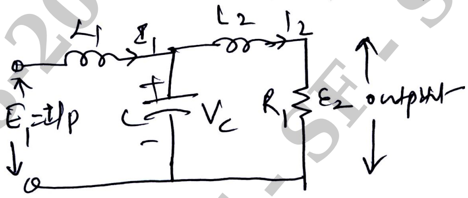

Fig.Q9(b) **(10 Marks)**

c. Explain spectrum analysis of sampling process. **(06 Marks)**

OR

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

b. What is Signal Reconstruction? Explain it with SAMPLE and HOLD circuit. **(06 Marks)**

c. Obtain the transition matrix Q(t) of the following system

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}.$$

Also obtain the inverse of the transition matrix $\phi^{i}(t)$ **(08 Marks)**

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