

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER-V (NEW) EXAMINATION – SUMMER 2024

Subject Code:2150909

Date:16-05-2024

Subject Name:Control System Engineering

Time:02:30 PM TO 05:00 PM

Total Marks:70

Instructions:

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.
4. Simple and non-programmable scientific calculators are allowed.

- Q.1** (a) Discuss the advantages of the transfer function for the modeling of the physical system **03**
- (b) Explain the difference between Open Loop System and Closed Loop System with appropriate diagram and applications. **04**
- (c) Derive the transfer function of the speed control of DC Motor using armature controlled method and also draw the block diagram for overall system. **07**
- Q.2** (a) Write mathematical equation for the Initial value and final value theorem in time domain and s-domain. **03**
- (b) Derive the overall transfer function of the system as shown in Fig.1 **04**
- (c) Derive the F-V analogues of the system from the Fig.2 **07**
- OR**
- (c) Derive the transfer function from the signal flow diagram as shown in Fig. 3. **07**
- Q.3** (a) Explain the standard state signals **03**
- (b) Consider the following characteristics equation **04**
- $$S^4 + K S^3 + S^2 + S + 1$$
- Determine the value of K for the stability.
- (c) Consider the unit step response of a unity feedback control system whose open loop transfer function is $G(s)=1/s(s+1)$ Obtain the Rise Time, peak time, maximum overshoot and settling time. **07**
- OR**
- Q.3** (a) Define: (1) Rise Time (2) Settling Time (3) Peak overshoot **03**
- (b) Determine the stability of a system having open loop transfer function given below : **04**
- $$G(s)H(s) = \frac{100}{S(S^3 + 10S^2 + 40s + 50)}$$
- (c) For the unity feedback system having open loop transfer function **07**
- $$G(s) = \frac{K(S + 2)}{S(S^3 + 7s^2 + 12s)}$$
- Determine (1) type of system (2) error constant K_p, K_v, K_a .

- Q.4** (a) How to calculate the Gain Margin and Phase Margin from the bode plot? **03**
 (b) What is the corner frequency? Derive the equation for it. **04**
 (c) Draw the Bode plot for the transfer function **07**

$$G(s) = \frac{10}{s(s+1)(s+10)}$$

From the Bode plot determine

- (a) Phase crossover frequency (b) Gain crossover frequency
 (c) Gain margin (d) Phase margin
 Also comment on stability of the system

OR

- Q.4** (a) State the advantages of the frequency domain analysis **03**
 (b) Draw the polar plot of the following transfer function **04**

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

- (c) Draw the Bode plot for the transfer function **07**

$$G(s) = \frac{36(1+0.2s)}{s^2(1+0.05s)(1+0.01s)}$$

From the Bode plot determine

- (a) Phase crossover frequency (b) Gain crossover frequency
 (c) Gain margin (d) Phase margin
 Also comment on stability of the system.

- Q.5** (a) Define. (1) State space (2) State Variable (3) State equations **03**
 (b) Obtain the transfer function from following state model of the system. **04**

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} -1 & 1 & 0 \\ 0 & -1 & 1 \\ 0 & 0 & -2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u \quad ; \quad y = [1 \ 0 \ 0] \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$$

- (c) Write the procedure for construction of Root locus. **07**

OR

- Q.5** (a) Develop the state space diagram from the following state equations. **03**
 $\dot{x}_1 = -2x_1 + 3x_2$
 $\dot{x}_2 = -5x_1 + 10x_2$
 $y = x_1 + x_2$
 Where x_1 and x_2 are state variables and y is output.

- (b) Obtain the state transition matrix $\Phi(t)$ of the following system: **04**

$$\begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix}$$

- (c) Sketch the root locus of the unity feedback system having **07**

$$G(S) = \frac{K}{S(S+2)(s+4)}$$

When K is varied from 0 to $+\infty$. Hence obtain the value of K for which the system is unstable.

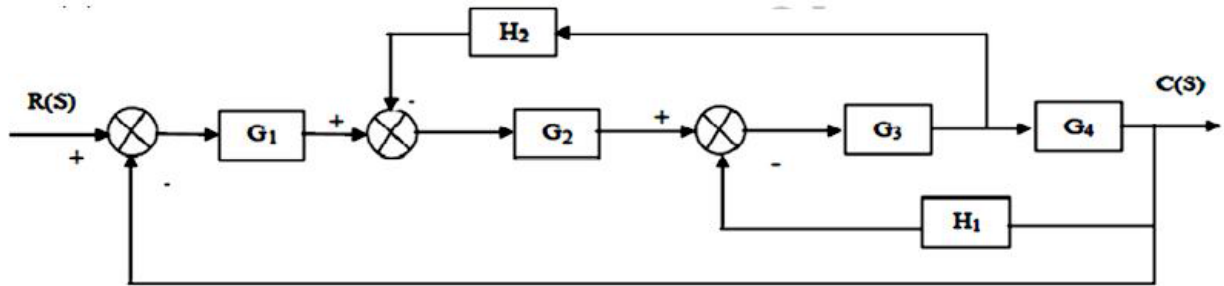


Fig. : 1

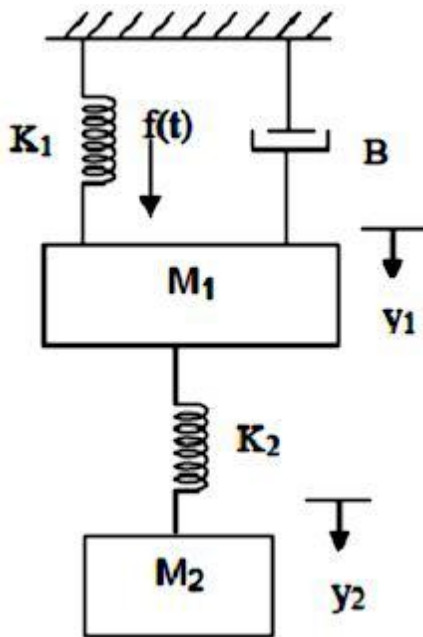


Fig. : 2

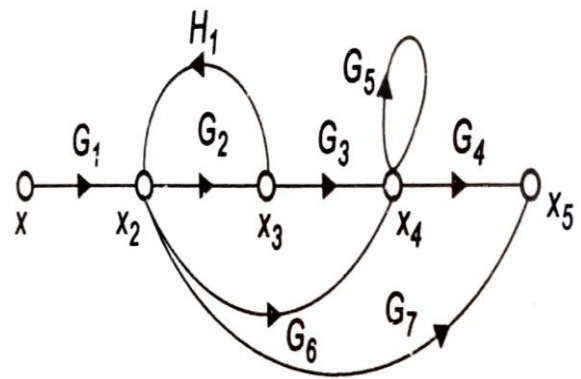


Fig :3