

Seat No.: \_\_\_\_\_

Enrolment No. \_\_\_\_\_

## GUJARAT TECHNOLOGICAL UNIVERSITY

BE- SEMESTER-III (NEW) EXAMINATION – WINTER 2020

**Subject Code:3131101**

**Date:10/03/2021**

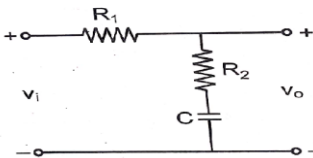
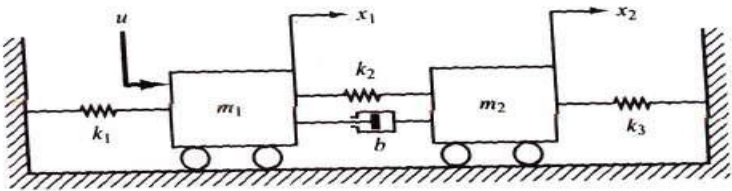
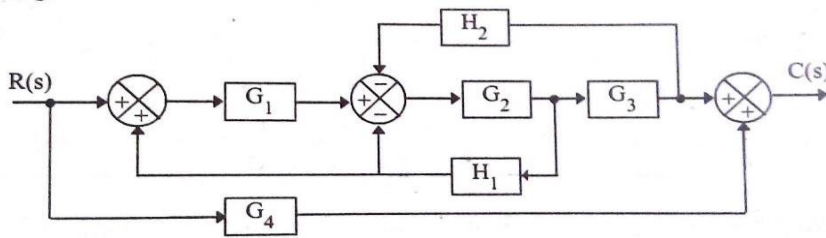
**Subject Name: Control Systems**

**Time: 10:30 AM TO 12:30 PM**

**Total Marks:56**

**Instructions:**

1. Attempt any **FOUR** questions out of **EIGHT** questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.

- |   |   | Marks |
|---|---|-------|
| <b>Q.1</b>  | (a) Compare open-loop and Closed-loop system.   | 3     |
|   | (b) For the network of Fig. find the transfer function $\frac{V_o(S)}{V_i(S)}$                                | 4     |
|   |                              |       |
| (c) Find the transfer function $\frac{X_2(S)}{U(S)}$ of the mechanical system shown in Fig. | 7   |       |
|         |   |       |
| <b>Q.2</b>  | (a) List properties of the Transfer Function.   | 3     |
|   | (b) Conclude Usefulness of analogues system and explain Force (Torque)-Voltage Analogy.                       | 4     |
|   | (c) For the system represented by the block diagram shown in Fig. evaluate the closed-loop transfer function. | 7     |
|         |   |       |
| <b>Q.3</b>  | (a) Discuss Unit-Ramp response of First-Order systems.  | 3     |
|   | (b) Define: (1) Delay time (2) Rise time (3) Peak time (4) Settling time                                      | 4     |
|   | (c) Discuss Unit-step time response of Second-order systems for $\xi > 0$ .                                   | 7     |
| <b>Q.4</b>  | (a) Discuss Static error constants and steady state errors for various inputs and systems.                    | 3     |

- (b) The characteristic equation of a system is given by  $S^4 + 8S^3 + 18S^2 + 16S + 4 = 0$ . Investigate the stability of a system by means of Hurwitz criterion. 4
- (c) The open-loop transfer function of a feedback control system is  $G(S).H(S) = \frac{K}{S(S+4)(S^2+4S+20)}$ . Construct the root locus. 7
- Q.5** (a) Discuss following terms with respect to Frequency response analysis. (i) Resonant Peak (ii) Resonant Frequency (iii) Bandwidth 3
- (b) Develop the Polar plot of  $G(S) = \frac{10}{S(S+1)}$ . 4
- (c) Develop the Bode plots for the transfer function given below:  $G(S).H(S) = \frac{10}{S(0.1S+1)(0.05S+1)}$ . Find the gain margin and Phase margin. 7
- Q.6** (a) Discuss Nyquist stability criterion. 3
- (b) List properties of M-circles. 4
- (c) The open-loop transfer function of a unity feedback control system is given as  $G(S).H(S) = \frac{S+2}{(S+1)(S-1)}$ . Investigate the closed-loop stability by applying Nyquist criterion. 7
- Q.7** (a) Justify: Compensation is required. 3
- (b) Discuss Lag compensator. Obtain the transfer function of a Lag Compensator. 4
- (c) Design a lead compensator for a unity feedback system with an open-loop transfer function  $G(S) = \frac{K}{S(S+1)}$  for the specifications of (i) static velocity error constant  $K_v = 10 \text{ sec}^{-1}$  and (ii) phase margin =  $35^\circ$ . 7
- Q.8** (a) Define: (i) State (ii) State Variable (iii) State Vector 3
- (b) List Advantages of State variable analysis. 4
- (c) Construct the transfer function of 7

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} -5 & -1 \\ 3 & -1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 2 \\ 5 \end{bmatrix} r(t) \quad Y = \begin{bmatrix} 1 & 2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

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