Seat No.: _____ Enrolment No._____

# GUJARAT TECHNOLOGICAL UNIVERSITY

**BE - SEMESTER–III (NEW) EXAMINATION – WINTER 2023**

**Subject Code:3131101 Date:16-01-2024**

**Subject Name:Control Systems**

**Time:10:30 AM TO 01:00 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.**

| | | | MARKS |
|---|---|---|---|
| **Q.1** | **(a)** | Define: Transfer function, Self loop, Steady-state error. | **03** |
| | **(b)** | Compare block-diagram and signal flow graph method. | **04** |
| | **(c)** | Explain rules for block-diagram reduction technique. | **07** |
| **Q.2** | **(a)** | Discuss Nyquist criteria for stability. | **03** |
| | **(b)** | Derive the expressions for error constants $\mathbf{K}_p$ , $\mathbf{K}_v$ and $\mathbf{K}_a$ corresponding to step, ramp and parabolic input respectively. | **04** |
| | **(c)** | Reduce the given block-diagram of figure.1 to its simple form and hence obtain the equivalent transfer function $\frac{C(s)}{R(s)}$. | **07** |

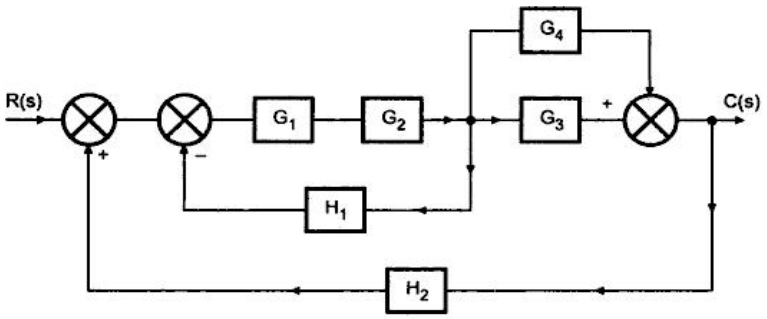


Figure.1

**OR**

| | | | |
|---|---|---|---|
| | **(c)** | Derive expressions of (i) Rise time, $t_r$ (ii) Peak time, $t_p$ and (ii) Peak overshoot, $M_p$ for a second order control system subjected to a unit step input. | **07** |
| **Q.3** | **(a)** | Explain: Frequency response, Root locus, Centroid. | **03** |
| | **(b)** | Write short note on PID controller. | **04** |
| | **(c)** | Obtain the transfer function $\frac{Y(s)}{X(s)}$ of the signal flow graph shown in figure 2. | **07** |

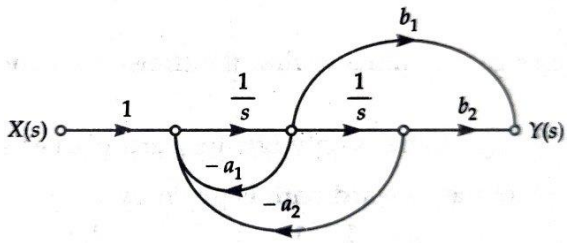


Figure.2

**OR**

| | | | |
|---|---|---|---|
| **Q.3** | **(a)** | What is polar plot? | **03** |
| | **(b)** | Conclude Usefulness of analogues system and explain Force (Torque)- Voltage Analogy. | **04** |
| | **(c)** | Determine the stability of a system having the characteristic equation $s^6+5s^5+11s^4+25s^3+36s^2+30s+36=0$. | **07** |
| **Q.4** | **(a)** | Derive an expression for the rise time for a 2nd order control system subjected to a unit step input. | **03** |
| | **(b)** | List properties of M-circles. | **04** |
| | **(c)** | Explain rules for construction of root locus. | **07** |

**OR**

| | | | |
|---|---|---|---|
| **Q.4** | **(a)** | Discuss Nyquist stability criterion. | **03** |
| | **(b)** | Write a short note on state space representation of a control system. | **04** |
| | **(c)** | The open-loop transfer function of a system is given by $G(s)H(s) = \frac{K(s+12)}{s^2(s+20)}$. Sketch the root loci for the system when K is varied from 0 to ∞. | **07** |
| **Q.5** | **(a)** | Define: (i) State (ii) State Variable (iii) State Vector. | **03** |
| | **(b)** | Define the following terms<br>1) Gain cross over frequency<br>2) Phase cross over frequency<br>3) Gain Margin<br>4) Phase Margin | **04** |
| | **(c)** | Sketch the Nyquist plot for the open-loop transfer function $G(s)H(s) = \frac{10}{(s+2)(s+4)}$. Determine the stability of the closed-loop system by Nyquist criterion. | **07** |

**OR**

| | | | |
|---|---|---|---|
| **Q.5** | **(a)** | Explain standard test signals. | **03** |
| | **(b)** | List Advantages of State variable analysis. | **04** |
| | **(c)** | Derive the state variable equation $X=AX+BU$ and $Y=CX+DU$. Also draw the block diagram. | **07** |

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