Seat No.: ________ Enrolment No.___________

# GUJARAT TECHNOLOGICAL UNIVERSITY

**BE - SEMESTER–IV (NEW) EXAMINATION – WINTER 2021**

**Subject Code:3140313 Date:04/01/2022**

**Subject Name:Control System and Analysis**

**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 the LTI Control system with appropriate example. | **03** |
| | **(b)** | Classify control system with necessary examples. | **04** |
| | **(c)** | Obtain the inverse Laplace transform of given F(s). | **07** |

$$F(s) = \frac{(s-2)}{s(s+1)^3}$$

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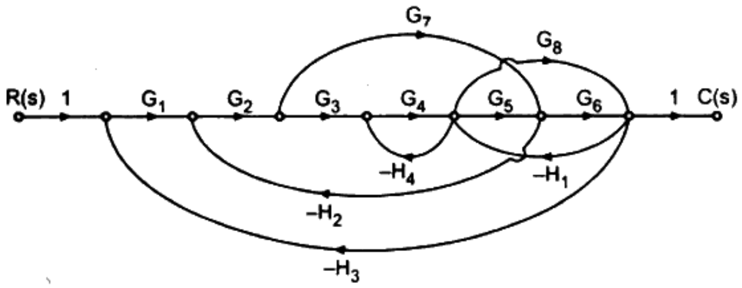
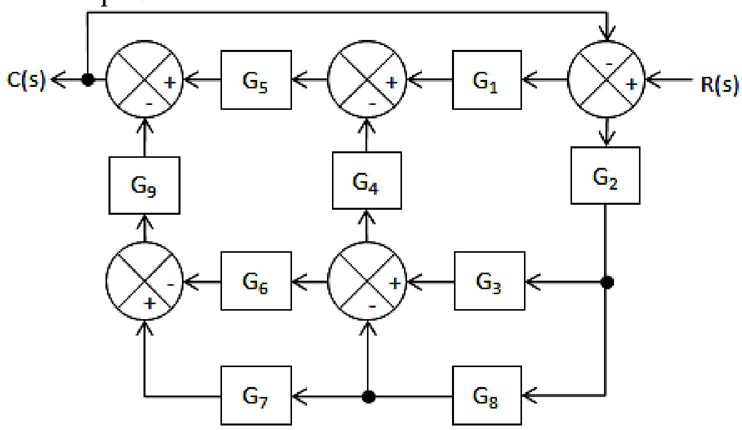
|---|---|---|---|
| **Q.2** | **(a)** | Draw the response of muscle stretch reflex model. | **03** |
| | **(b)** | Draw and illustrate the transient impulse and step response of a second order system. | **04** |
| | **(c)** | Obtain the transfer function C(s)/R(s) of below given signal flow graph by using mason's gain formula. | **07** |




**OR**

| | | | |
|---|---|---|---|
| | **(c)** | Obtain the close-loop transfer function C(s)/R(s) of given block diagram by reduction technique. | **07** |

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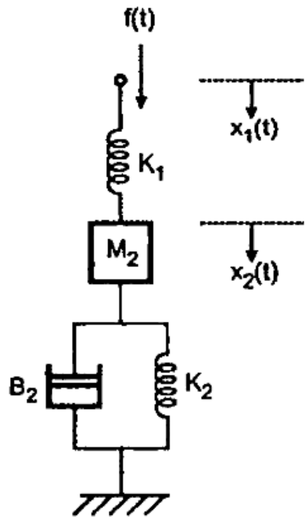
| **Q.3** | **(a)** | Enlist the demerits of Hurwitz stability analysis method. | **03** |
| | **(b)** | Equate the simple model of lung mechanics. | **04** |
| | **(c)** | Draw the equivalent mechanical system and analogous systems based on F-V and F-I methods for the below given system. | **07** |




**OR**

**Q.3** **(a)** A closed loop system has two complex conjugate poles at $s_1$, $s_2$ = -2 ± j 1. Determine the form of transfer function and values of $\omega_n$ , $T_P$ , $T_R$ , $T_S$ and % $M_P$ assuming standard second order system. **03**

**(b)** A system has 30% overshoot and settling time of 5 sec, for a unit step input. Determine the transfer function. Calculate peak time and output response. Assume $e_{ss}$ as 2%. **04**

**(c)** Consider a unity-feedback control system with the open-loop transfer function **07**

$$G(s) = \frac{k}{s(s^2+2s+4)}$$

Determine the value of the gain K such that the phase margin is 50˚. What is the gain margin with this gain K?

**Q.4** **(a)** Discuss Routh's stability criteria for below given characteristic equation. **03**

$$S^6 + 3S^5 + 7S^4 + 15S^3 + 9S^2 + 11S + 13 = 0$$

**(b)** Describe the effect of adding a zero and pole to a system with appropriate example. **04**

**(c)** For a unity feedback system, $G(s) = \frac{242(s+5)}{s(s+1)(s^2+5s+121)}$, sketch the bode plot. Find the values of $\omega_{gc}$ and $\omega_{pc}$. **07**

**OR**

**Q.4** **(a)** Explain PID Controller with necessary example. **03**

**(b)** Find the range of K and $K_{mar}$ for which the system given below is stable. **04**

$$S^4 + 2s^3 + 2s^2 + (3+K)s + K=0$$

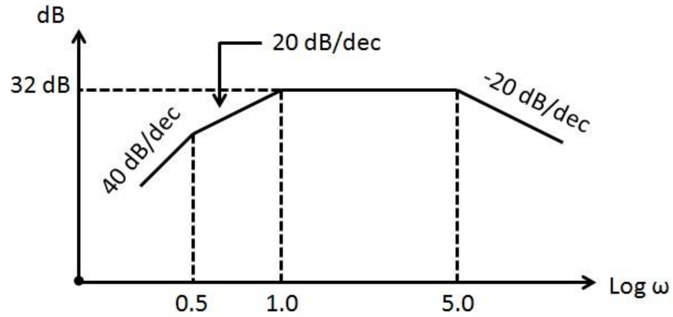
**(c)** Find the loci of roots for a unity feedback system and comment on stability. **07**

$$G(s) = \frac{K}{s(s+3)(s^2+3s+11.25)}$$

**Q.5** **(a)** For the unity feedback control system having open loop transfer function given below, determine the system "TYPE" and error constant $K_p$ , $K_v$ , $K_a$. **03**

$$G(s) = \frac{k\ (s+2)}{s\ (3s^3+4s^2+6s)}$$

**(b)** Determine the transfer function for the bode plot shown below. **04**




**(c)** Obtain a state-space equation and output equation for the system defined by **07**

$$\frac{Y(s)}{U(s)} = \frac{3s^3 + s^2 + 3s + 1}{s^3 + 2s^2 + 4s + 1}$$

**OR**

**Q.5** **(a)** Define Gain Margin and Phase margin and their relationship with system stability. **03**

**(b)** Obtain the transfer function of the system defined by **04**

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

$$y = \begin{bmatrix} 1 & 0 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$$

**(c)** Draw the nyquist plot and comment on stability for below given system. **07**

$$G(s)H(s) = \frac{100(1 + 5s)}{s^4(1 + s)}$$

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