Seat No.: _____ Enrolment No._____

# GUJARAT TECHNOLOGICAL UNIVERSITY

**BE - SEMESTER–VI • EXAMINATION – SUMMER 2013**

**Subject Code: 160304** **Date: 03-06-2013**

**Subject Name: Bio Medical Control Theory**

**Time: 10.30 am - 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.**

**Q.1** **(a)** Write Masonôs Gain formula & explain it with an appropriate example. **07**

**(b)** Discuss Routhôs stability criteria for below given characteristic equation. **07**

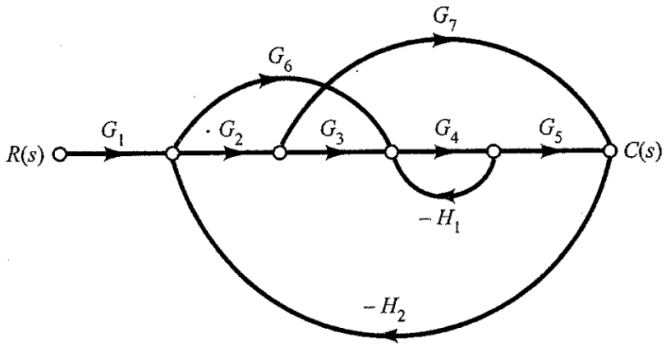
$S^6 + 3S^5 + 7S^4 + 15S^3 + 9S^2 + 11S + 13 = 0$

**Q.2** **(a)** Obtain the transfer function of the system defined by **07**

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

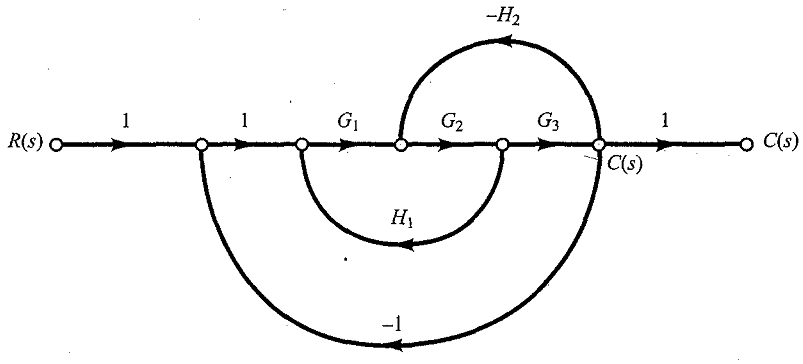
$$y = \begin{bmatrix} 1 & 0 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$$

**(b)** Obtain the closed-loop transfer function C(s)/R(s) of below given system by use of Mason's gain formula. **07**




**OR**

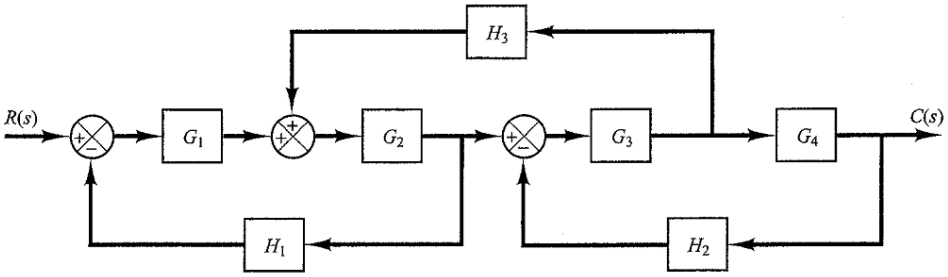
**(b)** Obtain the closed-loop transfer function C(s)/R(s) of below given system by use of Mason's gain formula. **07**



**Q.3** **(a)** Obtain a state-space equation and output equation for the system defined by **07**

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

**(b)** Simplify the block diagram shown in Figure. Obtain the closed-loop transfer function C(s)/R(s). **07**



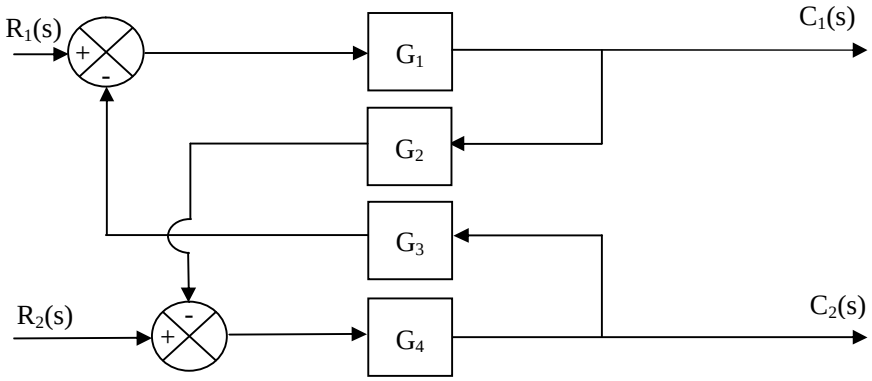

**OR**

**Q.3** **(a)** A control system has the open loop transfer function as given below. **07**

G(s).H(s) = $\frac{k\,(2s+3a)}{s^2(3s+2b)}$ with b>a

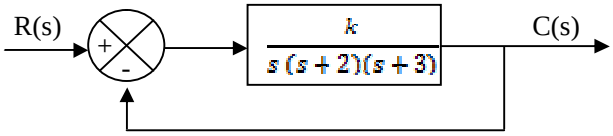
Plot its root-loci as *k* varies from zero to Ð with a = 5 & b = 25. Also calculate the value of *k* for the largest damping ratio of the Oscillatory mode.

**(b)** Figure shows a system with two inputs and two outputs. Derive $C_1(s)/R_1(s)$, $C_l(s)/R_2(s)$, $C2(s)/R_1(s)$ & $C_2(s)/R_2(s)$. **07**




(Hint: In deriving outputs for $R_1(s)$, assume that $R_2(s)$ is zero, and vice versa.)

**Q.4** **(a)** Obtain the phase and gain margins of the system shown in figure for the two cases, where K = 10 and K = 100 with the help of bode plot. Also discuss about the stability of same system with both gain. **07**




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

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

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

**OR**

**Q.4** **(a)** Draw the nyquist plot of below given open-loop transfer function: **07**

$$G(s) = \frac{1}{s^2+0.8s+1}$$

**(b)** i. The characteristic equation for a feed back control system is given by $S^3 + 17k.S^2 + 3S^2 + 6S + 12 = 0$. Determine the range of $k$ for which the system is stable. **07**

ii. For the unity feedback system having open loop transfer function

$$G(s) = \frac{k\,(s+3)}{s\,(2s^3+5s^2+7s)}$$

Determine the system ñTYPEò and error constant $K_p$, $K_v$, $K_a$.

**Q.5** **(a)** Obtain the polar plot of the following transfer function: **07**

$$G(j\gamma) = \frac{e^{-j\omega L}}{1+j\omega T}$$

**(b)** Consider the following transfer function: **07**

$$G(s) = \frac{25}{s^2 + 4s + 25}$$

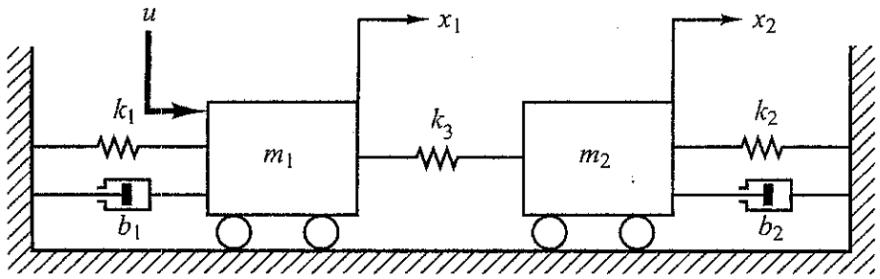
Plot a Bode diagram for this transfer function.

**OR**

**Q.5** **(a)** Draw the bode plot for the below given open-loop transfer function. **07**

$$G(s) = \frac{9(s^2+0.2s+1)}{s(s^2+1.2s+9)}$$

**(b)** Obtain the transfer functions $X_1(s)/U(s)$ and $X_2(s)/U(s)$ of the mechanical system shown in figure. **07**

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