Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–IV (New) EXAMINATION – WINTER 2015

Subject Code:2141004 **Date:30/12/2015**

Subject Name: Control System Engineering

Time: 2:30pm to 5:00pm **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 short notes on open loop control systems and closed loop control systems. Discuss their advantages and disadvantages. **07**

(b) Obtain system transfer function *C(s)/R(s)* using block diagram reduction technique for the system shown in figure 1. **07**

Q.2 **(a)** Derive Correlation Between Transfer Functions and State-Space Equations. **04**

(b) Explain Mason's gain formula. **03**

(c) Determine the state space model of the system shown in figure 2. **07**

OR

(c) Define transfer function. Obtain the transfer of the system defined by **07**

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

Q.3 **(a)** Define steady state error and derive the expressions for error constants K_p, K_v and K_a corresponding to step, ramp and parabolic input respectively. **07**

(b) Obtain the values of delay time t_d, rise time t_r, peak time t_p, settling time t_s and peak overshoot M_p for the given open loop transfer function of a unity feedback control system $G(s) = 16/s(s+6)$. **07**

OR

Q.3 **(a)** Derive the expressions of Rise time, Peak time and Peak overshoot for the system having close loop transfer function $T(s) = \dfrac{C(s)}{R(s)} = \dfrac{\omega_n^2}{s^2 + 2\xi\omega_n s + \omega_n^2}$. **07**

(b) The open loop transfer function of a unity feedback system is given by $G(s) = \dfrac{k}{s(1+Ts)}$ where k and T are constants. By what factor should the amplifier gain be reduced so that the peak overshoot of the system is reduced from 60% to 15% ? **07**

Q.4 **(a)** Using Routh's criterion check the stability of a system whose characteristic equation is given by $s^6 + 2s^5 + 8s^4 + 12s^3 + 20s^2 + 16s + 16 = 0$ **07**

(b) What is Root locus? Sketch the Root locus plot for the unity feedback system having $G(s) = \dfrac{K}{s(s+1)(s+3)(s+4)}$. **07**

OR

Q.4 **(a)** Determine range of k for system stability, for the given characteristic equation of Feedback control system $s^4 + 2s^3 + (4+k)s^2 + 9s + 25 = 0$. **07**

(b) Sketch the Root locus plot for the unity feedback system having an open loop transfer function $G(s)=\dfrac{K}{s(s+3)(s^2+2s+2)}$. **07**

Q.5 **(a)** State and explain compensator? Explain Phase-Lead compensator in detail. **07**

(b) The feed forward transfer function of a close loop system is $G(s)=1/s(s+1)$ and feedback transfer function is $H(s)=1/(s+2)$. **07**

(i) Draw the polar plot of $G(s)H(s)$.

(ii) Find ω corresponding to $\angle G(j\omega)H(j\omega)=180^{\bullet}$.

(iii) Find $|G(j\omega)H(j\omega)|$ corresponding to frequency obtain in (ii).

OR

Q.5 **(a)** Draw the Nyquist plot for $G(s)=1/s(s-1)$ and comment on system stability. **07**

(b) Determine gain margin and phase margin using bode plot for the system having transfer function $G(s)H(s)=\dfrac{1}{s(1+s)(1+0.1s)}$ and comment on stability. **07**

****

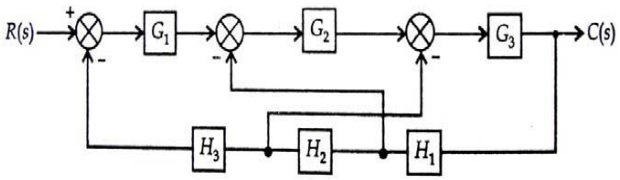

Figure 1

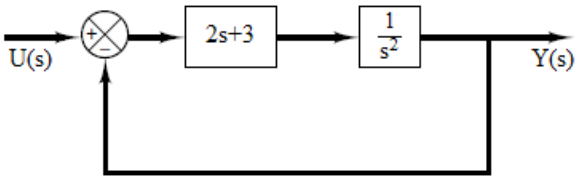

Figure 2