Enrolment No./Seat No_______________

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–III (NEW) EXAMINATION – SUMMER 2024

Subject Code:3130905 **Date:06-07-2024**

Subject Name: Control System Theory

Time:10:30 AM TO 01:00 PM **Total Marks:70**

Instructions:

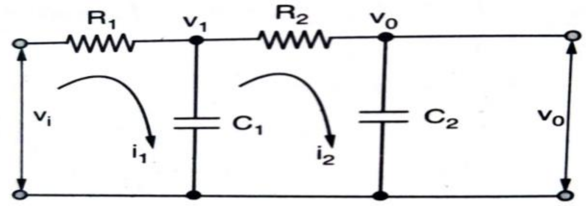
1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**

MARKS

Q.1 **(a)** Explain the block reduction technique for (a) shifting a summing point after the block (b) shifting a take-off point before a block (c) shifting a take-off point after a summing point **03**

(b) A system is represented by $\frac{C(s)}{R(s)} = \frac{100}{s^2+7s+25}$. Obtain the final value of $c(t)$ if the input $r(t)$ of 1.5 units. **04**

(c) Obtain the transfer function of the circuit shown in the figure. for Comment on the response of the system $R_1 = R_2 = 1M\Omega, C_1 = 1\mu F, C_2 = 0.5\mu F$ **07**



Q.2 **(a)** Define (a) Time response (b) Transient response (c) Steady state response **03**

(b) Define (a) gain margin (b) phase margin (c) cut-off frequency **04**

(c) A second order control system is represented by $\frac{\theta_o(s)}{T(s)} = \frac{1}{Js^2+fs+K}$, where θ_o is the angular output and T is the input torque. If the step input of 10 N-m is applied, Design the value of J, f, and K for (1) Mp=6% (2) tp=1 sec (3) the steady state value of the output is 0.5 radian. **07**

OR

(c) The maximum overshoot for a unity feedback control system having its forward path transfer function as $G(s) = \frac{K}{s(sT+1)}$ is to be reduced from 60% to 20%. The input to the system is a unit step function. Design the value of K to achieve the aforementioned reduction. **07**

Q.3 **(a)** State three advantages and dis-advantages of frequency domain approach **03**

(b) Check the stability of the system having characteristics equation as $s^5+s^4+2s^3+2s^2+3s+15=0$ by writing Routh's array. **04**

(c) Draw the root locus plot for a system having open loop transfer function as $G(s)H(s) = \frac{K}{s(s^2+2s+2)}$. Comment on stability and response of the system **07**

OR

Q.3 **(a)** Define (a) resonant peak (b) resonant frequency (c) cut-off rate **03**

(b) A unity feedback system has $G(s)=\frac{40(s+2)}{s(s+1)(s+4)}$. Obtain the steady state error for ramp input of magnitude 4. **04**

(c) Draw the root locus plot for a system having open loop transfer function as $G(s)H(s)=\frac{K}{s(s+1)(s+2)(s+3)}$. Comment on stability and response of the system **07**

Q.4 **(a)** State the effect of PD controller on the response of a second order system **03**

(b) Explain why PI controller reduces the steady state error of second order system to zero for ramp input **04**

(c) Draw the bode plot for a unity gain feedback system having $G(s)=\frac{80}{s(s+2)(s+20)}$ .Determine gain margin, phase margin, ω_{gc} , ω_{pc} and comment on stability **07**

OR

Q.4 **(a)** Define compensation. Explain series compensation. **03**

(b) Draw passive lag compensative network. Write the standard transfer function of the lag compensating network and hence draw PZ map and bode plot for the lag compensating network **04**

(c) A unity feedback control system has $G(s)=\frac{10}{s(s+1)(s+2)}$. Draw the Nyquist plot and comment on the stability of closed loop system **07**

Q.5 **(a)** State the advantages of state space approach **03**

(b) Derive the transfer function for a system with state model $\dot{x}=Ax+bu$, $y=Cx+Du$ **04**

(c) Consider a system having state model $\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix}=\begin{bmatrix}-2 & -3\\ 4 & 2\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}+\begin{bmatrix}3\\ 5\end{bmatrix}u$ and $y=\begin{bmatrix}1 & 1\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}$. Obtain its transfer function **07**

OR

Q.5 **(a)** Define (a) state variable (b) state vector (c) state space **03**

(b) State the properties of the state transition matrix **04**

(c) (a) Check observability of a system with system matrix $A=\begin{bmatrix}1 & 2\\ 3 & 4\end{bmatrix}$ and output matrix $C=\begin{bmatrix}1 & 2\end{bmatrix}$ **07**

(b) Check controllability of a system with system matrix $A=\begin{bmatrix}0 & 6 & -5\\ 1 & 0 & 2\\ 3 & 2 & 4\end{bmatrix}$ and input matrix $B=\begin{bmatrix}0\\ 1\\ 2\end{bmatrix}$

****