15109

BRAINWARE UNIVERSITY

Term End Examination 2025-2026
Programme – B.Tech.(EE)-2023
Course Name – Control System
Course Code - PCC-EE503
(Semester V)

Full Marks : 60 **Time : 2:30 Hours**

[The figure in the margin indicates full marks. Candidates are required to give their answers in their own words as far as practicable.]

Group-A

(Multiple Choice Type Question) 1 x 15=15

1. *Choose the correct alternative from the following :*

(i) Indicate the ratio of the damped frequency to the natural frequency of a system having a damping factor ξ.

a) $\sqrt{1-\xi^2}$ b) $\sqrt{1+\xi^2}$

c) $\frac{1}{\xi}$ d) $\frac{\xi}{1+\xi}$

(ii) Recognize the ratio of input and output operations of a system is called the transfer function.

a) Fourier transform b) Laplace transform

c) z-transform d) Both Fourier transform and Laplace transform

(iii) If the initial conditions for a system are inherently zero, indicate the physically mean.

a) The system is at rest, but stores energy b) The system is working, but it does not store energy

c) The system is at rest, or no energy is stored in any of its parts d) The system is working with a zero reference input

(iv) Choose the correct option: The coefficients of the numerator polynomial and the denominator polynomial in a transfer function must be

a) real b) complex

c) at least one real coefficient d) at least one complex coefficient

(v) Identify the overall transfer function from the block diagram reduction for cascaded blocks.

a) Sum of individual gains b) Product of individual gain

c) Difference in individual gain d) Division of individual gain

(vi) Indicate the overall transfer function of the two blocks in parallel.

a) Sum of individual gains b) Product of individual gain

c) Difference in individual gain
d) Division of individual gain

(vii) Choose the correct option: The associative law for summing points applies only to those summing points that are __________ connected.

a) Directly
b) Indirectly
c) Orthogonally
d) Diagonally

(viii) Identify the value of e^0, according to the property of the state transition method.

a) I
b) A
c) e^{-At}
d) $-e^{At}$

(ix) Identifying the mechanism in control engineering implies an ability to measure the state by taking measurements at the output.

a) Controllability
b) Observability
c) Differentiability
d) Adaptability

(x) Predict the transfer function for the state representation of the continuous-time LTI system:

$$\frac{dq(t)}{dt} = A\,q(t) + B\,x(t)$$

$$Y(t) = C\,q(t) + D\,x(t)$$

is given by:

a) $C(sI - A)^{-1}B + D$
b) $B(sI - A)^{-1}B + D$
c) $C(sI - A)^{-1}B + A$
d) $D(sI - A)^{-1}B + C$

(xi) Observe the rise time if the natural frequency of a system increases.

a) increases
b) decreases
c) doubles
d) halves

(xii) Predict the overshoot due to a decrease in the damping factor.

a) increases
b) decreases
c) remains unaltered
d) None of these

(xiii) Observe from Routh-Hurwitz criterion.

a) Number of roots in the right half of the s-plane
b) Value of the roots
c) Number of roots in the left half of the s-plane
d) Number of roots in the top half of the s-plane

(xiv) Observe the reason that the characteristic equation coefficients of the system Routh-Hurwitz criterion, cannot be applied.

a) Exponential function of s
b) Sinusoidal function of s
c) Complex
d) Exponential and sinusoidal functions of s and complex

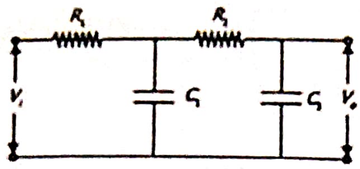
(xv) Predict the condition for making an unstable system stable.

a) Gain of the system should be increased
b) Gain of the system should be decreased
c) The number of zeroes to the loop transfer function should be increased
d) The number of poles to the loop transfer function should be increased

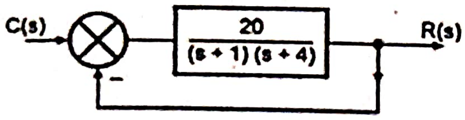
Group-B

(Short Answer Type Questions) 3 x 5=15

2. Define poles and zeros of a transfer function. (3)
3. Calculate the transfer function of the network as shown in Fig. (3)



4. For the system shown in the figure calculate the closed-loop transfer function, damping ratio, natural frequency and establish for the output response if subjected to unit step input. (3)



5. Illustrate the rule for obtaining the breakaway point in the root locii. (3)
6. Calculate the state transition matrix for the state equation (3)

$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix}=\begin{bmatrix}-3 & 1\\ 0 & -1\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}$$

OR

Evaluate the state transition matrix for the state model whose matrix A is given by (3)

$$A=\begin{bmatrix}0 & 1\\ -6 & -5\end{bmatrix}$$

Group-C

(Long Answer Type Questions) 5 x 6=30

7. The system equations are given by (5)

$$\dot{x}(t)=\begin{bmatrix}0 & 1\\ -2 & -3\end{bmatrix}x(t)+\begin{bmatrix}0\\ 1\end{bmatrix}u(t)$$

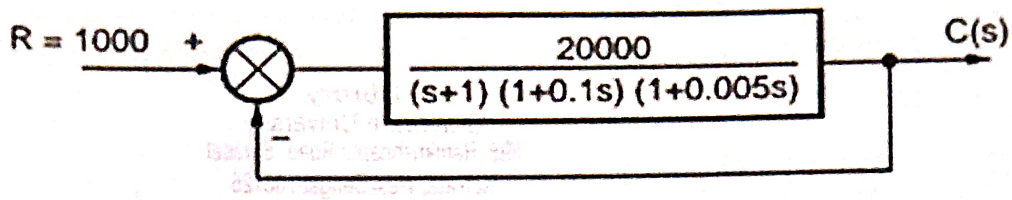
$$y(t)=[1 \quad 0]x(t)$$

Determine the transfer function of the system.

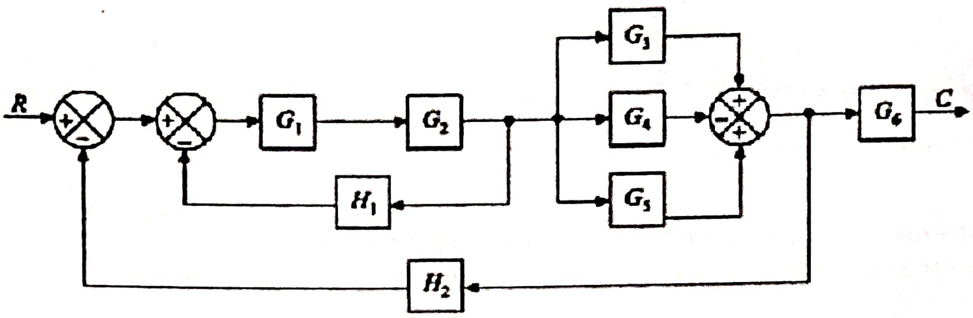
8. Determine the damping ratio, undamped natural frequency, delay time, rise time, peak time and maximum overshoot for the second-order system whose characteristic equation is given by, (5)

$s^2 + 2.5s + 10 = 0.$

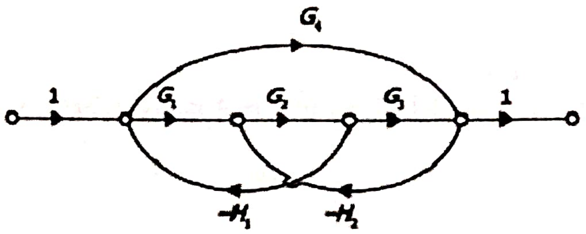
9. The block diagram shown in Fig. represents a heat treating oven. The set point is 1000°C. Calculate the steady-state temperature. (5)



10. Using block diagram reduction techniques, determine the overall transfer function. (5)



11. (5)



Evaluate the transfer function of the system using Mason's gain formula.

12. A system having input x and output y is represented by (5)

$$\frac{dy}{dt} + 3y = 2x$$

Evaluate the transfer function of the system.

OR

Distinguish between open-loop control system and closed-loop control system. (5)

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