Total number of printed pages: 4 **D/4th Semester/DIE404**

2023

CONTROL SYSTEMS

Full Marks : 100

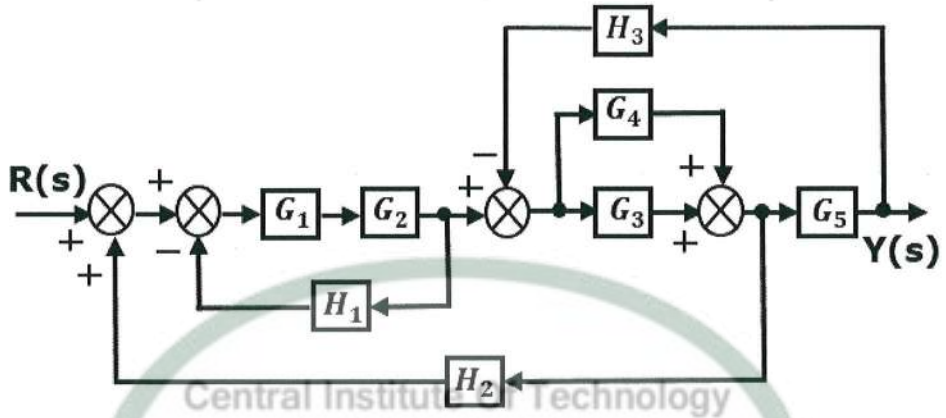
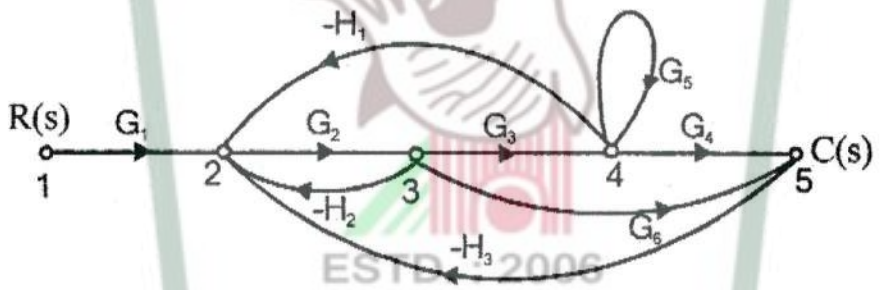
Time : Three hours

The figures in the margin indicate full marks for the questions.

*Answer **any five** questions.*

1.	Find the most appropriate answer:		1 x 10=10
	i)	Transfer function can be defined as [A] Ratio of change in output to change in input [B] Ratio of Laplace transform of input to the Laplace transform of output [C] Ratio of Laplace transform of output to the Laplace transform of input [D] Ratio of Laplace transform of output to input	
	ii)	An air conditioner is an example of [A] Closed loop system [B] Open loop system [C] Both open and closed loop system [D] Manually controlled system	
	iii)	A second order system will be underdamped for [A] $\xi > 1.2$ [B] $\xi = 0$ [C] $\xi = 0.2$ [D] $\xi = 1$	
	iv)	What will be the order of the system if $G(s)=(2s+2)/(s^3+2s^2+1)$ [A] Zero [B] One [C] Two [D] Three	
	v)	Laplace transform is used to study a system in [A] time-domain [B] s-domain [C] z-domain [D] none of the above	
	vi)	The overall transfer function of a system with forward gain of G(s) and negative unity feedback is given by [A] $1/[1+G(s)]$ [B] $G(s)/[1+G(s)H(s)]$	

		[C] G(s)/[1+G(s)] [D] G(s)/[1-G(s)]	
	vii)	The following system with G(s)=1/s(s+3) is [A] Stable [B] Unstable [C] Marginally stable [D] None of the above	
	viii)	Polar plot gives the [A] Variation of G(s) against ω [B] Variation of G(s) against s [C] Variation of G(s)H(s) against ω [D] Variation of G(s)H(s) against s	
	ix)	The Magnitude plot and phase plot in Bode plot are represented as: [A] 20log |G(jw)| versus log ω and phase shift versus log ω. [B] 10log|G(jw)| versus log ω and phase shift versus ω [C] 20log|G(jw)| versus ω and phase shift versus log ω [D] |G(jw)| versus ω and phase shift versus ω.	
	x)	A system has 2 poles and 1 zeros in its open-loop transfer function. The slope of its highest frequency asymptote in its magnitude plot is [A] +40 dB/dec [B] -40 dB/dec [C] +20 dB/dec [D] -20 dB/dec	
1	xi)	With the help of block diagram, describe the operation of any one practical closed loop system.	4
1	xii)	For a series RLC circuit, show the input, output and find the order of the system.	6
2.	a)	Find the Laplace transform of the following: i) $5e^{-3t}$ ii) sin 5t	3+3=6
2.	b)	Find the inverse Laplace transform of the following: i) $X(s)=\frac{1}{s+5}+\frac{2}{(s+3)^2+4}$ ii) $X(s)=\frac{3}{(s-3)(s+2)(s+1)}$	3+3=6
2.	c)	Write the expression of torque developed a rotational system and find the transfer function of the system. What are the analogies between second order electrical and second order mechanical system?	6+2=8

3	a)	Reduce the block diagram and obtain C(s)/R(s) 	10
3.	b)	Find the overall transfer function of the following signal flow graph 	10
4	a)	Determine the unit impulse response of a first order system and draw the waveforms of the input and the output.	5+2=7
4	b)	What is the most desired damping condition in a second order system? Derive the expression of the output for a critically damped system with unit step input.	1+6=7
4	c)	Define rise time, peak time and settling time of an underdamped second order system with the help of diagram.	4
4.	d)	How the type (0,1, etc.) of a system can be mathematically determined?	2
5	a)	Obtain the expression of transfer function of a first order single tank level system.	5
5	b)	What do you mean by steady state and transient errors? Derive the expression of steady state error of a control system.	2+4=6

5	c)	Determine the settling time of a second order system if its damping factor is 0.4 and the natural frequency is 5.5 rad/sec.	3
5	d)	Determine the steady state error of a type-0 and 1 system when unit step input is applied to it.	6
6	a)	Define stability of a system. If one of the poles of a transfer function is on the left half and the other pole is on the right half of the s-plane, whether the system will be stable? If yes/no-why? Using Routh Hurwitz method, examine the stability of a system with the following characteristic equation: $s^4+8\ s^3+18\ s^2+16s+5=0$	2+2+6=10
6	b)	What are the magnitude and angle conditions for a root locus? For what value of K, the point (-2 + 5j) will be present on the root locus. Consider that the system has closed loop gain, G(s)H(s) = K/s(s + 4) and unity feedback. Also check whether the angle condition is satisfied by point or not?	4+6=10
7	a)	Determine the magnitude and phase angle of the following transfer function and draw the polar plots $G(s) = \frac{K}{1+sT}$	8
	b)	What is the use of Bode plot? Mathematically define gain margin and phase margin. What do you mean by asymptotic Bode plot?	1+3+2=6
	c)	Determine the phase crossover frequency and gain margin of the following transfer function $G(s) = \frac{K}{s(1+2s)(1+s)}$	6