GURU NANAK INSTITUTE OF TECHNOLOGY

An Autonomous Institute under MAKAUT

2022

CONTROL ENGINEERING

EI503

TIME ALLOTTED: 3Hours **FULL MARKS:70**

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable

GROUP – A

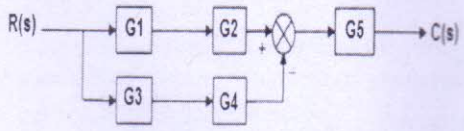
(Multiple Choice Type Questions)

Answer any ***ten*** from the following, choosing the correct alternative of each question: **10×1=10**

			Marks	CO No
1.	i)	If a Nyquist plot of G (jω) H (jω) for a closed loop system passes through (-1, j0) point in G(S)H(S) plane, what would be the value of gain margin of the system in dB? a) 4 dB b) 2.0201 dB c) 0 dB d) 6.0205 dB	1	CO1, CO3
	ii)	If the system is represented by G(s) H(s) = k (s+1) / s (s +5) (s + 2), what would be its magnitude at ω = ∞? a) 0 b) ∞ c) 1/10 d) 2	1	CO1,CO2
	iii)	If the unity feedback system is given by the open loop transfer function G(s) = ks / [(1 + 0.3s) (1+ 0.05s)], what would be the initial slope of magnitude plot? a) 20 dB/decade b) 40 dB/decade c) 60 dB/decade d) Unpredictable	1	CO1, CO3
	iv)	The system is said to be marginally stable, if gain margin is _____ a) 0 b) 1 c) +∞ d) None of the above	1	CO1
	v)	Characteristics equation of a system is s2+ 4 = 0. The system is a) Un damped b) Critically damped c) Under damped d) Over damped	1	CO2,CO3

vi) Unit impulse response of a system is c(t) $=e^{-at}$. The transfer function is — 1 — CO1,CO3
   a) 1
   b) 1/(s+a)
   c) s
   d) (s+a)

vii) Find the total transfer function of the system. — 1 — CO1,CO2



   a) G1.G2 + G3.G4 – G5
   b) (G1.G2 + G3) - G4.G5
   c) (G1 + G2).G3 + (G4 + G5)
   d) (G1.G2 - G3.G4).G5

viii) A system Gain Margin is -15 dB is found in bode graph.The system is — 1 — CO1,CO3
   a) Stable
   b) unstable
   c) marginally stable
   d) none of the above

ix) A type one system has the number of pole at origin — 1 — CO1
   a) 0
   b) 1
   c) 2
   d) 3

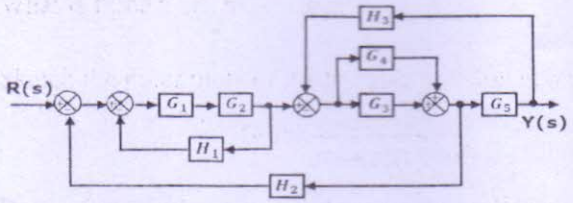
x) The roots of characteristics equation of a transfer function is called as — 1 — CO1
   a) Zero
   b) Pole
   c) gain
   d) attenuation

xi) A system transfer function has only one pole which is situated at origin, the impulse response of the system will be — 1 — CO2, CO3
   a) Step function
   b) ramp function
   c) impulse function
   d) parabolic function

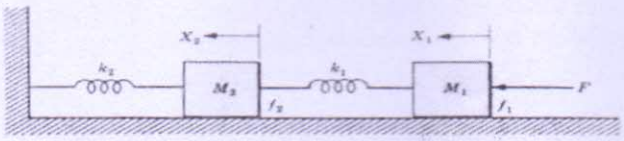
xii) The definition of transfer function is valid for — 1 — CO1
   a) Linear Time Invariant system
   b) Linear Time Variant system
   c) Nonlinear Time Invariant system
   d) Nonlinear Time Variant system

GROUP – B
(Short Answer Type Questions)
(Answer any *three* of the following) **3 x 5 = 15**

		Marks	CO No
2. a.	The characteristic equation of the system is given by $s^4 + 2s^3 + (4 + k)\, s^2 + 9s + 25 = 0$. Determine the range of k for the system to be stable using Routh Array Technique.	4	CO1,CO2
b.	Is it possible to find the relative Stability using Root Locus Plot?	1	CO4
3. a.	What do you mean by static Error coefficient?	1	CO3
b.	Calculate the steady state error of the close loop system of transfer function $G(s) = 2 / S(S+2)$ and $H(s) = 1$ with the I/P signal $5 + 2t + 5\, t^2/2$	4	CO1,CO3
4. a	Find the total transfer function of the system.	4	CO1,CO2



b.	What is Open Loop Transfer Function?	1	CO1
5. a.	Draw the electrical equivalent circuit of the following mechanical system using Force-voltage analogy?	4	CO1,CO2



b.	What is force Current Analogy?	1	CO1
6. a.	Sketch the polar plots of the transfer function given below. $G(s)=\frac{1}{s(1+s)(1+2s)}$	3	CO2,CO2
b.	Determine whether these plots cross the real axis or not. If yes, determine the frequency and corresponding magnitude.	2	CO4

GROUP – C
(Long Answer Type Questions)
(Answer any *three* of the following) **3 x 15 = 45**

		Marks	CO No
7. a.	Define Root Locus.	2	CO3,
b.	Consider a feedback system having characteristics equation $G(s) = K / [s(s + 2) (s2 + 2s + 5)]$ Find the root locus of the system.	10	CO1,CO2
c.	Explain the Relative stability measurement using Root Locus Technique.	3	CO1,CO3
8. a.	Sketch Bode plot for following transfer function showing magnitude in decibels and phase in degrees. Plot them against log frequencies for the following transfer function. $$G(s) = \frac{2(s+0.25)}{s(s+1)(s+0.5)}$$	10	CO4
b.	Find the GM and PM.	4	CO4
c.	Comment on the stability of the system.	1	CO3,CO4
9. a.	Explain Nyquist stability criteria.	5	CO1
b.	Using Nyquist, criteria find whether the closed-loop system will be stable for the open-loop transfer function and Calculate its gain margin. $G(s) = 14 / [s(s + 1) (s + 2)]$	10	CO2,CO4
10. a.	Derive expression of transfer function of the system which is represented in the following standard state space form: $\dot{X} = AX + BU$ $Y = CX + DU$ Draw the block diagram of this above state space model.	5	CO3,CO4
b.	Obtain the transfer function of the system defined by following state-space equations. $$\dot{X} = \begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} -1 & -1 \\ 1 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 1 \\ 0 \end{bmatrix} [u]$$ $$Y = [0 \quad 1] \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$	8	CO3,CO4
c.	Define controllability and observability.	2	CO4
11.	Write Short note: (Any three)	3x5=15	
a.	Polar Plot	5	CO2
b.	Lag-Lead Compensator	5	CO4
c.	Force Voltage Analogy	5	CO1
d.	Time response of Second Order System	5	CO4
e.	Breakaway Point in Root Locus Technique	5	CO3