Reg.No.:												

VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN
[AUTONOMOUS INSTITUTION AFFILIATED TO ANNA UNIVERSITY, CHENNAI]
Elayampalayam – 637 205, Tiruchengode, Namakkal Dt., Tamil Nadu.

Question Paper Code: 120025

B.E. / B.Tech. DEGREE END-SEMESTER EXAMINATIONS – JAN. 2026
Fourth Semester
Biomedical Engineering
U23BM408 – BIO CONTROL SYSTEMS
(Regulation 2023)

Time: Three Hours | Maximum: 100 Marks

Answer ALL the questions

Knowledge Levels (KL)	K1 – Remembering	K3 – Applying	K5 - Evaluating
	K2 – Understanding	K4 – Analyzing	K6 - Creating

PART – A

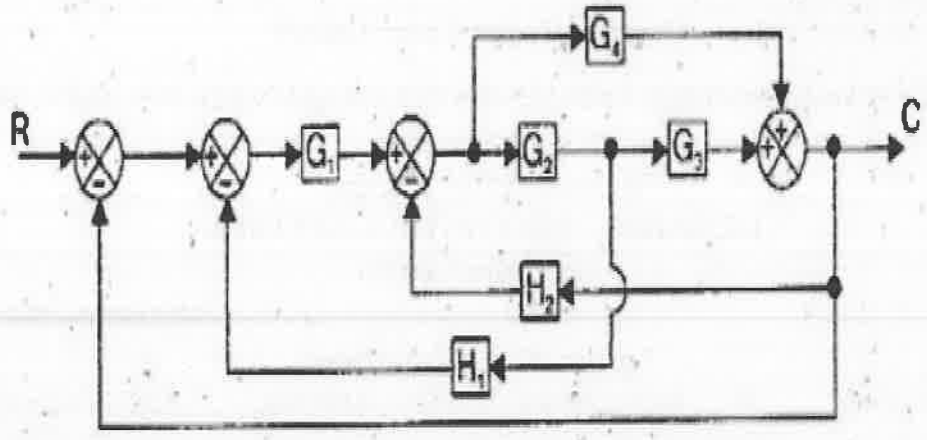
(10 x 2 = 20 Marks)

Q.No.	Questions	Marks	KL	CO
1.	Give the Mason's gain formula.	2	K1	CO1
2.	How are physiological control systems more complex than engineering control system?	2	K2	CO1
3.	A unity feedback system has a open loop transfer function of G(s)=10/(s+1)(s+2). Determine the steady state error for unit step input.	2	K3	CO2
4.	Classify the system depending on the value of damping.	2	K2	CO2
5.	State the necessary and sufficient conditions for stability according to Routh Hurwitz criterion.	2	K1	CO3
6.	Define asymptotes. How will you find the angle of asymptotes?	2	K2	CO3
7.	The damping ratio and natural frequency of oscillation of a second order system is 0.5 and 8 rad/sec respectively. Calculate the resonant peak and resonant frequency.	2	K2	CO4
8.	Define phase margin and Gain cross-over frequency.	2	K1	CO4
9.	What are the reflex arc components?	2	K1	CO5
10.	Define the term neuromuscular reflex motion.	2	K1	CO5

PART – B

(5 x 13 = 65 Marks)

Q.No.		Questions	Marks	KL	CO
11.	a)	Apply the block diagram reduction rules and find the transfer function C(s) / R(s).	13	K3	CO1



(OR)

	b)	Determine the overall gain of the system whose signal flow graph is shown in figure 1.	13	K3	CO1

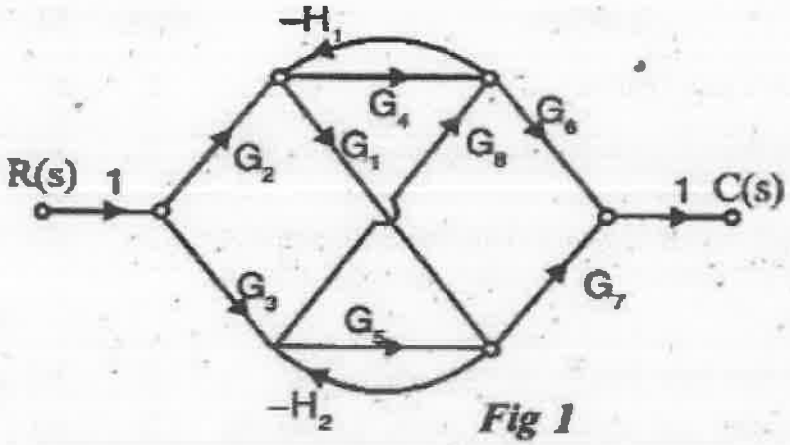


Fig 1

12.	a)	For a unity feedback control system, the open loop transfer function is $G(S) = \frac{10}{s2(S+1)(S+2)}$. Find		K3	CO2
		i. The position, velocity, acceleration error constants	6		
		ii. The steady state error when the input is R(s), where $R(s)=\frac{3}{S} - \frac{2}{s^2} + \frac{1}{3s^2}$	7		

(OR)

	b)	Analyze the second order underdamped system and derive the expression for		K4	CO2
		i. step response of the system	7		
		ii. Impulse response of the system.	6		

13.	a)	A unity feedback control system has an open loop transfer function $G(s) = \frac{K}{s(s^2+4s+13)}$. Construct the rootlocus. Determine its stability.	13	K3	CO3
		(OR)			
	b)	Construct Routharray and determine the stability of the system whose characteristic equation is $S^6+2S^5+8S^4+12S^3+20S^2+ 16S +16= 0$. Also determine the number of roots lying on right half of S-plane, left half of S plane and on imaginary axis.	13	K3	CO3
14.	a)	Sketch the bode plot for the following transfer function and determine the system gain K so that the system is stable with $G(S) = Ke^{-0.2s}/s(s+2)(s+8)$ gain margin equal to 2db and phase margin equal to 45^0.	13	K4	CO4
		(OR)			
	b)	The open loop transfer function of a unity feedback system is given by $G(s)=1/s^2(1+s)(1+2s)$. Sketch the polar plot and determine the gain margin and phase margin.	13	K4	CO4
15.	a)	With a clear diagram, explain the simple model of muscle stretch reflex action and analyze the steady state response with the resulting curve.	13	K4	CO5
		(OR)			
	b)	Analyze the frequency response of circulatory control model and explain how it controls the respiration heart rate and arterial blood pressure.	13	K4	CO5

PART – C

(1 x 15 = 15Marks)

Q.No.		Questions	Marks	KL	CO
16.	a)	Consider the linearized physiological model of skeletal muscle, where F0 is the force from the active contractile element, F is the actual force, R represents viscous damping, and Cp and Cs are the elastic elements, derive the differential equation relating F to x and F0. What does this model predict under steady-state isometric conditions?	15	K3	CO1
		(OR)			
	b)	Analyze the transient response of neuromuscular reflex motion. How does this analysis help in understanding the regulation of muscle length and reflexive muscle control.	15	K4	CO5