Reg. No. : | | | | | | | | | | | | |

Question Paper Code: U5B02

B.E./B.Tech. DEGREE EXAMINATION, NOV 2024

Fifth Semester

BIOMEDICAL ENGINEERING

21UBM502-BIO CONTROL SYSTEM

(Regulations 2021)

Duration: Three hours — Maximum: 100 Marks

PART A - (10 x 2 = 20 Marks)

1. Enlist the merits of closed-loop system over open-loop system. — CO1-U

2. Point out the remarkable effects of negative feedback in the closed loop control systems. — CO1-U

3. List various time domain specification used in stability analysis. — CO1-U

4. For the first order system having transfer function C(s)/R(s)=1/(1+sT), the unit-impulse response is __________. — CO2-App

5. Define gain and phase cross over frequencies. — CO1-U

6. If a system is said to have a damping $\xi = 0.5532$ with the natural frequency $\omega_n = 2$ rad/sec, what will be the value of resonant frequency? — CO2-App

7. List the four limitations of the transfer function model. — CO1-U

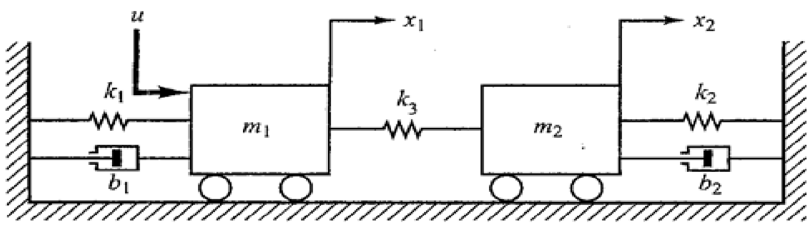
8. Define Controllability of a system. — CO1-U

9. What is stretch reflex? — CO1-U

10. Give examples of positive and negative feedback physiological control system. — CO1-U

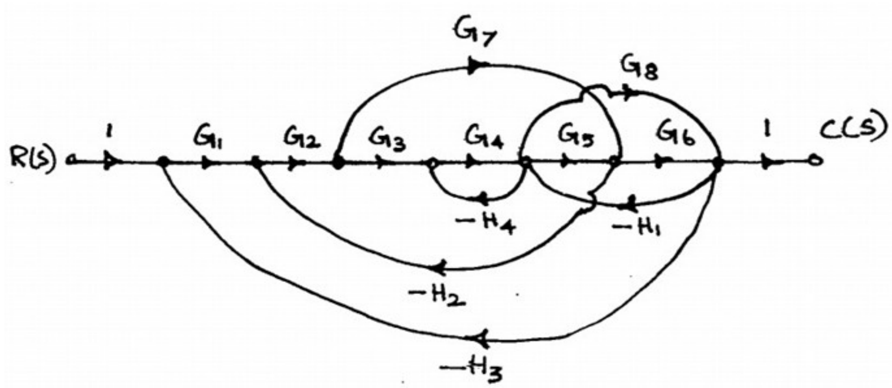
PART – B (5 x 16= 80Marks)

11.	(a)	Obtain the transfer function X2(s)/U(s) of the following mechanical system as shown in Fig. Also draw the Force-Voltage and Force-Current electrical analogous circuits and verify the equations.	CO2-App	(16)



Or

	(b)	Estimate the C(s)/R(s) for the Signal flow graph shown below using Mason's gain formula.	CO2-App	(16)



12.	(a)	(i)The open loop transfer function of a unity feedback system is given by G(s)= $\frac{20}{(s^2+5s+6)}$. Determine the damping ratio, maximum overshoot, peak time, settling time and rise time for unit step input.	CO3-App	(8)
		(ii)The open loop transfer function of a unity feedback system is given by $G(s)=\frac{1}{s(1+s)}$. Determine the generalized error coefficients and steady state error of the system for the input $r(t)=4+6t+2t^3$.	CO3-App	(8)

Or

	(b)	Draw the root locus plot of a unity feedback system, whose open loop transfer function is given by $G(s)H(s)=\frac{K}{s(s^2+9s+18)}$ and also, determine the value of K, so that the damping ratio of closed loop system is 0.5.	CO3-App	(16)

13. (a) Sketch the Bode plots of a unity feedback system showing the magnitude in decibels and phase angle in degrees as a function of log frequency for the given open-loop transferfunction — CO4-Ana (16)

$$(s)H(s) = \frac{10}{s(1 + 0.5s)(1 + 0.1s)}$$

From the Bode plots, determine the Phase cross-over frequency, Gain cross-over frequency, Gain margin and Phase margin of the system. Comment on the stability of this system.

Or

(b) Sketch polar plot for the given system whose open loop transfer function is — CO4-Ana (16)

$$G(s) = \frac{20}{s(s + 1)(s + 2)}$$

Determine gain margin and phase margin of the system and also analyze the system stability.

14. (a) (i) Construct state space model using phase variable approach for the following differential equation — CO2-App (8)

$$\dddot{y} + 10\ddot{y} + 15\dot{y} + 6y = 10u$$

(ii) A LTI system is characterized by the state equation $\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u$ where u is a unit step function. Compute the solution of these equations assuming initial condition $x_0 = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$. — CO2-App (8)

Or

(b) A linear time invariant system is characterized by statevariable model is given as — CO2-App (16)

$$\begin{bmatrix} \dot{x_1} \\ \dot{x_2} \\ \dot{x_3} \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & -11 & -6 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u$$

$$y = \begin{bmatrix} 3 & 4 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$$

Check the controllability & observability of the system by applying kalman's test.

15.	(a)	Analyze the transient response analysis of neuro muscular reflex model action with necessary diagrams.	CO5-Ana	(16)
		Or		
	(b)	Analyze the effects of atropine & propanolol on frequency responses of the circulatory control model with necessary diagrams.	CO5-Ana	(16)