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

Question Paper Code: U5B02

B.E./B.Tech. DEGREE EXAMINATION, NOV 2023

Fifth Semester

Biomedical Engineering

21UBM502 - BIO CONTROL SYSTEM

(Regulations 2021)

(Use of polar plot can be permitted)

Duration: Three hours Maximum: 100 Marks

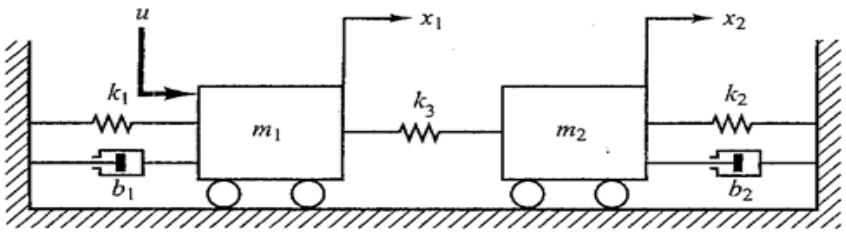
Answer All Questions

PART A - (10 x 2 = 20 Marks)

1.	Distinguish between open loop and closed loop system.	CO1 -U
2.	Define Transfer Function.	CO1 -U
3.	Define settling time.	CO1- U
4.	What is the necessary and sufficient condition for stability?	CO1 -U
5.	List out the different frequency domain specifications.	CO1- U
6	Define phase margin.	CO1- U
7	State the properties of State Transition matrix.	CO1- U
8	List any four limitations of the transfer function model.	CO1 -U
9	List the needs of stability analysis in physiological systems.	CO1 -U
10	Give examples of positive and negative feedback physiological control system.	CO1- U

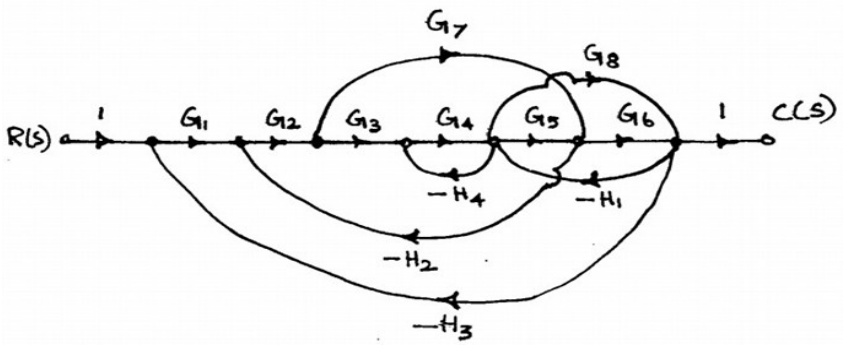
PART – B (5 x 16= 80Marks)

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 and rise time. Derive the used formula. CO3- Ana (8)

(ii) Determine K to limit the error of a system for input $1+8t+\frac{16}{2}t^2$ to 0.8 having $G(s)H(s)=\frac{K}{s^2(s+1)(s+4)}$. CO3 -Ana (8)

Or

(b) A unity feedback system is characterized by the open-loop transfer function, $G(s)=\frac{K(s+13)}{s(s+3)(s+7)}$ using the Routh-stability criterion method; calculate the range of values of K for the system to be stable. Determine the values of K, which cause sustained oscillations in the closed-loop system. What are the corresponding oscillating frequencies? CO3 -Ana (16)

13. (a) Sketch Bode log-magnitude and phase plot for the following transfer function CO4 -Ana (16)

$$G(s)H(s)=\frac{40}{s(s+2)(s+5)}$$

From the Bode plot, evaluate the gain cross over frequency, phase cross over frequency, gain margin and phase margin. Comment on stability.

Or

(b) Consider a unity feedback system having an open loop transfer function CO4- Ana (16)

$$G(s) = \frac{1}{s(1+0.2s)(1+0.05s)}$$

Sketch the Polar plot and determine the phase and gain margin values. Comment on stability of the system.

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

$$\dddot{y} + 6\ddot{y} + 11\dot{y} + 6y = 8u$$

(ii) The state equation and initial condition vector of an linear time invariant system are given below. Determine the solution of state equation. CO2 -App (8)

$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix} = \begin{bmatrix}1 & 0\\ 1 & 1\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix} \; ; \quad X_0 = \begin{bmatrix}1\\ 0\end{bmatrix}$$

Or

(b) Check controllability and observability for the system whose state space model is given as CO2- App (16)

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

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

15. (a) Discuss the model of neuromuscular reflex motion. CO1- U (16)

Or

(b) Discuss the stability analysis of the Pupillary light reflex. CO1-U (16)