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

Question Paper Code: U5B02

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

Fifth Semester

Biomedical Engineering

21UBM502 - BIO CONTROL SYSTEM

(Regulations 2021)

(Use of polar plot can be permitted)

Duration: Three hours Maximum: 100 Marks

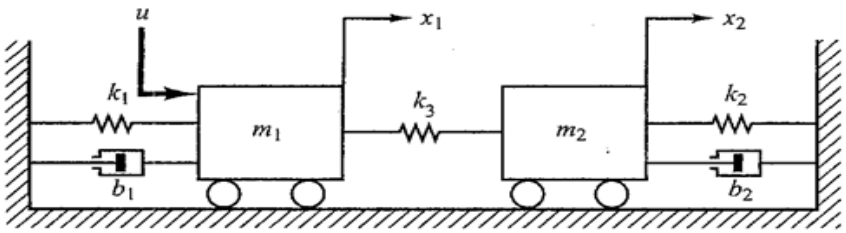
Answer All Questions

PART A - (10 x 2 = 20 Marks)

1.	Why negative feedback is invariably preferred in closed loop control system?	CO1 -U
2.	What is the need of Physiological system modeling?	CO1 -U
3.	List the time domain specifications.	CO1- U
4.	What is meant by type number of the system? What is its significance?	CO1 -U
5.	Define phase margin.	CO1- U
6	State Nyquist stability criterion.	CO1- U
7	Compare transfer function approach and state variable approach.	CO1- U
8	State the properties of State Transition matrix.	CO1 -U
9	List the needs of stability analysis in physiological systems.	CO1 -U
10	Draw the block diagram with labeling of muscle stretch reflex.	CO1- U

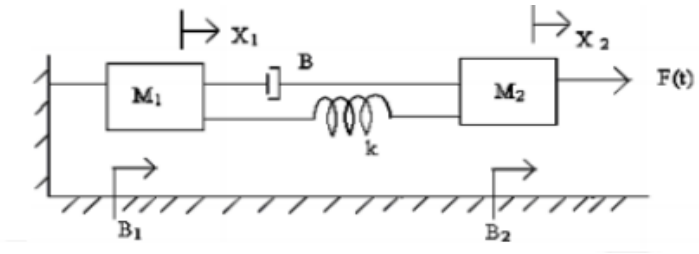
PART – B (5 x 16= 80 Marks)

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) Determine the transfer function $X_2(S)/F(S)$ of the mechanical system shown in Fig. 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) Draw the Nyquist plot for the system whose open loop transfer function is CO4- Ana (16)

$$G(s)H(s) = \frac{K}{s(s+2)(s+10)}$$

Determine the range of K for which closed loop system is stable.

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) Evaluate the transient response analysis of neuromuscular reflex model action with necessary diagrams. CO5- Eva (16)

Or

(b) Evaluate the effects of atropine & propanolol on frequency responses of the circulatory control model with necessary diagrams. CO5- Eva (16)