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Question Paper Code:95B03

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

Fifth Semester

Biomedical Engineering

19UBM503 – BIO CONTROL SYSTEM

(Regulation 2019)

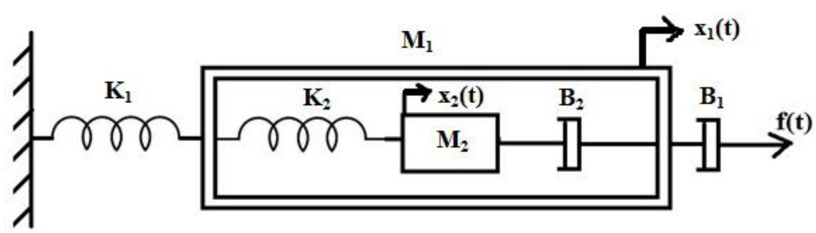
Duration: Three hours Maximum: 100 Marks

PART – A (10 x 2 = 20 Marks)

1. What is mathematical modeling? What is the advantage and explain it with suitable example. CO1 - U
2. Give the advantage of signal flow graph method over block diagram reduction method. CO1 - U
3. What are the effects of damping ratio on the time response of a second order system? CO1 - U
4. What are the main significances of root locus? CO1-U
5. The damping ratio and natural frequency of oscillations of a second order system is 0.3 and 3 rad/sec respectively. Calculate resonant frequency and resonant peak. CO2 - U
6. How do you find the stability of the system by using polar plot? CO1-U
7. Sketch the block diagram representation of a state model. CO1-U
8. Point out the limitations of physical system modeled by transfer function approach. CO1-U
9. What are the basic problems in physiological modeling? CO1-U
10. Write any four examples of physiological control system. CO1-U

PART – B (5 x 16 = 80 Marks)

11. a) (i) For the given mechanical system, draw the mechanical network. From the mechanical network, write the differential equations of performance and also draw the Force-Voltage analogy circuit. CO2-Ap (8)



(ii) A System is described by the following set of linear algebraic equations: CO2-Ap (8)

$x_2 = a_{12}x_1 + a_{22}x_2 + a_{32}x_3$

$x_3 = a_{23}x_2 + a_{43}x_4$

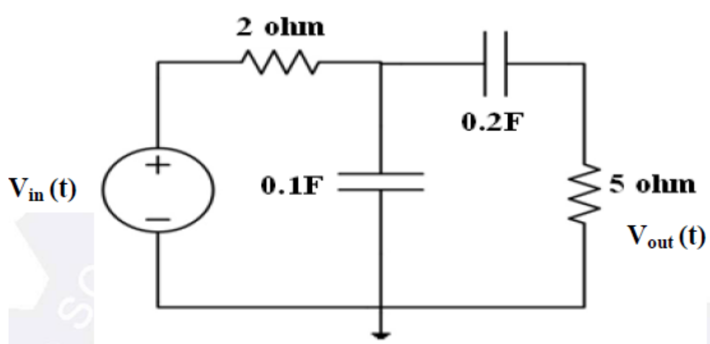
$x_4 = a_{24}x_2 + a_{34}x_3 + a_{44}x_4$

$x_5 = a_{25}x_2 + a_{45}x_4$

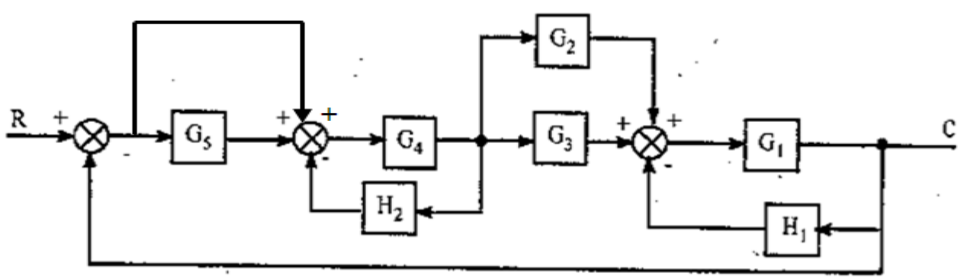
Draw the Signal flow graph and obtain the overall transfer function of the System using Mason's gain formula.

(OR)

b) (i) For the electrical circuit shown in Figure, determine the transfer function $\frac{V_{out}(s)}{V_{in}(s)}$. CO2-Ap (8)



(ii) Draw the signal flow graph and find C/R for the block diagram of the system shown in fig. CO2-Ap (8)



12. a) (i) Compute steady state error for the given unity feedback system whose open loop transfer function is given by $G(s) = \frac{10}{s^2 + 5s}$ using generalized error series when the input is $r(t) = 1 + t$. CO3-E (8)

(ii) The characteristic equation of for certain feedback control system is given below. Determine the range of value of K, for which the system is stable. $s^5 + s^4 + s^2 + s + K = 0$. CO4-An (8)

(OR)

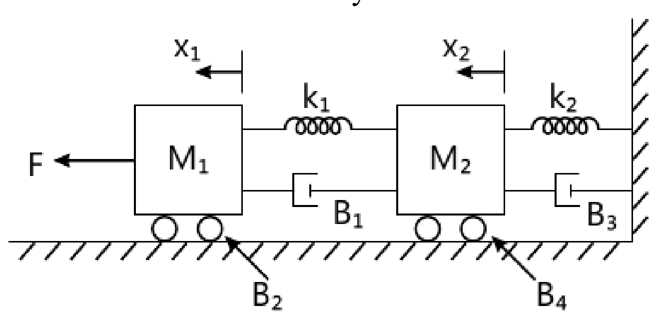
b)	(i) A unity negative feedback system is characterized by an open loop transfer function $G(s) = \frac{K}{s(s+2)}$. Determine the gain K so that the system will have a damping ratio of 0.6. For this value of K, find the rise time, settling time, peak time and peak overshoot to a unit step input.	CO3-E	(8)
	(ii) A unity feedback system has an open loop transfer function, $G(S) = \frac{K}{s(s^2+8s+32)}$. Sketch the root locus and determine the dominant closed loop poles with ζ=0.5. Determine the value of K at this point.	CO4-An	(8)

13\. a) Sketch Bode plot for the given system whose open loop transfer function is $G(s) = \frac{10}{s(s+50)(s+100)}$. Determine gain cross over frequency, phase crossover frequency, gain margin and phase margin of the system and analyze the system stability. CO3-E (16)

(OR)

b) The open loop transfer function of a unity feedback system is given by $G(s) = \frac{K}{s(s^2+s+4)}$. Using polar plot, determine the value of K so that phase margin is 50º. What is the corresponding gain margin? CO3-E (16)

14\. a) (i) Find the state model of the mechanical system shown below. CO5-Ap (8)



(ii) A system is represented by the state equation CO5-Ap (8)

$$\begin{bmatrix}\dot{x_1}\\ \dot{x_2}\\ \dot{x_3}\end{bmatrix} = \begin{bmatrix}0 & 1 & 0\\ 0 & 0 & 1\\ -24 & -26 & -9\end{bmatrix}\begin{bmatrix}x_1\\ x_2\\ x_3\end{bmatrix} + \begin{bmatrix}0\\ 0\\ 24\end{bmatrix}u, \quad \text{and} \quad y = [1 \quad 0 \quad 0]\begin{bmatrix}x_1\\ x_2\\ x_3\end{bmatrix}.$$

Determine the transfer function of the system.

(OR)

b) (i) Obtain the state model of the system described by the following transfer function $\frac{Y(s)}{U(s)} = \frac{s+3}{s^2+3s+2}$. CO5-Ap (8)

(ii) A Linear Time Invariant system is characterized by the state equation $\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 1 \\ 1 \end{bmatrix} u$; where u is a unit step function. Compute the solution of this equation assuming initial condition $x_0 = \begin{bmatrix} 1 \\ 1 \end{bmatrix}$. Use inverse Laplace transform technique. CO5-Ap (8)

15. a) (i) Explain with suitable examples the need for modeling in physiological system. CO1-U (8)

(ii) With a neat diagram explain the linear model of any one physiological system. CO1-U (8)

(OR)

b) (i) Analyze the various properties of generalized biological system and explain how to create models with combinations of system elements. CO1-U (8)

(ii) Differentiate physiological control system with an engineering control system. CO1-U (8)