U.S.N

P.E.S. College of Engineering, Mandya - 571 401

(An Autonomous Institution affiliated to VTU, Belagavi)

Fifth Semester, B.E. - Electrical and Electronics Engineering

Semester End Examination; Feb. - 2021

Linear Control Systems

Time: 3 hrs *Max. Marks: 100*

Course Outcomes

The Students will be able to:

CO1: Do the linear modeling (Transfer Function) for Electrical, Mechanical & Electromechanical systems with the analogy.

CO2: Do the analysis of the second order system with the transient & steady state performance specification & its importance.

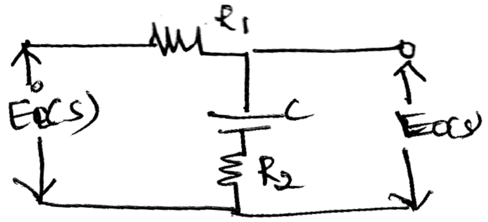
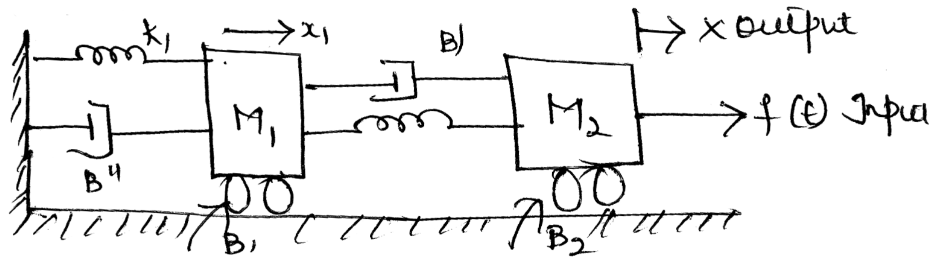
CO3: Do the stability analysis of different systems with RH criterion & Root locus technique.

CO4: Do the frequency response analysis using analytical & Bode diagram.

CO5: Do the relative stability analysis using Polar & Nyquist diagrams.

Note: ***I) PART - A** is compulsory. **Two** marks for each question.*

***II) PART - B**: Answer any **Two** sub questions (from a, b, c) for Maximum of **18 marks** from each unit.*

Q. No.	Questions	Marks	BLs	COs	POs
	I : PART - A	**10**			
1 a.	What is a mathematical model? What are the different types?	2	L1	CO1	PO1
b.	Define settling time.	2	L1	CO2	PO1
c.	What are poles and zeros of a system?	2	L1	CO3	PO1
d.	What is a polar plot?	2	L1	CO3	PO1
e.	What is state variable?	2	L1	CO4	PO1
	II : PART - B	**90**			
	UNIT - I	**18**			
1 a.	i) Explain the advantages and disadvantages of block diagram reduction process over signal flow graph.	6	L1	CO1	PO1
	ii) Find the transfer function $E_O(s)/E_i(s)$ of the following network, 	6	L2	CO1	PO2
b.	i) Obtain the T.F. of the mechanical system shown in figure below, 	6	L2	CO1	PO2

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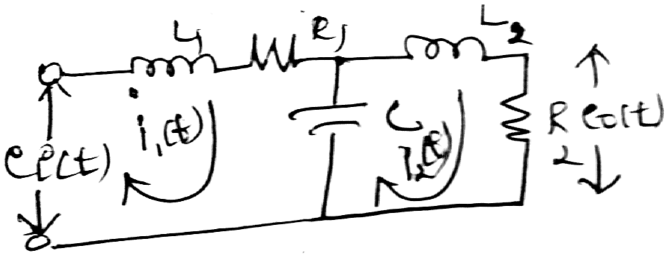
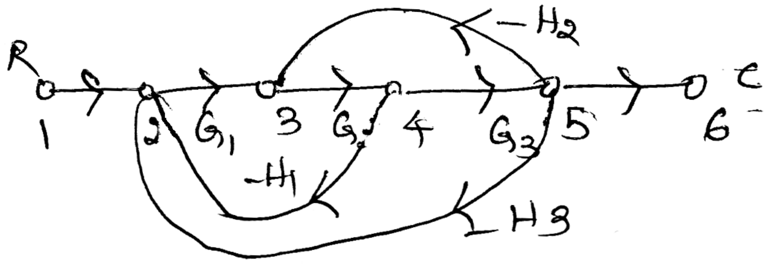
ii) Find the transfer function $E_O(s)/E_i(s)$ of the network shown below,



6 L1 CO1 PO2

c. Find C/R of the following signal flow graph using Mason's gain formula,



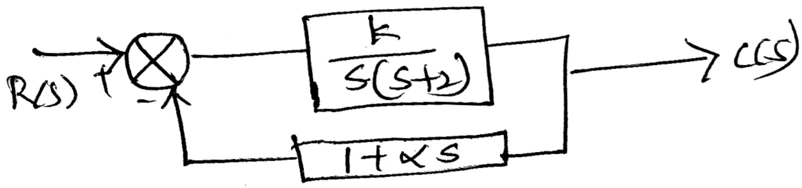
6 L2 CO2 PO2

UNIT - II

18

2 a. i) Give the expression for maximum peak overshoot for a second order system. 6 L1 CO2 PO2

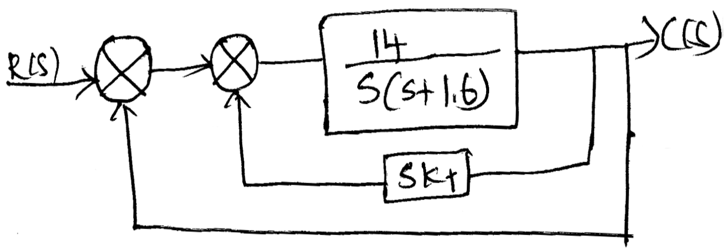
ii) Determine the value of K and α such that the system has a damping ratio of 0.7 and an un-dumped natural frequency of 4 rad/s for the system shown in figure below,



8 L2 CO2 PO3

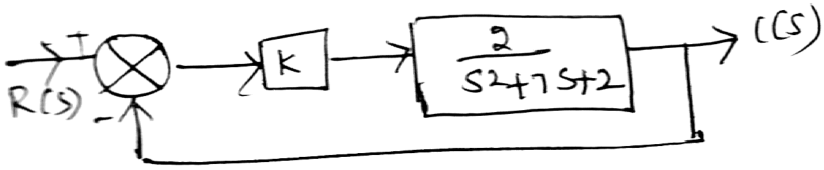
b. i) Give the expression for rise time of the step response for a second order system. 6 L1 CO2 PO2

ii) The system shown in figure below used a rate feedback controller. Determine tachometer constant K_t so as to obtain the damping ratio as 0.5. Calculate corresponding ω_d, t_p, t_s and M_p.



8 L3 CO2 PO3

c. For the control system shown below, what is the value of K for the system to be critically damped?



4 L2 CO2 PO2

UNIT - III **18**

3 a. i) What are poles and zeros of a system? 4 L1 CO3 PO2

ii) Use Routh's criterion to determine the number of roots of the following equation which lie in the RHS of S plane. $s^6+s^5+2s^4+s^3+2s^2+5s+6=0$. 5 L2 CO3 PO2

b. Sketch the root locus of a feedback system whose open loop T.F. is given by,

$$G(S)H(S)=\frac{K}{S(S+2)(S+3)}.$$

9 L3 CO3 PO3

c. Sketch the root locus for a unity feedback system with open loop T.F.

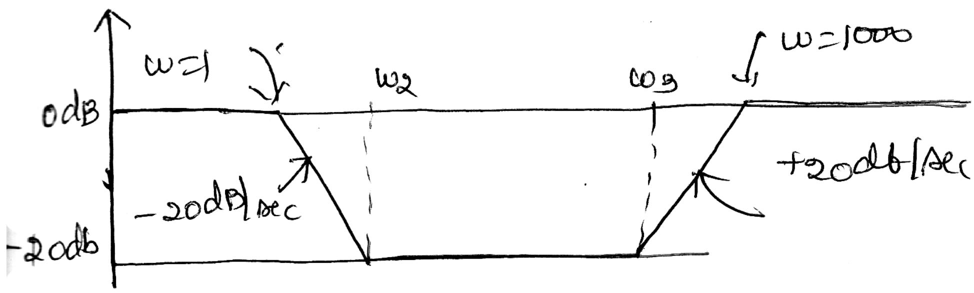
$$G(S)=\frac{K}{S\left(S^2+8S+32\right)}.$$

9 L3 CO3 PO3

UNIT - IV **18**

4 a. i) List the advantages of frequency response as compared to time domain response. 5 L2 CO4 PO4

ii) Determine the T.F. of a system whose asymptotic gain plot is given below, 7 L3 CO4 PO3



b. i) Define Bandwidth, Resonant peak and Resonant frequency. 4 L1 CO4 PO1

ii) Draw Bode plot and discuss stability

$$G(S)H(S)={}^{80}\!/_{S(S+2)(S+80)}.$$

8 L3 CO4 PO3

c. The closed loop T.F. of a feedback system is given by,

$$T(S)=\frac{1000}{(S+22.5)\left(S^2+2.4S+44.4\right)}$$

6 L3 CO4 PO3

Determine; i) M_r, ω_r ii) Bandwidth of the equivalent second order system.

UNIT - V **18**

5 a. Explain the concept of Nyquist stability criterion with example. 9 L1 CO5 PO2

b. Define phase margin and gain margin from polar plot. Consider a system with open loop transfer function as $G(S)H(S)=\frac{10}{S}$. Obtain its polar plot. 9 L2 CO5 PO2

c. For a certain control system $G(S)H(S)=\frac{K}{S(S+2)(S+10)}$ sketch the Nyquist plot and hence calculate the range of values of *K* for stability. 9 L3 CO5 PO3

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