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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; February / March - 2022

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**			
I a.	Define the transfer function of LTI system.	2	L1	CO1	PO1
b.	Define the rise time of a general second order system.	2	L1	CO2	PO1
c.	Define the characteristic equation of a linear system.	2	L1	CO3	PO1
d.	What is the gain margin of a closed loop system?	2	L2	CO4	PO1
e.	State Nyaquist stability criteria	2	L2	CO5	PO1
	II : PART - B	**90**			
	UNIT - I	**18**			
1 a.	i) Explain open loop and closed loop control systems.	3			
	ii) For the mechanical system shown in Fig.1(a), draw the mechanical network write its mathematical model and draw the F-I analogous circuit.	6	L2	CO1	PO1

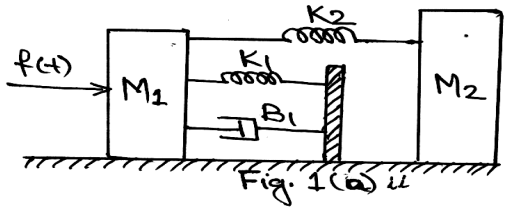

Fig. 1(a) ii

b.	Determine the transfer function for;				
	i) The system shown in Fig.1(b)	6			
	ii) Write 6 mechanical quantities and the corresponding F-V analogous electrical quantities	3	L3	CO1	PO2

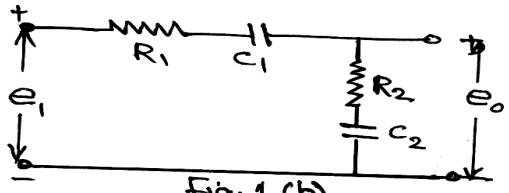

Fig. 1(b)

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c. Find the transfer functions for the signal flow graph shown in Fig.1(c) using Masons gain formula

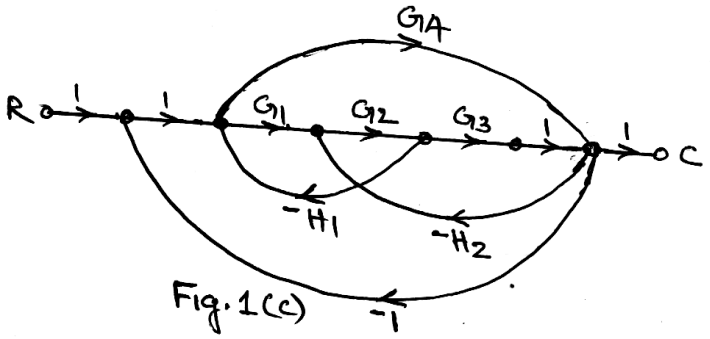

Fig. 1(c)

9 L3 CO1 PO1

UNIT - II **18**

2 a. Draw the time response of a typical under damped second order system to a unit step input. Indicate clearly the time domain specifications on the diagram. Derive the expression for peak time and maximum over shoot. 9 L2 CO2 PO2

b. A unity feedback system have an open loop transfer function, $G(S) = \frac{K}{S(S+10)}$. Determine the value of K so that the system will have a damping ratio 0.5 for this value of K determine t_v, t_p and M_p 9 L3 CO2 PO2

c. Derive expressions for steady state error, static position, velocity and acceleration error coefficients. 9 L2 CO2 PO1

UNIT - III **18**

3 a. i) Explain BIBO stability of a linear control system. 4 L2 CO3 PO1

ii) Find the range of values of k so that the following characteristic equations will represents a stable system, 5 L2 CO3 PO1

$F(S) = S^4 + 22S^3 + 10S^2 + S + K = 0.$

b. Define root locus. State the rules for construction of root loci of feedback control system 9 L2 CO3 PO1

c. Sketch the root locus plot for the system whose open loop transfer function is $G(S)H(S) = \frac{K}{S(S+2)(S+4)}$. 9 L3 CO3 PO2

UNIT - IV **18**

4 a. Draw a typical gain phase characteristic mark frequency response specifications. Derive the expression for μr and wr. 9 L2 CO4 PO2

Contd... 3

b. The bode plot of unity feedback system is shown in Fig. 4(b). obtain its open loop transfer functions

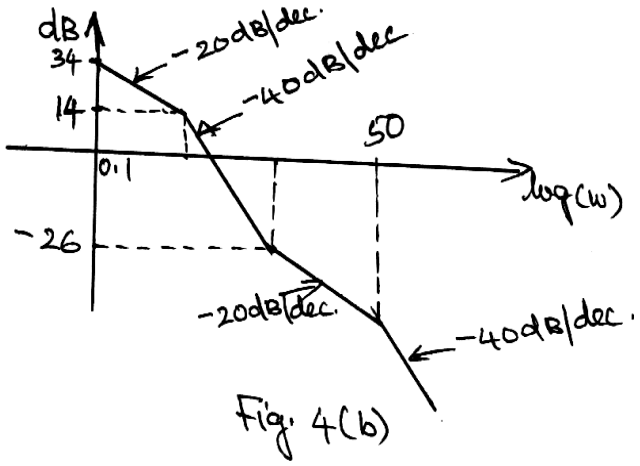

Fig. 4(b)

9 L3 CO4 PO2

c. A negative feedback control systems is given by,

$G(S) = \frac{K}{S(S+\alpha)}$, H(S) = 1. 9 L3 CO4 PO2

Find the values of K and α so that μr = 1.04 and wr = 11.55 rad/sec.

UNIT - V **18**

5 a. State and explain Nyquist stability criterion with example. 9 L2 CO5 PO1

b. Investigate the stability of a negative feedback control system whose open loop transfer function is given by, 9 L4 CO5 PO1

$G(S)H(S) = \frac{100}{(S+1)(S+2)(S+3)}$

c. A negative feedback system is characterized by the open loop transfer function $G(S)H(S) = \frac{1}{S(S+1)(S+0.5)}$. Find its gain margin and phase margin. 9 L3 CO5 PO2

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