JSS MAHAVIDYAPEETHA
JSS SCIENCE AND TECHNOLOGY, UNIVERSITY, MYSURU - 570006

5th Semester B.E.
INTERNAL ASSESSMENT TEST 1
EC530 CONTROL SYSTEMS

Duration: 1 Hours   Date: 18, September, 2018   MAX MARKS: 20

Name of Paper Setter: Dr.Sudarshan Patilkulkarni

Course Outcome Covered:

1. Student will be able to model various physical systems as transfer function.

Cognitive Domains:

Definitions	I. Remembering	II. Understanding	III. Applying	IV. Analyzing	V. Evaluating	VI. Creating
Bloom's Definition	Exhibit memory of previously learned material by recalling facts, terms, basic concepts, and answers.	Demonstrate understanding of facts and ideas by organizing, comparing, translating, interpreting, giving descriptions, and stating main ideas.	Solve problems to new situations by applying acquired knowledge, facts, techniques and rules in a different way.	Examine and break information into parts by identifying motives or causes. Make inferences and find evidence to support generalizations.	Present and defend opinions by making judgments about information, validity of ideas, or quality of work based on a set of criteria.	Compile information together in a different way by combining elements in a new pattern or proposing alternative solutions.

Q. No	CO	Question	Cognitive Domain	Marks
1	1	For the mechanical system shown in Figure 1, apply suitable laws and write differential equations only in terms of input variable u(t) and output variable y(t). Hence construct the transfer function $\frac{Y(s)}{U(s)}$.	L3	8
		OR		
2	1	For the electrical circuit shown in Figure 2, apply suitable law and write differential equations only in terms of input variable u(t) and output variable y(t). Hence construct the transfer function $\frac{Y(s)}{U(s)}$.	L3	8
3	1	For the interconnected system in Figure 3, obtain the overall transfer function $\frac{Y(s)}{U(s)}$ by applying the Mason's gain formula. Show all graphs.	L3	7
4	1	For the parallel RL circuit in Figure 4, derive the output current expression in s-domain for step input. Write the time-domain output current expression, if input signal is a pulse of height one Amps and duration 1 second. (Hint: Use LTI property)	L3	5

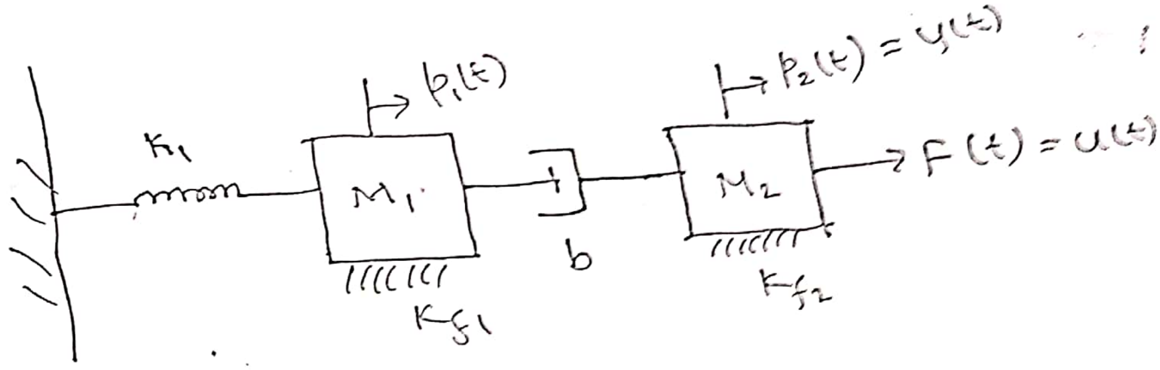


Figure 1.

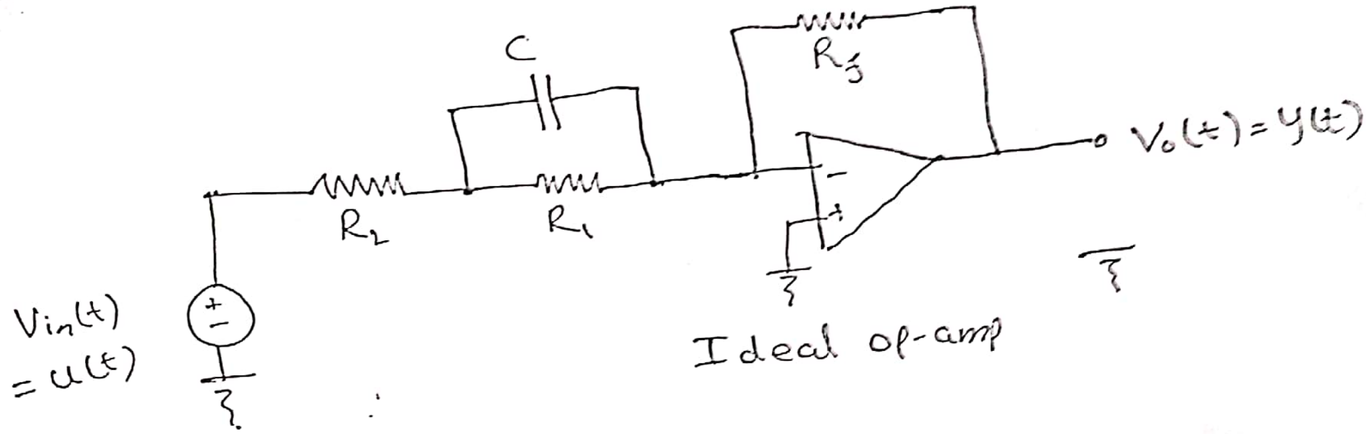


Figure 2

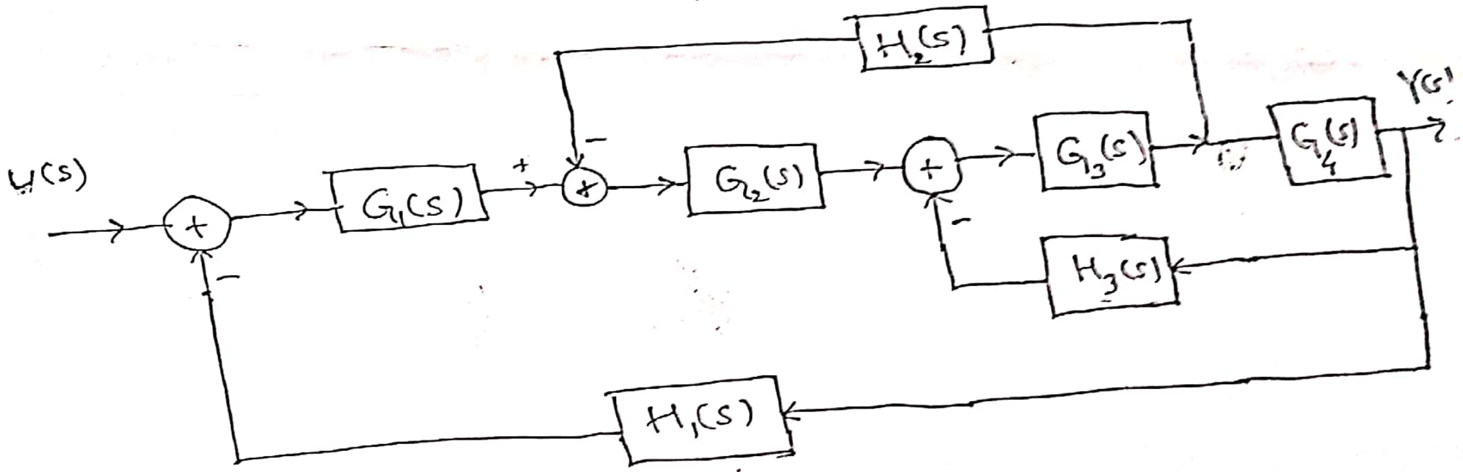


Figure 3

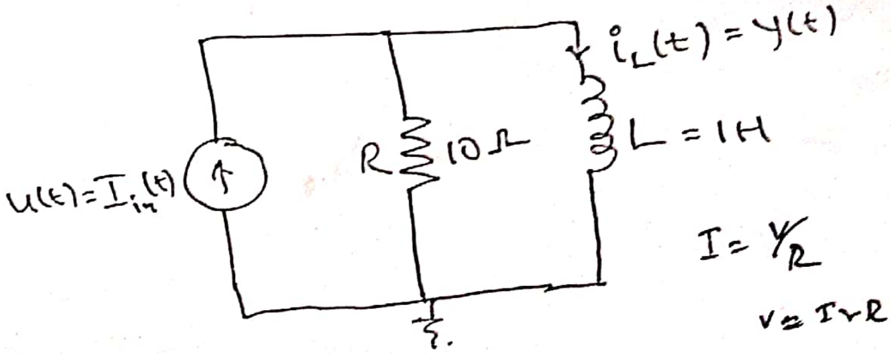


Figure 4.

JSS MAHAVIDYAPEETHA
JSS SCIENCE AND TECHNOLOGY, UNIVERSITY, MYSURU - 570006

5th Semester B.E.
INTERNAL ASSESSMENT TEST 1
EC530 CONTROL SYSTEMS

Duration: 1 Hour | Date: 16, October, 2018 | MAX MARKS: 20

Name of Paper Setter: Dr.Sudarshan Patilkulkarni

Course Outcome Covered:

2. Student will be able to do stability analysis of systems.
3. Student will be able to do time domain and frequency domain analysis using appropriate tools.
4. Student will be able to design PI, PD, PID controllers and phase-lead compensator.

Cognitive Domains:

Definitions	I. Remembering	II. Understanding	III. Applying	IV. Analyzing	V. Evaluating	VI. Creating
Bloom's Definition	Exhibit memory of previously learned material by recalling facts, terms, basic concepts, and answers.	Demonstrate understanding of facts and ideas by organizing, comparing, translating, interpreting, giving descriptions, and stating main ideas.	Solve problems to new situations by applying acquired knowledge, facts, techniques and rules in a different way.	Examine and break information into parts by identifying motives or causes. Make inferences and find evidence to support generalizations.	Present and defend opinions by making judgments about information, validity of ideas, or quality of work based on a set of criteria.	Compile information together in a different way by combining elements in a new pattern or proposing alternative solutions.

Q. No	CO	CD	Question	Marks
1	2	L3	In a unity feedback system, plant model is $G(s) = \frac{1}{s(s+6)^2}$ and controller is $D(s) = K\frac{s+2}{s+3}$. By applying Routh test, determine the values of K that will keep the closed-loop system stable.	6
			OR	
2	2	L3 $\alpha(s) = [1 + L(s)]$	In a unity feedback system it is given that $L(s) = \frac{25}{s(s^2+7s+31)}$. By using Routh test, determine how many poles of the closed-loop system are to the right of $s = -2$.	6
3	3	L3	For the system shown in Figure 3, $G(s) = \frac{10}{s+10}$, $F(s) = \frac{1}{s+2}$ and $H(s) = \frac{1}{s+1}$. Find the expressions for transfer function of closed-loop system $G_{cl}(s)$, $L(s)$ and $E(s)$. Compute steady state error values, when standard reference inputs are applied to the closed-loop system.	8
4	4	L3	Given the plant model $G(s) = \frac{10}{s+10}$, design a PI controller for the dominant pole-location in closed-loop system to be $-10 \pm j10$. Determine the steady state error for step and ramp reference inputs.	6

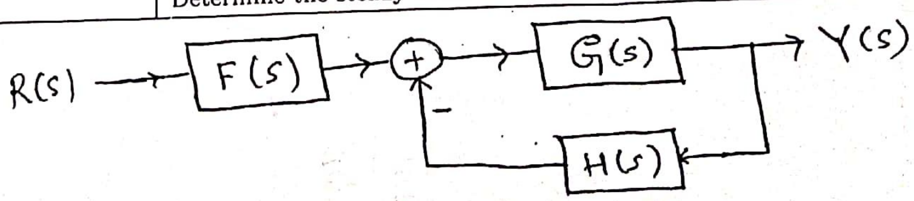


Figure 3

JSS MAHAVIDYAPEETHA
JSS SCIENCE AND TECHNOLOGY, UNIVERSITY, MYSURU - 570006

5th Semester B.E.
INTERNAL ASSESSMENT TEST 3
EC530 CONTROL SYSTEMS

Duration: 1 Hour | Date: 20, November, 2018 | MAX MARKS: 20

Name of Paper Setter: Dr.Sudarshan Patilkulkarni

Course Outcome Covered:

4. Student will be able to design PI, PD, PID controllers and phase-lead compensator..
5. Student will be able to model, analyze and design controllers using state-space methods.

Cognitive Domains:

Definitions	I. Remembering	II. Understanding	III. Applying	IV. Analyzing	V. Evaluating	VI. Creating
Bloom's Definition	Exhibit memory of previously learned material by recalling facts, terms, basic concepts, and answers.	Demonstrate understanding of facts and ideas by organizing, comparing, translating, interpreting, giving descriptions, and stating main ideas.	Solve problems to new situations by applying acquired knowledge, facts, techniques and rules in a different way.	Examine and break information into parts by identifying motives or causes. Make inferences and find evidence to support generalizations.	Present and defend opinions by making judgments about information, validity of ideas, or quality of work based on a set of criteria.	Compile information together in a different way by combining elements in a new pattern or proposing alternative solutions.

Q. No	CO	Blooms Level	Question	Marks
1	4	L3	Given the plant $G(s) = \frac{1}{s(s+4)}$ design a phase-lead controller such that dominant poles of the closed-loop system satisfy $\zeta = 0.6$ and $\omega_n = 10 rad/sec.$ 0.6+10 = 6	8
2	5	L3	Given the state-space model of a physical system: 2=6 w $$A = \begin{bmatrix} -5 & 1 \\ 0 & -8 \end{bmatrix}, B = \begin{bmatrix} 1 \\ 1 \end{bmatrix}, C = \begin{bmatrix} 1 & 0 \end{bmatrix},$$ find the the transfer function of the system. Hence write the controller canonical model (A_c, B_c, C_c).	6
3	5	L3	For the mechanical system shown in Figure 3, write the differential equations and obtain a state-space model. (Hint: 4th order system)	6

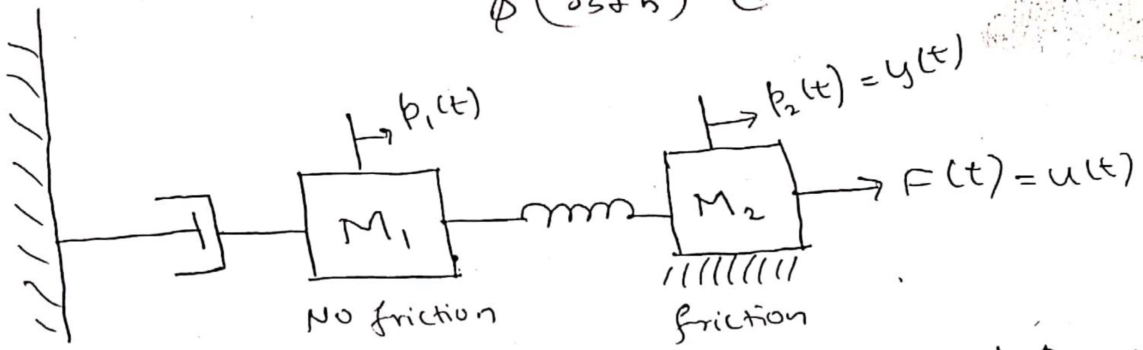
OR

Q. No	CO	Blooms Level	Question	Marks
4	5	L3	For the electric circuit shown in Figure 4, write the appropriate diiferential equations. Obtain a state-space model by defining voltages across capacitors and current through the inductor as state-variables.	6

le

$$\frac{K_1}{s^3 Js + s^2 \quad s + K_1 k_2}$$

$$s(Js+b)\,(Ls+R)\;+K_m$$



$$\begin{matrix} 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ -k/M & +k/M & -b/M & 0 \\ k/M & -k/M & 0 & -b/M \end{matrix} \qquad \begin{matrix} 0 \\ 0 \\ 0 \\ 1/M_2 \end{matrix}$$

Figure 3

$[0\ 1\ 0\ 0] + Du$

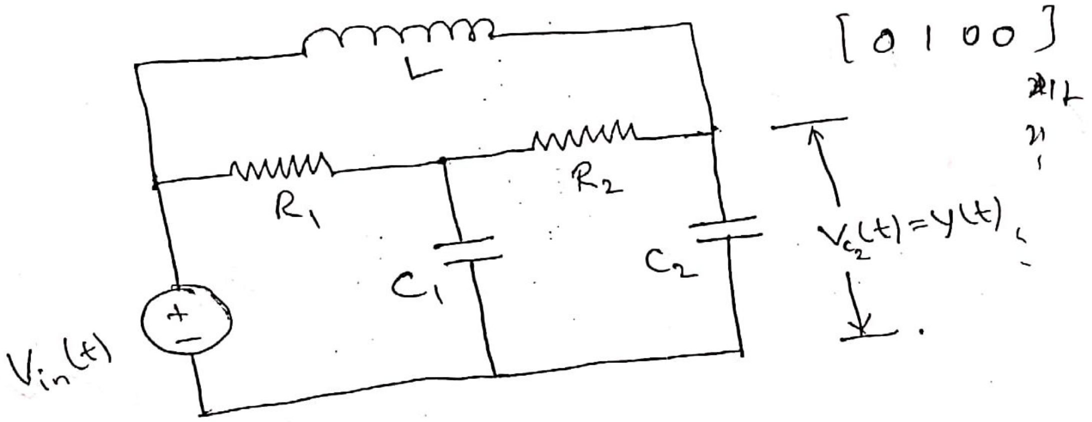


Figure 4

$$\begin{bmatrix} 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ k/M_1 & & & 0 \\ -k/M_2 & & 0 & \end{bmatrix} \quad \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 1/M \end{bmatrix}$$

$$[1\ 0\ 0\ 0\ 0] \qquad [0]$$

$$\begin{bmatrix} -R/L & 0 & -k/L \\ 0 & 0 & 1 \\ k/J & 0 & -b/J \end{bmatrix} \quad \begin{bmatrix} 1/L \\ 0 \\ 0 \end{bmatrix} \quad (0\ 1\ 0) \quad (0)$$

Code No: EC530

JSS Mahavidyapeetha
JSS Science and Technology University
JSS Technical Institution's Campus,
Mysuru – 570 006

V Semester B.E. Degree
Semester End Examination, December 2018

Branch : Electronics & Communication Engineering   Section: A & B

Name of the Paper Setter: Dr S Patilkulkarni

CONTROL SYSTEMS

Duration: 3 Hours   Time: 02.00 to 05.00PM   Max. Marks: 100
Date: 08.12.2018   Day: Saturday

Definitions	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
Bloom's Definition	Exhibit memory of previously learned material by recalling facts, terms, basic concepts, and answers.	Demonstrate understanding of facts and ideas by organizing, comparing, translating, Interpreting, giving descriptions and stating main Ideas.	Solve problems to new situations by applying acquired knowledge, facts, techniques and rules in a different Way	Examine and break information into parts by identifying motives or causes. Make Inferences and find evidence to support generalizations.	Present and defend opinions by making judgments about information, validity of ideas, or quality of work based on a set of criteria	Compile information together in a different way by combining elements in new pattern or proposing alternative solutions

Course Outcome: At the end of the course, the student should be able to	
1.	Demonstrate knowledge of modeling various physical systems as transfer function.
2.	Analyze stability of control systems by applying suitable tests.
3.	Analyze the control systems in time domain and frequency domain using appropriate tools.
4.	Design and test the controllers for transfer function models.
5.	Design and test the controllers for state – space models.

Instructions to the Candidate:
1. Part – A is compulsory.
2. Answer Part- B as per the internal choice
3. Sketch neat diagram wherever necessary.

Q. No	CO	Cognitive Domain	Question	Marks
1	CO1	L3	For the interconnected system shown in Figure 1, sketch the signal flow graph and then by applying the Mason's gain formula, determine the overall transfer function $\frac{Y(s)}{U(s)}$	10
2	CO2	L2	For a dynamical system, define BIBO stability. For LTI systems, state and prove theorems that give time – domain condition and S – domain condition for them to be BIBO stable.	10
3(a)	CO3	L3	In separate S – plane diagrams, indicate the region of pole – location for following condition: i) Rise time tr < 2 sec ii) Peak time tp < 1 sec iii) Overshoot Mp < 60% iv) Settling time ts < 10sec	04
(b)			Given the transfer function of the closed – loop system $\frac{Y(s)}{R(s)} = \frac{w_n^2}{s^2 + 2\Sigma_1 w_n S + w_n^2}$ Derive expressions for L(s) and E(s). Identify the type and compute the steady state errors for standard reference inputs.	06
4	CO4	L3	In a unity feedback system, given the standard first order plant and PI controller, derive expressions for damping factor Σ_1 and natural frequency w_n in terms of K_P and K_I. If $G(s) = \frac{8}{s+8}$ required $\Sigma_1 = 0.8$ and $w_n = 10$ rad / sec, solve for K_p and K_I. Compute the velocity error constant.	
5	CO5	L3	Given the circuit shown in Figure 5, with $V_{in}(t) = u(t)$, $V_2(t) = Y(t)$, define the state variables and obtain a state – space model.	10

PART- B

6	CO1	L3	Given the circuit shown in Figure 6, with Vin (t) = u(t), V2 (t) = Y (t), write the differential equations in time domain and then derive the transfer function. If $R_1 = R_2 = 10\Omega$ $C_1 = 0.1F$ and $C_2 = 0.4F$, find the impulse response.	10
			OR	

7	CO1	L3	Given the mechanical systems shown in Figure 7, with T (t) = u(t), θ_2 (t) = Y(t) write the torque equations in time domain and then derive the transfer function. If J1 = J2 = 10 Kgm^2, and friction coefficient b = 100 kg m^2/sec. find the impulse response.	10

8	CO2	L3	In a unity feedback system $L(s) = \frac{K}{(s+1)(s+4)^2}$ Determine the range of K for which closed – loop system is stable. When closed loop system is marginally stable, determine the pole locations.	10
			OR	
9	CO2	L3	$L(s) = \frac{60}{s(s^4 - 9s^3 + 27s^2 + 51s + 92)}$ Determine how many poles of the closed loop system are in strict left half of S – plane. Find the values of those poles which are not in strict left half.	10

10	CO3	L3	For the system given in Figure 10, obtain expressions for G_d (s), L(s), E(s) and compute the steady state errors for standard reference inputs.	10
			OR	
11	CO3	L3	Given unity feedback system with $L(s) = \frac{K(s+2)}{(s^2 - 2s + 2)}$ Sketch the root locus, showing all the rules. Find K and pole location when poles are on imaginary axis, and also when there are multiple poles.	10
12	CO4	L3	Given the plant model $G(s) = \frac{1}{s(s+4)}$ design a phase – lead controller, SO that dominant poles of the closed loop system satisfy Σ_1 = 0.6 and w_n = 5 rad / sec. Compute the velocity error constant for the system.	10
			OR	
13(a)	CO4	L3	Define gain margin and phase margin. Given $G(s) = \frac{1}{s(s+4)}$	06

			compute gain cross over frequency, gain margin and phase margin.	
(b)			For phase – lead compensator derive expressions for ϕ_{max} and W_{max}.	04

14	CO5	L3	Given the state pace model of a system, $A = \begin{bmatrix} -5 & 0 & 0 \\ 0 & -4 & 0 \\ 0 & 0 & -8 \end{bmatrix}$ $B = \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix}$ $C = \begin{bmatrix} 1 & 1 & 1 \end{bmatrix}$ a) Sketch the equivalent circuit for the above model b) Test for controllability c) Find the transfer function d) Sketch the controller canonical model	3+2+2+3
			OR	
15(a)	CO5	L3	Sketch the block diagram for state variable feedback system and write the state equations for closed – loop system.	04
(b)			Given the plant model $A = \begin{bmatrix} 8 & -4 \\ -1 & -2 \end{bmatrix}$ $B = \begin{bmatrix} 2 \\ 1 \end{bmatrix}$ $C = \begin{bmatrix} 1 & 0 \end{bmatrix}$ Determine SVFB controller gain K, to place the poles of closed loop system at -3 ± j4	06
				P.T.O.

ଓ ଃ ଓ ଓ ଓ ଃ ଓ ଓ

EC 530 CONTROL SYSTEMS

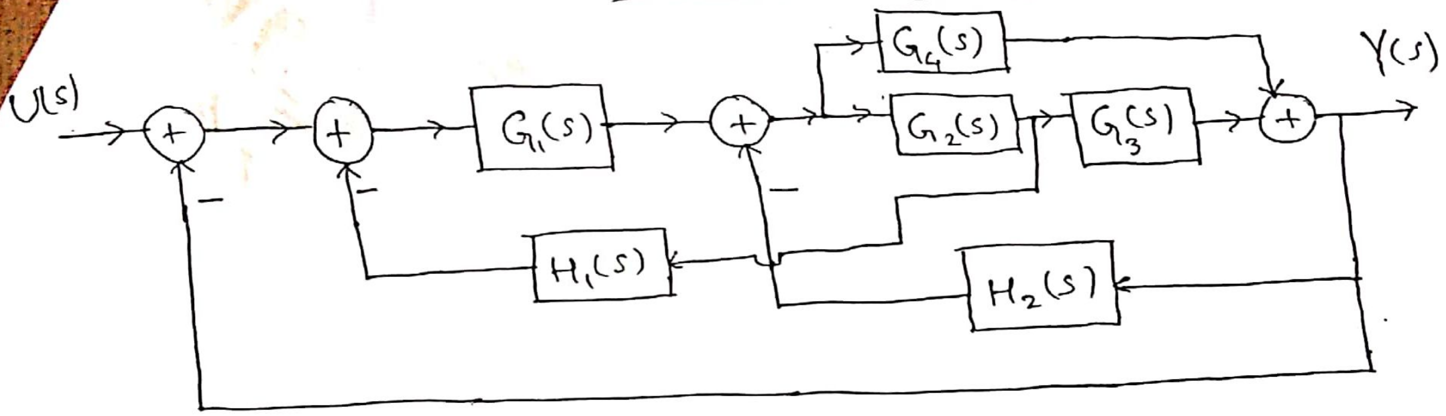


Figure 1.

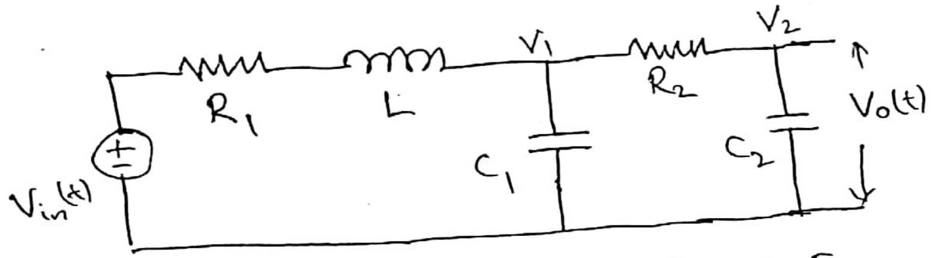


Figure 5

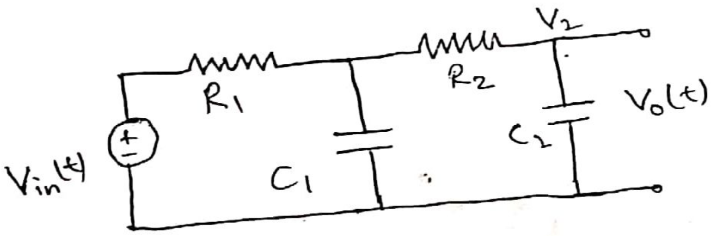


Figure 6

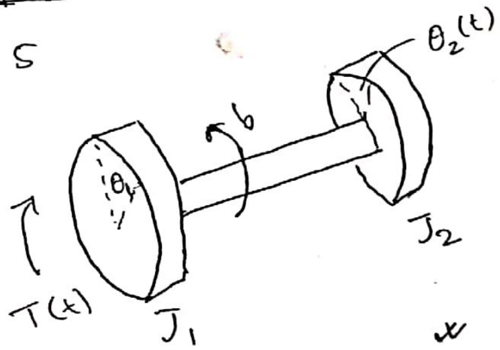


Figure 7

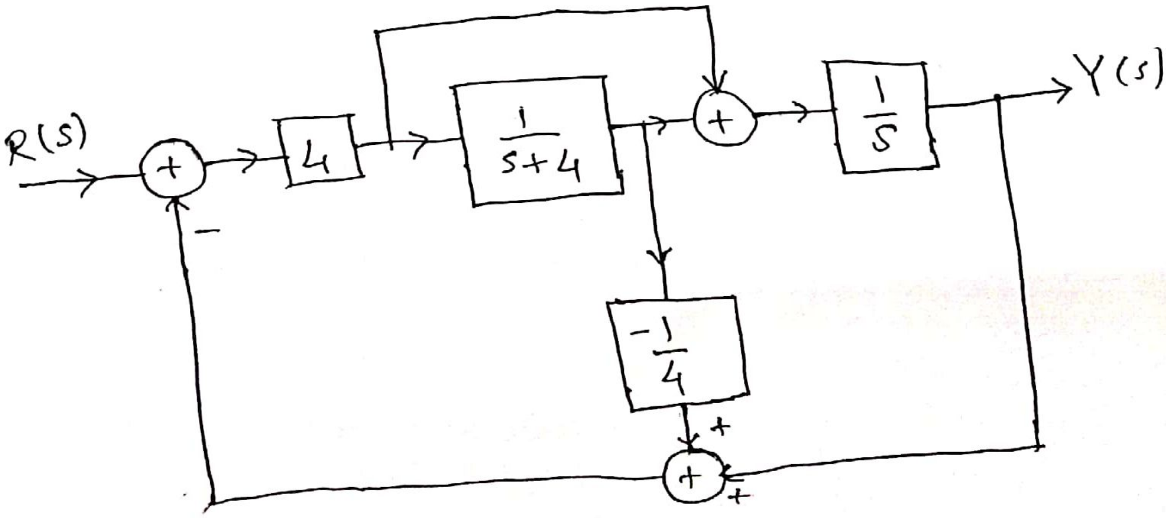


Figure 10.