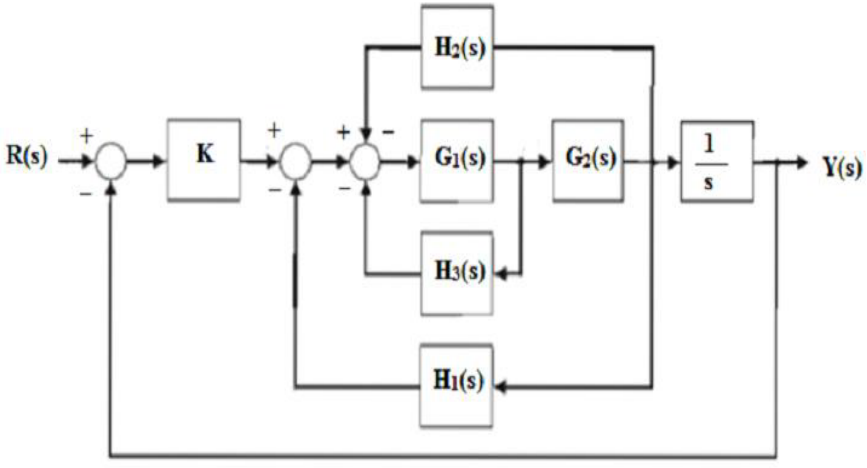
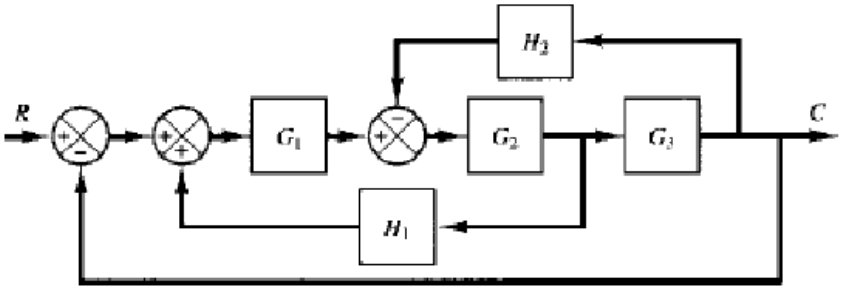
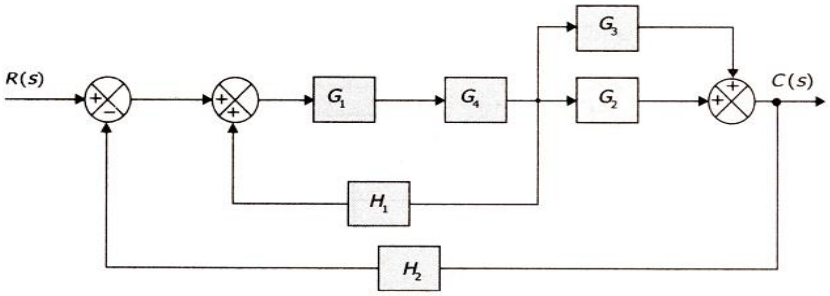
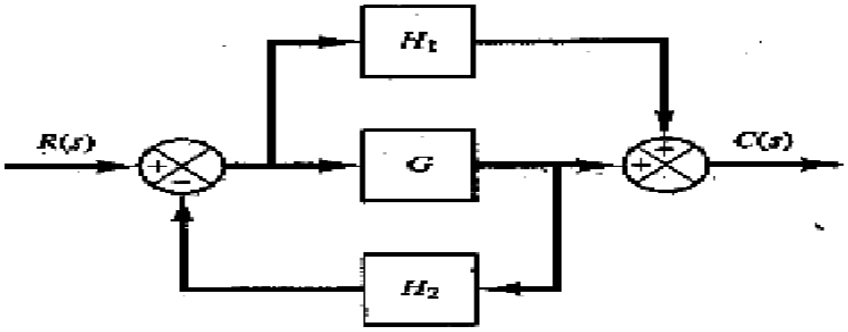
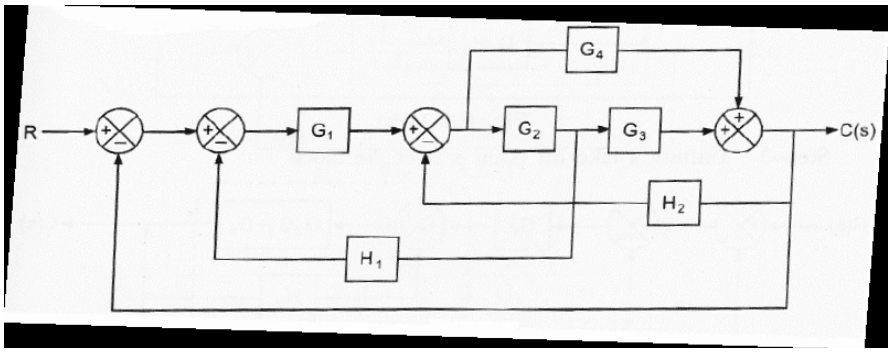
ALPHA COLLEGE OF ENGINEERING & TECHNOLOGY

DEPARTMENT OF MECHANICAL ENGINEERING
CONTROL ENGINEERING (2151908)

ASSIGNMENT: 1
INTRODUCTION TO CONTROL SYSTEM
B.E.–5th SEM CLASS: ME (A)

NO	QUESTION	YEAR	MARKS
1	What are open loops control systems and closed loop control systems? Compare open loop control system with closed loop control system. Write down major advantages and disadvantages of open loop control systems.	Nov-2011, Nov-2016	7
2	With the help of suitable examples discuss open loop and closed loop control system.	May-2015	7
3	What is modern control theory? Compare modern control theory with conventional control theory.	Dec-2014, Nov-2017	7
4	What does a block diagram represent? Explain it in detail. List its salient characteristics.	Dec-2014	7
5	Define transfer function of a linear, time invariant, differential equation systems. Write down general mathematical model for the above system and general mathematical expression for its transfer function.	Nov-2011	7
6	Write down the major three steps to derive the transfer function of a given physical system. Derive expression for closed loop transfer function.	Nov-2011	7
7	A control engineer, N. Minorsky, designed an innovative ship steering system in the 1930s for the U.S. Navy. The system is represented by the block diagram shown below, where Y(s) is the ship's course; R(s) is the desired course. Find the transfer function Y(s)/R(s). 	May-2012	7
8	Solve the block diagram shown in Figure Obtain its transfer function.	Jan-2013	7

			
9	Reduce block diagram as shown in Figure 3 and obtain overall transfer function.  **Figure:3**	Dec-2013, May-2018, Nov-2017, Apr-2017	7
10	Obtain transfer functions C(s)/R(s) of the system as shown in figure. State the initial step before obtaining the transfer function. 	May-2014	7
11	What does a block diagram represent? Explain it in detail. List its salient characteristics. Explain the following: Summing point, Take-Off Point.	May-2013, Nov-2017	4
12	Draw a general block diagram of an automatic control system.	May-2012	2
13	Define the following term. 1. Open loop control. 2. Close loop control.	Jan-2013, May-2013	2, 4
14	Write requirements of a good control system. Critically compare Open loop and Closed loop systems. Is an automatic electric iron an open loop or closed loop control system?	Dec-2013, Dec-2014, Nov-2017	7
15	Explain the open-loop operation of traffic signals at a road crossing. How can improved traffic control be achieved by means of a closed-loop scheme? What are the advantages and disadvantages of open loop and closed loop systems?	May-2014	7
16	Define Controlled variable and Manipulated variable. State requirements of a good control system.	Nov-2017	3
17	Discuss about the requirements of good control system.	Apr-2017	3
18	Obtain the overall transfer function of the system whose block diagram is as given in **figure 2** using block diagram reduction technique.	Nov-2016	7

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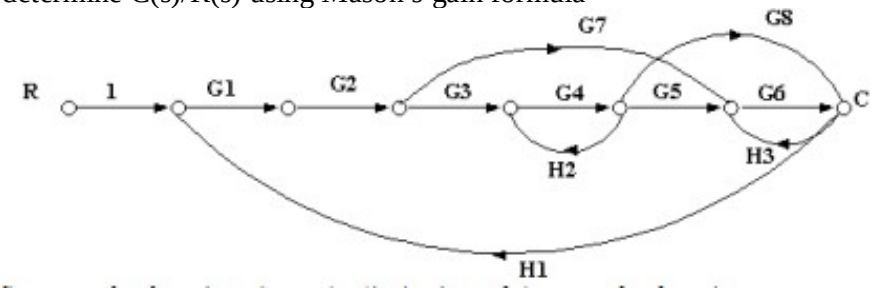
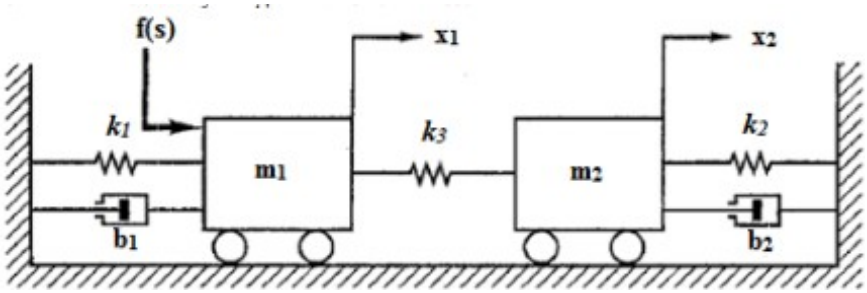
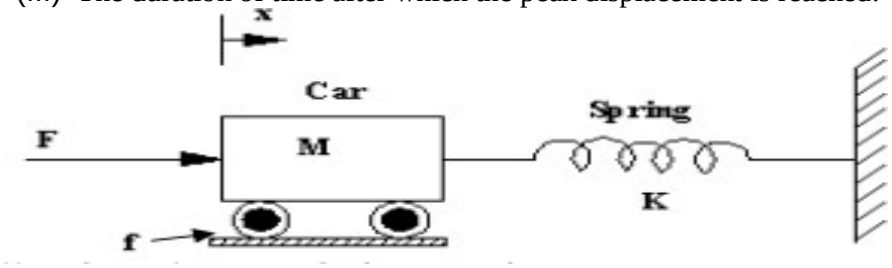
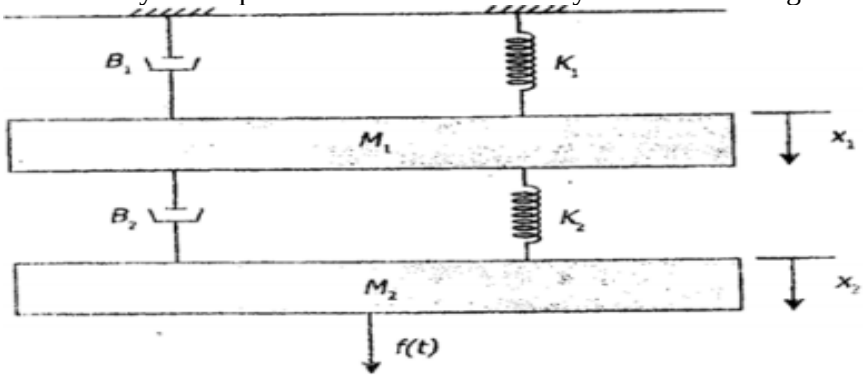
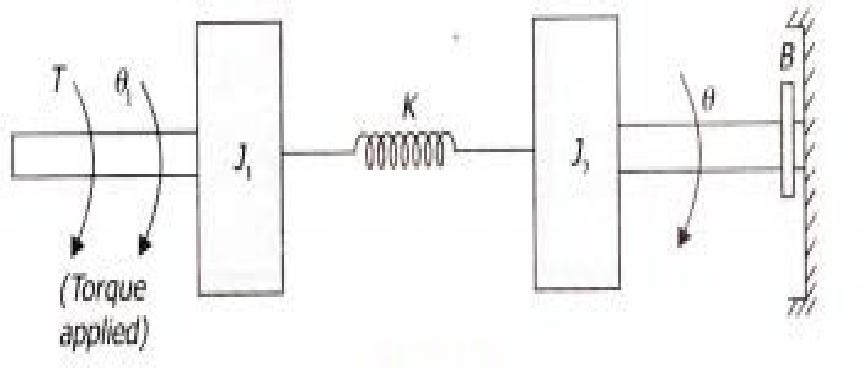
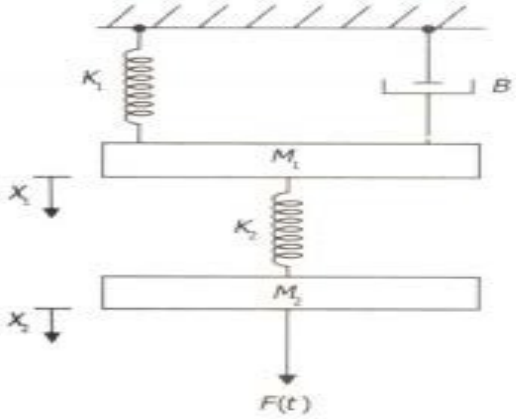
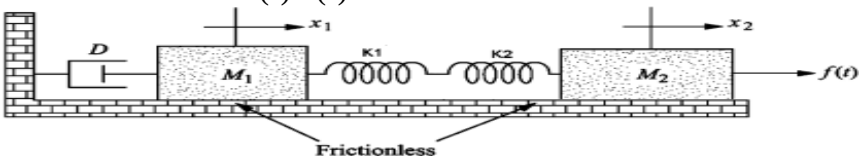
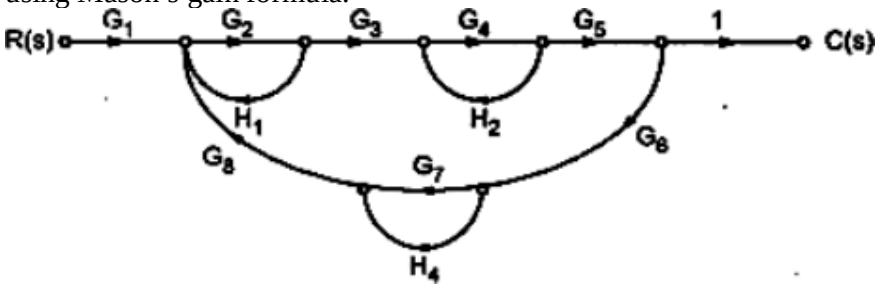
ALPHA COLLEGE OF ENGINEERING & TECHNOLOGY

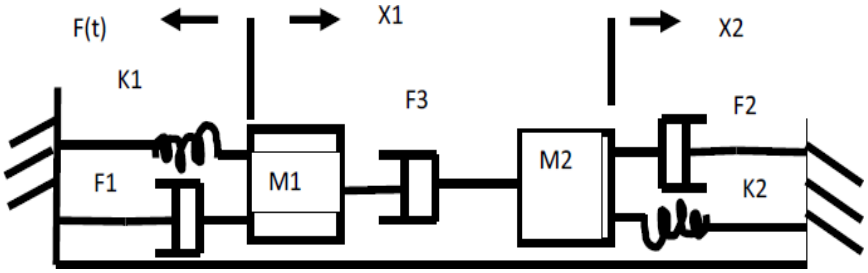
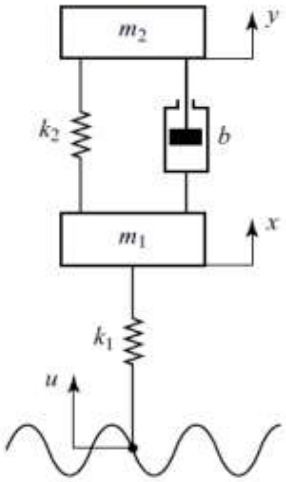
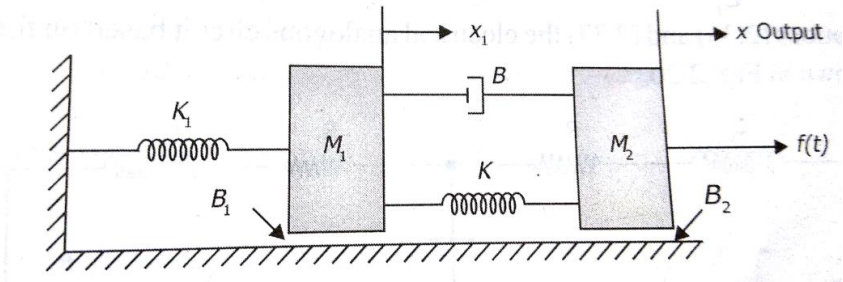
DEPARTMENT OF MECHANICAL ENGINEERING
CONTROL ENGINEERING (2151908)

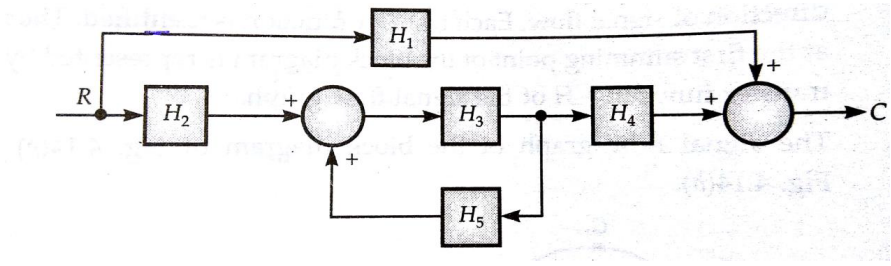
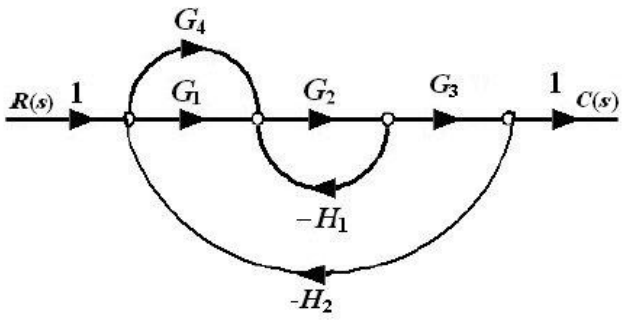
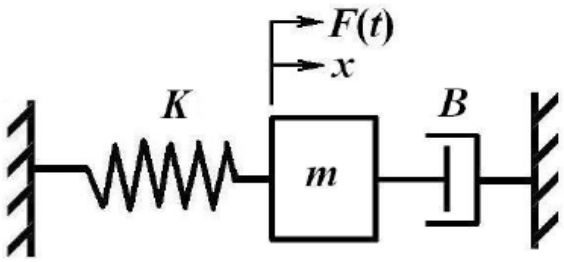
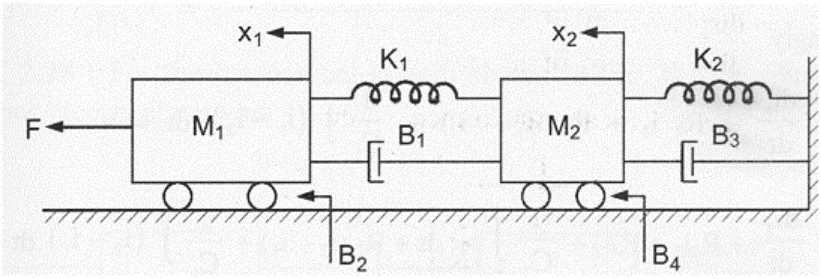
ASSIGNMENT: 2
TRANSFER FUNCTION & IMPULSE FUNCTIONS
B.E.–5th SEM CLASS: ME (A)

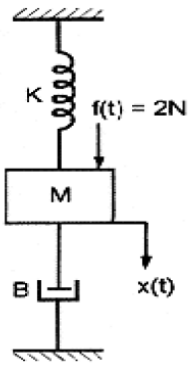
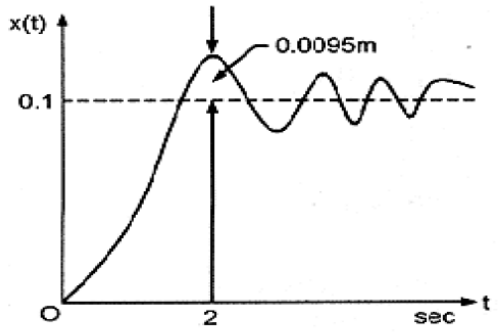
NO	QUESTION	YEAR	MARKS
1	Define transfer function of a linear, time invariant, differential equation systems. Write down general mathematical model for the above system and general mathematical expression for its transfer function.	Nov-2011, Jan-2013, May-2013, May-2015	2, 7
2	The transfer function is a property of a system itself, independent of the magnitude and nature of the input or driving function. Explain this statement with suitable example.	Nov-2011	7
3	If the transfer function of a system is known, the output or response can be studied for various forms of inputs with a view toward understanding the nature of the system. Explain this statement with suitable example.	Nov-2011	7
4	Describe force-voltage analogy and force- current analogy as applied to electrical analogies for mechanical systems.	Nov-2011, May-2015, Apr-2017, Nov-2016	7
5	What are SFG? Define node, transmittance, branch, source, sink, path, loop, and loop gain. Write down important properties of signal flow graphs. Write down the rules for signal flow graphs reduction? Write down Mason's gain formula for signal flow graphs. Explain Mason's gain formula with the help of one example.	Nov-2011, May-2015, May-2018	7
6	For the signal flow graph of a multiple loop system shown in figure, determine C(s)/R(s) using Mason's gain formula 	May-2012, May-2018	7
7	Define transfer function. State the limitation of the transfer function. Obtain the transfer functions x1(s)/f(s) and x2(s)/f(s) of the mechanical system shown below. Draw a free body diagram of each mass	May-2012	7

			
8	Figure shows a system in which a car of mass 1 kg. is attached to the wall through the spring. If the spring constant K=140 N/m, the coefficient of friction f=10N-sec per m and the step force applied is 10 N. Calculate, (i) The final displacement of the car. (ii) The peak displacement of the car and (iii) The duration of time after which the peak displacement is reached. 	May-2012	7
9	Obtain a system equation for the mechanical system shown in figure. 	Jan-2013	7
10	What is a signal flow graph? What are properties of signal flow graph? State and explain Mason's gain formula for signal flow graph.	Jan-2013, May-2013, Dec-2013, Dec-2014	7
11	What does a block diagram represent? Explain it in detail. List it salient characteristics. Explain the following: Summing point, takeoff point.	May-2013, May-2014, Dec-2014, May-2018	7
12	Write short note on: Analogue models of mechanical and electrical system.	May-2013, Dec-2014, May-2018	7
13	What is Transfer function? Obtain the transfer function of mechanical network shown in Fig. 1	Dec-2013, Nov-2017	7

	 Figure:1		
14	Write the differential equations governing the system shown in Figure and draw the Force-voltage analogous electrical network. 	Dec-2013	7
15	Write the differential equations governing the mechanical system. Derive transfer function of x1(s)/F(s) 	Dec-2013	7
16	Determine the transfer function C(s)/R(s) for the system shown in figure using Mason's gain formula. 	Dec-2013	7
17	Determine the transfer function X1/X2 for the physical system shown in figure below.	May-2015	7

			
18	Define transfer function. List important characteristics of transfer function.	May-2018	3
19	Obtain the transfer function Y(s)/U(s) of the system shown in figure 1. The displacement input is u(t).  Figure.1	May-2018	7
20	Find transfer function equation for simple mass-spring-dashpot system with usual notation.	May-2018	3
21	Compare block diagram representation versus Signal flow graph representation.	May-2018	4
22	What is Transfer function? Write down Advantages and disadvantages of Transfer function.	Nov-2017	3
23	Using Force-Voltage analogy, draw electrical analogous circuit of the mechanical system shown in Figure **I** and write the differential equations governing the system shown in figure. 	Nov-2017	4
24	What do you mean by Signal Flow graph? The block diagram representation of a control system is shown in Figure **II**. Draw the signal flow graph and determine overall transfer function using Mason's gain formula.	Nov-2017	7

			
25	Define the following terms: (1) Resonant peak (2) Gain Margin	Nov-2017	3
26	Obtain overall transmittance of the system whose signal flow graph is shown in Figure 2 by using Masson's gain formula. 	Apr-2017	7
27	Derive the differential equation for the mechanical system shown in Figure. 	Apr-2017	3
28	Obtain Differential Equation for the mechanical system shown in **figure3**. Also obtain analogus circuit using Force-Voltage analogy. 	Nov-2016	7
29	Ina mechanical vibratory system when 2N of force (step input) is applied to the system, the mass oscillates as shown in **figure 4.** Determine the values of M, B and K of the system from this response curve. The displacement is measured from equilibrium position.	Nov-2016	7

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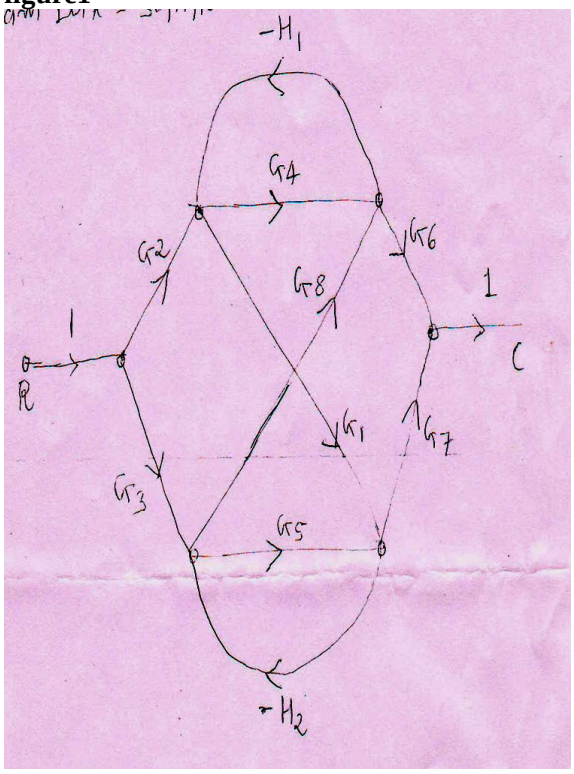
DEPARTMENT OF MECHANICAL ENGINEERING
CONTROL ENGINEERING (2151908)

ASSIGNMENT: 3
TIME & FREQUENCY RESPONSE ANALYSIS
B.E.–5th SEM CLASS: ME (A)

NO	QUESTION	YEAR	MARKS
1	If the transfer function of a system is known, the output or response can be studied for various forms of inputs with a view toward understanding the nature of the system. Explain this statement with suitable example.	Nov-2011	7
2	Define delay time, rise time, peak time, maximum overshoot, and settling time as transient response specifications of a second order system. Derive mathematical expressions for rise time, peak time, maximum overshoot, and settling time for the above system.	Nov-2011, May-2012, Jan-2013, May-2014, May-2018, Apr-2017	2, 7
3	Obtain Transient response of first order systems to unit step input and obtain the value of steady state error.	Jan-2013, Apr-2017	5
4	Determine the steady state error constant.	Jan-2013	5
5	Explain the transient response of second order system.	May-2013	7
6	Explain unit step response of first order linear time invariant systems.	May-2014	7
7	Obtain the mathematical equation and sketch the time response of a second order control system for a unit step input (for $0<\xi<1$).	Dec-2014	7
8	What do you understand by Transient and steady state response and hence discuss the various types of input test signals used for time response analysis of a control system.	May-2015, Apr-2017	7
9	What is a time varying system? Give suitable examples. How is it different from the time invariant system?	May-2018	4
10	What is meant by Step input, Impulse input and Ramp input?	Nov-2017	3
11	Discuss the effect of time constant on first order system response for unit step input.	Apr-2017	3
12	Explain the effect on steady state error when a step input applied to Type 0 systems.	Apr-2017	4
13	Explain the ramp input mathematically and graphically.	Apr-2017	3
14	The overall transfer function of a control system is given by $\frac{C(s)}{R(s)} = \frac{1}{s^2 + s + 1}$ Determine the rise time, peak time and maximum overshoot.	Apr-2017	4
15	Discuss about an On-Off control action type automatic industrial controller with differential gap.	Apr-2017	7

16	What do you mean by Frequency Response analysis? What are the methods used in frequency response analysis? Also state the advantages of the frequency response analysis.	Apr-2017	7
17	Obtain the Transfer function C/R from the signal flow graph as shown in **figure1** 	Nov-2016	7
18	Discuss the effect of time constant on 1st order system response for unit step input.	Nov-2016	3
19	Discuss the effect of damping on the position of closed loop poles of the 2nd order system with diagram.	Nov-2016	4
20	Discuss about gain margin and phase margin for frequency response of control system.	Nov-2016	4

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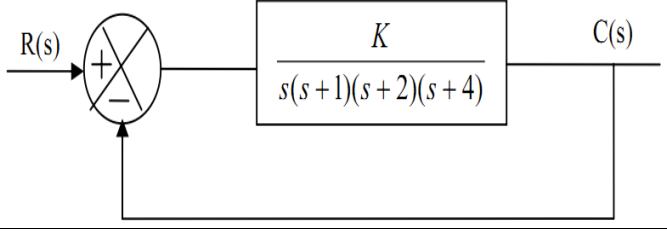
ASSIGNMENT: 4
STABILITY
B.E.–5th SEM CLASS: ME (A)

NO	QUESTION	YEAR	MARKS
1	Consider the following characteristic equation: $S^4 + KS^3 + S^2 + S + 1 = 0$ Determine the range of K for stability using Routh's stability criterion.	May-2012	7
2	Find the stability of control system having following characteristic equation. $a(s) = S^6 + 4S^5 + 3S^4 + 2S^3 + S^2 + 4S + 4$	Jan-2013	7
3	What do you mean by stability of a control system? Explain Routh's stability criterion.	May-2013, Dec-2014, May-2018	7, 3
4	The forward path transfer function of unity feedback control system is given by, $G(s) = \frac{k(s+10)(s+20)}{s^2(s+2)}$ Apply Routh's criterion to determine the stability of a closed loop control system as a function of k. Determine the value of k that will cause sustained constant amplitude oscillations in the system. Determine the frequency of oscillations.	Dec-2013	7
5	Using the Routh-Hurwitz criterion for simple design problems, consider that the characteristic equation of a closed-loop control system is $s^3 + 3ks^2 + (k+2)s + 4 = 0$ Determine the desired range of K so that the system is stable.	May-2014	7
6	Determine the stability of a closed loop control system with characteristic equation $s^5 + s^4 + 2s^3 + 2s^2 + 11s + 10 = 0$	May-2015	7
7	Sketch the root locus and its asymptotes for a unity feedback system s 	May-2012	7
8	Sketch the root loci for the following system. $G(s) = \frac{K}{s(s+1)(s+2)}, \quad H(s) = 1$	Jan-2013	7

9	State 'Angle condition' and 'Magnitude condition' of root locus method.	Jan-2013, May-2018	2,3
10	What is root locus method?	Jan-2013	2
11	The open loop transfer function of a control system is given as: $$G(s)H(s) = \frac{K}{(s+1)(s+10)(s+30)}$$ Draw the root locus. Determine the value of K for which the system is critically damped and also the value of K for which the system becomes unstable.	Dec-2013, May-2018	7
12	For a unity feedback system the open loop transfer function is given as follows. Sketch root locus for 0< K< ∞. At what value of K the system becomes unstable You may consider breakaway point as 0.8981. $$G(s) = \frac{K}{s(s+2)(s^2+6s+25)}$$	May-2015	7
13	Using R-H criterion determine the stability of the system whose characteristic equation is given by : $$s^5 + 1.5s^4 + 2s^3 + 4s^2 + 5s + 10 = 0$$	May-2018	4
14	Draw root locus diagram for the system with transfer function, $$G(s).\ H(s) = \frac{k}{s(s+3)(s+6)}$$ Obtain value of k when ζ =0.6 from root locus. Determine the value of k for stability and critical damping.	May-2018	7
15	Determine the stability of the system represented by the characteristic equation by means of the R-H Criterion. Also find root lying in right half of s-plane. $$s^6 + 3s^5 + 5s^4 + 9s^3 + 8s^2 + 6s + 4 = 0$$	May-2018	4
16	For Unity feedback control system has $$G(S) = \frac{K}{s(s+1)(s+2)}$$ Sketch the root locus. Also determine the value of K so that the damping ratio, ξ, of a pair of complex conjugate closed loop poles is 0.5.	Nov-2017	7
17	Find the frequency domain specifications with a unity feedback having, $$G(S) = \frac{36}{S(S+8)}$$	Nov-2017	7
18	Using Routh criterion, discuss about the stability for the system having characteristics equation is given as $$3s^7 + 9s^6 + 6s^5 + 4s^4 + 7s^3 + 8s^2 + 2s + 6 = 0$$	Apr-2017	7
19	Check stability of the system whose characteristics equation is given as	Apr-2017	7

	$s^3 + 8s^2 + 14s + 24 = 0$ by using Hurwitz criterion.		
20	A close loop system is characterized by the following transfer function, $s^4+5s^3+5s^2+4s+K=0$. Determine the range of K for which the system is stable.	Nov-2016	4
21	Draw root locus diagram for the system with transfer function, $G(s)\,H(s) = \frac{K}{s(s+5)(s+10)}$.	Nov-2016	7

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ASSIGNMENT: 5
HYDRAULIC CONTROL SYSTEM
B.E.–5th SEM CLASS: ME (A)

NO	QUESTION	YEAR	MARKS
1	Describe a proportional plus integral plus derivative control action type automatic industrial controller. Write down equation of the system; write down expression for the transfer function.	Nov-2011	7
2	Write down advantages and disadvantages of hydraulic systems. How proportional plus integral plus derivative control action is obtained in a hydraulic system?	Nov-2011, Dec-2014	7
3	State the various components of any hydraulic circuits. Name the various types of pumps commonly used for hydraulic power purposes.	May-2012, Nov-2016	5
4	Name various components used in any hydraulic circuits. Explain Vane pump with a neat sketch briefly.	Dec-2013	6
5	Represent a generalized hydraulic control system by a block diagram and explain the functions of each element.	May-2013	7
6	Compare hydraulic control system with pneumatic control system in detail. State the different applications of pneumatic control system.	May-2012, Jan-2013, May-2013, Dec-2013, May-2014, May-2015, May-2018, Nov-2016	3,7
7	Explain in detail about Proportional control action.	Jan-2013	5
8	Describe working of hydraulic proportional plus derivative controller and derive expression for its performance.	Jan-2013, Dec-2013, Dec-2014	7
9	Define hydraulic system.	Jan-2013	2
10	State the different types of hydraulic pumps and explain the factors affecting selection it. Explain the construction and working of vane pump with neat sketch.	May-2013	7
11	Write short note on Dashpots.	Jan-2013	2
12	Draw a schematic diagram & block diagram for a hydraulic proportional plus derivative control system. Derive expression for transfer function for above mentioned hydraulic PD control systems. Explain how this can be converted to PID controller.	May-2014, Dec-2014, May-2018	7
13	List the basic types of control actions and explain the PID control action in detail.	May-2013, Dec-2014, Nov-2016	7

14	With the help of neat diagrams, explain how the direction control valves are classified.	Apr-2017	4
15	Explain Hydraulic Integral Control and derive its transfer function.	Nov-2016	4

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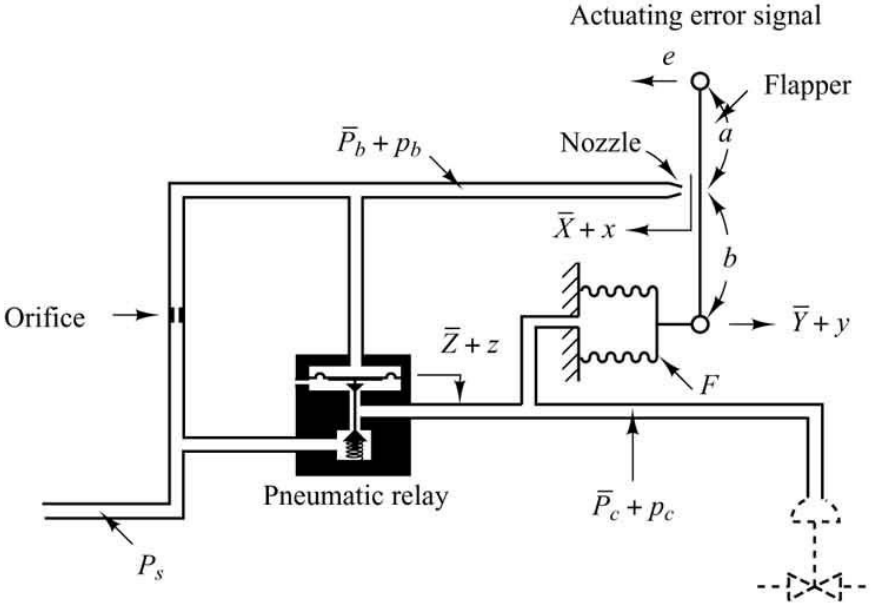
ASSIGNMENT: 6
PNEUMATIC CONTROL SYSTEM
B.E.–5th SEM CLASS: ME (A)

NO	QUESTION	YEAR	MARKS
1	With the help of a neat sketch explain the working of a pneumatic nozzle flapper amplifier and hence determine its transfer function.	Dec-2013, May-2015, May-2018, Nov-2016	4,7
2	Derive the transfer function of pneumatic controller shown in figure. • Name the type of controller. • State the assumptions made in the analysis of this controller. • Highlight the role of nozzle-flapper amplifier and pneumatic relay. 	May-2012	7
3	State the various types of Industrial controllers and describe any two of them.	May-2012	7
4	Describe the working of a force distance type pneumatic proportional controller and its transfer function.	May-2014	7
5	Write down the comparison between a pneumatic control system and hydraulic control system. Sketch a schematic diagram of a pneumatic nozzle flapper amplifier system and explain its working. Sketch characteristic curve relating nozzle back pressure and nozzle flapper distance for the above system.	Nov-2011	7
6	What is FRL unit in pneumatic system? Write about pneumatic power sources. State various components used in pneumatic circuit.	May-2014, May-2015	7
7	Explain the following :	Dec-2013	8

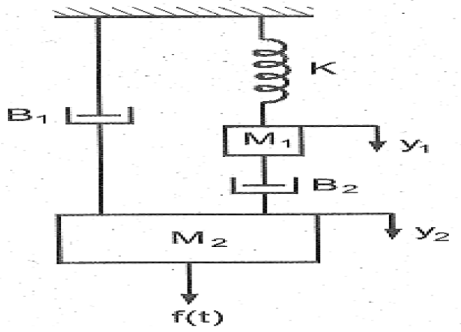
	(1) What is Relay? Explain the working principle of a pneumatic relay. (2) Explain theory of four way and pilot valves.		
8	Draw the schematic diagram of Pneumatic PI controller. Explain its working and derive its transfer function.	May-2018, Nov-2016	7
9	Explain Pneumatic PID controller with a schematic diagram .	Nov-2017	4
10	List out the basic elements of a Pneumatic system.	Apr-2017	3
11	Describe with neat sketch of a pneumatic proportional controller.	Apr-2017	4
12	With the help of a sketch explain a pneumatic proportional plus integral controller and derive its transfer function.	May-2015	7

Prepared by: Prof. Dhiren Patel

ALPHA COLLEGE OF ENGINEERING & TECHNOLOGY

DEPARTMENT OF MECHANICAL ENGINEERING
CONTROL ENGINEERING (2151908)

ASSIGNMENT: 7
STATE SPACE ANALYSIS
B.E.–5th SEM CLASS: ME (A)

NO	QUESTION	YEAR	MARKS
1	State the advantages of state-space representation over conventional control system analysis method.	Apr-2017, May-2018, Nov-2016	3
2	Explain the following terms: (i) State (ii) State variables (iii) State-space (iv) state transition matrix	May-2018, Nov-2016	4
3	Define State vector in the context of state-space approach. Obtain state model for the transfer function: $\frac{C(S)}{R(S)} = \frac{(S+2)}{(S+1)(S+3)}$	Nov-2017	7
4	Draw the Root Locus diagram of a system with transfer function is $G(s)H(s) = \frac{K}{s(s^2+15s+50)}$	Apr-2017	7
5	For series R-L-C circuit, obtain the state-space model.	Apr-2017, Nov-2016	7
6	Obtain the state space representation of system as shown in **figure.** 	Nov-2016	7

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