Code No: RT31043 **R13** SET - 1

III B. Tech I Semester Regular Examinations, November - 2015

CONTROL SYSTEMS

(Common to ECE and EIE)

Time: 3 hours Max. Marks: 70

Note: 1. Question Paper consists of two parts (**Part-A** and **Part-B)**
2. Answering the question in **Part-A** is compulsory
3. Answer any **THREE** Questions from **Part-B**
(Normal and semi & polar graph sheets are to be supplied)

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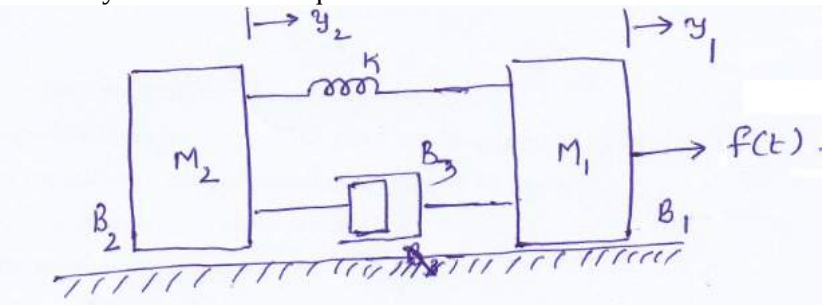
PART –A

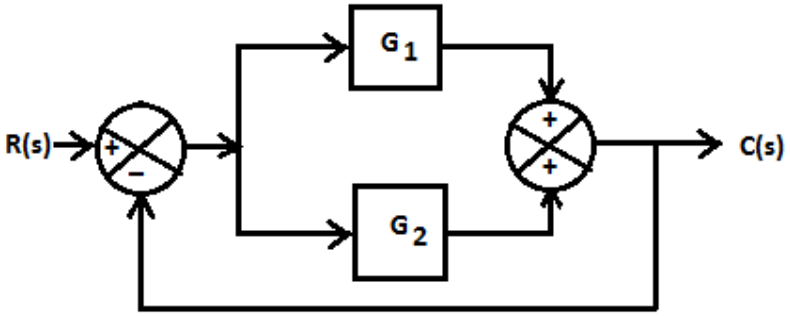
1	a)	What are the basic elements of a control system?	[3M]
	b)	Explain the advantages of signal flow graph over block diagram representation.	[4M]
	c)	Draw the unit step response of a first order system and explain.	[4M]
	d)	Explain the advantages of root locus technique.	[4M]
	e)	Define resonant peak and bandwidth.	[4M]
	f)	What is meant by Diagonalization?	[3M]

PART -B

2	a)	Write short notes on controlled variable and manipulated variable.	[4M]
	b)	Write the force equations of the linear translational system shown in figure. Draw the equivalent electrical network using force-voltage Analogy, with the help of necessary mathematical equations.	[8M]



	c)	What is meant by unity feedback control systems? Explain.	[4M]
3	a)	Draw the signal flow graph for the block diagram below and then obtain the transfer function C(s)/R(s) using Mason's gain formula.	[8M]



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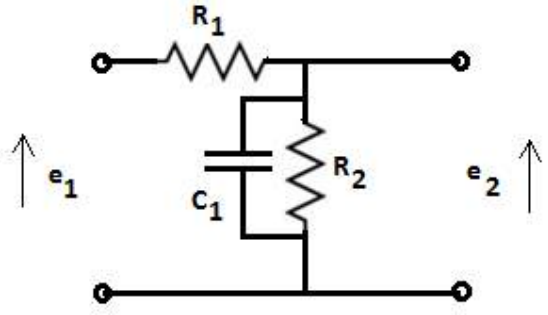
b) Obtain the transfer function $E_2(s)/E_1(s)$ for the electrical circuit below by representing the circuit into a block diagram and using block diagram algebra. [8M]



4 a) Explain the effect of PID control action on the performance of a second order system [6M]

b) Determine the step, ramp and parabolic error constants of the following unity feedback control system whose open loop transfer function is given by [10M]

$$G(s) = \frac{500}{(1+5s)\,(1+10s)}.$$

5 a) Using Routh-Hurwitz criterion, determine the stability of the closed loop system that has the following characteristic equation and also determine the number of roots that are in the right half s-plane and on the imaginary axis $s^4 + s^3 + 3s^2 + 2s + 5 = 0$. [7M]

b) Find the angles of departure and arrival for all complex poles and zeros of the open loop transfer function of $G(s)H(s) = \frac{K(s^2+3s+5)}{s(s^2+4)}, K > 0$. [9M]

6 a) Find resonant peak, resonant frequency and bandwidth of the unity feedback system whose open loop transfer function is as follows: $G(s) = \frac{0.5}{(s^2+3s+2)}$. [8M]

b) The characteristic equation of a linear control system is given below: [8M]

$$s^2 + 3s + 2 + K = 0 .$$

Using Nyquist Stability Criterion, determine the range of K for the system to be stable.

7 a) Draw the electrical circuit diagram that represents the Lead-Lag Compensator and explain in detail. [8M]

b) Determine the state and output equations in vector matrix form for the system whose transfer function is given by $G(s) = \frac{(s+3)}{s(s^2+3s+2)}$. [8M]

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3. Answer any **THREE** Questions from **Part-B**
(Normal and semi & polar graph sheets are to be supplied)

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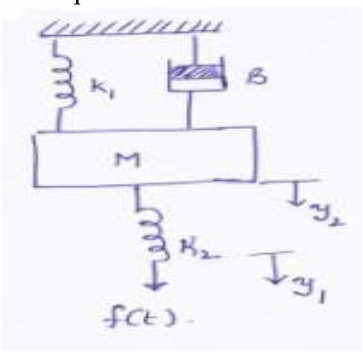
PART –A

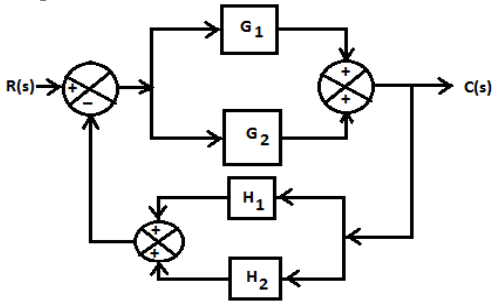
1	a)	What is meant by open loop control system?	[3M]
	b)	Describe the Mason's gain formula.	[4M]
	c)	Draw the unit impulse response of a first order system and explain.	[4M]
	d)	Define absolute stability and relative stability.	[4M]
	e)	Define resonant frequency and cut off rate.	[4M]
	f)	What is meant by Observability?	[3M]

PART -B

2	a)	Write short notes on feedback control.	[4M]
	b)	Write the force equations of the linear translational system shown in the figure below. Draw the equivalent electrical network using force- voltage analogy, with the help of necessary mathematical equations.	[8M]



	c)	Draw the block diagram of a control system and explain its operation.	[4M]
3	a)	Obtain the transfer function C(s)/R(s) for the block diagram below using block diagram reduction technique.	[8M]



b) Derive the transfer function of Synchro Pair. [8M]

4 a) Explain the effect of Proportional plus Derivative Control (PD) action on the performance of a second order system. [6M]

b) Determine the step, ramp and parabolic error constants of the following unity feedback control system whose open loop transfer function is given by [10M]

$$G(s) = \frac{1000}{(1+2s)(1+0.5s)}.$$

5 a) Using Routh-Hurwitz criterion, determine the stability of the closed loop system that has the following characteristic equation and also determine the number of roots that are in the right half s-plane and on the imaginary axis $3s^4 + 7s^3 + 2s^2 + s + 8 = 0$. [7M]

b) Find the angles of departure and arrival for all complex poles and zeros of the open loop transfer function of $G(s)H(s) = \frac{K(s^2+s+2)}{s(s^2+9)}, K > 0$. [9M]

6 a) Find resonant peak, resonant frequency and bandwidth of the unity feedback system whose open loop transfer function is $G(s) = \frac{1}{(s^2+6s+5)}$. [8M]

b) The forward path transfer function of a unity feedback system is given by $G(s) = \frac{K}{(s+1)(s+2)}$. Using Bode diagram, determine the value of K so that the phase margin of the system is 45°. [8M]

7 a) Draw the electrical circuit diagram that represents the Lag-Lead Compensator and explain in detail. [8M]

b) Determine the state and output equations in vector matrix form for the system whose transfer function is given by $G(s) = \frac{(s+2)}{s(s^2+4s+3)}$. [8M]

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Code No: RT31043 **R13** SET - 3

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2. Answering the question in **Part-A** is compulsory
3. Answer any **THREE** Questions from **Part-B**
(Normal and semi & polar graph sheets are to be supplied)

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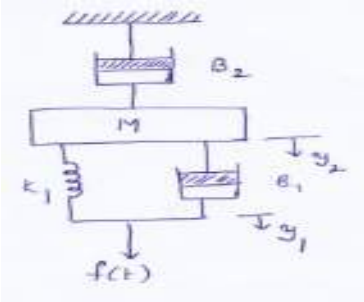
PART –A

1 a) What is meant by closed loop control system? [3M]
b) What are the advantages of block diagram representation of a system? [4M]
c) Define Delay time and rise time. [4M]
d) Compare the stability of open loop and closed loop systems. [4M]
e) Define gain and phase margins. [4M]
f) What is meant by controllability? [3M]

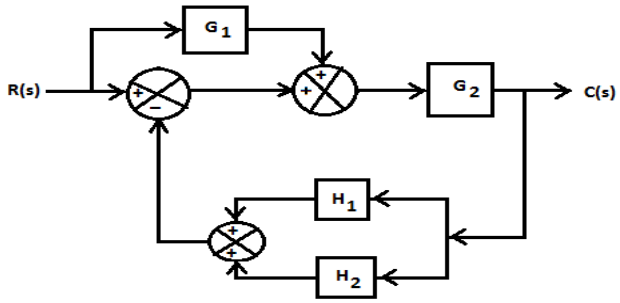
PART -B

2 a) Classify the control systems in detail. [4M]
b) Write the force equations of the linear translational system shown in the figure below. Draw the equivalent electrical network using force-voltage analogy, with the help of necessary mathematical equations. [8M]



c) Explain the effects of feedback on the system performance. [4M]

3 a) Using block diagram reduction techniques obtain the transfer function C(s)/R(s) for the block diagram below. [8M]



b) Derive the transfer function of AC servo motor. [8M]

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4 a) Explain the effect of Proportional plus Integral Control (PI) action on the performance of a second order system. [6M]

b) Calculate the steady state errors due to a unit step input, a unit ramp input and a unit parabolic input for a unity feedback control system whose open loop transfer function is $G(s) = \frac{1}{(s^2 + 3s + 1)}$. [10M]

5 a) Using Routh-Hurwitz criterion, determine the stability of the closed loop system that has the following characteristic equation and also determine the number of roots that are in the right half s-plane and on the imaginary axis $s^3 + 2s^2 + s + 8 = 0$. [7M]

b) Find the angles of asymptotes and the intersect of the asymptotes of the root locus of the following equation when K varies from $-\infty$ *to* ∞ [9M]

$$s^3 + 5s^2 + s + K(s+1) = 0.$$

6 a) The forward path transfer function of a unity feedback system is given by $G(s) = \frac{K}{(s+3)^2}$. Using Nyquist Stability Criterion, determine the range of K for the closed loop system to be stable. [8M]

b) The forward path transfer function of a unity feedback system is given by [8M]

$$G(s) = \frac{K}{(s+1)^2}$$

Using Bode diagram, determine the value of K so that the gain margin of the system is 20 dB.

7 a) Draw the electrical circuit diagram that represents the Lead Compensator and explain in detail. [8M]

b) The state equation of a linear time invariant system is represented by [8M]

$$\frac{d\,x(t)}{dt} = A\,x(t) + B\,u(t)$$

$A = \begin{bmatrix} 3 & 0 \\ 0 & -3 \end{bmatrix}, B = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$. Find the state transition matrix and the Eigen values of A.

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Code No: RT31043 **R13** SET - 4

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2. Answering the question in **Part-A** is compulsory
3. Answer any **THREE** Questions from **Part-B**
(Normal and semi & polar graph sheets are to be supplied)

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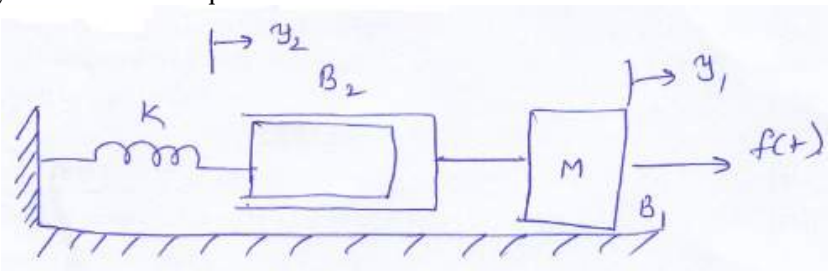
PART –A

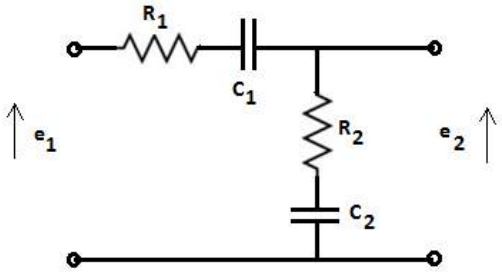
1	a)	What are the advantages of Mathematical Model?	[3M]
	b)	What are the advantages of transfer function representation of a system?	[4M]
	c)	Define maximum peak overshoot and settling time.	[4M]
	d)	Define qualitative stability and conditional stability.	[4M]
	e)	Explain the advantages of Polar plots.	[4M]
	f)	What does mean by state model?	[3M]

PART -B

2	a)	Compare the performances of closed loop and open loop control systems.	[4M]
	b)	Write the force equations of the linear translational system shown in the figure below. Draw the equivalent electrical network using force-voltage analogy, with the help of necessary mathematical equations.	[8M]



	c)	Derive the relationship that shows the effect of feedback on the overall gain of the system.	[4M]
3	a)	Obtain the transfer function $E_2(s)/E_1(s)$ for the electrical circuit below, by converting the circuit into a block diagram and then using block diagram reduction technique.	[8M]



	b)	Derive the transfer function of DC servo motor.	[8M]

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4 a) Explain the effect of Proportional Control action on the performance of a second order system. [6M]

b) Calculate the steady state errors due to a unit step input, a unit ramp input and a unit parabolic input for a unity feedback control system whose open loop transfer function is $G(s) = \frac{1}{s^2(s+6)}$. [10M]

5 a) Using Routh-Hurwitz criterion, determine the stability of the closed loop system that has the following characteristic equation and also determine the number of roots that are in the right half s-plane and on the imaginary axis $s^3 + 3s^2 + 6s + 1 = 0$. [7M]

b) Find the angles of asymptotes and the intersect of the asymptotes of the root locus of the following equation when K varies from $-\infty$ *to* ∞ [9M]

$$(1+K)s^3 + (2+3K)s^2 + s(3-K) - 3K = 0.$$

6 a) The loop transfer function of a system is given by $G(s)\,H(s) = \frac{1}{s^3(s+2)}$. Draw the polar plot. [8M]

b) The loop transfer function of a system is given by $G(s)\,H(s) = \frac{25}{(s+2)^2}$. Using Bode diagram, find gain and phase margins of the system. [8M]

7 a) Draw the electrical circuit diagram that represents the Lag Compensator and explain in detail. [8M]

b) The state equation of a linear time invariant system is represented by [8M]

$\frac{dx(t)}{dt} = Ax(t) + Bu(t)$

$A = \begin{bmatrix} -3 & 0 \\ 0 & -3 \end{bmatrix}, B = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$. Find the state transition matrix and the Eigen values of A

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