HA

Ref No:

< Sri Krishna Institute of Technology, Bangalore>

COURSE PLAN

Academic Year -2019- 20

Program:	B E –Electrical and Electronics Engineering
Semester :	6
Course Code:	17EE61
Course Title:	Control system
Credit / L-T-P:	4 / 4-0-0
Total Contact Hours:	50
Course Plan Author:	Arun Kumar R

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Note : Remove "Table of Content" before including in CP Book
Each Course Plan shall be printed and made into a book with cover page
Blooms Level in all sections match with A.2, only if you plan to teach / learn at higher levels

A. COURSE INFORMATION

1. Course Overview

Degree:	BE	Program:	EE

Semester:	6	Academic Year:	2019-20
Course Title:	Control system	Course Code:	17EE61
Credit / L-T-P:	4 / 4-0-0	SEE Duration:	180 Minutes
Total Contact Hours:	50 Hours	SEE Marks:	100 Marks
CIA Marks:	30 Marks	Assignment	1 / Module
Course Plan Author:	Arun kumar R	Sign ..	Dt:
Checked By:		Sign ..	Dt:
CO Targets	CIA Target : ...... %	SEE Target:	68%

Note: Define CIA and SEE % targets based on previous performance.

2. Course Content

Content / Syllabus of the course as prescribed by University or designed by institute. Identify 2 concepts per module as in G.

Module	Content	Teaching Hours	Identified Module Concepts	Blooms Learning Levels
1	**Introduction to control systems:** Introduction, classification of control systems. **Mathematical models of physical systems:** Modelling of mechanical system elements, electrical systems, Analogous systems, Transfer function, Single input single output systems, Procedure for deriving transfer functions, servomotors, synchros, gear trains	10	Classification Mathematical Modelling	L2 Understanding, L3 Apply
2	**Block diagram:** Block diagram of a closed loop system, procedure for drawing block diagram and block diagram reduction to find transfer function. **Signal flow graphs:** Construction of signal flow graphs, basic properties of signal flow graph, signal flow graph algebra, construction of signal flow graph for control systems.	10	block diagram reduction signal flow graph construction	L3 Apply L3 Apply
3	**Time Domain Analysis:** Standard test signals, time response of first order systems, time response of second order systems, steady state errors and error constants, types of control systems. **Routh Stability criterion:** BIBO stability, Necessary conditions for stability, Routh stability criterion, difficulties in formulation of Routh table, application of Routh stability criterion to linear feedback systems, relative stability analysis.	10	time response stability criterion	L3 Apply L4 Analyze
4	**Root locus technique:** Introduction, root locus concepts, construction of root loci, rules for the construction of root locus. **Frequency Response analysis:** Co-relation between time and frequency response – 2nd order systems only. **Bode plots:** Basic factors G(iw)/H(jw), General procedure for constructing bode plots, computation of gain margin and phase margin.	10	root loci construction bode plots construction	L2 Understanding L3 Apply
5	**Nyquist plot:** Principle of argument, Nyquist stability criterion, assessment of relative stability using Nyquist criterion. **Design of Control Systems:** Introduction, Design with the PD Controller, Design with the PI Controller, Design with the PID Controller, Design with Phase-Lead Controller, Design with Phase - Lag Controller, Design with Lead-Lag Controller	10	Nyquist criterion Controller Design	L2 Understanding L4 Analyze
-	**Total**	**50**	-	-

3. Course Material

Books & other material as recommended by university (A, B) and additional resources used by course teacher (C).

1. Understanding: Concept simulation / video ; one per concept ; to understand the concepts ; 15 – 30 minutes
2. Design: Simulation and design tools used – software tools used ; Free / open source
3. Research: Recent developments on the concepts – publications in journals; conferences etc.

Modules	Details	Chapters in book	Availability
A	**Text books (Title, Authors, Edition, Publisher, Year.)**	-	-
1-5	Anand Kumar , "Control Systems" PHI 2nd Edition, 2014	1-5	In Lib/ In dept
B	**Reference books (Title, Authors, Edition, Publisher, Year.)**	-	-
1.	Farid Golnaraghi, Benjamin C. Kuo , "Automatic Control Systems", Wiley, 9th Edition, 2010	1-3	In Lib
2.	Norman S. Nise, "Control Systems, Principles and Design ", Wiley, 4th Edition, 2012.	5	In lib
3.	Modern Control Systems: Richard C Dorf et al , Pearson , 11th Edition, 2008	2,3	In lib
4.	Control Systems, Principles and Design: M.Gopal, McGaw Hill, 4th Edition, 2012	1-5	In lib
5.	Control Systems Engineering S. Salivahanan et al, Pearson, 1st Edition, 2015	1,2,3,4	In lib
C	**Concept Videos or Simulation for Understanding**	-	-
C1	Modelling of mechanical system elements, electrical systems, Analogous systems, http://nptel.ac.in/courses/108106098/1 -30 mins, : http://nptel.ac.in/courses/108106098/2 – 15 Mins http://nptel.ac.in/courses/108106098/3 Transfer function, Single input single output systems, Procedure for deriving transfer functions http://nptel.ac.in/courses/108106098/4 http://nptel.ac.in/courses/108106098/5 http://nptel.ac.in/courses/108106098/6		
C2	This lecture introduces the concepts of transfer function of a system and the block diagram representation of a system. http://nptel.ac.in/courses/108106098/7 http://nptel.ac.in/courses/108106098/8 The videos can be downloaded in four formats (VIDEO DOWNLOADS) using the link : http://nptel.ac.in/courses/108106098/10 This tutorial covers solving of problems related to block diagram reduction, signal flow graphs and determining transfer functions. The videos can be downloaded in four formats (VIDEO DOWNLOADS) using the link : http://nptel.ac.in/courses/108106098/11		
C3	This lectures details on analyzing the time response of systems to various standard test inputs. The videos can be downloaded in four formats (VIDEO DOWNLOADS) using the link : http://nptel.ac.in/courses/108106098/12 This lecture introduces the specifications which describe the time response of a system. The videos can be downloaded in four formats (VIDEO DOWNLOADS) using the link : http://nptel.ac.in/courses/108106098/13 This is a tutorial which covers examples related to Time response analysis and specifications. The videos can be downloaded in four formats (VIDEO DOWNLOADS) using the link : http://nptel.ac.in/courses/108106098/14 The lecture introduces the concept of stability and explains the relationship between stability and pole-zeros of a system.		

	The videos can be downloaded in four formats (VIDEO DOWNLOADS) using the link :http://nptel.ac.in/courses/108106098/15 This lecture illustrate Routh Hurwitz criterion and determining stability of a system using the criterion. The videos can be downloaded in four formats (VIDEO DOWNLOADS) using the link :http://nptel.ac.in/courses/108106098/16 In this lecture the advantages and usefulness of closed loop systems are explained. Also, how do we determine relative stability of a system using Routh-Hurwitz criterion is shown. The videos can be downloaded in four formats (VIDEO DOWNLOADS) using the link :http://nptel.ac.in/courses/108106098/17		
C4	In this lecture the concept of root locus is introduced. Starting with the relationship between system parameters and poles of a system the importance of root locus is shown. The videos can be downloaded in four formats (VIDEO DOWNLOADS) using the link :http://nptel.ac.in/courses/108106098/19 his lecture highlights Evan's conditions and the first three rules for constructing root locus plot. The videos can be downloaded in four formats (VIDEO DOWNLOADS) using the link :http://nptel.ac.in/courses/108106098/20 In this lecture construction rule 4, 5 and 6 for plotting root locus is taught. The videos can be downloaded in four formats (VIDEO DOWNLOADS) using the link :http://nptel.ac.in/courses/108106098/21 In this lecture the last three construction rules for plotting root locus of a system is explained with examples The videos can be downloaded in four formats (VIDEO DOWNLOADS) using the link :http://nptel.ac.in/courses/108106098/22 The concept of frequency response is introduced in this lecture. The videos can be downloaded in four formats (VIDEO DOWNLOADS) using the link :http://nptel.ac.in/courses/108106098/23 Lecture discusses about Bode Plot analysis. The videos can be downloaded in four formats (VIDEO DOWNLOADS) using the link :http://nptel.ac.in/courses/108106098/26		
C5	In this lecture, the polar plot and Nyquist stability criterion is discussed The videos can be downloaded in four formats (VIDEO DOWNLOADS) using the link :http://nptel.ac.in/courses/108106098/24 The lecture comprises of special cases of Nyquist stability, Gain and Phase Margin and Relative Stability concepts. The videos can be downloaded in four formats (VIDEO DOWNLOADS) using the link :http://nptel.ac.in/courses/108106098/25 This lecture introduces the action of Proportional, Derivative and Integral Controllers on control systems. The videos can be downloaded in four formats (VIDEO DOWNLOADS) using the link :http://nptel.ac.in/courses/108106098/27 This lecture introduces the action of Proportional, Derivative and Integral Controllers on control systems.		

	The videos can be downloaded in four formats (VIDEO DOWNLOADS) using the link :http://nptel.ac.in/courses/108106098/28 Problems on PID Controllers The videos can be downloaded in four formats (VIDEO DOWNLOADS) using the link :http://nptel.ac.in/courses/108106098/29 This lecture covers the basics of control design in relation to PID Controllers. The videos can be downloaded in four formats (VIDEO DOWNLOADS) using the link :http://nptel.ac.in/courses/108106098/30		
	Lab : https://www.youtube.com/watch?v=P9e7hUNPGVs -		
D	**Software Tools for Design**	-	-
	MATLAB		
E	**Recent Developments for Research**	-	-
	We recommend taking MATLAB Onramp: https://www.mathworks.com/learn/tutorials/matlab-onramp.html>		
F	**Others (Web, Video, Simulation, Notes etc.)**	-	-
1	MathWorks has courseware available for Control Tutorials: https://www.mathworks.com/academia/courseware/control-tutorials.html The material provided includes tutorials, lectures, problem sets, quizzes and exams so students can explore material in more detail. To request the material, make sure you use the email used when creating your MathWorks account.		
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4. Course Prerequisites

Refer to GL01. If prerequisites are not taught earlier, GAP in curriculum needs to be addressed. Include in Remarks and implement in B.5.

Students must have learnt the following Courses / Topics with described Content . . .

Modules	Course Code	Course Name	Topic / Description	Sem	Remarks	Blooms Level
1	17MAT 21	Engineering mathematics-II	1,2,4 Laplace Transformation	2		L3
-						

5. Content for Placement, Profession, HE and GATE

The content is not included in this course, but required to meet industry & profession requirements and help students for Placement, GATE, Higher Education, Entrepreneurship, etc. Identifying Area / Content requires experts consultation in the area.

Topics included are like, a. Advanced Topics, b. Recent Developments, c. Certificate Courses, d. Course Projects, e. New Software Tools, f. GATE Topics, g. NPTEL Videos, h. Swayam videos etc.

Modules	Topic / Description	Area	Remarks	Blooms Level
1	Transformation of mathematical modeling using MATLAB	Control engineering	Required for higher education	L2
3	Transient response analysis using MATLAB	Control engineering	Required for higher education	L2
4	Root-Locus Techniques using MATLAB	Control engineering	Required for higher education	L2

5	Transformation of system models using MATLAB	Control engineering	Required for higher education	L2

B. OBE PARAMETERS

1. Course Outcomes

Expected learning outcomes of the course, which will be mapped to POs. Identify a max of 2 Concepts per Module. Write 1 CO per Concept.

Modules	Course Code.#	Course Outcome **At the end of the course, student should be able to . . .**	Teach. Hours	Instr Method	Assessment Method	Blooms' Level
1.	17EE61.1	Apply mathematical modelling to determine the transfer function of a system.	10	Lecture	CIA / Assignment	L3
2.	17EE61.2	Apply block diagram reduction technique and signal flow graph reduction methods to determine the transfer function of a system.	10	Lecture	CIA / Assignment	L3
3.	17EE61.3	Analyze system behavior in time domain for 1st and 2nd order systems and analyse system stability using R-H criteria.	10	Lecture	CIA / Assignment	L4
4.	17EE61.4	Analyze system stability using Root locus technique and Bode Plot technique.	10	Lecture	CIA / Assignment	L4
5.	17EE61.5	Analyze stability system using Nyquist criteria and Design the PID controllers.	10	Lecture	CIA / Assignment	L4
-	**-**	**Total**	**50**	**-**	**-**	**L2-L4**

2. Course Applications

Write 1 or 2 applications per CO.
Students should be able to employ / apply the course learnings to . . .

Modules	Application Area Compiled from Module Applications.	CO	Level
1	Used in single-input single-output filters in the fields of signal processing	CO1	L2
1	1.In robotics. 2.Traffic system. 3.Modelling of system(to check whether it is economical and reliable). 4.For radar tracking system	CO1	L4
2	SFGs are most commonly used to represent signal flow in a physical system and its controller(s), forming a cyber-physical system. Among their other uses are the representation of signal flow in various electronic networks and amplifiers, digital filters, state-variable filters and some other types of analog filters. In nearly all literature, a signal-flow graph is associated with a set of linear equations.	CO2	L3
2	Physical dimensions of appropriate products of the variables of the two types must be consistent. For the systems in which these conditions are satisfied, it is possible to draw a linear graph isomorphic with the dynamical properties of the system as described by the chosen variables.	CO2	L2
3	Used to design the damping ratio (ζ) and natural frequency (ωn) of a feedback system.	CO3	L2
3	The plot can be used to interpret how the input affects the output in both magnitude and phase over frequency.	CO3	L3
4	The steady state error is a measure of system accuracy. These errors arise from the nature of the inputs, system type and from nonlinearities of system components such as static friction, backlash, etc.	CO3	L3

4	These are generally aggravated by amplifiers drifts, aging or deterioration. The steady-state performance of a stable control system is generally judged by its steady state error to step, ramp and parabolic inputs.	CO4	L4
5	A control system manages, commands, directs, or regulates the behavior of other devices or systems using control loops. It can range from a single home heating controller using a thermostat controlling a domestic boiler to large Industrial control systems which are used for controlling processes or machines.	CO5	L2
5	Helical-Circularly polarized radio waves for satellite communication, Parabolic-direct the radio waves in radio telescopes, Yagi-Uda-high directivity for log distance communication, Log-Periodic-Wide bandwidth UHF terrestrial TV	CO5	L2

3. Articulation Matrix

CO – PO Mapping with mapping level for each CO-PO pair, with course average attainment.

-	-	Course Outcomes	Program Outcomes															-
Modules	CO.#	**At the end of the course student should be able to . . .**	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	Level
1	17EE61.1	Apply mathematical modelling to determine the transfer function of a system.	3	3	2									3	3		1	L3
2	17EE61.2	Apply block diagram reduction technique and signal flow graph reduction methods to determine the transfer function of a system.	3	3	2									3	3		1	L3
3	17EE61.3	Analyze system behavior in time domain for 1st and 2nd order systems and analyse system stability using R-H criteria.	3	3	2									3	3		1	L4
4	17EE61.4	Analyze system stability using Root locus technique and Bode Plot technique.	3	3	2	2								3	3		1	L4
5	17EE61.5	Analyze stability system using Nyquist criteria and Design the PID controllers.	3	3	2	2								3	3		1	L4
-	**17EE61**	**Average attainment (1, 2, or 3)**	**3**	**3**	**2**	**2**								**3**	**3**		**1**	**-**
-	*PO, PSO*	*1.Engineering Knowledge; 2.Problem Analysis; 3.Design / Development of Solutions; 4.Conduct Investigations of Complex Problems; 5.Modern Tool Usage; 6.The Engineer and Society; 7.Environment and Sustainability; 8.Ethics; 9.Individual and Teamwork; 10.Communication; 11.Project Management and Finance; 12.Life-long Learning; S1.Software Engineering; S2.Data Base Management; S3.Web Design*																

4. Curricular Gap and Content

Topics & contents not covered (from A.4), but essential for the course to address POs and PSOs.

Modules	Gap Topic	Actions Planned	Schedule Planned	Resources Person	PO Mapping
1	Transformation of mathematical modeling using MATLAB	Seminar	3rd week of March 2020	Concerned faculty	PO5
3	Transient response analysis using MATLAB	Seminar	3rd week of April 2020	Concerned faculty	PO5
4	Root-Locus Techniques using MATLAB	Seminar	2nd week of May 2020	Concerned faculty	PO5
5	Transformation of	Seminar	4th week of May	Concerned faculty	PO5

	system models using MATLAB		2020		

C. COURSE ASSESSMENT

1. Course Coverage

Assessment of learning outcomes for Internal and end semester evaluation. Distinct assignment for each student. 1 Assignment per chapter per student. 1 seminar per test per student.

Modules	Title	Teach. Hours	No. of question in Exam						CO	Levels
			CIA-1	CIA-2	CIA-3	Asg	Extra Asg	SEE		
1	Introduction to control systems: Mathematical models of physical systems:	10	2	-	-	1	1	2	CO1, CO2	L2, L3
2	Block diagram: Signal flow graphs,	10	2	-	-	1	1	2	CO3, CO4	L3,L3
3	Time Domain Analysis: Routh Stability criterion	10	-	2	-	1	1	2	CO5, CO6	L4, L4
4	Root locus technique: Frequency Response analysis: Bode plots:	10	-	2	-	1	1	2	CO7, C08	L2, L2
5	Nyquist plot: Design of Control Systems	10	-	-	4	1	1	2	CO9, CO10	L4, L2
-	**Total**	**50**	**4**	**4**	**4**	**5**	**5**	**10**	**-**	**-**

2. Continuous Internal Assessment (CIA)

Assessment of learning outcomes for Internal exams. Blooms Level in last column shall match with A.2.

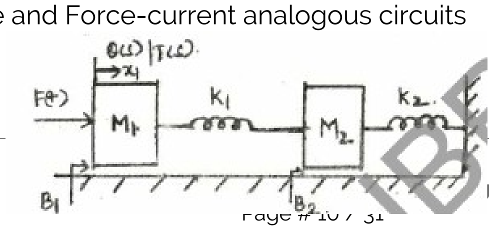
Modules	Evaluation	Weightage in Marks	CO	Levels
1, 2	CIA Exam – 1	30	CO1, CO2	L3,L3
3, 4	CIA Exam – 2	30	CO3, CO4	L3, L2,
5	CIA Exam – 3	30	CO5	L3
1, 2	Assignment - 1	10	CO1, CO2	L3,L3
3, 4	Assignment - 2	10	CO3, CO4	L3, L2,
5	Assignment - 3	10	CO5	L3
1, 2	Seminar - 1		-	-
3, 4	Seminar - 2		-	-
5	Seminar - 3		-	-
1, 2	Quiz - 1		-	-
3, 4	Quiz - 2		-	-
5	Quiz - 3		-	-
1 - 5	Other Activities – Mini Project	-		
	Final CIA Marks	**40**	**-**	**-**

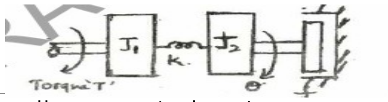
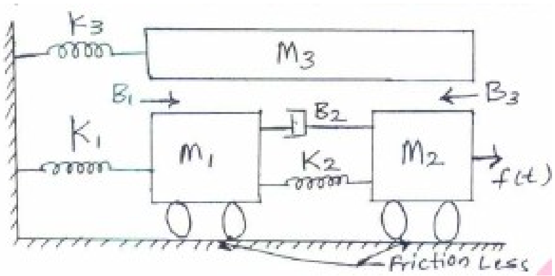
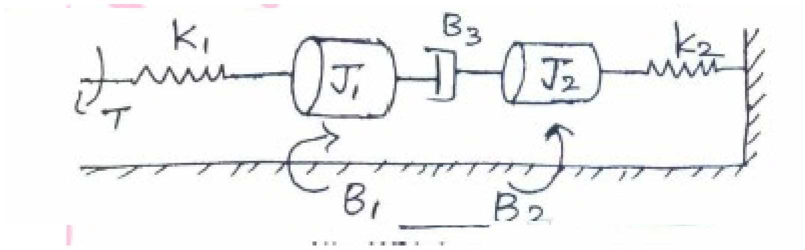
D1. TEACHING PLAN - 1

Module - 1

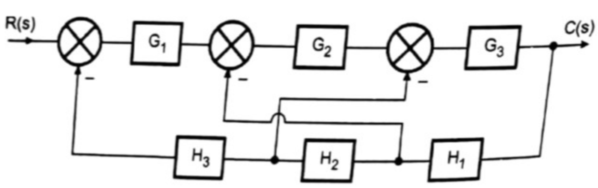
Title:	Introduction to control systems: Mathematical models of physical systems:	Appr Time:	10hrs

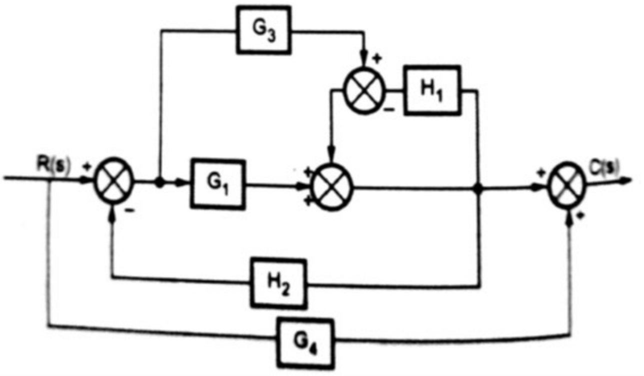
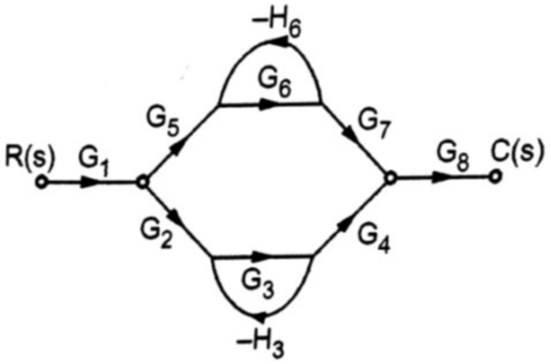
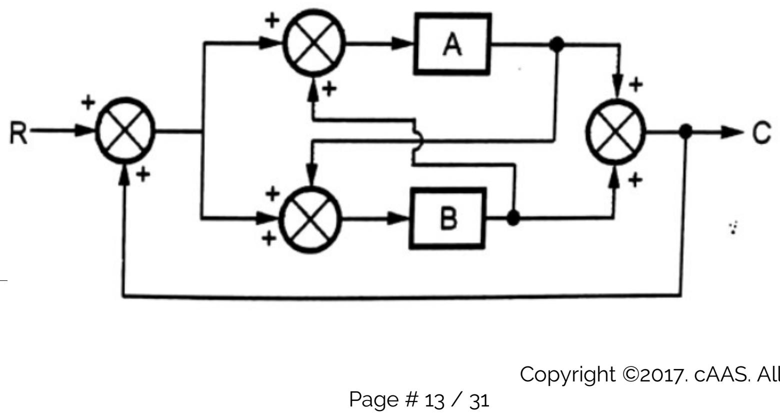
a	*Course Outcomes*	CO	Blooms
-	At the end of the topic the student should be able to . . .	-	Level
1	Apply mathematical modelling to determine the transfer function of a system.	CO1	L3
b	***Course Schedule***	-	-
Class No	**Portion covered per hour**	-	-
1	Introduction,	C01	L2
2	classification of control systems.	C01	L3
3	**Mathematical models of physical systems:** Modelling of mechanical system elements	C01	L3
4	Modelling of mechanical system elements	C01	L2
5	Modelling of electrical systems	C01	L3
6	Analogous systems	C01	L3
7	Transfer function	C01	L2
8	Single input single output systems, Procedure for deriving transfer functions	C01	L3
9	servomotors,	C01	L3
10	synchros, gear trains.	C01	L3
c	**Application Areas**	-	-
-	Students should be able employ / apply the Module learnings to . . .	-	-
1	Variables of the first type must obey a mesh law, analogous to Kirchhoff's voltage law, whereas variables of the second type must satisfy an incidence law analogous to Kirchhoff's current law.	CO1	L3
2	SFGs are most commonly used to represent signal flow in a physical system and its controller(s), forming a cyber-physical system. Among their other uses are the representation of signal flow in various electronic networks and amplifiers, digital filters, state-variable filters and some other types of analog filters. In nearly all literature, a signal-flow graph is associated with a set of linear equations.	CO1	L3
	Physical dimensions of appropriate products of the variables of the two types must be consistent. For the systems in which these conditions are satisfied, it is possible to draw a linear graph isomorphic with the dynamical properties of the system as described by the chosen variables.	CO1	L3
	1.The techniques [...] can be applied directly to these linear graphs as well as to electrical networks, to obtain a signal flow graph of the system."	CO1	L3
d	**Review Questions**	-	-
-	The attainment of the module learning assessed through following questions	-	-
1.	Define Control system? What are the requirements of a good control system?	CO1	L1
2.	Define and compare open loop and closed loop control systems and give one practical example of each. Write an explanatory	CO1	L3
3.	Write an explanatory note on gear trains?	CO1	L3
4.	Briefly explain the requirements of a good control system?	CO1	L3
5.	List the features of transfer function.	CO1	L3
6.	Define the term transfer function of a linear time invariant system. Derive the expression for the transfer function of a closed loop negative feedback system.	CO1	L3
7.	Explain AC and DC servo motor	CO1	L3
8.	For the mechanical system shown in below Fig. (i)Obtain its mathematical model .(ii)Write the performance equation (iii)Obtain its Force-Voltage and Force-current analogous circuits	CO2	L3

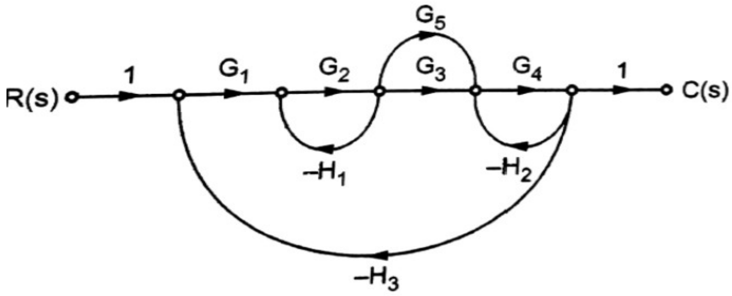
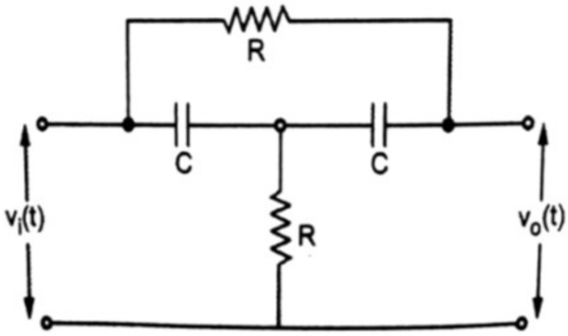
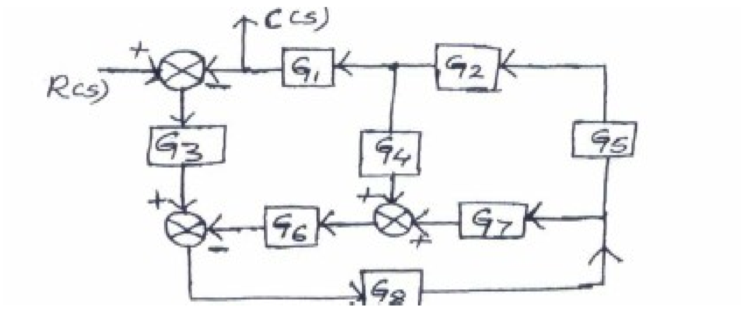


9.	Distinguish closed loop control system from open loop control system with suitable examples.	CO2	L4
10.	Obtain the transfer function of the system shown in below Fig. 	CO1	L2
11.	Explain linear and non-linear control system.	CO1	L3
12.	For the mechanical system shown in Fig.Q1(b): i) Draw the mechanical network. ii) Obtain equations of motion. H.) Draw an electrical network based on force current analogy. 		
13.	For the circuit shown in below Fig 'IC' is the gain of an ideal amplifier. Determine the transfer function I(s) / V (s) 		
14.	Problems on obtaining transfer function for given electrical/ mechanical system.	CO1	L3
15.	Distinguish between open loop and closed loop control system. Describe two examples for each	CO2	L4
16.	Write the differential equations for the mechanical system shown in fig. 1(b) and obtain F-V and F-I analogous electrical circuits.	CO2	L3
17.	Mention merits and demerits of open loop and closed loop control systems and give an example for each.	CO2	L4
18.	Obtain the transfer function of an armature controlled DC servomotor.	CO1	L1
e	**Experiences**	-	-
1		CO1	L2
2			
3			
4		CO2	L3
5			

Module – 2

Title:	Block diagram: Signal flow graphs:	Appr Time:	10hrs
a	***Course Outcomes***	**CO**	**Blooms**
-	At the end of the topic the student should be able to . . .	-	**Level**
1	Apply block diagram reduction technique and signal flow graph reduction methods to determine the transfer function of a system	CO2	L3
b	***Course Schedule***	-	-
Class No	**Portion covered per hour**	**-**	**-**
1	Block diagram of a closed loop system,	CO2	L3
2	procedure for drawing block diagram and block diagram reduction to find transfer function.	CO2	L3
3	block diagram reduction to find transfer function.	CO2	L3
4	block diagram reduction to find transfer function.	CO2	L3
5	**Signal flow graphs:** Construction of signal flow graphs,	CO2	L3
6	Basic properties of signal flow graph, signal flow graph algebra,	CO2	L3
7	Construction of signal flow graph for control systems.	CO2	L3
8	Construction of signal flow graph for control systems.	CO2	L3
9	Construction of signal flow graph for control systems.	CO2	L3
10	Construction of signal flow graph for control systems.	CO2	L3
c	**Application Areas**	**-**	**-**
-	Students should be able employ / apply the Module learnings to . . .	-	-
1	A signal-flow graph or signal-flow graph, invented by Claude Shannon, but often called a Mason graph after Samuel Jefferson Mason who coined the term, is a specialized flow graph, a directed graph in which nodes represent system variables, and branches represent functional connections between pairs of nodes.	CO3	L3
2	application of a negative feedback system is an electronic amplifier based on an operational amplifier	CO4	L4
	Masons rule is less important today than in the past. However, there are some derivations that rely on the concepts embodied by the rule, so it still has a role in the control designers toolbox	CO4	L3
d	**Review Questions**	-	-
-	The attainment of the module learning assessed through following questions	-	-
1	Apply Block diagram reduction technique to find the transfer function C(S)/ R(s) for the system shown 	CO3	L1
2	What is signal flow graph representation? Briefly explain the properties of signal flow graph.	CO4	L3
3	1 Define the following terms.(i) Self loop (ii) Node (iii) Branch (iv) feedback loop	CO3	L2
4	Define the term transfer function of a linear time invariant system. Derive the expression for the transfer function of a closed loop negative feedback system.	CO4	L4
5	Explain the basic elements of block diagram?	CO4	L2
6	What are the advantages and disadvantages of block diagram reduction	CO3	L5

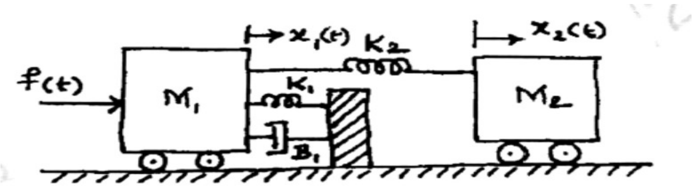
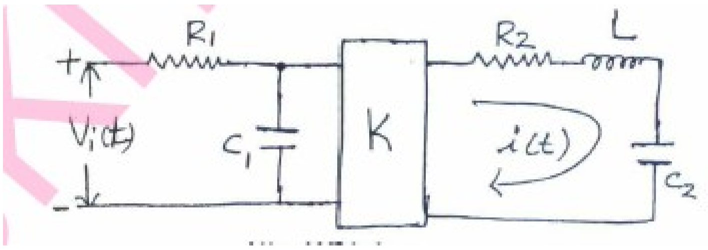
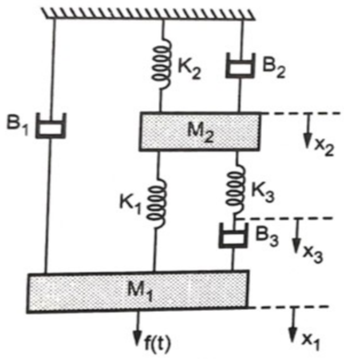
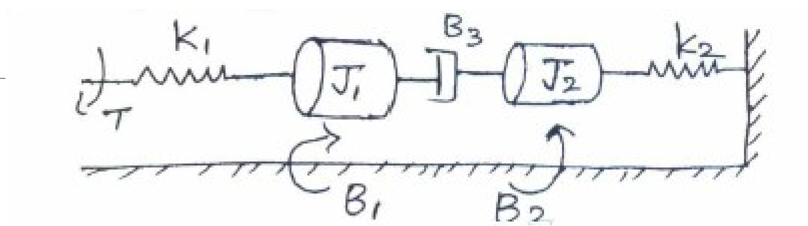
	technique.		
7	 Apply Block diagram reduction technique to find the transfer function C(S)/ R(s) for the system shown	CO3	L2
8	Apply Mason's Gain formula to find the transfer function for the signal flow graph shown 	CO3	L3
9	Construct the signal flow graph for the block diagram shown Find the transfer function using Mason's gain formula. 	CO3	L5

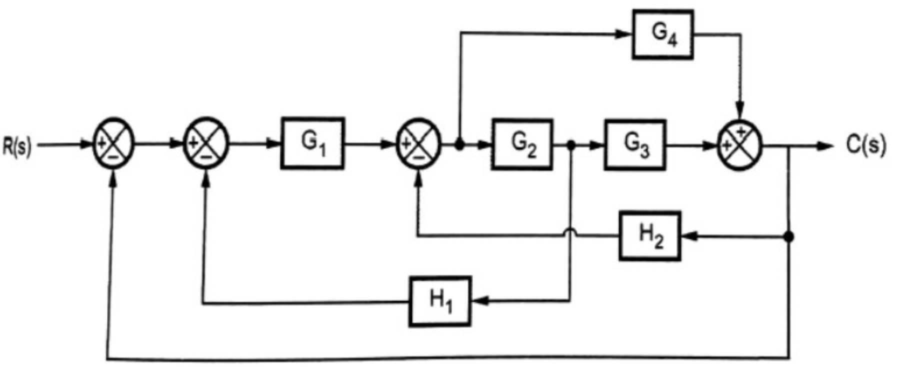
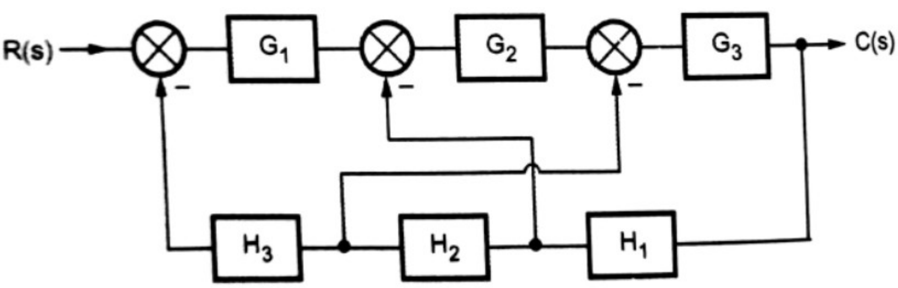
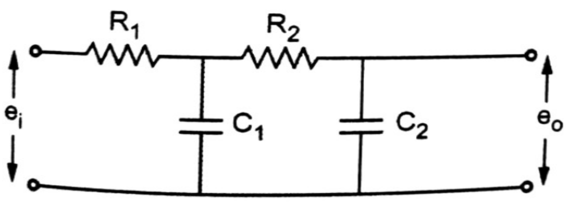
10	Construct the block diagram for the signal flow shown in Fig 14 and find the transfer function using block diagram reduction technique. Verify the answer using Mason's gain formula.  	CO3	L2
11	Construct the signal flow graph for the electrical network shown in Fig and find the transfer function. Also verify the answer using block diagram reduction technique  		
12	Obtain C(s)/R(s) for the block diagram shown in below Fig using block diagram reduction techniques.  		
e	**Experiences**	-	-
1		CO3	L2
2			
3			
4		CO4	L3
5			

E1. CIA EXAM – 1

a. Model Question Paper - 1

Crs Code:	15EE61	Sem:	VI	Marks:	30	Time:	75 minutes

<table>
<tr><td>Course:</td><td colspan="5">Control system</td></tr>
<tr><td>-</td><td>-</td><td>Note: Answer all questions, each carry equal marks. Module : 1, 2</td><td>Marks</td><td>CO</td><td>Level</td></tr>
<tr><td></td><td></td><td>Module 1</td><td></td><td></td><td></td></tr>
<tr><td>1</td><td>a</td><td>For the mechanical systems shown below
a. Draw the nodal equivalent circuit
b. Write the differential equations governing its dynamic behavior.
c. Write force voltage and force current analogous electrical networks.
d. List all analogous quantities.

</td><td>8</td><td>CO1</td><td>L3</td></tr>
<tr><td></td><td>b</td><td>For the circuit shown in below Fig 'IC' is the gain of an ideal amplifier. Determine the transfer function I(s) / V (s)

</td><td>7</td><td>CO1</td><td>L3</td></tr>
<tr><td></td><td></td><td>OR</td><td></td><td></td><td></td></tr>
<tr><td>2</td><td>a</td><td>For the mechanical systems shown below
a. Draw the nodal equivalent circuit
b. Write the differential equations governing its dynamic behavior.
c. Write force voltage and force current analogous electrical networks.
d. List all analogous quantities.

</td><td>8</td><td>CO1</td><td>L3</td></tr>
<tr><td></td><td></td><td>For the mechanical systems shown below
a. Draw the nodal equivalent circuit
b. Write the differential equations governing its dynamic behavior.
c. Write force voltage and force current analogous electrical networks.
d. List all analogous quantities.

</td><td>7</td><td>CO1</td><td>L3</td></tr>
</table>

		Module 2			
3		 Apply Block diagram reduction technique to find the transfer function C(S)/ R(s) for the system shown	8	CO2	L3
	b	Apply Mason's Gain formula to find the transfer function for the signal flow graph shown 	7	CO2	L3
		OR			
4	a	Construct the signal flow graph for the block diagram shown. Find the transfer function using Mason's gain formula.	8	CO2	L3
	b	Construct the signal flow graph for the electrical network shown and find the transfer function. 	7	CO2	L3

b. Assignment -1

Note: A distinct assignment to be assigned to each student.

D2. TEACHING PLAN - 2

Module – 3

Title:	Time Domain Analysis: Routh Stability criterion::	Appr Time:	10 Hrs
a	***Course Outcomes***	-	**Blooms**
-	The student should be able to:	-	**Level**
1	Analyze system behavior in time domain for 1st and 2nd order systems and analyse system stability using R-H criteria.	CO3	L2
b	***Course Schedule***		
Class No	**Module Content Covered**	**CO**	**Level**
1	Standard test signals,	CO3	L2
2	Time response of first order systems	CO3	L3
3	Time response of second order systems	CO3	L2
4	Steady state errors and error constants	CO3	L3
5	Types of control systems.	CO3	L2
6	**Routh Stability criterion:** BIBO stability, Necessary conditions for stability	CO3	L3
7	Routh stability criterion	CO3	L2
8	Difficulties in formulation of Routh table	CO3	L3
9	Application of Routh stability criterion to linear feedback systems	CO3	L3
10	Relative stability analysis	CO3	L3
c	**Application Areas**	**CO**	**Level**
1	Models which we have consist of differential equations so some integration is being done to determine time response. For simple linear system, analysis is being done easily by analytical solutions. However, for nonlinear systems or those which have complicated inputs, their integration is carried out numerically or by using MATLAB	CO3	L2
2	In time domain analysis, the time response of a linear dynamic system to an input is denoted as time's function c*(t)*. We can calculate the time response if the input and model of system is known.	CO3	L3
3	The time response of linear system is the addition of transient response which depend on preliminary conditions and the steady-state response which is based on input of system.	CO3	L2
d	**Review Questions**	-	-
1	State and explain the Routh's- Harwitz stability criterion.	CO3	L2
2	What are stable and unstable systems? What is the difference between absolute and relative stable system.	CO3	L3
3	Derive the expression for peak time tp for a second order system for step input.	CO3	L4
4	Draw the transient response characteristics of a control system to a unit step input and define the following (i) Delay time (ii) Rise time(iii) Peak time (iv) Maximum overshoot (iv) settling time.	CO3	L2
5	With a neat sketch explain all the time domain specifications.	CO3	L2
6	Obtain the expression for time response of the first order system subjected to	CO3	L2

	unit step input.		
7	What is the necessary and sufficient condition for a system to be stable according to RH criteria.	CO3	L3
8	Explain R-H criterion for determine the stability of the system and mention its limitations.	CO3	L2
9	Using R-H Criterion determine the stability of the system having the characteristic equation, $S^4 + 10S^3 + 36S^2 + 70S + 75 = 0$ has roots more negative than S = -2.	CO3	L3
10	Explain Routh-Hurwitz's criterion for determining the stability of a system and mention any three limitations of R-H criterion. (10 Marks, June 2012)	CO3	L2
11	Define: i) Marginally stable systems; ii) absolutely stable system; iii) conditionally stable systems. (06 Marks, June 2012)	CO3	L3
12	Using Routh's stability criterion determine the stability of the following systems: i) Its open loop transfer function has poles at s = 0, s= -1, s = -3 and s = -5. Gain K = 10. ii) It's a type 1 system with an error constant of 10/sec and poles at s = -3 and s = -6 (8 Marks, Dec 2012)	CO3	L2
13	Find stability of the following system given by G (s)= K/ S(S+1) and H(S)= 1 using Routh Hurwitz stability criterion	CO3	L3
14	Find stability of the following system given by G (s)= K/ S(S+2) (S+4) and H(S)= 1 using Routh Hurwitz stability criterion	CO3	L2
e	**Experiences**	-	-
1		CO6	L2

Module – 4

Title:	Root locus technique: Frequency Response analysis: Bode plots:	Appr Time:	10 Hrs
a	***Course Outcomes***	-	**Blooms**
-	The student should be able to:	-	**Level**
1	Analyze system stability using Root locus technique and Bode Plot technique.	CO4	L3
b	***Course Schedule***		
Class No	**Module Content Covered**	**CO**	**Level**
1	Introduction, root locus concepts.	CO4	L3
2	Construction of root loci.	CO4	L3
3	Rules for the construction of root locus.	CO4	L3
4	Construction of root loci-Problems.	CO4	L2
5	Construction of root loci-Problems.	CO4	L3
6	**Frequency Response analysis:** Co-relation between time and frequency response – 2^{nd} order systems only.	CO4	L3
7	**Bode plots:** Basic factors G(iw)/H(jw),	CO4	L3
8	General procedure for constructing bode plots,	CO4	L3
9	Computation of gain margin and phase margin.	CO4	L3
10	Bode plot-Numericals	CO4	L3
c	**Application Areas**	**CO**	**Level**
1	The steady state error is a measure of system accuracy. These errors arise from the nature of the inputs, system type and from nonlinearities of system components such as static friction, backlash, etc.	CO4	L3
2	These are generally aggravated by amplifiers drifts, aging or deterioration. The steady-state performance of a stable control system is generally judged by its steady state error to step, ramp and parabolic inputs.	CO4	L3

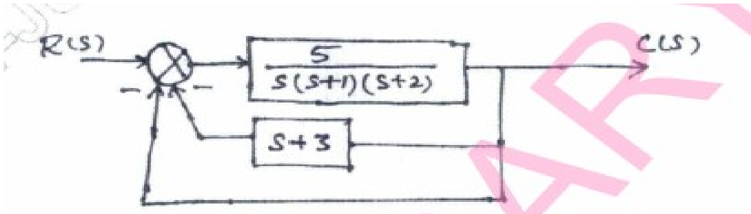
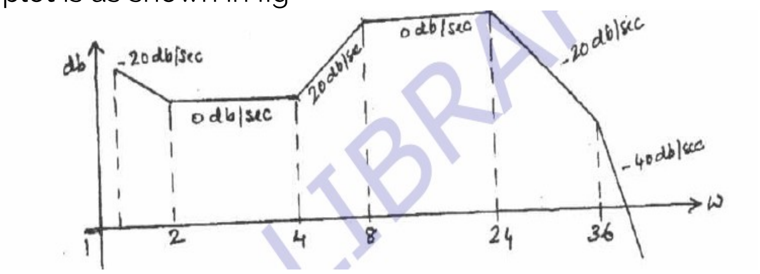
d	Review Questions	-	-
1	What is root locus? Discuss the various rules for construction of root locus	CO4	L2
2	List the advantages of root locus method.	CO4	L2
3	The open loop transfer function of a feedback control system is given by K/(S(S+2)(S+1)). Construct the root locus and find the range of K for which the closed loop system is stable.	CO4	L3
4	Discuss the procedure to evaluate gain margin and phase margin using bode plots	CO4	L2
5	What are the necessary and sufficient conditions for a system to be stable according to RH criteria?	CO4	L2
6	Define the following as applied to bode plot (i) Gain margin (ii) Phase margin (iii) Gain and phase cross over frequency.	CO4	L2
7	Draw the root-locus of the feedback system whose open-loop transfer function is given by G (s)H(S)= K / S(S+2) (S+4)	CO4	L3
8	Draw the root-locus of the feedback system whose open-loop transfer function is given by G (s)H(S)= K / S^2(S+1)	CO4	L3
9	Draw the root-locus of the feedback system whose open-loop transfer function is given by G (s)H(S)= K / $S^4 + 5S^3 + 8S^2 + 6S$	CO4	L3
10	Draw the Bode magnitude and phase plot of the following open-loop transfer function and determine gain margin, phase margin and absolute stability? G (s)H(S)= 1 / S(S+1)	CO4	L3
11	Draw the Bode magnitude and phase plot of the following open-loop transfer function and determine gain margin, phase margin and absolute stability? G (s)H(S)= 1 / S(S+2)(S+4)	CO4	L3
12	Draw the Bode magnitude and phase plot of the following open-loop transfer function and determine gain margin, phase margin and absolute stability? G (s)H(S)= 1/ S^2(S+1)	CO4	L3
13	Draw the Bode magnitude and phase plot of the following open-loop transfer function and determine gain margin, phase margin and absolute stability? G (s)H(S)= 1 / $S^4 + 5S^3 + 8S^2 + 6S$	CO4	L3
e	Experiences	-	-
1			

E2. CIA EXAM – 2

a. Model Question Paper - 2

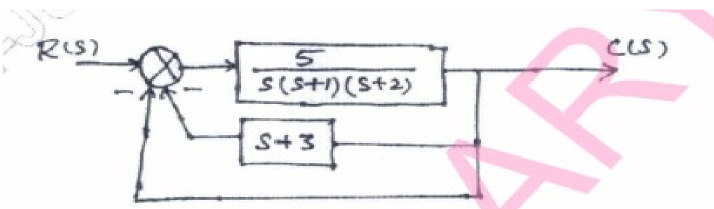
Crs Code:	17EE61	Sem:	VI	Marks:	30	Time:	75 minutes
Course:	Control system						

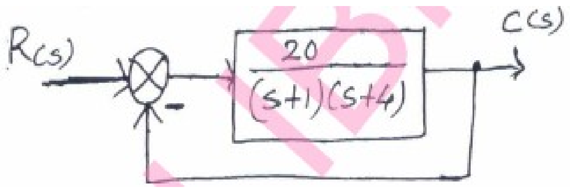
-	-	Note: Answer all questions, each carry equal marks. Module : 3, 4	Marks	CO	Level
		MODULE 1			
1	a	The characterisitic equation of a control system is $s^6 + 4s^5 + 3s^4 - 16s^2 - 64s - 48 = 0$. Find the number of roots of this equation real part, zero real part and negative real part using RH criterion.	8	CO3	L3
	b	For a unity feedback control system with G(s) = 64/ (s(s + 9.6)) Write the output response to a unit step input. Determine: i) The response at t = 0.1 sec. ii) Settling time for ± 2% of steady state.	7	CO3	L3
		OR			

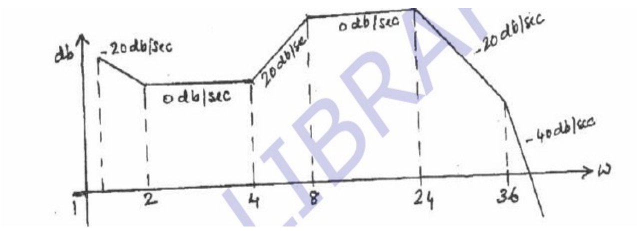
2	a	For the system shown in Fig. Find the : i) system type ii) static error constants kp, k_v and ka and iii) the steady state error for an input r(t) = 3 + 2t.  	7	CO3	L3
	b	Derive the expression of rise time and maximum overshoot for second order underdamped control system.	8	CO3	L3
		MODULE 2			
3	a	The open loop transfer function of a unity gain feedback is given by- G(s) = k(s+2)/(s4+3s3+4s2+2s) , k>=0 (a) Determine all the poles & zeros of G(s). (b) Draw the root locus.	7	CO4	L3
	b	Construct the Bode plot for the system with open loop transfer function $\frac{K}{S(S+1)(1+0.1S)}$ Determine the value of K such that (a) gain margin = 10db (b) Phase margin = 50^0.	8	CO4	L3
		OR			
4	a	Draw the root-locus of the feedback system whose open-loop transfer function is given by G (s)H(S)= K / S^4 + $5S^3$ + $8S^2$ + 6S	8	CO4	L3
	b	Determine the transfer function of a system whose asymptotic Bode plot is as shown in fig  	7	CO4	L3

b. Assignment – 2

Model Assignment Questions							
Crs Code:	17EE61	Sem:	6	Marks:	10	Time:	90 – 120 minutes
Course:	Control Systems						

SNo	Assignment Description	Marks	CO	Level
1.	For the system shown in Fig. Find the : i) system type ii) static error constants kp, k_v and ka and iii) the steady state error for an input r(t) = 3 + 2t.  	**10**	**CO3**	**L3**

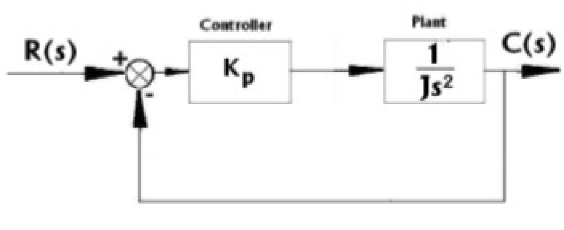
2.	Find the step-response, C(t) for the system described by C(s) / R(s) = 4/ (S+ 4) Also find the time constant, rise time and settling time.	**10**	**CO3**	**L3**
3.	Derive the expression for unit step response for 1^{st} order control system with closed loop transfer function K/(S+1/t)	**10**	**CO3**	**L3**
4.	Derive the expression for unit step response for 2^{nd} order control system with closed loop transfer function K/(S+1/t)	**10**	**CO3**	**L3**
5.	List the standard test inputs used in control system and write their Laplace transform.	**10**	**CO3**	**L3**
6.	Find Kp, Kv, Ka and steady state error for a system with open loop transfer function as G(s) / H(s) = (10(s + 2)(s + 3)) / (s(s +1)(s + 4)(s + 5)) where the input is $r(t) = 3 + t + t^2$.	**10**	**CO3**	**L3**
7.	For the system shown in Fig, obtain closed loop transfer function, damping ratio natural frequency and expression for the output response if subjected to unit step input. 	**10**	**CO3**	**L3**
8.	Derive the expression for rise time and maximum overshoot.	**8**	**CO3**	**L3**
9.	For a given system G(s) / H(s) = 2 K / (s (s + 2)(s + 3)). Find the value of K to limit steady state error to 10 when input to system is $1+10t + 20t^2$.	**10**	**CO3**	**L3**
10.	For a unity feedback control system with G(s) = 64/ (s(s + 9.6)) Write the output response to a unit step input. Determine: i) The response at t = 0.1 sec. ii) Settling time for ± 2% of steady state.	**10**	**CO3**	**L3**
11.	A control system with open loop transfer function $K(S+2)/(S^2+10S+20)$ produces 20% steady state error with unit step input. Determine the value of constant K.	**10**	**CO3**	**L3**
12.	Derive the expression for unit step response for 1^{st} order control system with closed loop transfer function K/(S+1/t)	**10**	**CO3**	**L3**
13.	Derive the expression for unit step response for 2^{nd} order control system with closed loop transfer function K/(S+1/t)	**10**	**CO3**	**L3**
14.	Sketch the root locus plot for a negative feedback control system whose open loop transfer function is given by $G(s)H(s) = K / (s(s+3)(s^2 + 2s + 2))$ for all values of K ranging from 0 to infinity. Also find the value of K for a damping ratio of 0.5	**10**	**CO4**	**L4**
15.	Sketch the rough nature of the root locus of a certain control system whose C.E is given by $s^3 + 9s^2 + Ks + K = 0$, comment on the stability.	**10**	**CO4**	**L4**
16.	Explain Rouths-Harwitz stability criterion.	**10**	**CO4**	**L4**
17.	$s^6 + 4s^5 + 3s^4 - 16s^2 - 64s - 48 = 0$. Find the number of roots of this equation real part, zero real part and negative real part using RH criterion.	**10**	**CO4**	**L4**
18.	The open loop transfer function of a system is G(s) = K/ (s (1+ s)(1+ 0.1s)) Determine the values of K such that (i) gain margin = 10 dB ii) phase margin = 24°. Use Bode plot.	**10**	**CO4**	**L4**
19.	Derive the expression for resonant peak 'Mr' and corresponding resonant frequency `Wr' for a second—order under-damped system in frequency response analysis.	**10**	**CO4**	**L4**
20.	For a closed loop control system G(s) = 100 / (s (s+8), H(s) = 1. Determine the resonant peak and resonant frequency.	**10**	**CO4**	**L4**
21.	Explain lag-lead compensator network and briefly discuss the effects of lead-lag compensator.	**10**	**CO4**	**L4**
22.	For a unity feedback system $G(s) = 242((s+5))/ (s(s +1)(s^2 + 5s +121))$ Sketch	**10**	**CO4**	**L4**

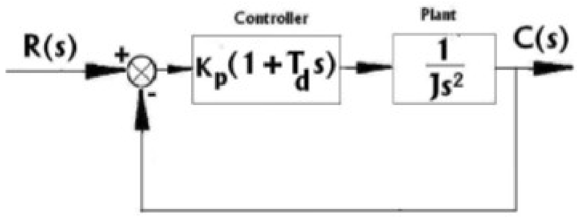
	the bode plot and find gain crossover freq,phase crossover freq, gain margin and phase margin.			
23.	Construct the Bode plot for the system with open loop transfer function $\frac{K}{S(S+1)(1+0.1S)}$ Determine the value of K such that (a) gain margin = 10db (b) Phase margin = 50^0.	**10**	**CO4**	**L4**
24.	Determine the transfer function of a system whose asymptotic Bode plot is as shown in fig 	**10**	**CO4**	**L4**
25.	Determine the ranges of K such that the characteristic equation : $S^3 + 3(K + 1)S^2 + (7K + 5)S + (4K + 7) = 0$, has roots more negative than S = -1.	**8**	**CO3**	**L3**
26.	Find the range of K for which the system with closed loop transfer function $K / (S(S+2)(S^2+ S+1))$ is stable. For what value of K the system oscillates and what is the corresponding frequency of oscillation.	**8**	**CO3**	**L3**
27.	Check the;&ability of the given characteristic equation using Routh's method.$S^6 + 2S^5 + 8S^4 + 12S^3 + 20S^2 + 16S + 16 = 0$.	**8**	**CO3**	**L3**
28.	Mention few limitations of Routh's criterion	**8**	**CO3**	**L3**
29.	Explain Rouths-Harwitz stability criterion.	**8**	**CO3**	**L3**
30.	$s^6 + 4s^5 + 3s^4 — 16s^2 — 64s — 48 = 0$. Find the number of roots of this equation real part, zero real part and negative real part using RH criterion.	**8**	**CO3**	**L3**

D3. TEACHING PLAN - 3

Module – 5

Title:	Nyquist plot: Design of Control Systems:	Appr Time:	10 Hrs
a	***Course Outcomes***	-	**Blooms**
-	The student should be able to:	-	**Level**
1	Analyze stability system using Nyquist criteria and Design the PID controllers.		L3
b	***Course Schedule***		
Class No	**Module Content Covered**	**CO**	**Level**
41.	Principle of argument.	CO5	L3
42.	Nyquist stability criterion.	CO5	L3
43.	Nyquist stability criterion.	CO5	L3
44.	Nyquist stability criterion.	CO5	L3
45.	Assessment of relative stability using Nyquist criterion.	CO5	L3
46.	**Design of Control Systems:** Introduction, Design with the PD Controller.	CO5	L3
47.	Design with the PI Controller,	CO5	L3

48.	Design with the PID Controller,	CO5	L3
49.	Design with Phase-Lead Controller,	CO5	L3
50.	Design with Phase - Lag Controller, Design with Lead-Lag Controller	CO5	L3
c	**Application Areas**	**CO**	**Level**
1	PID regulators provide reasonable control of most industrial processes, provided that the performance demands is not too high. PID control are generally ok if dominant plant dynamics are of 2nd-order.	CO5	L3
2	PI control are generally adequate when plant/process dynamics are essentially of 1st-order.•More elaborate control strategies needed if process has long time delays, or lightly-damped vibrationalmodes	CO5	L4
d	**Review Questions**	-	-
1	State the Nyquist stability criterion.		
2	Explain proportional +integral+differential controller and effect on stability.	CO5	L1
3	Explain the step by step design procedure of lead compensation network.	CO5	L3
4	What is controller? Explain the effect of PI and PD controller on second order system.	CO5	L2
5	Explain the principle of Argument in Nyquist stability criteria.	CO5	L4
6	Write a note on lead, lag and lead-lag compensator.	CO5	L2
7	List the limitation of lag and lead compensator.	CO5	L4
8	Problems on plotting Nyquist plot	CO5	L2
9	Sketch the Nyquist Plot for a unity feedback system having open-loop transfer function given by- G(s) = k/s(1+s)(1+2s)(1+3s) Determine the range of values of k for which the system is stable	CO5	L4
10	How many roots does each of the following polynomials have in the right half of the s-plane. (i) s4+2s3+4s2+8s+15 (ii) s6+4s5+11s4+12s3+26s2+84s+16	CO5	L2
11	Using Nyquist criterion, determine the stability of a feedback systemwhose open-loop transfer function is given by G (s)H(S)= 55 / S(S+2)(S+4)	CO5	L4
12	Sketch the nyquist plot for the open loop transfer function C (s)/ R(S)= 40 / S(S+1)(S+4)	CO5	L2
14	Consider the unity feedback system of Fig. Let Kp=20 and J=50. Determine the equation of response for a unit step input and determine the steady-state error.  	CO5	L2

15	Consider the unity feedback system of Figure 3. Let Kp=20 and J=50. Determine the equation of response for a unit step input and determine the steady-state error. Here, K p =20, T d =1 and J=50. 	CO5	L4
16	(g)List the advantages and disadvantages of carrying frequency analysis with Nyquist plot.	CO5	L2
17	(h) State the Zeigler-Nichols tuning Rules for PID Controller.	CO5	L4
18	i) Give all the properties of a minimum phase transfer function.	CO5	L2
19	Explain with sketch the use of drag cup rotor in servo application	CO5	L4
20	Explain drawing a neat diagram, the principle of operation of a position servo using a synchro system as error transducer.	CO5	L2
21	State the use of Nichol's Chart.	CO5	L2
22	State the merits and demerits of PI Controller.	CO5	L4
23	Explain drawing a neat diagram, the principle of operation of a position servo using a synchro system as error transducer.	CO5	L2
24	Draw the schematic diagram of a DC closed loop position control system consisting of (I) a pair of Potentiometers (II)Amplifier (III)Armature controlled DC Servomotor (IV)Gear Train as major component and explain the operation of this system	CO5	L4
e	**Experiences**	-	-
1			
2			

E3. CIA EXAM – 3

a. Model Question Paper - 3

Crs Code:	17EE61	Sem:	VI	Marks:	30	Time:	75 minutes
Course:	Control system						

-	-	Note: Answer all questions, each carry equal marks. Module : 5	Marks	CO	Level
1	a	Explain the step by step design procedure of lead compensation network.	8	CO5	L1
	b	What is controller? Explain the effect of PI and PD controller on second order system.	7	CO5	L2
		OR			
2	a	Sketch the Nyquist Plot for a unity feedback system having open-loop transfer function given by - G(s) = k/s(1+s)(1+2s)(1+3s) Determine the range of values of k for which the system is stable	8	CO5	L2
	b	How many roots does each of the following polynomials have in the right half of the s-plane. (i) s4+2s3+4s2+8s+15 (ii) s6+4s5+11s4+12s3+26s2+84s+16	7	CO5	L4
3	a	Write a note on lead, lag and lead-lag compensator.	7	CO5	L2

	b	List the limitation of lag and lead compensator	8	CO5	L4
		OR			
4	a	Explain proportional +integral+differential controller and effect on stability.	7	CO5	L2
	b	Explain the principle of Argument in Nyquist stability criteria.	8	CO5	L2

b. Assignment – 3

Note: A distinct assignment to be assigned to each student.

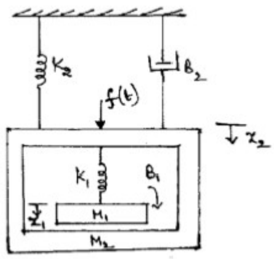
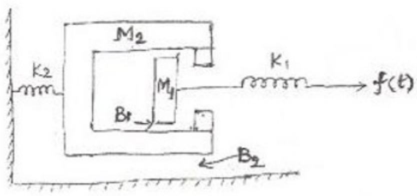
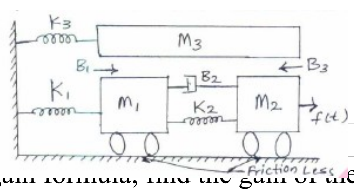
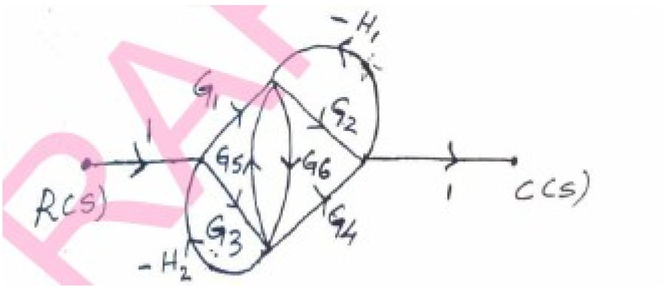
Model Assignment Questions							
Crs Code:	17EE61	Sem:	VI	Marks:	5 / 10	Time:	90 – 120 minutes
Course:	Control system						
Note: Each student to answer 2-3 assignments. Each assignment carries equal mark.							

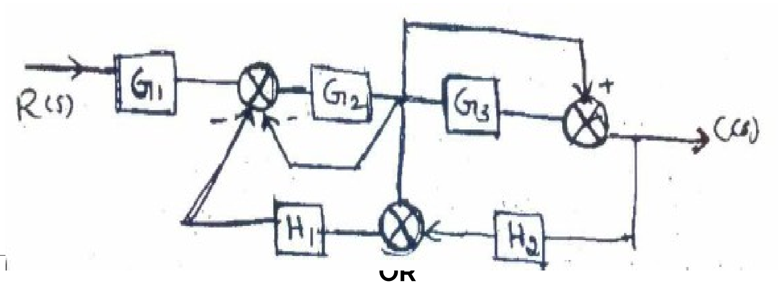
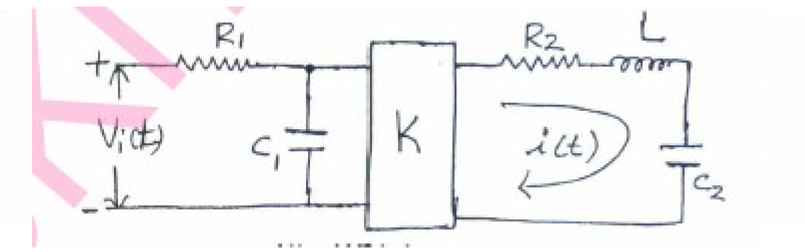
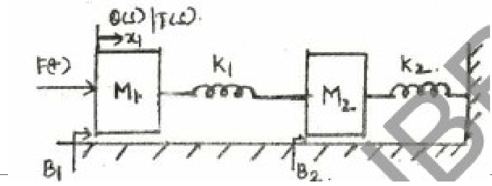
SNo	Assignment Description	Marks	CO	Level
1	Explain drawing a neat diagram, the principle of operation of a position servo using a synchro system as error transducer.	5	CO5	L2
2	State the use of Nichol's Chart.	5	CO5	L3
3	State the merits and demerits of PI Controller.	6	CO5	L4
4	Explain drawing a neat diagram, the principle of operation of a position servo using a synchro system as error transducer.	5	CO5	L3
5	Draw the schematic diagram of a DC closed loop position control system consisting of (I) a pair of Potentiometers (II)Amplifier (III)Armature controlled DC Servomotor (IV)Gear Train as major component and explain the operation of this system	6	CO5	L2
6	Explain drawing a neat diagram, the principle of operation of a position servo using a synchro system as error transducer.	7	CO5	L3
7	State the use of Nichol's Chart.	5	CO5	L4
8	State the merits and demerits of PI Controller.	5	CO5	L3
9	Sketch the Nyquist Plot for a unity feedback system having open-loop transfer function given by - G(s) = k/s(1+s)(1+2s)(1+3s) Determine the range of values of k for which the system is stable	5	CO5	L2
10	How many roots does each of the following polynomials have in the right half of the s-plane. (i) s4+2s3+4s2+8s+15 (ii) s6+4s5+11s4+12s3+26s2+84s+16	6	CO5	L3
11	Write a note on lead-lag compensator.	5	CO5	L4
12	List the limitation of lag and lead compensator.	6	CO5	L3
13	Write a note on lead, lag and lead-lag compensator.	7	CO5	L2
14	Explain proportional +integral+differential controller and effect on stability.	5	CO5	L3
15	Explain the principle of Argument in Nyquist stability criteria.	5	CO5	L4
16	Sketch the Nyquist Plot for a unity feedback system having open-loop transfer function given by - G(s) = k/s(1+s)(1+2s)(1+3s) Determine the range of values of k for which the system is stable	5	CO5	L3

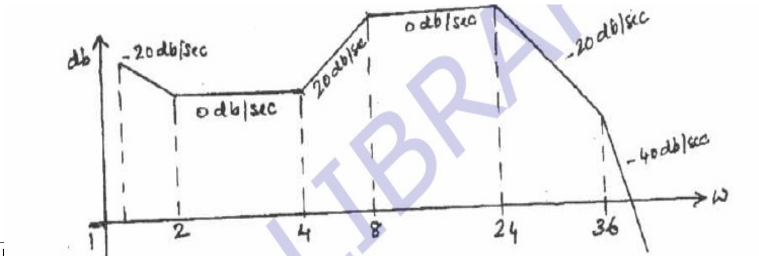
F. EXAM PREPARATION

1. University Model Question Paper

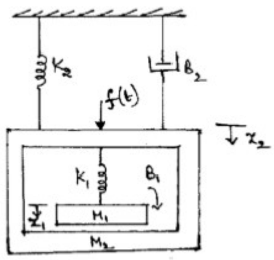
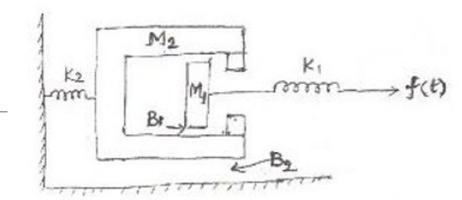
Course:	Control system					Month / Year	May /2018
Crs Code:	17EE61	Sem:	VI	Marks:	100	Time:	180 minutes

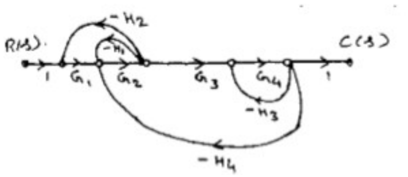
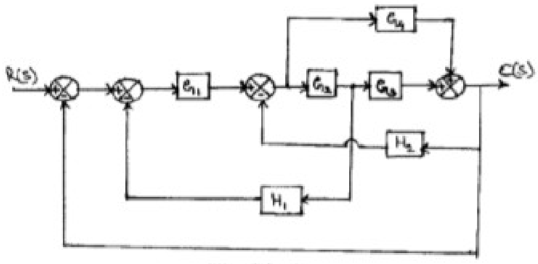
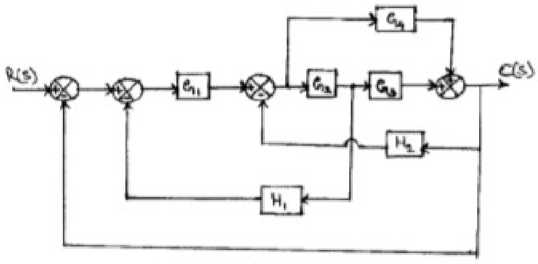
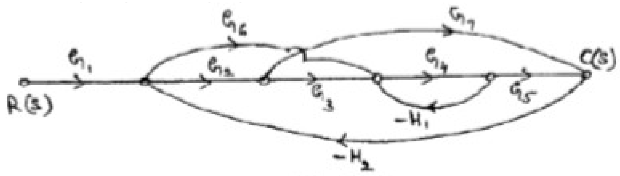
Module	Note	Answer all FIVE full questions. All questions carry equal marks.	Marks	CO	Level
1	a	Draw the equivalent mechanical system of the given system. Hence write the set of equilibrium equation for it and obtain electrical analogous circuit using F-V analogy.  Fig.Q1(b)	8	CO1	L3
	b	For the mechanical system shown in fig, write the differential equation describing its behavior. 	8	CO1	L3
	c	Explain open loop & closed loop control systems by giving suitable examples & also highlights their merits & demerits.	4	CO1	L3
		OR			
2	a	Obtain the transfer function of an armature controlled DC servomotor.	10	CO1	L3
	b	For the mechanical system shown : i) Draw the mechanical network. ii) Obtain equations of motion. H.) Draw an electrical network based on force current analogy. 	10	CO1	L3
3	a	Using Mason's gain formula, find the gain of the system shown in Fig 	10	CO2	L3

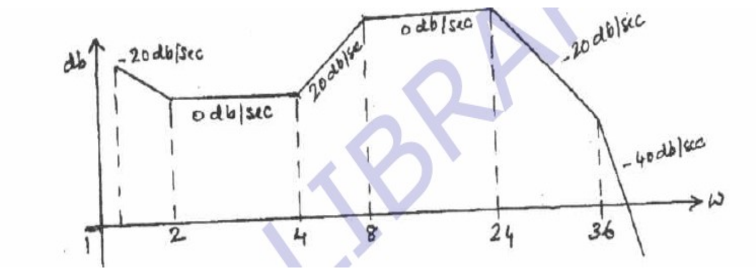
	b	Reduce the block diagram shown in Fig.Q2(c) using reduction rules and obtain C(s)/R(s). 	10	CO2	L3
		OR			
4	a	For the circuit shown in below Fig 'IC' is the gain of an ideal amplifier. Determine the transfer function I(s) / V (s) 	10	CO2	L3
	b	For the mechanical system shown in below Fig. (i)Obtain its mathematical model .(ii)Write the performance equation (iii)Obtain its Force-Voltage and Force-current analogous circuits 	10	CO2	L3
5	a	Derive the expression for unit step response for 2nd order control system with closed loop transfer function K/(S+1/t)	10	CO3	L3
		Find the step-response, C(t) for the system described by C(s) / R(s) = 4/ (S+ 4) Also find the time constant, rise time and settling time.	10	CO3	L3
		OR			
6	a	With the help of Routh Hurwitz criterion comments upon the stability of the system having the following characteristic equation S6+s5-2s4-3s3-7s2-4s-4=0	10	CO3	L3
	b	Derive the expression of rise time and maximum overshoot for second order underdamped control system.	10	CO3	L3
7	a	The open loop transfer function of a unity gain feedback is given by- G(s) = k(s+2)/(s4+3s3+4s2+2s) , k>=0 (a) Determine all the poles & zeros of G(s). (b) Draw the root locus.	10	CO4	L3
	b	Construct the Bode plot for the system with open loop transfer function $\frac{K}{S(S+1)(1+0.1S)}$ Determine the value of K such that (a) gain margin = 10db (b) Phase margin = 50^0.	10	CO4	L3
		OR			
8	a	Draw the root-locus of the feedback system whose open-loop transfer function is given by G (s)H(S)= K / $S^4 + 5S^3 + 8S^2 + 6S$	10	CO4	L3
		Determine the transfer function of a system whose asymptotic	10	CO4	L3

		Bode plot is as shown in fig 			
9	a	Explain the step by step design procedure of lead compensation network.	10	CO5	L3
	b	What is controller? Explain the effect of PI and PD controller on second order system.	10	CO5	L3
		OR			
10	a	Sketch the Nyquist Plot for a unity feedback system having open-loop transfer function given by - G(s) = k/s(1+s)(1+2s)(1+3s) Determine the range of values of k for which the system is stable	10	CO5	L3
	b	Explain proportional +integral+differential controller and effect on stability.	10	CO5	L3

2. SEE Important Questions

Course:	Control system		Month / Year	June /2020	
Crs Code:	17EE61	Sem: VI	Marks: 100	Time:	180 minutes
	Note	Answer all FIVE full questions. All questions carry equal marks.	-	-	
Module	Qno.	Important Question	**Marks**	**CO**	**Year**
1	1	**Define Control system? What are the requirements of a good control system.**	8	CO1	2014
	2	Draw the equivalent mechanical system of the given system. Hence write the set of equilibrium equation for it and obtain electrical analogous circuit using F-V analogy.  Fig.Q1(b)	10	CO1	2015
	3	For the mechanical system shown in fig, write the differential equation describing its behavior. 	10	CO1	2013

1	1	Obtain the transfer function of an armature controlled DC servomotor. (6 Marks),	10	CO1	July 2009, Dec 2010
2	3	 For the system described by the signal flow graph shown in fig. Q2(c), obtain the closed loop transfer function C(s) / R(s) , using Mason's gain formula. (6 Marks, Dec 2010) 	10	CO2	2012
2	1	Obtain the transfer function for the block diagram shown in fig. Q2(b) using block diagram reduction technique.(10 Marks, June 2012) 	10	CO2	2016
	2	2.(a) Determine the overall transfer function (C/R) of the system shown in figure by block dia (b) verify the result by 	10	CO2	2010
		Obtain the closed loop transfer function C(s)/ R(s) for the signal flow graph of a system shown in fig. Q2(b) using Mason's gain formula.	10 Marks	CO2	, June 2012)
2	1	Draw signal flow graph for the following equations- (i) y2 = a1*dy1/dt (ii) y3 = d2y2/dt2 + dy1/dt – y1 (iii) d2y/dx2 + 2/3 * dy/dx + 11/2 * y = x	10	CO2	2017
	2	A servo system for the position control of a rotable mass is stabilized by	10	CO3	2014

		viscous friction damping which is three-quarters of that is needed for critical damping. The undamped natural frequency of the system in 12Hz. Derive an expression for the output of the system, if the input control is suddenly moved to a new position, being initially at rest. Hence, find the maximum overshoot.			
3	1	Measurements conducted on a servomechanism show the system response to be C(t) = 1+0.2 e-60t – 1.2 e-10t , when subjected to a unit step input, obtain the expression for closed loop transfer function, the damping ratio & undamped natural frequency of oscillations.	10	CO3	2017
	2	The transfer function of a control system is given by G(s) = 1/(1+sT)2 . Show that if the input is a step displacement, the output will complete 98.26% of the step in 6T seconds for critical damping.	10	CO3	2014
4	1	Draw the root-locus of the feedback system whose open-loop transfer function is given by G (s)H(S)= $K / S^4 + 5S^3 + 8S^2 + 6S$	10	CO4	2014
	2	Determine the transfer function of a system whose asymptotic Bode plot is as  shown in fig	10	CO4	2015
	3	The open loop transfer function of a unity gain feedback is given by- G(s) = k(s+2)/(s4+3s3+4s2+2s) , k>=0 (a) Determine all the poles & zeros of G(s). (b) Draw the root locus.	10	CO4	2012
	4	Construct the Bode plot for the system with open loop transfer function $\frac{K}{S(S+1)(1+0.1S)}$ Determine the value of K such that (a) gain margin = 10db (b) Phase margin = 50^0.	10	CO4	2011
5	1	State the use of Nichol's Chart.	5	CO5	2004
	2	State the merits and demerits of PI Controller.	5	CO5	2005
	3	Sketch the Nyquist Plot for a unity feedback system having open-loop transfer function given by - G(s) = k/s(1+s)(1+2s)(1+3s) Determine the range of values of k for which the system is stable			

Course Outcome Computation

Academic Year:

Odd / Even semester

INTERNAL TEST	T1	T2	T3
Course Outcome			

QUESTION NO	
MAX MARKS	
USN-1	
USN-2	
USN-3	
USN-4	
USN-5	
USN-6	
Average CO Attainment	

LV Threshold : 3:>60%, 2:>=50% and <=60%, 1: <=49%
CO1 Computation :(2+2+2+3)/4 = 10/4=2.5

PO Computation

Program Outcome	PO1	PO3	PO3	PO1	PO12	PO12	PO6	PO1
Weight of CO - PO	3	1	3	2	2	3	3	1
Course Outcome								
Test/Quiz/ Lab	T1			T2			T3	
QUESTION NO								
MAX MARKS								
USN-1								
USN-2								
USN-3								
USN-4								
USN-5								
USN-6								
Average CO Attainment								