Ref No:

SRI KRISHNA INSTITUTE OF TECHNOLOGY BANGALORE

COURSE PLAN

Academic Year 2019-20

Program:	B E – Mechanical Engineering
Semester :	7
Course Code:	15ME73
Course Title:	CONTROL ENGINEERING
Credit / L-T-P:	04/3-2-0
Total Contact Hours:	54
Course Plan Author:	Mr. Harendra Kumar H V

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A. COURSE INFORMATION

1. Course Overview

Degree:	ME	Program:	ME
Semester:	VII	Academic Year:	2019-2020
Course Title:	CONTROL ENGINEERING	Course Code:	15ME71
Credit / L-T-P:	04/3-2-0	SEE Duration:	180 min
Total Contact Hours:	54 Hrs	SEE Marks:	80 Marks
CIA Marks:	20	Assignment	1 / Module
Course Plan Author:	Mr. Harendra Kumar H V	Sign	Dt:
Checked By:	Mr. Dinesh P	Sign	Dt:
CO Targets	CIA Target :90%	SEE Target:	85%

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: Concept of automatic controls, Open loop and closed loop systems, Concepts of feedback, requirements of an ideal control system, Types of controllers-Proportional, Integral, Differential, Proportional & Integral, Proportional Differential and Proportional Integral Differential controllers.	7	Control, feedback, controllers	L2
2	Modeling of Physical Systems :Mathematical Models of Mechanical, Electrical, Thermal, Hydraulic and Pneumatic Systems. Analogous Systems: Direct and inverse analogs for mechanical, thermal and fluid systems. Block diagram Algebra: General representation of a feedback control system, transfer functions, rules of block diagram algebra, reduction of block diagram to obtain closed loop transfer function. Signal flow graphs : Mason's gain formula	13	Mathematical Model, block and signal diagram	L3
3	Steady state operation: Steady state analysis for general block diagram. for a control system, steady state characteristics, equilibrium in a system. Transient Response: Transient response and steady state analysis of unit, step input, general operational representation for a differential equation of control system, distinct, repeated and complex conjugate zeros, general form of transient response, Routh's stability criterion for a control system. Root Locus Plots : Root locus method: Significance of Root locus, angle and magnitude conditions, breakaway points, angles of departure and arrival, construction of Root locus using general rules and steps, Lead and Lag compensation	13	Analysis of a system	L4
4	Frequency Domain Analysis: Relationship between time and frequency response, Polar plot, Bode's Plot, Nyquist plot and Nyquist stability criterion, Relative Stability, Phase and Gain Margins	14	stability analysis	l4
5	System Compensation and State Variable Characteristics of Linear Systems :Series and feedback compensation, Introduction to state concepts, state equation of linear continuous data system. Matrix representation of state equations, controllability and observability, Kalman and Gilberts test	7	transient and steady state time response	L3
-	**Total**	**54**	-	-

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.)**	-	-
1,2,4,5	Control Systems by Anand Kumar PHI,2nd edition	1,2,4,5	In Lib
3	Control Systems, Principles and Design by M.Gopal,McGaw Hill, 4th Edition, 2012	3	In Lib
B	**Reference books (Title, Authors, Edition, Publisher, Year.)**	-	-
3	Automatic Control Systems,FaridGolnaraghi, Benjamin C. Kuo Wiley 9 th Edition, 2010	3	In dept
4	Control Systems Engineering Modern Control Systems Norman S. Nise Richard C Dorf et al Wiley Pearson 4 th Edition, 2004,11 th Edition, 2008	4	In dept
1,2,4,5	Control Systems Engineering M.Gopal McGaw Hill 4 th Edition, 2012 S. Salivahanan et al Pearson 1 st Edition, 2015Automatic Control Systems	1,2,4,5	In dept
C	**Concept Videos or Simulation for Understanding**		
1	encyclopedia.che.engin.umich.edu ›		
2	https://www.powermag.com ›		
3	https://www.acciona-energia.co\		
4	https://www.delta-t.co.uk ›		
5	https://study.com › academy		
5	https://www.studentenergy.org › t		

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
4	15MAT21	Engineering Mathematics	Engineering calculus	II		L2

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

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	Concept	Instr Method	Assessment Method	Blooms' Level
1	15ME73.1	Understand the effects of feedback and	3	Control	Chalk and	Assignmen	L2

		types of feedback control systems		,feedback system	board	t and Slip Test	Understand
1	15ME73.2	Recognize control system and its types , control actions	4	controllers	Chalk and board	Assignment and Slip Test	L2 Understand
2	15ME73.3	Apply the system governing equations for physical models	7	Modelling systems	Chalk and board	Assignment and Slip Test	L3 Apply
2	15ME73.4	Calculate the gain of the system using block diagram and signal flow graph	6	Block and signal flow diagram	Chalk and board	Assignment and Slip Test	L3 Apply
3	15ME73.5	Apply response of 1st and 2nd order systems	7	Analysis of a system	Chalk and board	Assignment and Slip Test	L3 Apply
3	15ME73.6	Analysis of system using root locus plots.	6	stability analysis	Chalk and board	Assignment and Slip Test	L4 Analyse
4	15ME73.7	To analyze stability of a control system using Nyquist plot.	7	Frequency response analysis using polar plot.	Chalk and board	Assignment and Slip Test	L4 Analyse
4	15ME73.8	Analyse stability analysis using Bode plots	7	Frequency response analysis using bode plot.	Chalk and board	Assignment and Slip Test	L4 Analyse
5	15ME73.9	state equations to study the controllability and observability	3	system compensators	Chalk and board	Assignment and Slip Test	L3 Apply
5	15ME73.10	Different system compensators and variable characteristics of linear systems.	4	characteristics	Chalk and board	Assignment and Slip Test	L2 understand

2. Course Applications

Modules	Application Area Compiled from Module Applications.	CO	Level
1	Thermostat, thermoresister	CO1	L2
1	Industrial control panel, sensors	CO2	L2
2	Animal digestive system, solar system,	CO3	L3
2	Antenna control, amplifiers, digital filters	CO4	L3
3	Circuits for electrical systems	CO5	L3
4	synthesis of systems and to the prediction of the transient response.	CO6	L4
4	synthesis of systems and to the prediction of polar plot.	CO7	L4
5	synthesis of systems and to the prediction of bode plot.	CO8	L4
5	Multiple system application,	CO9	L3
	multivariable systems	CO10	L2

3. Mapping And Justification

CO – PO Mapping with mapping Level along with justification for each CO-PO pair.
To attain competency required (as defined in POs) in a specified area and the knowledge & ability required to accomplish it.

Modules	Mapping		Mapping Level	Justification for each CO-PO pair	Level
-	**CO**	**PO**	-	**'Area': 'Competency' and 'Knowledge' for specified 'Accomplishment'**	-
1	CO1	PO1	L2	'Engineering Knowledge:'Acquisition of Engineering_Knowledge is required to understand the different energy sources and there utilization to accomplish solutions to complex engineering problems in Mechanical Engineering.	L2
1	CO1	PO2	L3	'Problem Analysis':Analyzing problems require knowledge / understanding	L2

				different conversions of energy engineering fundamentals to accomplish solutions to complex engineering problems in Mechanical engineering.	
2	CO2	PO1	L3	'Engineering Knowledge:'Acquisition of Engineering_Knowledge is required to understand the different Thermal energy storage systems_to accomplish solutions to complex engineering_problems in Mechanical Engineering..	L2
2	CO2	PO2	L3	'Problem Analysis': Analyzing problems require knowledge / understanding storage systems to accomplish solutions to complex engineering problems in Mechanical engineering.	L3
3	CO3	PO1	L2	'Engineering Knowledge:'Acquisition of Engineering_Knowledge is required to understand the diesel engine power plant in Mechanical Engineering.	L2
3	CO3	PO2	L2	'Problem Analysis':Analyzing problems require knowledge / understanding diesel engine power plant,to accomplish solutions to complex engineering problems in Mechanical engineering.	L2
4	CO4	PO1	L3	'Engineering Knowledge:'Acquisition Knowledge of storage plants is required to understand hydroelectric power plant in Mechanical Engineering.	L3
4	CO4	PO2	L3	'Problem Analysis': Analyzing problems require knowledge / understanding storage plants in the hydro power plant systems to complex engineering problems in Mechanical engineering.	L2
5	CO5	PO1	L3	'Engineering Knowledge:'Acquisition of Engineering_Knowledge is required to understand the basic concept of solar power plant to accomplish solutions to complex engineering_problems in Mechanical Engineering.	L2
5	CO5	PO2	L3	'Problem Analysis': Analyzing problems in an solar Pv modules require knowledge / understanding problems in the soalr power plant in Mechanical engineering.	L2
6	CO6	PO1	L2	'Engineering Knowledge:'Acquisition of Engineering_Knowledge is required to understand the energy conversions from alternate source of energy in an complex engineering_problems in Mechanical Engineering.	L2
6	CO6	PO2	L3	'Problem Analysis': Analyzing problems require knowledge / understanding problems in conversion systems in an environment.	L2
7	CO7	PO1	L3	'Engineering Knowledge:'Acquisition of Engineering_Knowledge is required to understand the tide and wave enrgy to accomplish solutions to complex engineering problems in Mechanical Engineering.	L2
7	CO7	PO2	L3	'Problem Analysis': Analyzing problems require knowledge / understanding problems in the different types of wave and tidal energy to complex engineering problems in Mechanical engineering.	L3
8	CO8	PO1	L2	'Engineering Knowledge:'Acquisition of Engineering_Knowledge is required to understand the different biomass gasification process to complex engineering problems in Mechanical Engineering.	L2
8	CO8	PO2	L2	Problem Analysis':Analyzing problems require knowledge / understanding problems in the different gasifiers s in Mechanical engineering	L2
9	CO9	PO1	L2	'Engineering Knowledge:'Acquisition of Engineering_Knowledge is required to understand the fuel cell principles to complex engineering_problems in Mechanical Engineering.	L2
9	CO9	PO2	L2	Problem Analysis':Analyzing problems require knowledge / understanding problems in the different types of fuel cells to complex engineering problems in Mechanical engineering	L2

4. 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	15ME73.1	Evaluate time and space complexity	2	3														L2

		and calculate performance																Understand
1	15ME73.2	Understanding searching and sorting	3	2														L3 Apply
2	15ME73.3	Use AND / OR graph, spanning trees	2	3														L2 Understand
2	15ME73.4	Use Backtracking technique for searching a set of solutions or for searching an optimal solution	2	3														L3 Apply
3	15ME73.5	Apply Greedy method for finding optimal solution	3	2														L3 Apply
3	15ME73.6	Circuits for electrical systems	3	2														L3 Apply
4	15ME73.7	To analyze stability of a control system using Nyquist plot.	2	3														L2 Understand
4	15ME73.8	Analyse stability analysis using Bode plots	3	2														L2 Understand
5	15ME73.9	Able to differentiate NP – Hard and NP – Complete Problems	2	1														L2 Understand
5	15ME73.10	Analyse stability analysis with different tests	3	2														
-	**15ME73**	**Average attainment (1, 2, or 3)**																

5. 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	Root locus plot	NPTEL Videos	-	-	PO2
3	Nyquist Plot	NPTEL Videos	-	-	PO2
5	Bode plot	NPTEL Videos	12/11/2019	Self	PO2

6. Content Beyond Syllabus

Topics & contents required (from A.5) not addressed, but help students for Placement, GATE, Higher Education, Entrepreneurship, etc.

Modules	Gap Topic	Area	Actions Planned	Schedule Planned	Resources Person	PO Mapping
3	Construction of an array and PV Module	Placement, GATE, Higher Study	Presentation	9/9/2019	Self	PO5

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	7	2	-	-	1	1	2	CO1, CO2	L2,L2
2	Modeling of Physical Systems Block diagram Algebra Signal flow graphs	13	2	-	-	1	1	2	CO3, CO4	L3,L3
3	Steady state operation Transient Response Root Locus Plots	13	-	2	-	1	1	2	CO5, CO6	L3,L4
4	Frequency Domain Analysis	14	-	2	-	1	1	2	CO7, C08	L4,L4
5	System Compensation and State Variable Characteristics of Linear Systems	7	-	-	4	1	1	2	CO9, CO10	L3,L2
-	**Total**	**54**	**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	15	CO1, CO2, CO3, CO4	L2, L3, L2,L3
3, 4	CIA Exam – 2	15	CO5, CO6, CO7,	L4,L2,L2
5	CIA Exam – 3	15	CO8, CO9,CO10	L2, L2
1, 2	Assignment - 1	05	CO1, CO2, CO3, CO4	L2, L3, L2,L3
3, 4	Assignment - 2	05	CO5, CO6, CO7,	L3,L2,L2
5	Assignment - 3	05	CO8, CO9, CO10	L2, L2
1, 2	Seminar - 1	00		
3, 4	Seminar - 2	00		
5	Seminar - 3	00		
	-			
	Final CIA Marks	**20**	CO1 to CO10	L2, L3

D1. TEACHING PLAN – 1

Module – 1

Title:	Introduction	Appr Time:	7 Hrs
a	***Course Outcomes***	-	**Blooms**
-	The student should be able to:	-	**Level**
1	Understand the effects of feedback and types of feedback control systems	CO1	L2
2	Recognize control system and its types , control actions	CO2	L2
b	***Course Schedule***	-	-
Class No	**Module Content Covered**	**CO**	**Level**
1	Introduction	C01	L2
2	Concept of automatic controls,	C01	L2
3	Open loop and closed loop systems	C01	L2
4	Concepts of feedback, requirements of an ideal control system,	C01	L2
5	Types of controllers-Proportional, Integral	C02	L2
6	Differential, Proportional & Integral	C02	L2

7	Proportional Differential and Proportional Integral Differential controllers	C02	L2
c	**Application Areas**	**CO**	**Level**
1	Thermostat, thermoresister	CO1	L3
2	Industrial control panel, sensors	CO2	L4
d	**Review Questions**	-	-
1	Define control system with an examples	CO1	L2
2	Explain the concept of automatic controls, with examples	CO1	L2
3	Explain the concepts of feedback with examples	CO1	L2
4	Explain requirements of an ideal control system.	CO1	L2
5	Write the different types of controllers.	CO2	L2
6	Explain in detail proportional integral, proportional differential controllers.	CO2	L2
7	Explain in detail Proportional Differential controllers	CO2	L2
8	Explain in detail Proportional Integral Differential controllers.	CO2	L2
e	**Experiences**	-	-
1		CO1	L2
2			
3			
4		CO3	L3
5			

Module – 2Frequency Domain Analysis: Relationship between time and frequency response,

Title:	Modeling of Physical Systems	Appr Time:	13 Hrs
a	***Course Outcomes***	-	**Blooms**
-	The student should be able to:	-	**Level**
1	Apply the system governing equations for physical models	CO3	L4
2	Calculate the gain of the system using block diagram and signal flow graph	CO4	L3
b	***Course Schedule***	-	-
Class No	**Module Content Covered**	**CO**	**Level**
1	Modeling of Physical Systems	CO3	L4
2	Mathematical Models of Mechanical,Hydraulic and Pneumatic Systems.	CO3	L4
3	Mathematical Models of Electrical, thermal systems.	CO3	L4
4	Analogous Systems: Direct and inverse analogs	CO3	L4
5	Analogous Systems: for mechanical, thermal and fluid systems.	CO3	L4
6	Block diagram	CO4	L3
7	General representation of a feedback control system, transfer functions,	CO4	L3
8	rules of block diagram algebra, reduction of block diagram to obtain closed loop transfer function	CO4	L3
9	problems	CO4	L3
10	problems	CO4	L3
11	Signal flow graphs : Mason's gain formula	CO4	L3
12	problems	CO4	L3
13	problems	CO4	L3
c	**Application Areas**	**CO**	**Level**
1	Animal digestive system, solar system,	CO3	L3
2	Antenna control, amplifiers, digital filters	CO4	L4
d	**Review Questions**	-	-
1	obtain differential equations for the mechanical system shown. Also draw equivalent force-voltage and force-current circuits using analogues quantities.	CO3	L3
2	liquid level system in which q, is inflow rate, qo is out flow rate, R is hydraulic	CO4	L3

	resistance, C is hydraulic capacitance and h is head of liquid. Obtain transfer function.		
3	Obtain differential equation for RLC circuit.	CO3	L3
4	Obtain closed loop transfer function of the block diagram shown in Fig. using block diagram reduction techniques	CO4	L4
5	Draw signal flow graph for the system shown in Fig. and find using Mason's gain formula.	CO4	L3
6	Write the differential equations governing the behaviour of the mechanical system Also obtain the analogous electrical circuit based on force voltage analogy and loop equations	CO3	L4
7	Obtain the transfer function of field controlled DC motor	CO3	L3
8	reduce the block diagram shown in Fig.Q3(a) and obtain the transfer function	CO3	L3
9	fnd the transfer function by using Mason's gain formula for the signal flow graph shown in fig.	CO4	L4
10	A units feedback system characterized by an open loop transfer function Determine the following, when the system is subjected to a unit step input:i) Undamped natural frequently ii) Damping ratio iii) Peak overshoot iv) Peak time v) Settling time	CO3	L3
11	fnd the transfer function by using Mason's gain formula for the signal flow graph shown in fig.	CO4	L4
12	reduce the block diagram shown in Fig.Q3(a) and obtain the transfer function	CO4	L3
13	fnd the transfer function by using Mason's gain formula for the signal flow graph shown in fig.	CO4	L3
14	reduce the block diagram shown in Fig.Q3(a) and obtain the transfer function	CO4	L4
15	fnd the transfer function by using Mason's gain formula for the signal flow graph shown in fig.	CO4	L4
16	reduce the block diagram shown in Fig.Q3(a) and obtain the transfer function	CO4	L4
17	Write the differential equations governing the behaviour of the mechanical system	CO3	L4
18	Write the differential equations governing the behaviour of the mechanical system.	CO3	L4
19	obtain the analogous electrical circuit based on force voltage analogy and loop equations	CO3	L4
20	obtain the analogous electrical circuit based on force voltage analogy and loop equations	CO3	L4
e	**Experiences**	-	-
1		CO1	L2
2			
3			
4		CO3	L3
5			

E1. CIA EXAM – 1

a. Model Question Paper - 1

Crs Code:	15ME73	Sem:	7	Marks:	15	Time:	75 minutes
Course:							

-	-	**Note: Answer any 2 questions, each carry equal marks.**	**Marks**	**CO**	**Level**
1	a	Define control system with an examples	3	CO1	L1
	b	Explain the concept of automatic controls, with examples	2	CO1	L2
	c	Explain in detail Proportional Integral Differential controllers.	2	CO1	L3
2	a	Explain in detail Proportional Differential controllers	3	CO1	L2
	b	Explain requirements of an ideal control system.	2	CO1	L4
	c	Explain in detail proportional integral, proportional differential controllers.	2	CO1	L3
3	a	Write the differential equations governing the behaviour of the mechanical system.	4	CO2	L3
	b	obtain the analogous electrical circuit based on force voltage analogy and loop equations	2	CO2	L3

	c	obtain the analogous electrical circuit based on force voltage analogy and loop equations	2	CO2	L3
4	a	obtain differential equations for the mechanical system shown. Also draw equivalent force-voltage and force-current circuits using analogues quantities.	4	CO2	L3
	b	liquid level system in which q, is inflow rate, qo is out flow rate, R is hydraulic resistance, C is hydraulic capacitance and h is head of liquid. Obtain transfer function.	2	CO2	L3
	c	Obtain differential equation for RLC circuit.	2	CO2	L2

b. Assignment -1

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

Model Assignment Questions							
Crs Code:	15ME73	Sem:	VII	Marks:	5	Time:	90 – 120 minutes
Course:	Design and Analysis of Algorithms						
Note: Each student to answer 2-3 assignments. Each assignment carries equal mark.							

SNo	USN	Assignment Description	Marks	CO	Level
1		Define control system with an examples	5	CO1	L2
2		Explain the concept of automatic controls, with examples	5	CO1	L2
3		Explain the concepts of feedback with examples		CO1	L2
4		Explain requirements of an ideal control system.	5	CO1	L2
5		Write the different types of controllers.	5	CO1	L2
6		Explain in detail proportional integral, proportional differential controllers.	5	CO1	L2
7		Explain in detail Proportional Differential controllers	5	CO1	L2
8		Explain in detail Proportional Integral Differential controllers.	5	CO1	L2
9		obtain differential equations for the mechanical system shown. Also draw equivalent force-voltage and force-current circuits using analogues quantities.	5	CO2	L3
10		liquid level system in which q, is inflow rate, qo is out flow rate, R is hydraulic resistance, C is hydraulic capacitance and h is head of liquid. Obtain transfer function.	5	CO2	L3
11		Obtain differential equation for RLC circuit.	5	CO2	L3
12		Obtain closed loop transfer function of the block diagram shown in Fig. using block diagram reduction techniques	5	CO2	L3
13		Draw signal flow graph for the system shown in Fig. and find using Mason's gain formula.	5	CO2	L3
14		Write the differential equations governing the behaviour of the mechanical system Also obtain the analogous electrical circuit based on force voltage analogy and loop equations	5	CO2	L3
15		Obtain the transfer function of field controlled DC motor	5	CO2	L3
16		reduce the block diagram shown in Fig.Q3(a) and obtain the transfer function	5	CO2	L3
17		fnd the transfer function by using Mason's gain formula for the signal flow graph shown in fig.	5	CO2	L3
18		A units feedback system characterized by an open loop transfer function Determine the following, when the system is subjected to a unit step input:i) Undamped natural frequently ii) Damping ratio iii) Peak overshoot iv) Peak time v) Settling time	5	CO2	L3
19		fnd the transfer function by using Mason's gain formula for the signal flow graph shown in fig.	5	CO2	L3
20		reduce the block diagram shown in Fig.Q3(a) and obtain the transfer function	5	CO2	L3
21		fnd the transfer function by using Mason's gain formula for the signal flow graph shown in fig.	5	CO2	L3
22		reduce the block diagram shown in Fig.Q3(a) and obtain the transfer function	5	CO2	L3
23		fnd the transfer function by using Mason's gain formula for the signal flow graph shown in fig.	5	CO2	L3

24		reduce the block diagram shown in Fig.Q3(a) and obtain the transfer function	5	CO2	L3
25		Write the differential equations governing the behaviour of the mechanical system	5	CO2	L3
26		Write the differential equations governing the behaviour of the mechanical system.	5	CO2	L3
27		obtain the analogous electrical circuit based on force voltage analogy and loop equations	5	CO2	L3
28		obtain the analogous electrical circuit based on force voltage analogy and loop equations	5	CO2	L3
29		Obtain closed loop transfer function of the block diagram shown in Fig. using block diagram reduction techniques	5	CO2	L3
30		Draw signal flow graph for the system shown in Fig. and find using Mason's gain formula.	5	CO2	L3
31		Write the differential equations governing the behaviour of the mechanical system Also obtain the analogous electrical circuit based on force voltage analogy and loop equations	5	CO2	L3
32		Obtain the transfer function of field controlled DC motor	5	CO2	L3
33		reduce the block diagram shown in Fig. and obtain the transfer function	5	CO2	L3
34		fnd the transfer function by using Mason's gain formula for the signal flow graph shown in fig.	5	CO2	L3
35		A units feedback system characterized by an open loop transfer function Determine the following, when the system is subjected to a unit step input:i) Undamped natural frequently ii) Damping ratio iii) Peak overshooti v) Peak time v) Settling time	5	CO2	L3
36		fnd the transfer function by using Mason's gain formula for the signal flow graph shown in fig.	5	CO2	L3
37		reduce the block diagram shown in Fig. and obtain the transfer function	5	CO2	L3
38		fnd the transfer function by using Mason's gain formula for the signal flow graph shown in fig.	5	CO2	L3
39		reduce the block diagram shown in Fig. and obtain the transfer function	5	CO2	L3
40		reduce the block diagram shown in Fig.Q3(a) and obtain the transfer function	5	CO2	L3
41		Write the differential equations governing the behaviour of the mechanical system	5	CO2	L3
42		Write the differential equations governing the behaviour of the mechanical system.	5	CO2	L3
43		reduce the block diagram shown in Fig. and obtain the transfer function	5	CO2	L3
44		Write the differential equations governing the behaviour of the mechanical system	5	CO2	L3
45		Write the differential equations governing the behaviour of the mechanical system.	5	CO2	L3

D2. TEACHING PLAN - 2

Module – 3

Title:	Steady state operation,Transient Response,Root Locus Plots	Appr Time:	13 Hrs
a	***Course Outcomes***	-	**Blooms**
-	The student should be able to:	-	**Level**
1	Apply response of 1st and 2nd order systems	CO5	L3
2	Analysis of system using root locus plots.	CO6	L4
b	***Course Schedule***		
Class No	**Module Content Covered**	**CO**	**Level**
1	Steady state analysis for general block diagram.	CO5	L3
2	control system, steady state characteristics	CO5	L3
3	equilibrium in a system	CO5	L3
4	Transient response and steady state analysis of unit, step input,	CO5	L3
5	General operational representation for a differential	CO5	L3

	equation of control system,		
6	Distinct, repeated and complex conjugate zeros, general form of transient response	CO5	L3
7	Routh's stability criterion for a control system.	CO6	L4
8	Significance of Root locus, angle and magnitude conditions	CO6	L4
9	breakaway points, angles of departure and arrival	CO6	L4
10	construction of Root locus using general rules and steps	CO6	L4
11	Lead and Lag compensation	CO6	L4
12	problems	CO6	L4
13	problems	CO6	L4
c	**Application Areas**	**CO**	**Level**
1	Circuits for electrical systems	CO5	L3
2	synthesis of systems and to the prediction of the transient response.	CO6	L4
d	**Review Questions**	-	-
1	Obtain response equation for a first order mechanical system subjected to unit step input.	CO5	L3
2	Define the following terms: ii) Delay time i) Rise time iv)Maximum overshoot iii) Settling time	CO5	L3
3	Discuss on stability of system.	CO5	L3
4	Obtain response equation for a first order mechanical system subjected to unit step input.	CO5	L3
5	Discuss the Value of K for phase margin	CO6	L4
6	Discuss the Value of K for gain margin	CO6	L4
7	Explain the effect of addition of poles and zero's to the system	CO5	L3
8	Discuss the Limiting value of K for system to be stable.	CO6	L4
9	Explain Routh Hurwitz criterion for stability of a control system	CO5	L3
10	Obtain response equation for a first order mechanical system subjected to unit step input.	CO5	L3
11	Sketch Root Locus plot for the unity feedback system whose open loop transfer function on stability of system.	CO6	L4
12	Sketch Root Locus plot for the unity feedback system whose open loop transfer function on stability of system.	CO6	L4
13	Sketch Root Locus plot for the unity feedback system whose open loop transfer function on stability of system.	CO6	L4
14	Sketch Root Locus plot for the unity feedback system whose open loop transfer function on stability of system.	CO6	L4
15	Sketch Root Locus plot for the unity feedback system whose open loop transfer function on stability of system.	CO6	L4
16	Sketch Root Locus plot for the unity feedback system whose open loop transfer function on stability of system.	CO6	L4
17	Discuss on stability of system.	CO6	L4
18	Obtain response equation for a first order mechanical system subjected to unit step input.	CO6	L4
19	Discuss the Value of K for phase margin	CO6	L4
20	Discuss the Value of K for gain margin	CO6	L4
21	Sketch Root Locus plot for the unity feedback system whose open loop transfer function on stability of system.	CO6	L4
22	Sketch Root Locus plot for the unity feedback system whose open loop transfer function on stability of system.	CO6	L4
23	Sketch Root Locus plot for the unity feedback system whose open loop transfer function on stability of system.	CO6	L4
24	Sketch Root Locus plot for the unity feedback system whose open loop transfer function on stability of system.	CO6	L4
25	Sketch Root Locus plot for the unity feedback system whose open loop transfer function on stability of system.	CO6	L4
26	Sketch Root Locus plot for the unity feedback system whose open loop transfer	CO6	L4

	function on stability of system.		
27	Sketch the root locus plot for the system whose open loop transfer function	CO6	L4
28	Sketch the root locus plot for the system whose open loop transfer function	CO6	L4
29	Sketch the root locus plot for the system whose open loop transfer function	CO6	L4
30	Sketch the root locus plot for the system whose open loop transfer function	CO6	L4
31	Explain the following: i) Lead compensator ii) Lag compensator	CO6	L3
e	**Experiences**	-	-
1			
2			
3			
4			
5			

Module – 4

Title:	Frequency Domain Analysis:	Appr Time:	14 Hrs
a	***Course Outcomes***	-	**Blooms**
-	The student should be able to:	-	**Level**
1	To analyze stability of a control system using Nyquist plot.	CO7	L4
2	Analyse stability analysis using Bode plots	CO8	L4
b	***Course Schedule***		
Class No	**Module Content Covered**	**CO**	**Level**
1	Relationship between time and frequency response,	CO7	L4
2	Polar plot,Phase and Gain Margins	CO7	L4
3	problems	CO7	L4
4	problems	CO7	L4
5	problems	CO7	L4
6	problems	CO7	L4
7	problems	CO7	L4
8	Nyquist plot and Nyquist stability criterion, Relative Stability	CO8	L4
9	Nyquist plot ,Phase and Gain Margins	CO8	L4
10	problems	CO8	L4
11	problems	CO8	L4
12	problems	CO8	L4
13	problems	CO8	L4
14	problems	CO8	L4
c	**Application Areas**	**CO**	**Level**
1	synthesis of systems and to the prediction of polar plot.	CO8	L4
2	synthesis of systems and to the prediction of bode plot.	CO7	L4
d	**Review Questions**	-	-
1	Discuss the Value of K for phase margin	CO7	L4
2	Sketch the bode plot for a unity feed-back system, whose open loop transfer function	CO7	L4
3	Sketch the bode plot for a unity feed-back system, whose open loop transfer function	CO8	L4
4	Discuss the gain and phase cross over frequencies.	CO7	L4
5	Discuss the gain and phase margin.	CO8	L4
6	Discuss the stability of the closed loop system.	CO8	L4
7	Sketch the bode plot for a unity feed-back system, whose open loop transfer function	CO7	L4
8	Sketch the bode plot for a unity feed-back system, whose open loop transfer function	CO7	L4
9	Sketch the bode plot for a unity feed-back system, whose open loop transfer	CO7	L4

	function		
10	Sketch the bode plot for a unity feed-back system, whose open loop transfer function	CO7	L4
11	Plot the Nyquit diagram for the open loop transfer function	CO8	L4
12	Plot the Nyquit diagram for the open loop transfer function	CO8	L4
13	Plot the Nyquit diagram for the open loop transfer function	CO8	L4
14	Plot the Nyquit diagram for the open loop transfer function	CO8	L4
15	Plot the Nyquit diagram for the open loop transfer function	CO8	L4
16	Plot the Nyquit diagram for the open loop transfer function	CO8	L4
17	Plot the Nyquit diagram for the open loop transfer function	CO8	L4
18	Plot the Nyquit diagram for the open loop transfer function	CO8	L4
19	Plot the Nyquit diagram for the open loop transfer function	CO8	L4
20	Plot the Nyquit diagram for the open loop transfer function	CO8	L4
21	Plot the Nyquit diagram for the open loop transfer function	CO8	L4
22	Sketch the bode plot for a unity feed-back system, whose open loop transfer function	CO7	L4
23	Sketch the bode plot for a unity feed-back system, whose open loop transfer function	CO7	L4
24	Sketch the bode plot for a unity feed-back system, whose open loop transfer function	CO7	L4
25	Sketch the bode plot for a unity feed-back system, whose open loop transfer function	CO7	L4
26	Sketch the bode plot for a unity feed-back system, whose open loop transfer function	CO7	L4
27	Sketch the bode plot for a unity feed-back system, whose open loop transfer function	CO7	L4
28	Sketch the bode plot for a unity feed-back system, whose open loop transfer function	CO7	L4
29	Sketch the bode plot for a unity feed-back system, whose open loop transfer function	CO7	L4
30	Sketch the bode plot for a unity feed-back system, whose open loop transfer function	CO7	L4
e	**Experiences**	-	-
1		CO7	L2
2			
3			
4		CO8	L3
5			

E2. CIA EXAM – 2

a. Model Question Paper - 2

Crs Code:	15ME73	Sem:	VII	Marks:	15	Time:	75 minutes
Course:	Steady state operation,Transient Response,Root Locus Plots,Frequency Domain Analysis:						

-	-	**Note: Answer any 2 questions, each carry equal marks.**	**Marks**	**CO**	**Level**
1	a	Discuss on stability of system.	2	CO5	L2
	b	Obtain response equation for a first order mechanical system subjected to unit step input.	4	CO5	L2
	c	Sketch Root Locus plot for the unity feedback system whose open loop transfer function on stability of system.	3	CO6	L4
2	a	Sketch Root Locus plot for the unity feedback system whose open loop transfer function on stability of system.	3	CO6	L4
	b	Discuss the Value of K for phase margin	2	CO5	L2
	c	Discuss the Value of K for gain margin	2	CO5	L2
3	a	Discuss the gain and phase margin.	2	CO7	L2
	b	Plot the Nyquit diagram for the open loop transfer function.	5	CO8	L4

4	a	Discuss the gain and phase margin.	2	CO7	L2
	b	Sketch the bode plot for a unity feed-back system, whose open loop transfer function.	5	CO8	L4

b. Assignment – 2

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

Model Assignment Questions							
Crs Code:	15ME73	Sem:	VII	Marks:	5 / 10	Time:	90 – 120 minutes
Course:	Steady state operation,Transient Response,Root Locus Plots,Frequency Domain Analysis:						
Note: Each student to answer 2-3 assignments. Each assignment carries equal mark.							

SNo	USN	Assignment Description	Marks	CO	Level
1		Obtain response equation for a first order mechanical system subjected to unit step input.	5	CO5	L3
2		Define the following terms: ii) Delay time i) Rise time iv)Maximum overshoot iii) Settling time	5	CO5	L3
3		Discuss on stability of system.	5	CO5	L3
4		Obtain response equation for a first order mechanical system subjected to unit step input.	5	CO5	L3
5		Discuss the Value of K for phase margin	5	CO6	L4
6		Discuss the Value of K for gain margin	5	CO6	L4
7		Explain the effect of addition of poles and zero's to the system	5	CO5	L3
8		Discuss the Limiting value of K for system to be stable.	5	CO6	L4
9		Explain Routh Hurwitz criterion for stability of a control system	5	CO5	L3
10		Obtain response equation for a first order mechanical system subjected to unit step input.	5	CO5	L3
11		Sketch Root Locus plot for the unity feedback system whose open loop transfer function on stability of system.	5	CO6	L4
12		Sketch Root Locus plot for the unity feedback system whose open loop transfer function on stability of system.	5	CO6	L4
13		Sketch Root Locus plot for the unity feedback system whose open loop transfer function on stability of system.	5	CO6	L4
14		Sketch Root Locus plot for the unity feedback system whose open loop transfer function on stability of system.	5	CO6	L4
15		Sketch Root Locus plot for the unity feedback system whose open loop transfer function on stability of system.	5	CO6	L4
16		Sketch Root Locus plot for the unity feedback system whose open loop transfer function on stability of system.	5	CO6	L4
17		Discuss on stability of system.	5	CO6	L4
18		Obtain response equation for a first order mechanical system subjected to unit step input.	5	CO6	L4
19		Discuss the Value of K for phase margin	5	CO6	L4
20		Discuss the Value of K for gain margin	5	CO6	L4
21		Sketch Root Locus plot for the unity feedback system whose open loop transfer function on stability of system.	5	CO6	L4
22		Sketch Root Locus plot for the unity feedback system whose open loop transfer function on stability of system.	5	CO6	L4
23		Sketch Root Locus plot for the unity feedback system whose open loop transfer function on stability of system.	5	CO6	L4
24		Sketch Root Locus plot for the unity feedback system whose open loop transfer function on stability of system.	5	CO6	L4
25		Sketch Root Locus plot for the unity feedback system whose open loop transfer function on stability of system.	5	CO6	L4
26		Sketch Root Locus plot for the unity feedback system whose open loop transfer function on stability of system.	5	CO6	L4

27		Sketch the root locus plot for the system whose open loop transfer function	5	CO6	L4
28		Sketch the root locus plot for the system whose open loop transfer function	5	CO6	L4
29		Sketch the root lSketch Root Locus plot for the unity feedback system whose open loop transfer function on stability of system.Sketch Root Locus plot for the unity feedback system whose open loop transfer function on stability of system.Obtain response equation for a first order mechanical system subjected to unit step input.Explain Routh Hurwitz criterion for stability of a control systemDiscuss the Limiting value of K for system to be stable.Explain the effect of addition of poles and zero's to the systemDiscuss the Value of K for gain margin Discuss the Value of K for phase marginObtain response equation for a first order mechanical system subjected to unit step input.Discuss on stability of system.Define the following terms: ii) Delay time i) Rise time iv)Maximum overshoot iii) Settling timeObtain response equation for a first order mechanical system subjected to unit step input.Sketch Root Locus plot for the unity feedback system whose open loop transfer function on stability of system.ocus plot for the system whose open loop transfer function	5	CO6	L4
30		Sketch the root locus plot for the system whose open loop transfer function	5	CO6	L4
31		Explain the following: i) Lead compensator ii) Lag compensator	5	CO6	L3
32		Discuss the Value of K for phase margin	5	CO7	L4
33		Sketch the bode plot for a unity feed-back system, whose open loop transfer function	5	CO7	L4
34		Sketch the bode plot for a unity feed-back system, whose open loop transfer function	5	CO8	L4
35		Discuss the gain and phase cross over frequencies.	5	CO7	L4
36		Discuss the gain and phase margin.	5	CO8	L4
37		Discuss the stability of the closed loop system.	5	CO8	L4
38		Sketch the bode plot for a unity feed-back system, whose open loop transfer function	5	CO7	L4
39		Sketch the bode plot for a unity feed-back system, whose open loop transfer function	5	CO7	L4
40		Sketch the bode plot for a unity feed-back system, whose open loop transfer function	5	CO7	L4
41		Sketch the bode plot for a unity feed-back system, whose open loop transfer function	5	CO7	L4
42		Plot the Nyquit diagram for the open loop transfer function	5	CO8	L4
43		Plot the Nyquit diagram for the open loop transfer function	5	CO8	L4
44		Plot the Nyquit diagram for the open loop transfer function	5	CO8	L4
45		Plot the Nyquit diagram for the open loop transfer function	5	CO8	L4
46		Plot the Nyquit diagram for the open loop transfer function	5	CO8	L4
47		Plot the Nyquit diagram for the open loop transfer function	5	CO8	L4
48		Plot the Nyquit diagram for the open loop transfer function	5	CO8	L4
49		Plot the Nyquit diagram for the open loop transfer function	5	CO8	L4
50		Plot the Nyquit diagram for the open loop transfer function	5	CO8	L4
51		Plot the Nyquit diagram for the open loop transfer function	5	CO8	L4
52		Plot the Nyquit diagram for the open loop transfer function	5	CO8	L4
53		Sketch the bode plot for a unity feed-back system, whose open loop transfer function	5	CO7	L4
54		Sketch the bode plot for a unity feed-back system, whose open loop transfer function	5	CO7	L4
55		Sketch the bode plot for a unity feed-back system, whose open loop transfer function	5	CO7	L4
56		Sketch the bode plot for a unity feed-back system, whose open loop transfer function	5	CO7	L4

57		Sketch the bode plot for a unity feed-back system, whose open loop transfer function	5	CO7	L4
58		Sketch the bode plot for a unity feed-back system, whose open loop transfer function	5	CO7	L4
59		Sketch the bode plot for a unity feed-back system, whose open loop transfer function	5	CO7	L4
60		Sketch the bode plot for a unity feed-back system, whose open loop transfer function	5	CO7	L4
61		Sketch the bode plot for a unity feed-back system, whose open loop transfer function	5	CO7	L4

D3. TEACHING PLAN - 3

Module – 5

Title:	System Compensation and State Variable Characteristics of Linear Systems	Appr Time:	7 Hrs
a	***Course Outcomes***	-	**Blooms**
-	The student should be able to:	-	**Level**
1	state equations to study the controllability and observability	CO9	L2
2	Different system Compensators and variable characteristics of linear systems.	CO10	L3
b	***Course Schedule***		
Class No	**Module Content Covered**	**CO**	**Level**
1	Series and feedback compensation,	CO9	L2
2	Introduction to state concepts, state equation of linear continuous data system	CO9	L2
3	Matrix representation of state equations,	CO9	L2
4	Controllability and observability	CO10	L3
5	Kalman and Gilberts test	CO10	L3
6	Problems	CO10	L3
7	problems	CO10	L3
c	**Application Areas**	**CO**	**Level**
1	Multiple system application,	CO9	L2
2	*m*ultivariable systems	CO10	L3
d	**Review Questions**	-	-
1	Explain the series with block diagrams	CO9	L2
2	A system is represented by a differential equation y + 6y +12y +10y = 4U , where y is the output and U is the input of the system. Obtain state space equation.	CO9	L2
3	A system is represented by a differential equation, where y is the output and U is the input of the system. Obtain state space equation.	CO10	L3
4	Explain the effect of addition of poles and zero's to the system.	CO9	L2
5	Explain Kalman and Gilberts test	CO9	L2
6	Discuss the Controllability and observability	CO9	L2
7	Explain the feedback compensated system, with block diagrams	CO9	L2
8	A system is represented by a differential equation, where y is the output and U is the input of the system. Obtain state space equation.	CO10	L3
9	A system is represented by a differential equation, where y is the output and U is the input of the system. Obtain state space equation.	CO10	L3
10	A system is represented by a differential equation, where y is the output and U is the input of the system. Obtain state space equation.	CO10	L3
11	A system is represented by a differential equation, where y is the output and U is the input of the system. Obtain state space equation.	CO10	L3
12	A system is represented by a differential equation, where y is the output and U is the input of the system. Obtain state space equation.	CO10	L3
13	A system is represented by a differential equation, where y is the output and U is the input of the system. Obtain state space equation.	CO10	L3
14	A system is represented by a differential equation, where y is the output and U is the input of the system. Obtain state space equation.	CO10	L3

15	A system is represented by a differential equation, where y is the output and U is the input of the system. Obtain state space equation.	CO10	L3
16	A system is represented by a differential equation, where y is the output and U is the input of the system. Obtain state space equation.	CO10	L3
17	A system is represented by a differential equation, where y is the output and U is the input of the system. Obtain state space equation.	CO10	L3
18	A system is represented by a differential equation, where y is the output and U is the input of the system. Obtain state space equation.	CO10	L3
19	A system is represented by a differential equation, where y is the output and U is the input of the system. Obtain state space equation.	CO10	L3
20	A system is represented by a differential equation, where y is the output and U is the input of the system. Obtain state space equation.	CO10	L3
e	**Experiences**	-	-
1		CO10	L2
2			
3			
4		CO9	L3
5			

E3. CIA EXAM – 3

a. Model Question Paper - 3

Crs Code:	15ME73	Sem:	VII	Marks:	15	Time:	75 minutes
Course:	System Compensation and State Variable Characteristics of Linear Systems						

-	-	Note: Answer any 2 questions, each carry equal marks.	Marks	CO	Level
1	a	Explain the series with block diagrams	2	CO9	L2
	b	A system is represented by a differential equation y + 6y +12y +10y = 4U , where y is the output and U is the input of the system. Obtain state space equation.	3	CO10	L3
	c	Explain the feedback compensated system, with block diagrams	2	CO9	L2
2	a	A system is represented by a differential equation, where y is the output and U is the input of the system. Obtain state space equation.	3	CO10	L3
	b	Explain the effect of addition of poles and zero's to the system.	2	CO9	L2
	c	A system is represented by a differential equation, where y is the output and U is the input of the system. Obtain state space equation.	2	CO10	L3
3	a	Explain Kalman test.	2	CO9	L2
	b	Discuss the Controllability.	2	CO9	L2
	c	A system is represented by a differential equation, where y is the output and U is the input of the system. Obtain state space equation.	4	CO10	L3
4	a	Explain Gilberts test	2	CO9	L2
	b	A system is represented by a differential equation, where y is the output and U is the input of the system. Obtain state space equation.	4	CO10	L3
	c	Discuss the observability	2	CO9	L2

b. Assignment – 3

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

Model Assignment Questions							
Crs Code:	17ME73	Sem:	VII	Marks:	5 / 10	Time:	90 – 120 minutes
Course:	System Compensation and State Variable Characteristics of Linear Systems						
Note: Each student to answer 2-3 assignments. Each assignment carries equal mark.							

SNo	USN	Assignment Description	Marks	CO	Level
1		Explain the series with block diagrams	5	CO9	L2
2		A system is represented by a differential equation y + 6y +12y +10y = 4U , where y is the output and U is the input of the system. Obtain state space equation.	5	CO9	L2

3		A system is represented by a differential equation, where y is the output and U is the input of the system. Obtain state space equation.	5	CO10	L3
4		Explain the effect of addition of poles and zero's to the system.	5	CO9	L2
5		Explain Kalman and Gilberts test	5	CO9	L2
6		Discuss the Controllability and observability	5	CO9	L2
7		Explain the feedback compensated system, with block diagrams	5	CO9	L2
8		A system is represented by a differential equation, where y is the output and U is the input of the system. Obtain state space equation.	5	CO10	L3
9		A system is represented by a differential equation, where y is the output and U is the input of the system. Obtain state space equation.	5	CO10	L3
10		A system is represented by a differential equation, where y is the output and U is the input of the system. Obtain state space equation.	5	CO10	L3
11		A system is represented by a differential equation, where y is the output and U is the input of the system. Obtain state space equation.	5	CO10	L3
12		A system is represented by a differential equation, where y is the output and U is the input of the system. Obtain state space equation.	5	CO10	L3
13		A system is represented by a differential equation, where y is the output and U is the input of the system. Obtain state space equation.	5	CO10	L3
14		A system is represented by a differential equation, where y is the output and U is the input of the system. Obtain state space equation.	5	CO10	L3
15		A system is represented by a differential equation, where y is the output and U is the input of the system. Obtain state space equation.	5	CO10	L3
16		A system is represented by a differential equation, where y is the output and U is the input of the system. Obtain state space equation.	5	CO10	L3
17		A system is represented by a differential equation, where y is the output and U is the input of the system. Obtain state space equation.	5	CO10	L3
18		A system is represented by a differential equation, where y is the output and U is the input of the system. Obtain state space equation.	5	CO10	L3
19		A system is represented by a differential equation, where y is the output and U is the input of the system. Obtain state space equation.	5	CO10	L3
20		A system is represented by a differential equation, where y is the output and U is the input of the system. Obtain state space equation.	5	CO10	L3

F. EXAM PREPARATION

1. University Model Question Paper

Course:	Control engineering					Month / Year	AUG /2019	
Crs Code:	17ME73	Sem:	VII	Marks:	80	Time:	180 minutes	

-	**Note**	Answer all FIVE full questions. All questions carry equal marks.	**Marks**	**CO**	**Level**
1	a	Define control system with an examples	3	CO1	L1
	b	Explain the concept of automatic controls, with examples	2	CO1	L2
	c	Explain in detail Proportional Integral Differential controllers.	2	CO1	L3
		OR			
-	a	Explain in detail Proportional Differential controllers	3	CO1	L2
	b	Explain requirements of an ideal control system.	2	CO1	L4
	c	Explain in detail proportional integral, proportional differential controllers.	2	CO1	L3
2	a	Write the differential equations governing the behaviour of the mechanical system.	4	CO2	L3
	b	obtain the analogous electrical circuit based on force voltage analogy and loop equations	2	CO2	L3
	c	obtain the analogous electrical circuit based on force voltage analogy and loop equations	2	CO2	L3
		OR			
-	a	obtain differential equations for the mechanical system shown. Also draw equivalent force-voltage and force-current circuits using analogues quantities.	4	CO2	L3
	b	liquid level system in which q, is inflow rate, qo is out flow rate, R is hydraulic resistance, C is hydraulic capacitance and h is head of liquid. Obtain transfer function.	2	CO2	L3
	c	Obtain differential equation for RLC circuit.	2	CO2	L2

3	a	Discuss on stability of system.	2	CO5	L2
	b	Obtain response equation for a first order mechanical system subjected to unit step input.	4	CO5	L2
	c	Sketch Root Locus plot for the unity feedback system whose open loop transfer function on stability of system.	3	CO6	L4
		OR			
-	a	Sketch Root Locus plot for the unity feedback system whose open loop transfer function on stability of system.	3	CO6	L4
	b	Discuss the Value of K for phase margin	2	CO5	L2
	c	Discuss the Value of K for gain margin	2	CO5	L2
4	a	Discuss the gain and phase margin.	2	CO7	L2
	b	Plot the Nyquit diagram for the open loop transfer function.	5	CO8	L4
		OR	2	CO7	L2
-	a	Discuss the gain and phase margin.	5	CO8	L4
	b	Sketch the bode plot for a unity feed-back system, whose open loop transfer function.		CO8	
5	a	Explain the series with block diagrams	2	CO9	L2
	b	A system is represented by a differential equation y + 6y +12y +10y = 4U , where y is the output and U is the input of the system. Obtain state space equation.	3	CO10	L3
	c	Explain the feedback compensated system, with block diagrams	2	CO9	L2
		OR			
	a	A system is represented by a differential equation, where y is the output and U is the input of the system. Obtain state space equation.	3	CO10	L3
	b	Explain the effect of addition of poles and zero's to the system.	2	CO9	L2
	c	A system is represented by a differential equation, where y is the output and U is the input of the system. Obtain state space equation.	2	CO10	L3

2. SEE Important Questions

Course:		Control engineering	Month / Year		Aug /2019
Crs Code:		17ME73 Sem: VII Marks: 80	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 with an examples	2	CO1	2013
	2	Explain the concept of automatic controls with examples	4	CO1	2014
	3	Explain the concepts of feedback with examples	3	CO1	2015
	4	Explain requirements of an ideal control system.	5	CO1	2016
	5	Write the different types of controllers.	6	CO2	2017
	6	Explain in detail proportional integral, proportional differential controllers.	6	CO2	2015
	7	Explain in detail Proportional Differential controllers	6	CO2	2016
	8	Explain in detail Proportional Integral Differential controllers.	6	CO2	2017
2	1	obtain differential equations for the mechanical system shown. Also draw equivalent force-voltage and force-current circuits using analogues quantities.	7	CO3	2013
	2	liquid level system in which q, is inflow rate, qo is out flow rate, R is hydraulic resistance, C is hydraulic capacitance and h is head of liquid. Obtain transfer function.	7	CO4	2014
	3	Obtain differential equation for RLC circuit.	4	CO3	2015
	4	Obtain closed loop transfer function of the block diagram shown in Fig. using block diagram reduction techniques	5	CO4	2016
	5	Draw signal flow graph for the system shown in Fig. and find using Mason's gain formula.	7	CO4	2017
	6	Obtain the transfer function of field controlled DC motor	7	CO3	2015
	7	obtain the analogous electrical circuit based on force voltage analogy and loop equations	7	CO3	2016
	8	fnd the transfer function by using Mason's gain formula for the signal flow graph shown in fig.	7	CO4	2017

	9	reduce the block diagram shown in Fig. and obtain the transfer function	7	CO3	2016
	10	fnd the transfer function by using Mason's gain formula for the signal flow graph shown in fig.	7	CO4	2017
3	1	Obtain response equation for a first order mechanical system subjected to unit step input.		CO5	2013
	2	Define the following terms: ii) Delay time i) Rise time iv)Maximum overshoot iii) Settling time		CO5	2014
	3	Discuss on stability of system.		CO5	2015
	4	Obtain response equation for a first order mechanical system subjected to unit step input.		CO5	2016
	5	Discuss the Value of K for phase margin		CO5	2017
	6	Discuss the Value of K for gain margin		CO5	2015
	7	Explain the effect of addition of poles and zero's to the system		CO5	2016
	8	Discuss the Limiting value of K for system to be stable.		CO5	2017
	9	Explain Routh Hurwitz criterion for stability of a control system		CO6	2016
	10	Sketch Root Locus plot for the unity feedback system whose open loop transfer function on stability of system.		CO6	2017
4	1	Discuss the Value of K for phase margin	2	CO7	2016
	2	Sketch the bode plot for a unity feed-back system, whose open loop transfer function	12	CO8	2017
	3	Plot the Nyquit diagram for the open loop transfer function	12	CO8	2016
	4	Discuss the gain and phase cross over frequencies.	4	CO8	2017
	5	Discuss the gain and phase margin.	4	CO7	2018
	6	Discuss the stability of the closed loop system.	4	CO7	2018
5	1	Explain the series with block diagrams	2	CO9	2014
	2	A system is represented by a differential equation y + 6y +12y +10y = 4U , where y is the output and U is the input of the system. Obtain state space equation.	8	CO9	2015
	3	A system is represented by a differential equation, where y is the output and U is the input of the system. Obtain state space equation.	8	CO10	2016
	4	Explain the effect of addition of poles and zero's to the system.	8	CO9	2017
	5	Explain Kalman and Gilberts test	4	CO9	2015
	6	Discuss the Controllability and observability	4	CO9	2016
	7	Explain the feedback compensated system, with block diagrams	4	CO9	2017
	8	A system is represented by a differential equation, where y is the output and U is the input of the system. Obtain state space equation.	6	CO10	2016
	9	A system is represented by a differential equation, where y is the output and U is the input of the system. Obtain state space equation.	6	CO10	2017
	10	A system is represented by a differential equation, where y is the output and U is the input of the system. Obtain state space equation.	6	CO10	2018

G. Content to Course Outcomes

1. TLPA Parameters

Table 1: TLPA – Example Course

Module- #	Course Content or Syllabus (Split module content into 2 parts which have similar concepts)	Content Teaching Hours	Blooms' Learning Levels for Content	Final Blooms' Level	Identified Action Verbs for Learning	Instruction Methods for Learning	Assessment Methods to Measure Learning
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*
1	Introduction: Concept of automatic controls, Open loop and closed loop systems,	4	L1,L2	L2	Understand	Chalk and board	Assignment

	Concepts of feedback, requirements of an ideal control system, Types of controllers-Proportional, Integral, Differential, Proportional & Integral, Proportional Differential and Proportional Integral Differential controllers.						
1	Block diagram Algebra: General representation of a feedback control system, transfer functions, rules of block diagram algebra, reduction of block diagram to obtain closed loop transfer function. Signal flow graphs : Mason's gain formula	3	L1,L2,L3	L3	Apply	Chalk and board	Assignment
2	Steady state operation: Steady state analysis for general block diagram. for a control system, steady state characteristics, equilibrium in a system. Transient Response: Transient response and steady state analysis of unit, step input,	7	L1,L2,L3	L3	Apply	Chalk and board	Assignment and Slip Test
2	general operational representation for a differential equation of control system, distinct, repeated and complex conjugate zeros, general form of transient response, Routh's stability criterion for a control system.	6	L1,L2,L3	L3	Apply	Chalk and board	Assignment
3	Root Locus Plots : Root locus method: Significance of Root locus,	7	L1,L2,L3	L3	Apply	Chalk and board	Assignment and slip test
3	angle and magnitude conditions, breakaway points, angles of departure and arrival, construction of Root locus using general rules and steps, Lead and Lag compensation	7	L1,L2	L2	Understan d	Chalk and board	Assignment
4	Frequency Domain Analysis: Relationship between time and frequency response, Polar plot, Bode's Plot,	7	L1,L2,L3	L3	Apply	Chalk and board	Assignment
4	Nyquist plot and Nyquist stability criterion, Relative Stability, Phase and Gain Margins	7	L1,L2,L3	L3	Apply	Chalk and board	Assignment
5	System Compensation and State Variable Characteristics of Linear Systems :Series and feedback compensation, Introduction to state concepts,	4	L1,L2	L2	Understan d	Chalk and board	Assignment
5	state equation of linear continuous data system. Matrix representation of state equations, controllability and observability, Kalman and Gilberts test	3	L1,L2	L2	understand	Chalk and board	Assignment

2. Concepts and Outcomes:

Table 2: Concept to Outcome – Example Course

Modul e- #	Learning or Outcome from study of the Content or Syllabus	Identified Concepts from Content	Final Concept	Concept Justification (What all Learning Happened from the study of Content / Syllabus. A short word for learning or outcome)	CO Components (1.Action Verb, 2.Knowledge, 3.Condition / Methodology, 4.Benchmark)	Course Outcome **Student Should be able to ...**
A	*I*	*J*	*K*	*L*	*M*	*N*
1	Introduction: Concept of automatic controls,	Control, feedback, controllers	Control, feedback, controllers	Different types of methods	- Understand - conversion methodology -	Understand Control, feedback, controllers

	Open loop and closed loop systems, Concepts of feedback, requirements of an ideal control system, Types of controllers- Proportional, Integral, Differential, Proportional & Integral, Proportional Differential and Proportional Integral Differential controllers.				-	
1	Block diagram Algebra: General representation of a feedback control system, transfer functions, rules of block diagram algebra, reduction of block diagram to obtain closed loop transfer function. Signal flow graphs : Mason's gain formula	Mathematical Model, block and signal diagram	Mathematical Model, block and signal diagram	Working principal	- Understand - conversion methodology - -	Applying the knowledge Mathematical Model, block and signal
2	Steady state operation: Steady state analysis for general block diagram. for a control system, steady state characteristics, equilibrium in a system. Transient Response: Transient response and steady state analysis of unit, step input,	Analysis of a system	Analysis of a system	Different system	Understand - conversion methodology	Analysis of a system

2	general operational representation for a differential equation of control system, distinct, repeated and complex conjugate zeros, general form of transient response, Routh's stability criterion for a control system.	stability analysis	stability analysis	stability analysis	-Understand - conversion methodology -	Applying the knowledge stability analysis
3	Root Locus Plots : Root locus method: Significance of Root locus,	stability analysis	stability analysis	stability analysis	Understand - conversion methodology - -	Applying the knowledge stability analysis
4	angle and magnitude conditions, breakaway points, angles of departure and arrival, construction of Root locus using general rules and steps, Lead and Lag compensation	stability analysis	stability analysisstability analysis	stability analy	- Understand - conversion methodology -	Applying the knowledge stability analysis
4	Frequency Domain Analysis: Relationship between time and frequency response, Polar plot, Bode's Plot,	stability analysis	stability analysis	stability analysis	- Understand - conversion methodology - -	Applying the knowledge stability analysis
5	Nyquist plot and Nyquist stability criterion, Relative Stability, Phase and Gain Margins	stability analysis	stability analysisstability analysis	stability analysis	- Understand - conversion methodology	Applying the knowledge stability analysis
	System Compensation and State Variable	transient and steady state time	transient and steady state time response	state time response	Understand - conversion methodology	Applying the knowledge transient and steady

	Characteristics of Linear Systems :Series and feedback compensation, Introduction to state concepts,	response				
	state equation of linear continuous data system. Matrix representation of state equations, controllability and observability, Kalman and Gilberts test	transient and steady state time response	transient and steady state time response	state time response	Understand - conversion methodology	Applying the knowledge state time response