K.S. SCHOOL OF ENGINEERING AND MANAGEMENT, BANGALORE - 560109

DEPARTMENT OF MECHANICAL ENGINEERING

CO-PO Mapping (2022-23)

Course: Control Engineering		**Course Code: 18ME71**	
Type: Core			
No of Hours			
Theory (Lecture Class)	Practical/Field Work/Allied Activities	Total hours/Week	Total teaching hours
3	1	4	40
Marks			
Internal Assessment	Examination	Total	Credits
40	60	100	3

Aim/Objectives of the Course

1. **Modeling of mechanical, hydraulic, pneumatic and electrical systems.**
2. **Representation of system elements by blocks and its reduction.**
3. **Transient and steady state response analysis of a system and root locus plots.**
4. **Frequency response analysis using polar plot and Bode plot.**
5. **Different system compensators and variable characteristics of linear systems.**

Course Learning Outcomes

After completing the course, the students will be able to

CO1	**Recognize** control system and its types , control actions	**Applying (K3)**
CO2	**Determine** the system governing equations for physical models(Electrical, Thermal, Mechanical, Electro Mechanical) and Calculate the gain of the system using block diagram and signal flow graph	**Applying (K3)**
CO3	**Illustrate** the response of 1st and 2nd order systems	**Applying (K3)**
CO4	**Determine** the stability of transfer functions in complex domain and frequency domain	**Applying (K3)**
CO5	**Employ** state equations to study the controllability and observability	**Applying (K3)**

Syllabus Content

Module 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 Proportional Integral, Proportional Integral Differential controllers. Learning Outcomes	**CO1** **8 hrs** PO1-3 PO2-3 PO3-2 PO4 - 2

At the end of this unit student able to 1. Define the basic terms involved in the controls system 2. Explain the various open loop and closed loop controls systems 3. Distinguish between the open loop and closed loop system 4. State the characteristics of the controller	PO5-1 PO12 -1 PSO1-3 PSO2-1

Module 2: **Mathematical Models:** Mathematical models of Mechanical, Electrical, Thermal, Hydraulic and pneumatic systems Analogous systems: Direct and invert analogs for mechanical, thermal and fluid systems. **Learning Outcomes** **At the end of this unit student able to** 1. Define the Transfer function 2. Study the different types of models(mech, electrical,etc.,) 3. Develop the mathematical model and Determine the Transfer Functions of the above mentioned models. **Block Diagrams and Signal Flow Graphs:** Transfer Functions definition, function, block representation of systems elements, reduction of block diagrams, Signal flow graphs: Mason's gain formula. **Learning Outcomes** **At the end of this unit student able to** 1. Define and Explain the functions of the block diagrams 2. Modify the original block diagram in to reduced Block diagram in determining the Transfer function. Apply of Mason's gain formula in determining the Transfer Function	**CO2** **8 hrs.** PO1-3 PO2-3 PO3-2 PO4-2 PO5-1 PO6-1 PO12-1 PSO1-3 PSO2-1

Module 3: **Transient and Steady State Response Analysis:** Introduction, first order and second order system response to step, ramp and impulse inputs, concepts of time constant and its importance in speed of response. System stability Routh's-Hurwitz Criterion. **Learning Outcomes** **At the end of this unit student able to** 1. Identify the various responses for first order and second order systems 2. Determine the stability of the linear invariant system using RH criteria	**CO3** **8 hrs** PO1-3 PO2-3 PO3-2 PO4-2 PO5-1 PO6-1 PO12-1 PSO1-3 PSO2-1
Module 4: **Frequency Domain Analysis:** Relationship between time and frequency response, Polar plots, bode's plot, Nyquist plot and Nyquist stability criterion,, Relative stability concepts, Gain margin and phase margin. **Learning Outcomes** **At the end of this unit student able to** 1. **Define** the terms involved in Frequency Response Analysis and Explain Nyquist criteria,cauchyi's principle 2. Sketch the polar plot for given Transfer function 3. Check for the stability of the system **Frequency Response Analysis Using Bode Plots:** Bode attenuation diagrams, Stability analysis using Bode plots, Simplified Bode Diagrams. **Learning Outcomes** **At the end of the unit student able to:** 1. List the factor affecting in plotting bode plot and Explain the bode plot 2. Draw the bode plot for following control systems 3. Determine the gain margin and phase margin for the control system	**CO4** **8 hrs** PO1-3 PO2-3 PO3-2 PO4-2 PO5-1 PO6-1 PO12-1 PSO1-3 PSO2-1
Module 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. **Learning Outcomes**	**CO5** **8 hrs** PO1-3 PO2-3 PO3-2 PO4-1 PO5-1

At the end of the unit student able to	PO6-1 PO12-1 PSO1-3 PSO2-2
1. Define compensators 2. Explain the different types of compensators 3. Derive the transfer function for the compensator 4. Draw the block diagram for series compensation control system	

Text Books

1. Modern Control Engineering, Katsuhiko Ogatta, Pearson Education,2004.
2. Control Systems Principles and Design, M.Gopal, 3rd Ed.,TMH,2000.
3. Control Systems, N K Sinha, Publisher: New Age International Pub (2002), ISBN-10: 8122411681

Reference Books (specify minimum two foreign authors text books)

1. Modern Control Systems, Richard.C.Dorf and Robert.H.Bishop, Addison Wesley,1999
2. System dynamics & control, Eronini-Umez, Thomson Asia pte Ltd. singapore, 2002.
3. Feedback Control System, Schaum's series. 2001.

Useful Websites

1. http://nptel.iitg.ernet.in
2. http://elearning.vtu.ac.in
3. http://freevideolectures.com/Subject/Mechanical
4. http://video.mit.edu/channel/mechanical-engineering

Useful Journals

1. http://www.nitc.ac.in/app/webroot/img/upload/Modern_Control.pdf
2. http://cce.iisc.ernet.in/Advanced%20Control%20Systems.htm
3. http://www.springer.com/engineering/robotics/journal/12555
4. www.journals.elsevier.com/control-engineering-practice/

Teaching and Learning Methods

1. Lecture class : 40 hrs
2. Self-study : 00 hrs
3. Field visits/Group Discussions/Seminars : 02 hrs
4. Practical classes : 00 hrs

Assessment

Type of test/examination: Written examination

Continuous Internal Evaluation(CIE) : 20 marks (15 marks -Average of three tests + 5 marks Assignments)

Semester End Exam(SEE) : 80 marks (students have to answer all main questions).

Test duration: 1 :30 hours

Examination duration: 3 hours

CO to PO Mapping

PO1: Science and engineering Knowledge	**PO7:**Environment and Society
PO2: Problem Analysis	**PO8:**Ethics
PO3: Design & Development	**PO9:**Individual & Team Work
PO4: Investigations of Complex Problems	**PO10:** Communication
PO5: Modern Tool Usage	**PO11:**Project Mgmt. & Finance
PO6: Engineer & Society	**PO12:**Lifelong Learning

PSO1: Ability to apply concept of mechanical engineering to design a system, a component or a process/system to address a real world challenges

PSO2: Ability to develop effective communication, team work, entrepreneurial and computational skills

	PO	PO1	PO2	PO3	PO 4	PO5	PO6	PO 7	PO8	PO9	PO10	PO1 1	PO12	PS O1	PS O 2
15 ME73	K-level														
CO1	K3	3	3	2	2	1	--	-	-	-	-	-	1	3	2
CO2	K3	3	3	2	2	1	1	-	-	-	-	-	1	3	2
CO3	K3	3	3	2	2	1	1	-	-	-	-	-	1	3	2
CO4	K3	3	3	2	2	1	1	-	-	-	-	-	1	3	2
CO5	K3	3	3	2	1	1	1		-	-	-	-	1	3	2

Course In charge **Head of the Department** **Principal**