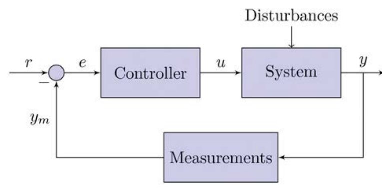
22EE301 LINEAR CONTROL SYSTEMS



Source: https://lab.vanderbilt.edu/taha/teaching/ee-5143-linear-systems-and-controls/

Hours Per Week :

L	T	P	C
3	0	2	4

PREREQUISITE KNOWLEDGE: Basic Engineering Mathematics.

COURSE DESCRIPTION AND OBJECTIVES:

This course offers the basic concepts of modeling, analysis and design of linear continuous time systems. The objective of the course is to introduce the modeling of systems from physical laws, feedback characteristics and a few important control system components. In addition, it also provides graphical methods to analyze and assess system stability in time and frequency domains. Further, it introduces the state variable approach and basics of controller's design.

MODULE-1

UNIT-1 **12L+0T+8P=20 Hours.**

INTRODUCTION TO CONTROL SYSTEMS:

Concepts of control systems - Open loop and closed loop control systems and their differences; Different examples of control systems, Classification of control systems; Mathematical Models of Physical Systems; Differential equations, transfer function and block diagram representation of electrical systems; Block diagram algebra, Signal flow graph reduction using Mason's gain formula, Translational and rotational mechanical systems.

UNIT-2 **12L+0T+8P=20 Hours.**

FEED-BACK CHARACTERISTICS & CONTROL COMPONENTS AND TIME RESPONSE ANALYSIS:

Feed-Back Characteristics and Control Components: Feed-Back Characteristics: Effects of feedback - Reduction of parameter variations, Control over system dynamics. Elements of Control Systems: Operation and derivation of transfer function of DC and AC Servo motors, Synchro transmitter and receiver.

Time Response Analysis: Standard test signals, Time response of first order systems, Characteristic equation and transient response of second order systems, Time domain specifications, Steady state response, Steady state errors and error constants.

PRACTICES:

- Characteristics of Magnetic Amplifier.
- Characteristics of Synchros.
- Characteristics Of AC Servo Motor.
- Transfer Function of DC Generator.
- Time Response of Second Order Systems.
- Linear System Analysis (Time Domain Analysis , Error Analysis) Using MATLAB.

MODULE-2

UNIT-1 **12L+0T+8P=20 Hours**

STABILITY AND FREQUENCY RESPONSE ANALYSIS:

Stability: Concept of stability, Routh stability criterion.

Root Locus Technique: Root locus concept, Construction of root loci and analysis.

SKILLS:

- ✓ *Model any physical system (Electrical, Mechanical, Electro-mechanical…).*
- ✓ *Determine overall transfer function of a system using Block Diagram Reduction Technique and SFG method.*
- ✓ *Analyse first and second order systems in time domain.*
- ✓ *Carry out stability analysis of any system in time and frequency domain.*
- ✓ *Design Lag, Lead Compensator using R, L and C for any Linear Time Invariant System.*

Frequency Response Analysis: Introduction, Frequency domain specifications, Bode plots Construction and determination of frequency domain specifications, Phase margin, Gain margin and stability analysis; Introduction to polar plots, Nyquist plots and Nyquist stability criterion.

UNIT-2 **12L+0T+8P=20 Hours**

COMPENSATION TECHNIQUES AND STATE SPACE ANALYSIS:

Compensation Techniques: Design problem, Preliminary design considerations, Realization of basic compensators - lead, lag and lead-lag. PID controllers.

State Space Analysis: Concept of state variables and state model, Derivation of state models from block diagrams and diagonalization, Solving the time invariant state equations, State transition matrix. Concept of controllability and observability.

PRACTICES:

- Stability Analysis (Bode , Root Locus, Nyquist Plot) Linear Time Invariant System using MATLAB.
- State Space Model for Classical Transfer Function Using MATLAB-Verification.
- Design of PID Controller And Simulation Using MATLAB.
- Water level control system using PLC.
- Traffic light control system using PLC.
- Temperature Control System.

COURSE OUTCOMES:

Upon successful completion of this course, students will have to ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Model differential equations for electromechanical systems and describe the effects of feedback on control systems.	Apply	1	1,2,9,11
2	Apply mathematical techniques to perform time response analysis of a control system.	Apply	1	1,2,9,11
3	Analyze linear control systems for absolute stability and relative stability using Root Locus technique and frequency domain analysis.	Analyze	2	1,2,9,11
4	Analysis of control system in state space	Analysis	2	1,2,9,11
5	Design controllers and compensators.	Create	2	1,2,3,4,5,9,11

TEXT BOOKS:

1. Norman. S. Nise, “Control Systems Engineering”, 5th edition, John Wiley and Son’s, 2018.
2. Katsuhiko Ogata, “Modern Control Engineering“, 5th edition, Prentice Hall of India Private Ltd., 2010.

REFERENCE BOOKS :

1. M. Gopal, “Control Systems: Principles and Design”, 3rd edition, Mc Graw, Hill, 2008.
2. Benjamin. C. Kuo, “ Automatic Control System”, Prentice Hall of India Private Ltd., New Delhi, 2009.
3. R.C. Dorf and R.H. Bishop, “Modern Control Systems”, 12th edition, Prentice Hall, 2010.