

# CONTROL ENGINEERING

B.E, VII Semester, Mechanical Engineering  
[As per Choice Based Credit System (CBCS) scheme]

|                               |                         |            |    |
|-------------------------------|-------------------------|------------|----|
| Course Code                   | 17ME73                  | CIE Marks  | 40 |
| Number of Lecture Hours/Week  | 04                      | SEE Marks  | 60 |
| Total Number of Lecture Hours | 50(10 Hours per Module) | Exam Hours | 03 |

Credits – 04

## Course Objectives:

- Modeling of mechanical, hydraulic, pneumatic and electrical systems.
- Representation of system elements by blocks and its reduction
- Transient and steady state response analysis of a system.
- Frequency response analysis using polar plot.
- Frequency response analysis using bode plot.
- Analysis of system using root locus plots.
- Different system compensators and variable characteristics of linear systems.

## 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, Differential, Proportional & Integral, Proportional Differential and Proportional Integral Differential controllers.

## Module - 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 dia. to obtain closed loop transfer function.

Signal flow graphs : Mason's gain formula

## Module - 3

**Steady state operation:** Steady state analysis for general block dia. 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

## Module - 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

**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.

**Course outcomes:**

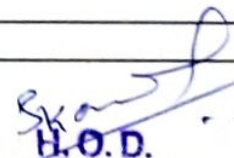
1. Recognize control system and its types , control actions
2. Determine the system governing equations for physical models(Electrical, Thermal, Mechanical, Electro Mechanical)
3. Calculate the gain of the system using block diagram and signal flow graph
4. Illustrate the response of 1st and 2nd order systems
5. Determine the stability of transfer functions in complex domain and frequency domain
6. Employ state equations to study the controllability and observability

**TEXT BOOKS:**

1. Modern control theory, Katsuhiko Ogata, Pearson Education International , Fifth edition.
2. "Control systems Principles and Design", M.Gopal, 3<sup>rd</sup> Edition, TMH, 2000.

**REFERENCE BOOKS:**

3. Control system engineering, Norman S Nise, John Wiley & Sons, Inc., Sixth edition
4. Modern control systems, Richard C. Dorf, Robert H Bishop, Pearson Education International, Twelfth edition.
5. Automatic control systems, Farid Golnaraghi, Benjamin C Kuo, John Wiley & Sons, Inc., Ninth edition
6. J.Nagrath and M.Gopal," Control System Engineering", New Age International Publishers, 5th Edition, 2007
7. "Feedback control systems", Schaum's series, 2001.
8. System dynamics and control, Eronini-Umez, Thomas Asia Pte ltd., Singapore 2002.

  
**H.O.D.**

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