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, Kalmanand 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, 3rd 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., Nineth 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.

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