# IC8451 CONTROL SYSTEMS

DETAILED SYLLABUS

## COURSE OBJECTIVES

- To understand the use of transfer function models for analysis physical systems and introduce the control system components.
- To provide adequate knowledge in the time response of systems and steady state error analysis.
- To accord basic knowledge in obtaining the open loop and closed–loop frequency responses of systems.
- To introduce stability analysis and design of compensators
- To introduce state variable representation of physical systems

## UNIT I SYSTEMS AND REPRESENTATION

Basic elements in control systems: – Open and closed loop systems – Electrical analogy of mechanical and thermal systems – Transfer function – AC and DC servomotors – Block diagram reduction techniques – Signal flow graphs.

## UNIT II TIME RESPONSE

Time response: – Time domain specifications – Types of test input – I and II order system response – Error coefficients – Generalized error series – Steady state error – Root locus construction- Effects of P, PI, PID modes of feedback control –Time response analysis.

## UNIT III FREQUENCY RESPONSE

Frequency response: – Bode plot – Polar plot – Determination of closed loop response from open loop response - Correlation between frequency domain and time domain specifications

## UNIT IV STABILITY AND COMPENSATOR DESIGN

Characteristics equation – Routh Hurwitz criterion – Nyquist stability criterion- Performance criteria – Effect of Lag, lead and lag-lead compensation on frequency response-Design of Lag, lead and laglead compensator using bode plots.

## UNIT V STATE VARIABLE ANALYSIS

Concept of state variables – State models for linear and time invariant Systems – Solution of state and output equation in controllable canonical form – Concepts of controllability and observability.

## OUTCOMES

At the end of the course, the student should have the:

- Ability to develop various representations of system based on the knowledge of Mathematics, Science and Engineering fundamentals.

- Ability to do time domain and frequency domain analysis of various models of linear system.
- Ability to interpret characteristics of the system to develop mathematical model.
- Ability to design appropriate compensator for the given specifications.
- Ability to come out with solution for complex control problem.
- Ability to understand use of PID controller in closed loop system.

**TEXT BOOKS**

1. Nagarath, I.J. and Gopal, M., "Control Systems Engineering", New Age International Publishers, 2017.

2. Benjamin C. Kuo, "Automatic Control Systems", Wiley, 2014.

REFERENCES

1. Katsuhiko Ogata, "Modern Control Engineering", Pearson, 2015.

2. Richard C.Dorf and Bishop, R.H., "Modern Control Systems", Pearson Education,2009.

3. John J.D., Azzo Constantine, H. and Houpis Sttuart, N Sheldon, "Linear Control System Analysis and Design with MATLAB", CRC Taylor& Francis Reprint 2009.

4. Rames C.Panda and T. Thyagarajan, "An Introduction to Process Modelling Identification and Control of Engineers", Narosa Publishing House, 2017.

5. M.Gopal, "Control System: Principle and design", McGraw Hill Education, 2012.

6. NPTEL Video Lecture Notes on "Control Engineering "by Prof. S. D. Agashe, IIT Bombay