Process Control Systems (GE)

Credits: Theory-03 **Theory Lectures: 45h**

Course Learning Objectives

This course introduces the student to the fundamental understanding of process control, basic principles of various manufacturing processes, mathematical modeling and analysis of open loop and closed loop control systems in terms of electrical equivalent circuits. Student would be in position to explain the nature of stability of systems using different criteria and plots.

.

Course Learning Outcomes

At the end of this course, Students will be able to

CO1 Analyze the concepts of open and closed loop control systems
CO2 Develop the mathematical model of a physical system
CO3 Analyze the stability of control systems with the help of different criteria and plots.
CO4 Identify the needs of different type of controllers.
CO5 Understand the need of process control, basic principles of various manufacturing processes and apply engineering knowledge to do problem analysis in process control

Prerequisites: Basic knowledge of analog and digital circuits and different types of signals.

L-T-P: 3-0-1

Syllabus Contents

Unit I: Introduction to Process Control (11 lectures)

Process variables, degree of freedom, industrial measurement systems, different types of industrial variables and measurement systems elements, sensors and transducers for different industrial variables like pressure, torque, speed, temperature etc., sensor principles, examples of sensors, sensor scaling, Industrial signal conditioning systems, Amplifiers, Filters, A/D converters for industrial measurements systems, review of general industrial instruments, I/P and P/I converters, pneumatic and electric actuators.

Unit II: Introduction to Control Systems (11 lectures)

Overview of Laplace Transformation, Classification of systems (Definitions only): Linear and Nonlinear systems, Time invariant and Time varying system, Continuous time and Discrete time system, Dynamic and Static system, SISO and MIMO, Open loop and Closed loop control systems, Transfer functions, Mathematical modelling of Physical systems (Electrical, Mechanical), block diagram representation & signal flow graph, Mason's Gain Formula, Effect of feedback on parameter variations.

Unit III: Time Domain Analysis (12 lectures)

Test input signals for transient Analysis, transient response of first, second and higher order system for different test input signals, Time domain performance parameters of second order System, Steady state errors and Static error constants. Concept of Stability: Effect of location of poles on stability, Asymptotic stability and Conditional stability, Routh-Hurwitz criterion, Concept and applications of PI, PD and PID controllers.

Unit IV: Frequency Domain Analysis (11 lectures)

Advantages of frequency domain analysis, Frequency domain specifications, Correlation between time and frequency response, Logarithmic plots (Bode Plots), Gain and Phase margins, Nyquist stability criterion. Compensation Techniques: Concept of compensation techniques, Lag, Lead and Lag-Lead networks.

References/Suggested Readings

1. J. Nagrath & M. Gopal, Control System Engineering, New Age International, 2021
2. B S Manke, Linear Control Systems, Khanna Publications
3. A. Anand Kumar, Control Systems, PHI, 2014
4. K. Ogata, Modern Control Engineering, Pearson, 2015
5. B. C. Kuo, Automatic Control Systems, Wiley, 2014
6. Joseph J. DiStefano, Allen Stubberud, Ivan J. Williams, Control Systems (Schaum's Outline Series), Tata McGraw Hill
7. C.D. Johnson, Process Control Instrumentation Technology, Pearson
8. Thomas E Marlin, Process Control: Designing Processes and Control Systems for Dynamic Performance, Tata McGraw Hill.

Process Control Systems Lab

(Hardware and Scilab/MATLAB/Other Mathematical Simulation software)

Credits: 01 **Lectures: 30h**

Course Learning Outcomes

At the end of this course, Students will be able to

CO1 Perform experiments involving concepts of control systems
CO2 Understand, interpret and implement tuning of the controllers using various methods and study about digital controllers
CO3 Design experiments for controlling devices
CO4 Study behavior of systems

Syllabus Contents

1. To study response of systems for various standard test input signals.
2. To study an open loop system.
3. To study a closed loop system.
4. To study steady state error of a system.
5. To study I/P and P/I systems.
6. To study time and frequency domain specifications of a control system.
7. To plot Bode and Nyquist plots and determine stability.
8. To study the Routh Hurwitz criterion of a system.
9. To study the effect of PI, PD and PID controller on closed loop systems.
10. To design a sensor/transducer based control system.
11. Report making after an Industrial visit to see process control systems working.