MASTER OF SCIENCE IN CHEMICAL ENGINEERING FOR THE SUSTAINABLE DEVELOPMENT

DYNAMICS AND CONTROL OF INDUSTRIAL PROCESSES

SSD ING-IND/25, 6 CFU - ING-INF/04, 3 CFU

Objectives

The goal of the course is to provide students of Chemical Engineering for Sustainable Development the tools to study the dynamic behavior of industrial processes and to design the control systems of both single equipment and complete industrial plants.

Starting from the knowledge of mathematical and physical basic concepts such as Laplacian operators, energy and material balances, the concept of stability of open and closed loops, the student will apply these concepts to the dynamic study of the industrial equipment and to the analysis of feed-back and feed-forward control cycles.

After completing the course, the student will have all elements to analyze and design an industrial controller.

KNOWLEDGE AND UNDERSTANDING ABILITY
The course aims to provide knowledge and understanding ability on dynamic modeling of industrial processes and on the development of process control systems.

APPLICATION ABILITY
At the end of the course the student will be able to:
- formulate dynamic models of industrial processes;
- define control strategies;
- set the tuning of feedback control parameters;
- develop process schemes.

AUTONOMY OF JUDGEMENT
The student will be encouraged to develop a critical approach on the processing and understanding of concepts through questions on topics which may prove confusing. Students will be encouraged to independently verify the plausibility of the proposed solutions of their problems.

COMMUNICATION SKILLS
The student will learn how to present the arguments clearly and effectively. It will organize the presentation in sequential order starting from the basic knowledge required to develop the argument in a comprehensive manner.

LEARNING SKILLS
The student will develop an increasing capacity to learn through a method of study that makes productive the attendance at lectures and exercises, through active participation to them.

Contents

Module A
Dynamics of an industrial process: application of models of the first and second order, FOPTD and SOPTD.
Dynamic model of a distillation column: Matlab modeling.
Empirical models of industrial equipment.

Valves and actuators.
Feedback control loops: control algorithms and tuning of the parameters, cascade control, ratio control, applicative examples.
Feedforward control loops: the concept of predictive model, control algorithms.
Control cycles modeling in Simulink environment.
Batch control systems.
Process schemes: graphics criteria and applications.
P&ID schemes
Laboratory activities.

Module B
Concept of process control and its objectives.
General information on control systems and on the transmission of signals; terminology.
Mathematical methods in control systems
Mathematical Methods - Laplace Transform, state-space, transfer functions and linearization.
Dynamical systems - Dynamic response of systems of the first and second order, the development of empirical models.
Dynamic Processes
Systems of supervision, monitoring and control
Architecture and operating principles of the Distributed Control System (DCS), Programmable Logic Controller (PLC), Supervisory Control And Data Acquisition (SCADA); signs of fieldbus protocol.

Teaching Methods

Lectures presenting the topics of the course, exercises to show their application to specific problems. Labs activities are carried out.

Verification of learning

The knowledge acquired will be verified by a written exam and an oral test.

During the written exam, the knowledge and skills related to the study of dynamic systems and the design of industrial control systems are verified by the execution of four exercises, two related to the Module A and two related to the Module B. The exam involves an evaluation that is expressed as a grade of out of 30 and the written exam is deemed to be passed successfully if the final grade is equal to or higher than 18/30.
The oral exam consists of three questions on the course program, two for the Module A and one for the Module B. The oral test lasts about 20 minutes. The evaluation is expressed as a grade of out of 30 a and the oral test is deemed to be passed successfully if the final grade is equal to or higher than 18/30. The final score is the average of the two votes and will be registered on both a paper and an electronic record-book.

Texts

Dale E. Seborg - "Process Dynamics and Control".