Course guide
330159 - SCPQ - Simulation and Control for Chemical Processes

Last modified: 25/04/2024

Unit in charge: Manresa School of Engineering
Teaching unit: 750 - EMIT - Department of Mining, Industrial and ICT Engineering.

Degree: BACHELOR'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2009). (Compulsory subject).
BACHELOR'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2016). (Compulsory subject).

Academic year: 2024 **ECTS Credits:** 6.0 **Languages:** Catalan

LECTURER

Coordinating lecturer: XAVIER GAMISANS NOGUERA

Others: ANTONIO DAVID DORADO CASTAÑO

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
1. Acquire knowledge of the elements of instrumentation and performance common in the chemical industries.
2. Apply process modeling techniques
3. Use simulation software for both static and dynamic systems.

Transversal:
4. EFFICIENT ORAL AND WRITTEN COMMUNICATION - Level 3. Communicating clearly and efficiently in oral and written presentations. Adapting to audiences and communication aims by using suitable strategies and means.
5. SELF-DIRECTED LEARNING - Level 3. Applying the knowledge gained in completing a task according to its relevance and importance. Deciding how to carry out a task, the amount of time to be devoted to it and the most suitable information sources.
6. THIRD LANGUAGE. Learning a third language, preferably English, to a degree of oral and written fluency that fits in with the future needs of the graduates of each course.

TEACHING METHODOLOGY

Explanatory classes in which the contents of the subject will be treated with the support of PowerPoint presentations. The active participation of the students will be encouraged in the classroom in various ways: inviting students to highlight the most relevant points discussed in class or answer questions related to the contents explained. In the classes of exercises, problems and practices, problems and exercises that the student will have previously available the statement will be solved and will have to try to solve independently. The students will be able to comment on the doubts that have arisen in the realization of the same. On some occasions, the students themselves will be asked to develop the problems on the board or to explain the practice to the rest of the students.

Problems, exercises or practices related to the specific objectives of the content will be proposed, which the student must solve individually outside the classroom and deliver to the teacher. These will be part of the ongoing evaluation. Once the problems and the practice reports have been corrected by the teacher, they will be returned and the debate among the students will be promoted, the objective of creating learning situations (analysis, discussion, synthesis), improving communication skills while providing a more effective feedback than that obtained with only the delivery of the problems corrected by the teacher.

LEARNING OBJECTIVES OF THE SUBJECT

After taking the Chemical Process Simulation and Control Subject, the student must be able to:
- Differentiate the static and dynamic mathematical models related to the processes common to the chemical industry.
- Understand the mathematical modeling of chemical processes.
- Apply numerical techniques in solving mathematical models.
- Understand the dynamic behavior of chemical process control systems.
- Distinguish the different control structures applicable to the regulation of a chemical process.
- Choose the most appropriate primary elements of measurement and action to establish a control loop.

STUDY LOAD

Type	Hours	Percentage
Hours small group	30,0	20.00
Hours large group	30,0	20.00
Self study	90,0	60.00

Total learning time: 150 h

CONTENTS

Content 1: Modeling and Simulation of Chemical Processes

Description:
- INTRODUCTION
Basic concepts.
Modeling and simulation of processes: the modeling process, types of models.
- MODELING OF CHEMICAL PROCESSES
Fundamental laws.
Examples of dynamic models of chemical processes: processes with and without chemical reaction, thermal processes, mass transfer operations.
- SIMULATION OF MATHEMATICAL MODELS
Solving ordinary differential equations.
Solving equations with partial derivatives.
Determination of parameters.

Related activities:
- Lectures with active participation of students.
- Problem solving and exercises in the classroom (Large and small group).
- Problems and / or exercises (forms part of assessable activity 1).
- Individual test (these contents will be part of activity 6).
- Activities 2 and 3.

Full-or-part-time: 100h
Theory classes: 20h
Laboratory classes: 20h
Self study : 60h

Content 2: Chemical Process Control

Description:
- DYNAMIC BEHAVIOR OF CHEMICAL PROCESS CONTROL SYSTEMS
Transfer functions. Block diagrams.
Dynamic behavior of first and second order systems.
Dynamic behavior of higher order systems.
Dynamic behavior of feedback control systems.
- DESIGN ASPECTS OF CHEMICAL PROCESS CONTROL SYSTEMS
Control structures: cascade, feedforward, ratio, override, selective, split range.
Instrumentation in process control: Measurement and transmission of control variables. Final elements of a control loop.

Related activities:
- Lectures with active participation of students.
- Problem solving and exercises in the classroom (Large and small group).
- Problems and / or exercises (forms part of assessable activity 1).
- Individual test (this content is part of assessable activity 6).
- Activities 2 and 3.

Full-or-part-time: 50h
Theory classes: 10h
Laboratory classes: 10h
Self study : 30h

ACTIVITIES

TITLE OF ACTIVITY 1: PROBLEM SOLVING AND/OR EXERCISES.

Description:
For each content, problem solving and / or exercises by the student body, proposed by the teacher.
Correction by the teacher who will return it evaluating the results and conclusions with the students.

Specific objectives:
At the end of this activity, the student should be able to:
Understand, apply, analyze and discuss the theoretical concepts of the related content.

Material:
Statements of the problems and / or exercises available on the ATENEA digital campus.
Power-Point Presentations.
Recommended bibliography.
Exercises solved in class.

Delivery:
Delivery of the solution of the problems and / or exercises proposed in writing.

Full-or-part-time: 23h
Laboratory classes: 8h
Self study: 15h

TITLE OF ACTIVITY 2: SIMULATION IN STEADY STATE.

Description:
Performance of analysis and design practices of equipment and facilities, typical of the chemical industry, using the HYSYS simulation package.

Specific objectives:
At the end of this activity, the student should be able to:
Understand, apply, analyze and discuss the theoretical concepts of the related content.

Material:
Statements of the practices available in the digital campus ATENEA.
Recommended bibliography.
HYSYS software.

Delivery:
Delivery of practice reports and HYSYS files.

Full-or-part-time: 18h
Laboratory classes: 8h
Self study: 10h

TITLE OF ACTIVITY 3: SIMULATION IN UNSTEADY STATE.

Description:
Use of the MATLAB package for the simulation of mathematical models corresponding to unit operations and chemical reactors, by solving both ordinary differential equations and partial derivatives.

Specific objectives:
At the end of this activity, the student should be able to:
Understand, apply, analyze and discuss the theoretical concepts of the related content.

Material:
Statements of the practices available in the digital campus ATENEA.
MATLAB tutorial.
Recommended bibliography.
MATLAB software.

Delivery:
Delivery of practice reports.

Full-or-part-time: 16h
Laboratory classes: 6h
Self study: 10h

TITLE OF ACTIVITY 4: SIMULATION IN PROCESS CONTROL.

Description:
Use of the MATLAB / SIMULINK package for the simulation of block diagrams typical of process control engineering.

Specific objectives:
At the end of this activity, the student should be able to:
Understand, apply, analyze and discuss the theoretical concepts of the related content.

Material:
Statements of the practices available in the digital campus ATENEA.
SIMULINK tutorial.
Recommended bibliography.
MATLAB / SIMULINK software.

Delivery:
Delivery of practice reports.

Full-or-part-time: 14h
Laboratory classes: 4h
Self study: 10h

TITLE OF ACTIVITY 5: INSTRUMENTATION FOR PROCESS CONTROL.

Description:
Preparation of a small project for the selection of instruments and measurement of performance for a control loop of an equipment or plant.

Specific objectives:
At the end of this activity, the student should be able to:
Understand, apply, analyze and discuss the theoretical concepts of the related content.

Material:
Statements of the practices available in the digital campus ATENEA.
Recommended bibliography.
Commercial instrumentation manuals.

Delivery:
Delivery of practice reports.

Full-or-part-time: 14h
Laboratory classes: 4h
Self study: 10h

TITLE OF ACTIVITY 6: INDIVIDUAL EVALUATION TEST

Description:
Individual test in the classroom with a part of theoretical concepts and resolution of problems and / or questions related to contents 1 and 2 of the subject.

Specific objectives:
Evaluate the general achievement of the objectives of contents 1 and 2.

Material:
Statements and calculator to carry out the tests.

Delivery:
Resolution of the evidence and presentation in writing.

Full-or-part-time: 39h
Theory classes: 4h
Self study: 35h

GRADING SYSTEM

The final grade is obtained by applying the following percentages:
- Individual theory test: BLOCK 1 (20%) + BLOCK 2 (20%)
- Individual practical test: BLOCK 1 (20%) + BLOCK 2 (15%)
- Activities / Jobs: BLOCK 1 (10%) + BLOCK 2 (15%)

EXAMINATION RULES.

- Deliver, according to the conditions required by the teacher, the problems and / or continuous assessment exercises.
- Compulsory attendance to practices and delivery of reports.
- Solve and deliver the individual evaluation test.

BIBLIOGRAPHY

Basic:
- Luyben, William L. Process modeling, simulation, and control for chemical engineers. 2nd ed. New York: McGraw-Hill, 1990. ISBN 0071007938.
- Ollero de Castro, P.; Fernández Camacho, E. Control e instrumentación de procesos químicos. Madrid: Síntesis, 1997. ISBN 8477385173.
- Puigjaner, L., i altres. Estrategias de modelado, simulación y optimización de procesos químicos. Madrid: Síntesis, 2006. ISBN 8497564049.

Complementary:
- Seider, W. D.; Seader, J. D.; Lewin, D. R. Process design principles: synthesis, analysis and evaluation. New York: Wiley, 1999. ISBN 0471243124.
- Biran, A.; Breiner, M. Matlab for engineers. Wokingham: Addison-Wesley, 1995. ISBN 0201565242.
- Creus Solé, Antonio. Instrumentación industrial [on line]. 8a ed. Barcelona: Marcombo, 2011 [Consultation: 08/06/2022]. Available on: https://www-ingebook-com.recursos.biblioteca.upc.edu/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=9767. ISBN 9788426716682.

RESOURCES

Other resources:
Digital teaching material (Power Point Presentations).
Virtual digital support (Athena).

The physical space (the classroom with blackboard and audio-visual support to teach the classes).
Computer rooms.