UAB
Universitat Autònoma de Barcelona

Control, Instrumentation and Automatisms

Code: 102445
ECTS Credits: 6

2024/2025

Degree	Type	Year
2500897 Chemical Engineering	OB	3

Contact

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Teachers

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Teaching groups languages

You can view this information at the end of this document.

Prerequisites

Non steady-state mass and energy balances.
Ordinary differential equations.
Complex variable calculus
Willingness to understand the main concepts of process control.

Objectives and Contextualisation

To learn about automatic control as an essential tool in the chemical industry to guarantee its operation and the stability of the production processes.
Know the basic tools for process control and instrumentation in chemical engineering systems.
Identify the elements needed to implement a feedback control loop.
Describe the dynamics of common systems in chemical engineering using models developed from balances and expressed in the Laplace space.
Design control loops and know the procedures to determine their stability and tuning controllers.
Know the frequency response methods for the design and study of control loops.
Identify the elements needed to design other more advanced control schemes.
Use of simulation software for control design.

Competences

Chemical Engineering
- Demonstrate basic knowledge of the use and programming of computers, and apply the applicable IT resources to chemical engineering.
- Demonstrate understanding of the main concepts for controlling chemical engineering processes.
- Develop personal work habits.
- Develop thinking habits.
- Work in a team.

Learning Outcomes

1. Apply IT resources to the simulation and control of processes.
2. Develop a capacity for analysis, synthesis and prospection.
3. Develop critical thinking and reasoning
4. Use mathematical models of dynamic systems and processes in the field of chemical engineering.
5. Work autonomously.
6. Work cooperatively.

Content

Theme 0: Laplace Transforms (LT)
LT of basic functions.
Solution of differential equations with LT.
LT inversion.

Theme 1: Introduction to process control
1.1.- Control Systems.
1.2.- Definitions and basic concepts. Control schemes.
1.3.- Modelling of the dynamic behaviour of chemical processes. Input-output models.

Theme 2: Analysis of the dynamics of chemical processes
2.1.- Transfer function (TF) of a process with only one output.
2.2.- TF of a process with multiple outputs.
2.3.- TF poles and zeros.
2.4.- First-order systems.
2.5.- Second-order systems.

Theme 3: Feedback control
3.1.- Concept of feedback control. Instrumentation: sensors and final elements. Selection of control valves.
3.2.- Closed loop dynamics. Effect of the different control actions.
3.3.- Stability. Routh-Hurwitz criterion.
3.4.- Design and tuning of controllers.
3.5.- Specification sheets for control loops.

Theme 4: Design based on frequency response
4.1.- Frequency response analysis. Bode and Nyquist diagrams.
4.2.- Design of feedback controllers using frequency response techniques.

Theme 5: Other control configurations
5.1.- Cascade control.
5.2.- Feedforward control.
5.3.- Other control schemes.
5.4.- Systems with interactive units.
5.5.- Typical control schemes in the chemical industry.

Activities and Methodology

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Seminars	5	0.2	1, 2, 3
Theory theme 0. Laplace transforms	2	0.08	4
Theory theme 1. Introduction	2	0.08	2
Theory theme 2. Analysis of chemical processes dynamics	4	0.16	4
Theory theme 3. Feedback control	12	0.48	4
Theory theme 4. Design based on frequency response	4	0.16	3
Theory theme 5. Other control configurations	4	0.16	4
Type: Supervised			
Theme 0 problems	2	0.08	4
Theme 2 problems	2	0.08	2
Theme 3 problems	8	0.32	2
Theme 4 problems	2	0.08	2
Type: Autonomous			
Accomplishment of works.	7	0.28	1
Individual or small group tutorials	5	0.2	1, 2, 3
Problem solving	50	2	1, 2, 3
Study of theoretical background	33	1.32	2, 3

Theory classes. Basic theoretical concepts are introduced in an orderly and concise way for further practical development. Small activities are proposed to be developed by the student during the class.
Classes of problems. A series of problems is selected from the collection of each topic. The step-by-step resolution is shown for the most representative problems and the scheme for solving other problems is presented. Problem solving by students.
Seminars / Works: Introduction to Simulink, PLC Programming, Simulink: Closed Loop Dynamics, Simulink: Frequency Response.
Moodle will be used as the virtual platform to communicate with students.
Simulink tutorials at YouTube: https://www.youtube.com/channel/UCq4HnZPBPb4A3JspPish78g

Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

Assessment

Continous Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Partial exam 1. Dynamics of chemical processes.	25%	2	0.08	2, 3, 4, 5
Partial exam 2. Closed-loop dynamics. Tuning.	25%	2	0.08	2, 3, 4, 5
Partial exam 3. Frequency response. Other control schemes.	25%	2	0.08	2, 3, 4, 5
Simulink work and other activities	25%	2	0.08	1, 2, 3, 4, 5, 6

(a) Scheduled evaluation process and activities

The following are the activities of evaluation of the subject with its percentage of weight on the final grade:

- Activity 1 (4%). Practice. Introduction to Simulink.
- Activity 2 (7%). Practice. Programmable logic controller(PLC).
- Activity 3 (7%). Work. Simulink closed loop.
- Activity 4 (7%). Work. Simulink frequency response.
- Activity 5 (25%). Partial exam 1
- Activity 6 (25%). Partial exam 2
- Activity 7 (25%). Partial exam 3

Each partial exam consists of a theoretical and a practical part.

In order to be able to apply the calculation of the final grade, it is required an average score of partial exams higher than 4.5. If the criterion is not met, the maximum final grade for the subject will be 4.0.

The non-presence in class when evaluation tests are carried out is a zero of the activity, without possibility of retake.

b) Programming of evaluation activities

The schedule of evaluation activities will be given on the first day of the course and will be made public through the Moodle. The following schedule is foreseen:

- Activity 1. Week 4
- Activity 2. Week 8
- Activity 3. Week 9
- Activity 4. Week 13
- Activity 5. Week 7
- Activity 6. Week 12
- Activity 7. Week 16

(c) Recovery process

Students may apply for make-up as long as they have submitted to a set of activities that represent at least two-thirds of the total grade for the subject.

The retake exam will include all the contents of the subject. This exam will consist of a theoretcial and a practical part. The mark of this exam will replace the mark of the activities 5-7(partial exams). A minimum of 4.5 in the exam will be required to apply this calculation. If it is not met, the maximum final grade for the subject will be 4.0.

According tothe coordination of the Grade and the direction of the School of Engineering the following activities

cannot be recovered:
- Activity 1 (4%).
- Activity 2 (7%).
- Activity 3 (7%).
- Activity 4 (7%).
- Evaluative activities of any type in which the student has committed an irregularity (copy, plagiarize, let copy ...).

d) Grade review procedure

For each assessment activity, a place, date and time of review will be indicated where the student can review the activity with the professor. In this context, complaints can be made about the grade of the activity, which will be evaluated by the professor responsible for the subject. If the student does not submit to this review, this activity will not be reviewed at a later date.

e) Qualifications

Honor grade. Awarding an honor roll grade (MH) is the decision of the faculty responsible for the subject. UAB regulations state that MH can only be awarded to students who have obtained a final grade of 9.00 or more. Up to 5% of the total number of students enrolled may be awarded.

A student will be considered non-assessable (NA) if he has not presented to a set of activities the weight of which equals a minimum of two thirds ofthe total grade of the subject.

f) Student Irregularities, Copying and Plagiarism

Without prejudice to other disciplinary measures that may be deemed appropriate, irregularities committed by the student that may lead to a variation in the grade of an evaluation act shall be graded with a zero. Therefore, copying, plagiarism, cheating, letting copy, etc. in any of the evaluation activities will involve suspending with a zero. Evaluation activities graded in this way and by this procedure will not be recoverable.

h) Evaluation of Repeating Students

The only change in the assessment of the subject repeaters is the possibility of maintaining the grades of the 1-4 activities taken previouslt. This option must be communicated by email to the professor responsible, no later than 15 days after the start of classes.

i) Single assessment

This course allows for a single assessment, following the procedure applicable at the UAB.
The single assessment will consist of 1) an exam including all the contents of the course (75% of the final mark) and 2) the delivery on the same day of activities 1-4 (25% of the final mark).
The date of the single assessment will be the same day as activity 7 (Test 3).
The revision of the final mark follows the same procedure as for the continuous assessment.
The same recovery system will be applied as for the continuous assessment.

Bibliography

Most relevant bibliography
Stephanopoulos, G."Chemical Process Control: An Introduction to Theory and Practice". Prentice-Hall (New Jersey), 1984.
Seborg, D.E.; Edgar, T.; Mellichamp, D.A. "Process Dynamics and Control". J. Wiley (NY), 2nd edition. 2004.
Babatunde A. Ogunnaike, W. Harmon Ray. "Process Dynamics, Modeling and Control". Oxford University Press. 1994.

Additional references
Ollero de Castro, P. ; Fernández, E. "Control e instrumentación de procesos químicos". Síntesis (Madrid), 1998.
Baeza, J.A. Book chapter: "Principles of Bioprocess Control" al llibre "Current Developments in Biotechnology and Bioengineering. Bioprocesses, Bioreactors and Controls", Elsevier, 2017.
http://www.sciencedirect.com/science/article/pii/B9780444636638000185

Software

Matlab - Simulink

Siemens Step7 - Microwin (PLCs Seminar)

Language list

Name	Group	Language	Semester	Turn
(PAUL) Classroom practices	211	Catalan	first semester	morning-mixed
(PAUL) Classroom practices	212	Catalan	first semester	morning-mixed
(SEM) Seminars	211	Catalan	first semester	morning-mixed
(SEM) Seminars	212	Catalan	first semester	morning-mixed
(TE) Theory	21	Catalan	first semester	morning-mixed