

Degree programme	Type	Course
Chemical Engineering	OB	3

Contact lecturer

Name : Albert Guisasola Canudas

Email : albert.guisasola@uab.cat

Teaching staff

Joan Antoni Baeza Labat

Teresa Gea Leiva

Albert Guisasola Canudas

Group languages

You can consult this information at the [end](#) of the 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

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.

Learning outcomes

1. Develop critical thinking and reasoning

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

Contents

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.

Learning activities and methodology

Title	Hours	ECTS	Learning outcomes
Seminars	5	0.2	
Theory theme 0. Laplace transforms	2	0.08	
Theory theme 4. Design based on frequency response	4	0.16	
Theory theme 2. Analysis of chemical processes dynamics	4	0.16	
Theory theme 1. Introduction	2	0.08	
Theory theme 5. Other control configurations	4	0.16	

Accomplishment of works.	7	0.28
Study of theoretical background	33	1.32
Theme 4 problems	2	0.08
Theme 0 problems	2	0.08
Theme 2 problems	2	0.08
Theme 3 problems	8	0.32
Problem solving	50	2
Theory theme 3. Feedback control	12	0.48
Individual or small group tutorials	5	0.2

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/UCq4HnZBPb4A3JspPish78g>

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

Continuous assessment activities

Title	Weight	Hours	ECTS	Learning outcomes
Partial exam 3. Frequency response. Other control schemes.	25%	2	0.08	1, 2, 3, 4
Partial exam 1. Dynamics of chemical processes.	20%	2	0.08	1, 2, 3, 4
Simulink work and other activities	20%	2	0.08	1, 2, 3, 4, 5
Partial exam 2. Closed-loop dynamics. Tuning.	35%	2	0.08	1, 2, 3, 4

(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. They are all individual.

- Activity 1 (5%). Practice. Introduction to Simulink.
- Activity 2 (5%). Practice. Programmable logic controller(PLC).

- Activity 3 (5%). Work. Simulink closed loop.
- Activity 4 (5%). Work. Simulink frequency response.
- Activity 5 (20%). Partial exam 1
- Activity 6 (35%). 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 a minimum score of 3.0 in each partial exam and 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.

(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 theoretical 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 to the coordination of the Grade and the direction of the School of Engineering the following activities cannot be recovered:

- Activities 1 to 4
- 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 of the 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 previously. 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)

Course groups and languages

The information provided is provisional until November 30. After this date, you will be able to consult the language of each group through this [link](#). To access the information, you will need to enter the course CODE

Type of teaching	Group	Language	Semester	Shift
(TE) Theory	21	Catalan	first semester	morning-mixed
(PAUL) Classroom practices	211	Catalan	first semester	morning-mixed
(SEM) Seminars	211	Catalan	first semester	morning-mixed
(PAUL) Classroom practices	212	Catalan	first semester	morning-mixed
(SEM) Seminars	212	Catalan	first semester	morning-mixed