COURSE DATA

DATA SUBJECT

Code: 34762
Name: Process dynamics and control
Cycle: Undergraduate Studies
ECTS Credits: 6
Academic year: 2025-26

STUDY (S)

Degree	Center	Acad. year	Period
1401 - Degree in Chemical Engineering	Escola Tècnica Superior d'Enginyeria	3	Second quarter

SUBJECT-MATTER

Degree	Subject-matter	Character
1401 - Degree in Chemical Engineering	Dynamics and control	COMPULSORY

COORDINATION

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SUMMARY

Automatic control has played a vital role in the advancement of engineering and science, becoming an important and integral part of modern industrial manufacturing processes. The chemical process control is a specialty of Automatic that deals the selection and application of techniques for safe and efficient operation of process plants. As advances in theory and practice of automatic control means to provide optimal operation of dynamic systems, improve quality and lower production costs, expand production rates, free from the complexity of many routine, repetitive tasks , etc.., most engineers and scientists must have good knowledge in this field.

The aim of Dynamics and Control subject is to enable the student for the analysis and design of control systems. It deals with the problems of process modeling and feedback control, graphical methods to represent feedback systems (block or flow diagrams), methods to analyze their stability, and finally the usual methods of design controllers / compensators. The course contents are: modeling of continuous systems. Transfer function and frequency response. Representation of feedback systems. Methods of analysis of the stability of feedback systems. Controller design methods, which are divided into thematic units listed below. It is a compulsory subject that is taught quarterly in the second semester of the third year of Degree in Chemical Engineering. The curriculum consists of a total of 6 ECTS. This is a subject with a practical component in which, following the introduction of the concepts, students will undertake

numerous practical exercises and experimentation in the laboratory.

The overall objectives of the course are:

- To educate the student of the importance of discipline and control dynamics in the safe and efficient operation of process plants.
- To inform the student of selection methods and application of techniques to achieve the optimal performance of dynamic systems, improve quality and lower costs of production and release of the complexity of many routine and repetitive tasks.
- To develop the students' capacity for analysis and design control systems.
- To develop the students' ability for setting up and solving numerical problems of dynamics and control of processes, as well as to interpret the results.
- To enhance students' abilities in reasoning and systematic work.
- To encourage and promote in the student those values and attitudes that must be inherent to an engineer.

The **contents** of the subject are: Modelling of continuous systems. Transfer and frequency response. Representation of feedback systems. Analysis methods of the stability of feedback systems. Design methods of controllers.

Remarks: Theoretical classes will be taught in Spanish and the practical and laboratory classes according to the subject information available on the degree website.

PREVIOUS KNOWLEDGE

RELATIONSHIP TO OTHER SUBJECTS OF THE SAME DEGREE

There are no specified enrollment restrictions with other subjects of the curriculum.

OTHER REQUIREMENTS

To successfully address the subject it is recommended that the student has previous knowledge and a required level for the subjects taken in first, second and third year (first semester) and in subjects studied simultaneously in the second semester of third year. Among such prior knowledge it is included:
Solving systems of differential equations.
The Laplace transform.
Conservation laws.
Balance property approach.
Unit Operations, transport phenomena and chemical reaction engineering.

COMPETENCES / LEARNING OUTCOMES

Acquire knowledge of basic and technological subjects to facilitate the learning of new methods and theories, and develop the versatility to adapt to new situations.

Act autonomously in learning, make informed decisions in different contexts, issue judgements based on experimentation and analysis and transfer knowledge to new situations.

Collaborate effectively in work teams, assume responsibilities and leadership roles, and contribute to collective improvement and development.

Saber comunicarse de manera efectiva, tanto de forma oral como escrita, adaptándose a las características de la situación y de la audiencia

Solve problems with initiative, make decisions, think creatively and critically, and communicate and convey knowledge, skills and competences in the field of industrial engineering.

Understand and apply the fundamentals of automation and control methods.

DESCRIPTION OF CONTENTS

1. INTRODUCTION. PROCESS CONTROL

Illustrative examples. Classification of control strategies. Process control and block diagrams. Control and modeling. Analog control vs. digital control. Economic justification of process control.

2. MODELLING THE STATIC AND DYNAMIC BEHAVIOR OF PROCESSES

Development of mathematical model. Mathematical modeling of some chemical processes. Lumped and distributed parameter systems. Dynamic of a heated stirred tank system, of an equilibrium-stage separation system and a heat exchange system.

3. OPEN-LOOP DYNAMICS OF LINEAR SYSTEM. THE TRANSFER FUNCTION

The Laplace transform. The transfer function. Transfer function matrix of a process with multiple inputs and outputs. Standard process inputs. Dynamic responses. First order systems. First-order systems in series. Interactive and noninteractive systems. Second-order systems. Linearization of nonlinear systems. Transport delay.

Feedback control. Analysis of the various elements of a control loop. Sensors and transmitters. Final control elements. Feedback controllers. Actions and types. Dynamics of feedback controlled processes.

4. FEEDBACK CONTROL. CLOSED-LOOP SYSTEM

Closed-Loop transfer functions. Servo and control systems. Transient responses. Stability. The characteristic equation. Routh test. Diagram of root locus.

5. DESIGN OF FEEDBACK CONTROLLERS

Performance criteria of closed-loop systems. Direct synthesis method. Control through the internal model. Design relations for PID controllers. Cohen-Coon method. Methods based on the criterion of the error integral. Setting the controller on the installation. Controller setting by trial and error. Method of continuous oscillations (Ziegler-Nichols).

6. FREQUENCY RESPONSE OF LINEAR SYSTEMS

Frequency response. Substitution rules. Bode plots. Closed-loop response by the method of the frequency response.

7. DESIGN OF CONTROLLERS USING FREQUENCY RESPONSE THECNIQUES

Bode stability criterion. Gain and phase margins. Application to the design of controllers. Ziegler-Nichols rules through the frequency response. Nyquist stability criterion.

8. SEMINARS-DYNAMICS AND CONTROL ACTIVITIES

Simulation of the frequency test. Using computer-simulation packages in the area of Dynamics and Control.

9. DYNAMICS AND CONTROL LABORATORY

Control of an interactive system tanks. Temperature control of a heating block. Calculations and reporting.

WORKLOAD

PRESENCIAL ACTIVITIES

Activity	Hours
Theory	25,00
Laboratory	10,00
Classroom practices	25,00
Total hours	**60,00**

NON PRESENCIAL ACTIVITIES

Activity	Hours
Attendance at other activities	0,00
Individual or group project	5,00
Independent study and work	25,00
Preparation of lessons	35,00
Preparation for assessment activities	15,00
Resolution of case studies	10,00
Total hours	**90,00**

TEACHING METHODOLOGY

The development of the course is structured around the theory and problems classes, seminars, laboratory sessions and the performance of tasks.

In the theory classes we will use the lecture model. The teacher will present and / or explain the contents of each issue stressing the key aspects for understanding.

Practical classes of problems will be developed following two models. In some classes the professor will resolve a number of sample problems so that the students learn to identify the essential elements of the approach and problem resolution. In other problems the students, individually or arranged in clusters, will be who should solve similar problems under the supervision of the teacher. After the work, the problems will be collected, analyzed and corrected by the teacher or the students themselves.

In the seminar sessions students, individually or arranged in groups, will be instructed in the use of computer-simulation packages in the area of Dynamics and Control; they also must solve specific problems using these techniques.

For practical laboratory sessions, where attendance is mandatory, students will have a practical guide and the experimentation will be conducted strictly by them under the teacher supervision.

The proposed work for the students will be divided into three types: full Problems of similar complexity to those proposed in exams, questionnaires aimed at preparing the most important concepts of each topic and self-correcting tests, performed on the Virtual Classroom. Some of these activities will take place in class and the rest will have a timetable for completion and delivery by the students. After correction, students will be informed of their results and they will receive a summary of the most consolidated and frequent failures.

EVALUATION

Attendance to the laboratory of experimental practices is a **non-recoverable and obligatory** activity to overcome the subject.

The assessment of student learning will take place following two methods:

Method A: By assessing the activities of students (questionnaires and problems), the laboratory grade and objective exams.

To be evaluated by the Mode A, students must have attended 100% of the lab classes. Likewise, students should also get in the activities proposed an average score equal to or greater than 4 (over 10). Once these requirements are achieved, the mark of this mode is obtained as the greater of:

- the weighting of the average mark of the objective exams (60%), the average mark of the laboratory (15%) and the average score of the activities (25%), provided that the average mark of the objective exams is equal to or greater than 4 (over 10).

- the weighting of the average mark of the objective exams (85%) and the average score of the laboratory (15%), provided that the average mark of the objective exams is equal to or greater than 5 (over 10).

Method B: By assessing the activities of students (questionnaires and problems), the laboratory grade and the final exam.

To be evaluated by the Mode B, the student must have attended 100% of the lab classes. Beyond this requirement, the mark of this form is obtained as:

- the weighting of the average mark of the exam (75%), the average score of the laboratory (15%) and the average mark of the activities (10%) provided that the exam mark is equal to or greater than 4 (over 10).

The subject is considered passed when the grade obtained is equal to or greater than 5 (over 10).

Copying or plagiarism of any activity that is part of the evaluation will result in the impossibility of passing the course, and the student will then be subject to the appropriate disciplinary procedures indicated in the ACTION PROTOCOL FOR FRAUDULENT PRACTICES AT THE UNIVERSITY OF VALENCIA (ACGUV 123/2020).

In any case, the evaluation system will be governed by the Reglament d'Avaluació i Qualificació de la Universitat de València per a Títols de Grau i Màster (ACGUV 108/2017).

REFERENCES

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