

Course guide

3200662 - EEQ2 - Experimentation on Chemical Engineering II

Last modified: 19/04/2023

Unit in charge: Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit: 713 - EQ - Department of Chemical Engineering.

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

Academic year: 2023 **ECTS Credits:** 6.0 **Languages:** Catalan, Spanish

LECTURER

Coordinating lecturer: Xavier Colom Fajula

Others: Manuel Carrasco
Federic DeBruin

PRIOR SKILLS

It is recommended that the student has some knowledge about the subjects of Unit Operations and Chemical Reaction Engineering.

On the other hand, it is also recommended that the student knows the objectives of the first level of generic skills: independent learning, effective oral and written communication and teamwork.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:

6. CHE: Knowledge of material and energy balances, biotechnology, the transfer of materials, separation operations, chemical reaction engineering, the design of reactors, and the reuse and transformation of raw materials and energy resources.

5. CHE: Ability to design and manage applied experimental procedures, in particular to determine thermodynamic and transport properties, and to model phenomena and systems related to chemical engineering: systems with fluid flow, heat transfer, mass-transfer operations, and reactor and reaction kinetics.

Transversal:

05 TEQ N2. TEAMWORK - Level 2. Contributing to the consolidation of a team by planning targets and working efficiently to favor communication, task assignment and cohesion.

TEACHING METHODOLOGY

Lecturers communicate with students via the UPC Digital Campus, which is now open to both faculty and students.

Students are provided with educational materials that cover the theoretical foundations of the subject, experimental procedures and a bibliography for each experimental run.

This subject is planned to work and assess the teamwork skill.

The following student's tasks will be developed during the laboratory course:

- Cooperative learning based on laboratory experiments (54 h): The students will carry out laboratory experiment through a cooperative learning methodology (three- or four-person per team). Teams, under guidance of tutors, will be responsible for planning and designing the experiments.
- Homework (90): The students have to dedicate time to develop the programmed course activities and the pre and post- laboratory activities.
- Exams (6h): two written exams and two oral presentation have been planned.

LEARNING OBJECTIVES OF THE SUBJECT

Upon completion of this subject, students will be able to: design and manage chemical-engineering experimental procedures for determining thermodynamic and transport properties; and model chemical-engineering phenomena and systems, systems with fluid flow, heat transfer, mass transfer operations, chemical kinetics and reactors.

STUDY LOAD

Type	Hours	Percentage
Self study	90,0	60.00
Hours small group	60,0	40.00

Total learning time: 150 h

CONTENTS

TOPIC 1: MASS TRANSFER: PHENOMENA AND BASIC OPERATIONS

Description:

- 3.P1. Vapour-liquid equilibrium diagrams.
- 3.P2. Liquid-liquid extraction: ternary plot.
- 3.P3. Distillation and bubble and dew points of multicomponent mixtures: simulation with HYSYS.
- 3.P4. Diffusivity and solid-liquid mass-transfer coefficient.
- 3.P5. Acetic acid adsorption on activated carbon: isotherms.
- 3.P6. Batch rectification of binary mixtures: plate columns and packed columns.

Specific objectives:

On completing this topic, students will be able to:

- Identify the various transfer mechanisms.
- Develop and apply the expressions that describe mass-transfer phenomena.
- Experimentally analyse the behaviour of systems and operations controlled by mass transfer.
- Experimentally determine equilibrium diagrams of mass-transfer systems under different conditions: liquid-vapour binary mixtures, liquid-liquid ternary mixtures, liquid-solid adsorption isotherms.
- Experimentally determine the diffusion coefficient of a component in a system from molecular mass-transfer equations.
- Experimentally determine the mass-transfer coefficient of a component in a system from derived equations for turbulent mass transfer.
- Using a pilot plant, experimentally analyse the behaviour of basic mass-transfer operations: batch rectification, water cooling towers, separation operations using reverse-osmosis membranes and ultrafiltration.
- Handle laboratory equipment at the pilot-plant scale.
- Assess the degree of fit of the theoretical equations proposed for reactor design on the basis of laboratory data.
- Predict the behaviour of basic industrial operations from laboratory data.
- Independently document, plan and lead an experiment while working in a team.
- Use computer-based techniques and tools for data computation, processing and interpretation and for the presentation of results.

Related activities:

- Under guidance, document, plan and lead an open-result experiment while working in a team.

Full-or-part-time: 72h

Laboratory classes: 27h

Self study : 45h

TOPIC 2: CHEMICAL KINETICS AND REACTORS

Description:

Experiments in terms of main objectives.

Specific objectives:

On completing this topic, students will be able to:

- Determine the reaction rate and rate equation of chemical reactions.
- Determine the rate constant of a chemical reaction and evaluate the influence of temperature.
- Develop and apply mass and energy balances to determine the design equations for batch and continuous chemical reactors.
- Experimentally determine the behaviour of chemical reactors.
- Characterise the type of flow in a continuous reactor and determine the residence time distribution.
- Handle chemical reagents, measuring instruments and chemical reactors at the pilot-plant scale.
- Assess the degree of fit of the theoretical equations proposed for reactor design on the basis of laboratory data.
- Predict the behaviour of industrial continuous reactors from laboratory data.
- Independently document, plan and lead an experiment while working in a team.
- Use computer-based techniques and tools for data computation, processing and interpretation and for the presentation of results.

Related activities:

- Independently, document, plan and lead an open-result experiment while working in a team.

Full-or-part-time: 72h

Laboratory classes: 27h

Self study : 45h

EXAMINATIONS

Description:

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Full-or-part-time: 6h

Theory classes: 6h

GRADING SYSTEM

- Tests on each of the topic 1: 35%
- Student laboratory notebook: 15%
- Laboratory reports: 25%
- Oral presentations of coordinated experiments: 25%

- Generic competencies - Group work: 5%

Transversal Competency Assessment of Teamwork:

Teamwork generic competency will be assessed considering the participation of each student in relation with the following criteria: cooperation, individual accountability, efficiency and motivation.

The team activities planned to assess this competency are:

- Development of a standards document operation.
- Working plan of the group.
- Planning of an experiment.
- Management of subordinate groups for carrying out the experiment as planned.
- Presentation of weekly reports with the agreements of the team.
- Oral and written presentation of group reports.

grade of the reevaluation exam will replace the grades of all the on-site written evaluation acts (tests, midterm and final exams) and the grades obtained during the course for lab practices, works, projects and presentations will be kept.

If the final grade after reevaluation is lower than 5.0, it will replace the initial one only if it is higher. If the final grade after reevaluation is greater or equal to 5.0, the final grade of the subject will be pass 5.0.

BIBLIOGRAPHY

Basic:

- Calleja, Guillermo. Introducción a la ingeniería química. Madrid: Síntesis, 1999. ISBN 8477386641.
- Aucejo, Antoni. Introducció a l'enginyeria química. Barcelona: Pòrtic, 1999. ISBN 8473065565.
- Coulson, J. M.; Richardson, J. F. Ingeniería química, vols. 1, 2, 4, 5. Barcelona: Reverté, 1979-1981. ISBN 9788429171341.

Complementary:

- Fogler, H. Scott. Elementos de ingeniería de las reacciones químicas. 3a ed. México: Pearson Educación, 2001. ISBN 9702600790.
- McCabe, Warren L [et al.]. Operaciones unitarias en ingeniería química. 7a ed. Madrid: McGraw-Hill, 2007. ISBN 9789701061749.
- Levenspiel, Octave. Ingeniería de las reacciones químicas. 3a ed. México: Limusa Wiley, 2004. ISBN 9681858603.