PERSONA CIÈNCIA EMPRESA
UNIVERSITAT RAMON LLULL

COURSE: SCALE-UP

SUBJECT: Scale-up
MODULE: Process and Product Engineering
STUDIES: MASTER IN CHEMICAL ENGINEERING

GENERALES FEATURES

Type: ☐ Basic training, ☐ Mandatory, ☑ Elective

☐ Master thesis, ☐ Internship

Duration: Semestral **Semester/s**: 2
Number of ECTS: 3
Language/s: English, may include sessions in Spanish.

DESCRIPTION

BRIEF DESCRIPTION AND JUSTIFICATION

For many chemists, the production plant is, simply, a laboratory with very large flasks. This philosophy has led to plants with reactors called "universal". Badly said: they do not exist. These reactors are large, indeed, and they mix large quantities of dangerous products, which led to important accidents. The processes are difficult to automate and there are many human errors. Quality assurance is difficult. The processes require a lot of energy and have a lot of waste: they are not friendly to the environment.

Chemical Engineering has a lot to say, from how to rationally transform a laboratory process into one that does not require carrying out those monstrous flasks called batch reactors, to completely redesign the processes. The purpose of this subject is to give answers and offer tools to face the problems of how to prepare a Fine Chemical process.

SKILLS

- CB6 – The student has knowledge and understanding of what constitutes a basis or an opportunity to be original by developing and/or applying ideas, often in a research context.
- CB7 – The student can apply their knowledge and their ability to solve problems in new or unfamiliar environments within broader (or multidisciplinary) contexts related to his/her field of study.
- CE4 – The student has the ability to solve problems that are unfamiliar, incompletely defined, and have contradictory specifications, considering the possible methods of solution, including the most innovative, selecting the most appropriate, being able to correct implementation and evaluating the different design solutions.
- CE3 – The student can conceptualize engineering models, apply innovative methods in problem solving and use suitable software for the design, simulation, optimization and process and system control.

PREREQUISITES

Admission to the Master in Chemical Engineering of the Universitat Ramon Llull.

CONTENTS

1. Introduction
   1.1 What is the change of scale?
   1.2 What to consider in a change of scale: safety, energy, waste, ...
   1.3 Security of product, process, of people.
   1.4 Technological aspects: discontinuous process vs. semicontinuous.
   1.5 Continuous processes.
   1.6 Considerations on the work-up.
2. 2.- Dynamic systems and change of scale
   2.1 Transport of momentum.
   2.2 Heat transport.
   2.3 Transportation of matter.
   2.4 Kinetics
   2.5 The case of crystallization: polymorphism.
3. 3.- Security of discontinuous processes
   3.1 Thermal safety of products and processes.
   3.2 Methodologies for risk analysis in discontinuous processes .: HarsMeth, Hazop.
   3.3 Stability of products to friction, impact, ...
4. 4.- Planning of experiments, simulation and optimization.
   4.1 Basic techniques for designing experiments.
   4.2 Parametric sensitivity of a process.
   4.3 Experimental optimization techniques: Simplex, EVOP.
5. 5.- Development of Pharmaceutical Chemistry processes
   5.1 Relationship between practical laboratory work and the integrated plant process in a quality environment.
   5.2 The requirements of accrediting agencies (FDA).

METHODOLOGY

TRAINING ACTIVITIES

Training activities	ECTS	Skills
Concept sessions.	0,72	CB6, CB7, CB4
Sessions solving exercises, problems and cases.	0,28	CB6, CB7, CE4
Seminars.	0,29	CB6, CB7, CE4
Practical work / projects / laboratory.	0,04	CB6, CB7, CE4
Personal study activities of students.	1,63	CB6, CB7, CE4
Evaluation activities.	0,04	CB6, CB7, CE4
TOTAL	**3,00**	

EXPLANATION OF THE TEACHING METHODOLOGY

This subject uses the following teaching methodologies:

- Presentation of contents by presentation or explanation (possibly including demonstrations) by a teacher.
- Resolution of exercises, approach / resolution of problems and exposure / discussion of cases by a teacher with the active participation of students. It may include exercises in the laboratory.
- Instruction carried out by a teacher with the objective of reviewing, discussing and resolving doubts about the materials and topics presented in the concept's presentation sessions and in the resolution sessions of exercises, problems and cases. It can include visits to companies and facilities.
- Oral presentation by the students.
- Student's personal work to acquire the competences of each subject.
- Oral or written tests to evaluate the competences acquired.

The subject will be developed basically in English.

EVALUATION

ASSESSMENT METHODS

Methods of evaluation	Weight	Skills
Exams.	35 – 45%	CB6, CB7, CE4
Monitoring activities.	30 – 40%	CB6, CB7, CE4
Homework and presentations.	10 – 20%	CB6, CB7, CE4
Participation	10%	CB6, CB7, CE4

LEARNING OUTCOMES

The student will acquire:

- Knowledge that gives the basis or opportunity to be original in the development and / or application of ideas.
- Ability to apply the knowledge acquired.
- Ability to solve problems in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their area of study.

EVALUATION

The final exam of the subject has a value between 35 and 45% of the final grade.

The monitoring activities of this subject consist of periodic written controls and individual and / or group interviews on aspects related to the development of the project. Its weight on the whole of the final grade ranges between 30 and 40%.

The works and presentations have in this case, a range between 10 and 20%. They consist in the accomplishment of small works related to aspects of the project and its exhibition in joint seminars.

The qualification for participation is obtained from the intervention of the students in forums, seminars, visits and interviews. It constitutes 10% of the final grade.
To pass the subject, it will be necessary to obtain a minimum grade of 4 in each of the previous sections.

The concrete weight of each evaluation system will be set at the beginning of the course.

EVALUATION OF SKILLS

The evaluation of competences will be carried out as indicated in the table of evaluation methods.

BIBLIOGRAPHY

There is no textbook.

Other references:

- R. H. Perry, D. Green and J. O. Maloney; "Chemical Engineers' Handbook"; 7ª ed., McGraw-Hill, New York 1997. Nueva edición: 8ª ed., 2007 (ISBN 0071422943).
- R. E. Treybal; "Mass Transfer Operations"; 3rd ed., McGraw-Hill International Editions, Singapore 1981. Nueva edición: 1998, (ISBN 0070666156 - agotado)
- R. C. Reid, J. M. Prausnitz and B. E. Poling; "The Properties of Gases and Liquids"; 4ª ed., McGraw-Hill, New York 1987. Nueva edición: B. E. Poling, J. M. Prausnitz, J. O' Connell , 5ª ed., 2000 (ISBN 0070116822).
- Kirk-Othmer; "Encyclopedia of Chemical Technology"; Wiley Inrscience, New York 1978 (3ª edición).
- Ullman's; "Encyclopedia of Industrial Chemistry"; VCH, Weinheim (Germany) 1985 y siguientes.
- D. Q. Kern; Procesos de transferencia de calor; Compañía Editorial Continental, México 1990.
- J. J. McKetta; "Encyclopedia of Chemical Processing and Design"; Marcel Dekker Inc., New York.
- D. Q. Kern; Procesos de transferencia de calor; Compañía Editorial Continental, México 1990.

- Standards of the tubular exchanger manufacturers association; Tubular Exchanger Manufacturers Association, New York 1988.

DOCUMENT RECORD

PREVIOUS CHANGES

LAST REVISION
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