Universidad Zaragoza

Year : 2020/21

30810 - Basic principles of chemical engineering

Syllabus Information

Academic Year: 2020/21
Subject: 30810 - Basic principles of chemical engineering
Faculty / School: 105 - Facultad de Veterinaria
Degree: 568 - Degree in Food Science and Technology
ECTS: 6.0
Year: 2
Semester: First semester
Subject Type: Basic Education
Module: ---

1.General information

1.1.Aims of the course

1.2.Context and importance of this course in the degree

1.3.Recommendations to take this course

2.Learning goals

2.1.Competences

2.2.Learning goals

2.3.Importance of learning goals

3.Assessment (1st and 2nd call)

3.1.Assessment tasks (description of tasks, marking system and assessment criteria)

4.Methodology, learning tasks, syllabus and resources

4.1.Methodological overview

The methodology followed in this course is oriented towards the achievement of the learning objectives.

The course is divided in 48 participatory lectures both theory and problem solving, 4 hours of seminars, 8 hours of laboratory practice (2 hours/practice) and resolution and presenting problems given at the end of each block (practical work).

The seminars will be organized in 2 sessions of 2 hours each, in which students will solve using the spreadsheet problems of mass balance of the block II of the subject.

The lab practices will be held in 4 sessions of 2 hours each and they will be made at the end of the semester. They are done in groups 12-15 students divided in 4 practices that are performed simultaneously each day (4-5 students per practice).

Students must follow the regulations described in:

- Prevention: A guide for students at the University of Zaragoza: http://uprl.unizar.es/publicaciones/estudiantes_ingles.pdf
- Manual de seguridad en los laboratorios de la Universidad de Zaragoza y normas marcadas por la Unidad de Prevención de Riesgos Laborales: http://uprl.unizar.es/seguridad/pdfs/seglaborUZ.pdf http://uprl.unizar.es/seguridad/pdfs/laboratorios.pdf

In addition, students will follow as well any instructions related to biosecurity given by the professor

4.2.Learning tasks

The course includes the following learning tasks:

- Lectures: 21 h to discuss the theoretical content. Sessions of issues and problems: 27 h for the resolution of the exercises.
- Seminars: 4 h for the resolution, comment and sharing of case studies. Lab: 8 h distributed in four sessions of 2 hours each.
- Mentored practical work: 15 hours of autonomous work in which the student will work personally in the resolution of problems proposed by the lecturer which will guide the learning.
- Study: 71 h of autonomous work, not supervised by the lecturer.
- Exams: 4 h for the realization of two assessment tests (theoretical and practical).

WEEK 1 WEEK 2	**BLOCK I** UNIT 1 4 hours of theory and and 4 hours of problems related to Unit 1 Practical work: delivery of questions and problems related to Unit 1
WEEK 3 WEEK 4 WEEK 5 WEEK 6 WEEK 7 WEEK 8	**BLOCK II** UNITS 2, 3 and 4 8 hours of theory (4 + 3 + 1) and 14 hours of problems (6 + 5 + 3) related to Block II Practical work: delivery of questions and problems: Unit 2 in week 4, Unit 3 in week 6 and Unit 4 in week 8 Seminars for solving mass balances problems using spreedsheets (computer classroom) in week 8 (4 h)
WEEK 9 WEEK 10 WEEK 11 WEEK 12 WEEK 13	**BLOCK III** UNITS 7, 8 and 9 9 hours of theory (3 + 3 + 3 h) and 9 hours of problems (4 + 3 + 2) Practical work: delivery of questions and problems. Laboratory practices 1, 2, 3 and 4 (2 h/practice) from week 10.

4.3.Syllabus

The course will address the following topic:

I. INTRODUCTION.

- ***Unit 1. Introduction to chemical engineering*** . ***Systems units and calculation methods.*** The food industry and chemical engineering . Scheme of a process in the food industry. Magnitudes, units and dimensions. Systems of units. Dimensional analysis. Units conversion. Temperature scales. Dimensional homogeneity and dimensionless groups. Unit conversion in formulas. Scientific notation. Significant figures and precision.

II. MASS AND ENERGY MACROSCOPIC BALANCES

- ***Unit 2. Mass balances in steady state without chemical reaction.*** Preliminary considerations. Principle of mass conservation. Basic concepts. Processes classification. General equation of balance: balance for continuous, batch and semi-continuous processes. Flowchart of a process. System limits, calculation base, a key element. Recycle, bypass and purge. Systematic procedure for performing mass balances in steady state without chemical reaction.
- ***Unit 3. Energy balances in steady state without chemical reaction.*** General concepts. Forms of energy: 1st Law of Thermodynamics. General equation of conservation of energy. Enthalpy balances: reference state, calculation of enthalpies. Energy balances in steady state without chemical reaction. Simultaneous mass and energy balances
- ***Unit 4. Mass and Energy balances in unsteady state.*** Deduction and solving of differential equations

of the balances in unsteady state. Application to concrete examples.

III. INTRODUCTION TO FLUID DYNAMICS, HEAT TRANSFER AND MASS TRANSFER.

- ***Unit 5. Fluid Dynamics.*** Continuity equation, mechanical energy balance, Bernoulli equation, loads, load loss, Fanning equation, Colebrook equation.
- ***Unit 6. Heat transfer.*** Heat transfer mechanisms: conduction, convection and radiation. Conductive heat transfer: conduction through cylindrical shells, spherical shells, flat sheets and conduction through solids in series. Heat transfer by convection: dimensionless numbers, empirical correlations for forced and natural convection. Calculating the global heat transfer coefficient. Heat transfer in non-steady state: dimensionless numbers and Sucec relationship.
- ***Unit 7. Mass Transfer.*** Mass transfer mechanisms: advective flow, molecular diffusion and turbulent diffusion. Mass transfer between phases: thermodynamic requirement (separation factor) and mechanical nature requirement. Mass transfer through porous solids: solute movement by diffusion (ordinary and Knudsen) and solute movement by hydrodynamic flow. Permeation through plastics.

4.4.Course planning and calendar

The dates and key milestones of the subject are described in detail, along with the other subjects in the second year in CTA Degree, on the website of the Faculty of Veterinary (link: http://veterinaria.unizar.es/gradocta/). This link will be updated at the beginning of every academic year

4.5.Bibliography and recommended resources

- **Aguado. J.; Calles, J.A.; Cañizares, P.; López, B.; Rodríguez, F.; Santos, A.; Serrano, D.;** *Ingeniería de la Industria Alimentaria. Vol. 1. Conceptos Básicos.* Síntesis S.A., Madrid, 1999.
- **Calleja, G.; García, F.; Martínez, A.L.; Prats, D.; Rodríguez, J.M.;** *Introducción a la Ingeniería Química.* Síntesis S.A., Madrid, 1999.
- **Hermida Bun, J.R.,** *Fundamentos de Ingeniería de Procesos Agroalimentarios*, Mundi-Prensa y A. Madrid Vicente Ediciones, Madrid, 2000.
- **Lomas Esteban, María del Carmen;** *Introducción al Cálculo de los Procesos Tecnológicos de los Alimentos*. Acribia, Zaragoza, 2002.
- **Peiró Pérez, J.J.; García Barrido, J.;** *Balances de materia. Problemas resueltos.* (3 vols.). Universidad Politécnica de Valencia. Valencia, 1989.
- **Reklaitis, G.V.;** *Balances de Materia y Energía*. Interamericana (1ª ed. en español), México (1986).
- **Ruiz Palacín, J.;** *Problemas resueltos de balances de materia en estado estacionario.* Prensas Universitarias de Zaragoza (1ª ed), Zaragoza, 2009.
- **Singh, R.P.; Heldman, D.R.;** *Introducción a la Ingeniería de los Alimentos.* Acribia, Zaragoza, 1997.
- **Toledo, R.T.;** *Fundamentals of food process engineering.* Chapman and Hall (2ª ed., reimpr.), Nueva York, 1994.
- **Valiente, A.;** *Problemas de Balance de Materia y Energía en la Industria Alimentaria. Limusa (2ª ed.), Méjico, 1997.*