3rd/4th Year

Track 7: Chemical and Environmental Engineering

1	55000057	Applied Mathematics
2	55000701	Experimentation in Chemistry
3	55000702	Analytical Chemistry
4	55000703	Experimentation in Chemical Engineering I
5	55000704	Separation Processes I
6	55000705	Chemical Reactors
7	55000706	Chemical Processes Fundamentals
8	55000707	Chemical Engineering Experimentation II
9	55000708	Separation Process II

55000057 - APPLIED MATHEMATICS

CREDITS:	4.5 ECTS
DEPARTMENT:	Industrial and Applied Mathematics (MAT)
COURSE	Dolores Barrios Rolanía
COORDINATOR: TYPE:	Common
YEAR AND SEMESTER:	3rd Year / Spring

LIST OF TOPICS

MODULE 1. Round-off errors and computer arithmetic.

MODULE 2. Interpolation.

MODULE 3. Non linear equations.

MODULE 4. Numerical linear algebra.

MODULE 5. Functions approximation.

MODULE 6. Numerical integration.

MODULE 7. Numerical solutions for ordinary differential equations.

RECOMMENDED COURSES OR KNOWLEDGE

RECOMMENDED PREVIOUS COURSES:

COURSE:

TOPIC:

RECOMMENDED PREVIOUS KNOWLEDGE OR ABILITIES:

- Basic mathematics: Calculus, algebra and differential equations.
- Numerical linear algebra
- Fundamentals of programming (in Matlab)

SPECIFIC OUTCOMES FOR THE COURSE

At the end of the course, the student will be able to (or will have ability for):

- Solving systems of equations.
- Understanding numerical solutions
- Formulate engineering problems by using mathematical language

STUDENT OUTCOMES

- ABET_1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
- ABET_2. An ability to apply engineering design to produce solutions that meet specified needs with consideration fo public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
- ABET_3. An ability to communicate effectively with a range of audiences
- ABET_5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
- ABET_7. An ability to acquire and apply new knowledge as needed using appropriate learning strategies

BIBLIOGRAPHY

TEXT BOOKS

Numerical Analysis, R. L. Burden, J. D. Faires, A. M. Burden. 10th ed. Cengage learning, 2016

Análisis numérico: las matemáticas del método científico, D. Kinkaid, W. Cheney. Addison Wesley Iberoamericana 1994

OTHER MATERIALS

Compilation of exercises, scripts for practices with MatLab

55000701 - EXPERIMENTATION IN CHEMISTRY

CREDITS:	6 ECTS
DEPARTMENT:	Chemical and Environmental Engineering (CHE)
COURSE COORDINATOR:	Joaquín Martínez Urreaga
TYPE:	Elective - Track Industrial Chemistry and Enviromental Engineering
YEAR AND SEMESTER:	3rd Year / Spring

LIST OF TOPICS

MODULE 1. General

- 1) General information about the subject
- 2) Labour standards. Safety standards
- 3) Laboratory notebook. Presentation of results. How to prepare a lab report. Introduction to the use of spreadsheets.

MODULE 2. Chemical characterization and common operations

- 4) Preparation of solutions.
- 5) Statistical treatment of data. Calibration of volumetric material.

MODULE 3. Titrations

- 6) Acid-base titrations.
- 7) Redox titration.

MODULE 4. Determination of physico-chemical parameters

- 8) Kinetic simulation of an elementary reaction.
- 9) Kinetics: hydrolysis.
- 10) Sugars: determination and characterization.

MODULE 5. Separation and purification

- 11) Liquid-liquid extraction.
- 12) Crystallization / recrystallization.
- 13) Chromatography.

MODULE 6. Synthesis and characterization

- 14) Synthesis and characterization of inorganic compounds.
- 15) Synthesis and characterization of organic compounds.

MODULE 7. Final projects

- 16) Project: Making a calorimeter. Measurement of enthalpies and heat capacities.

RECOMMENDED COURSES OR KNOWLEDGE

RECOMMENDED PREVIOUS COURSES:

COURSE:

TOPIC: Computer user (basic level); spreadsheets, word processors

RECOMMENDED PREVIOUS KNOWLEDGE OR ABILITIES:

- Resolution of exercises and problems
- Reporting
- Math skills to achieve results and to interpret them
- Organization and personal execution of work
- Responsibility for work in chemical laboratory
- Teamwork

SPECIFIC OUTCOMES FOR THE COURSE

At the end of the course, the student will be able to (or will have ability for):

- Search for simple data in the bibliography
- Independent and in teamwork
- Making decisions
- Observe and analyze chemical phenomena
- Managment of the waste generated during his work in the laboratory
- Recognize and implement best practices in scientific measurement and experimentation
- To plan, design and execute small experimental works, from the stage of problem statment to the assessment and evaluation of the results. Be responsible for such experiments
- Express correctly the experimental results
- Manage information, evaluating, interpreting and synthesizing data and chemical information
- Use of computer tools to manage the information
- Plan work to wisely use the available time
- Interpret data from observations and measurements in the laboratory in terms of its significance and the theories underlying them
- Identify the errors committed in the experimental work and recognize the limitations of the work in the laboratory
- Comparing experimental and calculated data with data collected in the bibliography
- Promote the critical reasoning through the discussion of results
- Apply the theoretical knowledge to chemical experimentation
- Solve problems similar to the experiments which have been done in the lab
- Proper work in the chemical laboratory (safety, proper handling of reagents, taking and processing of data, the use of instrumental equipment)
- Design a process of synthesis, separation, purification and characterization of a compound and put it into practice
- Build a written text understandable and organized. Develop scripts and reports

STUDENT OUTCOMES

- ABET_3. An ability to communicate effectively with a range of audiences
- ABET_6. An ability to develop and conduct appropriate experimentation,analyse and interpret data,and use engineering judgment to draw conclusions
- ABET_7. An ability to acquire and apply new knowledge as needed using appropriate learning strategies

BIBLIOGRAPHY

TEXT BOOKS

Experimentación en Química Básica
Martín Urreaga J., Narros Sierra A., de la Fuente García-Soto MM., Pozas Requejo F., Diez Lorente V.M. Editorial Thomson, 2006

Técnicas Experimentales en Síntesis Orgánica
Martínez Grau, M.A., Csákÿ A.G, Editorial Síntesis, 2001

Química Orgánica
Wade, L.G. Editorial Pearson Educación, 2004

OTHER MATERIALS

Guiones de prácticas y material docente adicional:
https://moodle.upm.es/titulaciones/oficiales/course/view.php?id=8844

Reactivos, material e instrumentación necesarios para el desarrollo de las sesiones de laboratorio

55000702 - ANALYTICAL CHEMISTRY

CREDITS:	6 ECTS
DEPARTMENT:	Chemical and Environmental Engineering (CHE)
COURSE COORDINATOR:	Adolfo Narros
TYPE:	Elective - Track Industrial Chemistry and Enviromental Engineering
YEAR AND SEMESTER:	3rd Year / Spring

LIST OF TOPICS

MODULE 1. GENERAL CONCEPTS.

- 1) Introduction. General analytical chemistry concepts
- 2) The analytic process. Sampling and sample preparation
- 3) Statistical treatment of results.

MODULE 2. Chemical equilibria and titrations

- 4) Acid-base equilibria and titrations.
- 5) Complex formation equilibrium. Complexometric titrations.
- 6) Equilibrium of precipitation. Gravimetry and precipitation titrations
- 7) Equilibrium and redox titrations
- 8) Separation methods

MODULE 3. Instrumental Analysis

- 9) Optical methods of analysis
- 10) Electroanalytical methods
- 11) Chromatographic techniques

RECOMMENDED COURSES OR KNOWLEDGE

RECOMMENDED PREVIOUS COURSES:

COURSE: Chemistry I and Chemistry II

TOPIC:

RECOMMENDED PREVIOUS KNOWLEDGE OR ABILITIES:

- Problem solving of simple chemical equilibria.
- Basic use of scientific calculators (linear regression, statistical calculations).
- Representation of equations.
- Basic statistics.
- Basic operation of computer programs as user-level: word processors, spreadsheets.

SPECIFIC OUTCOMES FOR THE COURSE

At the end of the course, the student will be able to (or will have ability for):

- Statistical treatment of experimental data. Rejection of outliers.
- Resolution of concurrent equilibria in solution.
- Representation and interpretation of titration graphs based on different types of chemical reactions.
- Selection of chemical indicators in titrations.
- Representation and interpretation of diagrams of chemical equilibria in solution.
- Understanding the principles of the operation of some chemical analysis instruments.

STUDENT OUTCOMES

- ABET_1. An ability to identify,formulate,and solve complex engineering problems by applying principles of engineering,science,and mathematics
- ABET_4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments,which must consider the impact of engineering solutions in global,economic,environmental,and societal contexts
- ABET_5. An ability to function effectively on a team whose members together provide leadership,create a collaborative and inclusive environment,establish goals,plan tasks,and meet objectives
- ABET_6. An ability to develop and conduct appropriate experimentation,analyse and interpret data,and use engineering judgment to draw conclusions
- ABET_7. An ability to acquire and apply new knowledge as needed using appropriate learning strategies

BIBLIOGRAPHY

TEXT BOOKS

- "Equilibrios Iónicos y sus Aplicaciones Analíticas", Silva, M. y Barbosa, J., Editorial Síntesis, 2002
- "Ionic Equilibria in Analytical Chemistry"; Burgot, J.L.; Editorial Springer, 2012
- "Química Analítica", 6ª Ed; Christian, G.D., Editorial Mac Graw Hill, 2009
- "Fundamentos de Química Analítica", 9ª Ed; Skoog, D.A., West, D.M., Holler, F.J., Crouch, S.R. Editorial Cengage Learning, 2014
- "Análisis Químico Cuantitativo", 3ª Ed; Harris, D.C. Editorial Reverté, 2016
- "Principios de Análisis Instrumental", 6ª Ed; Skoog, D.A., Holler, F.J. y Crouch, S.R. Editorial Cengage Learning, 2008

OTHER MATERIALS

- "Problemas resueltos de Química Analítica"; Yáñez-Sedeño, P., Pingarrón, J.M. y Villena, F.J.M., Editorial Síntesis, 2003
- "Curso Experimental en Química Analítica"; Guiteras, J., Rubio, R. y Fonrodona, G., Editorial Síntesis, 2003
- Equipos y material del Departamento de Ingeniería Química Industrial y del Medio Ambiente de la ETSI Industriales de la UPM.

55000703 – EXPERIMENTATION IN CHEMICAL ENGINEERING I

CREDITS:	3 ECTS
DEPARTMENT:	Chemical and Environmental Engineering (CHE)
COURSE COORDINATOR:	Mª del Mar de la Fuente
TYPE:	Track (Chemical and Environmental Engineering)
YEAR AND SEMESTER:	4th Year / Fall

LIST OF TOPICS

MODULE 1. General

- 1) The laboratory work. Specific rules. Safety standards.
- 2) Statistical treatment of results.

MODULE 2. Physicochemical and transport properties

- 3) Density determination of liquids and solids.
- 4) Viscosity measurement of liquid. Influence of temperature.
- 5) Molecular weight determination by viscometry.
- 6) Determination of mixing volume and partial molar volumes in a binary solution. Project.

MODULE 3. Thermodynamic properties: balance

- 7) Solubility. Influence of ionic strength and common ion effect.

MODULE 4. kinetics of chemical reaction

- 8) Kinetics I: Determination of Kinetics parameters
- 9) Kinetics II: Project

RECOMMENDED COURSES OR KNOWLEDGE

RECOMMENDED PREVIOUS COURSES:

COURSE:

- Chemistry I
- Experimentation in Chemistry
- Chemistry II
- Thermodynamics
- Analytic chemistry
- Organic Chemistry
- Inorganic chemistry
- Physical Chemistry

TOPIC:

RECOMMENDED PREVIOUS KNOWLEDGE OR ABILITIES:

- Finding information (methods, properties, etc.)
- Organization and personnel work performance
- Responsibility for work in the chemical laboratory
- Teamwork
- Reporting

SPECIFIC OUTCOMES FOR THE COURSE

At the end of the course, the student will be able to (or will have ability for):

- Interpret data from observations and measurements in the laboratory in terms of its significance and theories that support them.
- Identify the mistakes made in the experimental work and recognize the limitations of laboratory work.
- Promote critical thinking through discussion of results.
- Concern for quality.
- Make decisions and solve problems.
- Correctly express the results of an experiment.
- Compare experimental data and calculated data collected in the literature.
- Sustainable use of natural resources.
- Plan, design and execute experimental work from the problem-recognition stage to evaluation and assessment of results. Be responsible for such experiments.
- Build a comprehensive and organized written text. Develop guide notes and reports.
- Manage information, evaluating, interpreting, and synthesizing data and chemical information.
- Find simple data in the literature.
- Plan the work to rationally use the available time.
- Recognize and implement good scientific and technical measuring and testing practices.
- Manage software to manage, organize and present the information.
- Work independently and as a team.

STUDENT OUTCOMES

- ABET_1. An ability to identify, formulate and solve complex engineering problems by applying principles of engineering, science, and mathematics.
- ABET_3. An ability to communicate effectively with a range of audiences.
- ABET_6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
- ABET_7. An ability to acquire and apply new knowledge as needed using appropriate learning strategies.

BIBLIOGRAPHY

TEXT BOOKS

OTHER MATERIALS

- Basic bibliography:

  Practice guide notes developed by the teaching staff and computerized in the MOODLE computer resources accessible to students of the subject.

- Reference bibliography:

  The students choose and manage their own bibliography since the subject is based to a great extent on the realization of projects and it varies according to the practice that is carried out.

  Practice guide notes and additional material in Moodle: https://moodle.upm.es/titulaciones/oficiales/my/

- Reagents, material, and instrumentation necessary for the development of the laboratory sessions.

55000704 - SEPARATION PROCESSES I

CREDITS:	6 ECTS
DEPARTMENT:	Chemical and Environmental Engineering (CHE)
COURSE COORDINATOR:	S. Galán
TYPE:	Track (Chemical and Environmental Engineering)
YEAR AND SEMESTER:	4th Year / Fall

LIST OF TOPICS

MODULE 1. Equilibrium-Stage separation systems

- 1) Phase Equilibrium and Flash Calculations
- 2) Multistage Systems

MODULE 2. Distillation

- 3) Binary Distillation
- 4) Tray Columns
- 5) Multicomponent Distillation
- 6) Special Distillations
- 7) Batch Distillation

MODULE 3. Solvent Extraction

- 8) Liquid-Liquid Extraction.
- 9) Leaching and Washing

RECOMMENDED COURSES OR KNOWLEDGE

RECOMMENDED PREVIOUS COURSES:

COURSE:

TOPIC:

RECOMMENDED PREVIOUS KNOWLEDGE OR ABILITIES:

SPECIFIC OUTCOMES FOR THE COURSE

At the end of the course, the student will be able to (or will have ability for):

- Use of professional design software
- Analysis, design and optimization of industrial mass transfer separation processes

STUDENT OUTCOMES

- ABET_1. An ability to identify,formulate,and solve complex engineering problems by applying principles of engineering,science,and mathematics
- ABET_2. An ability to apply engineering design to produce solutions that meet specified needs with consideration fo public health,safety,and welfare,as well as global,cultural,social,environmental,and economic factors
- ABET_3. An ability to communicate effectively with a range of audiences
- ABET_7. An ability to acquire and apply new knowledge as needed using appropriate learning strategies

BIBLIOGRAPHY

TEXT BOOKS

Separation process principles (3rd ed.)
J.D. Seader, E.J. Henley & D.K. Roper Editorial Wiley, 2010

Distillation design
H.Z. Kister Editorial McGraw-Hill, 1992

Distillation. Principles and practices (2nd ed.)
J.G. Stichlmair, H. Klein & S. Rehfeldt Editorial Wiley-AIChE, 2021

OTHER MATERIALS

• Apuntes de la asignatura • Colección de problemas de exámenes • Software de diseño y simulación • Moodle

55000705 - CHEMICAL REACTORS

CREDITS:	6 ECTS
DEPARTMENT:	Chemical and Environmental Engineering (CHE)
COURSE COORDINATOR:	Emilio J. González Gómez
TYPE:	Track (Chemical and Environmental Engineering)
YEAR AND SEMESTER:	4th Year / First half

LIST OF TOPICS

MODULE 1. Ideal homogeneous reactors

- 1) Phenomenology of chemical reactors
- 2) Isothermal ideal reactors
- 3) Reactions ideal change in the number of moles and multiple reactions
- 4) Association reactors and reactors with recirculation. Membrane Reactor. Pressure drop in reactors
- 5) Non-isothermal reactors in steady state
- 6) Non-isothermal reactors in non-steady state

MODULE 2. Not ideal homogeneous reactors

- 7) Nonideality in chemical reactors. Macromixing concept micromezclay
- 8) Residence time distributions
- 9) Nonideal reactor models

MODULE 3. Introduction to heterogeneous reactors

- 10) Catalytic reactors
- 11) Multiphase reactors

RECOMMENDED COURSES OR KNOWLEDGE

RECOMMENDED PREVIOUS COURSES:

COURSE:

- Chemistry I
- Chemistry II
- Fluid mechanics I
- Differential equations

TOPIC:

RECOMMENDED PREVIOUS KNOWLEDGE OR ABILITIES:

- Approach and solving systems of ordinary differential equations.
- Regression of experimental data.
- Approach and solve material and energy balances on systems with chemical reaction.

SPECIFIC OUTCOMES FOR THE COURSE

At the end of the course, the student will be able to (or will have ability for):

STUDENT OUTCOMES

- ABET_1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering,science,and mathematics
- ABET_2. An ability to apply engineering design to produce solutions that meet specified needs with consideration fo public health,safety,and welfare,as well as global,cultural,social,environmental,and economic factors
- ABET_3. An ability to communicate effectively with a range of audiences

BIBLIOGRAPHY

TEXT BOOKS

- H. S. Fogler, "Elements of Chemical Reaction Engineering", Prentice Hall, 5th Ed. (2016).
- O. Levenspiel, Chemical Reaction Engineering, Wiley, 3rd Ed. (1998).
- J. M. Smith, Chemical Engineering Kinetics, McGraw-Hill, 3rd Ed. (1981).

OTHER MATERIALS

- Lecture notes
- List of proposed exercises
- Web resources
- Self-assessment questionaries

55000706 - CHEMICAL PROCESSES FUNDAMENTALS

CREDITS:	3 ECTS
DEPARTMENT:	Chemical and Environmental Engineering (CHE)
COURSE COORDINATOR:	S. León
TYPE:	Track (Chemical and Environmental Engineering)
YEAR AND SEMESTER:	4th Year / Fall

LIST OF TOPICS

MODULE 1. Mass Balances

- 1) Algebraic formalism for mass balances
- 2) Resolution of mass balances for systems without chemical reactions
- 3) Resolution of mass balances for systems with chemical reactions
- 4) Resolution of mass balances for systems with multiple units

MODULE 2. Energy Balances

- 5) Algebraic formalism for energy balances
- 6) Resolution of energy balances for systems without chemical reactions
- 7) Resolution of energy balances for systems with chemical reactions
- 8) Combined mass and energy balances

RECOMMENDED COURSES OR KNOWLEDGE

RECOMMENDED PREVIOUS COURSES:

COURSE:

- Chemistry I
- Chemistry II

TOPIC:

RECOMMENDED PREVIOUS KNOWLEDGE OR ABILITIES:

- Posing and solving systems of algebraic equations
- Basics on chemistry and thermodynamics

SPECIFIC OUTCOMES FOR THE COURSE

At the end of the course, the student will be able to (or will have ability for):

- Comprehensive analysis of chemical processes and their overall efficiencies
- Data from mass and energy balances for the basic design of unit operations in a chemical plant

STUDENT OUTCOMES

- ABET_1. An ability to identify,formulate,and solve complex engineering problems by applying principles of engineering,science,and mathematics
- ABET_2. An ability to apply engineering design to produce solutions that meet specified needs with consideration for public health,safety,and welfare,as well as global,cultural,social,environmental,and economic factors
- ABET_3. An ability to communicate effectively with a range of audiences
- ABET_4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments,which must consider the impact of engineering solutions in global,economic,environmental,and societal contexts
- ABET_5. An ability to function effectively on a team whose members together provide leadership,create a collaborative and inclusive environment,establish goals,plan tasks,and meet objectives
- ABET_6. An ability to develop and conduct appropriate experimentation,analyse and interpret data,and use engineering judgment to draw conclusions
- ABET_7. An ability to acquire and apply new knowledge as needed using appropriate learning strategies

BIBLIOGRAPHY

TEXT BOOKS

- D. M. Himmelblau, "Principios Básicos y Cálculos en Ingeniería Química". Prentice-Hall, 6th ed., 1997
- R. Murphy, "Introducción a los Procesos Químicos". McGraw Hill, 2007.

OTHER MATERIALS

- Lecture notes
- List of proposed exercises

55000707 – EXPERIMENTATION IN CHEMICAL ENGINEERING II

CREDITS:	6 ECTS
DEPARTMENT:	Chemical and Environmental Engineering (CHE)
COURSE COORDINATOR:	Mª del Mar de la Fuente
TYPE:	Track (Chemical and Environmental Engineering)
YEAR AND SEMESTER:	4th Year / Spring

LIST OF TOPICS

MODULE 1. General

- 1) Theoretical Foundations of experiments.
- 2) Databases and literature searches.
- 3) Reports: stylebook.
- 4) Teamwork.

MODULE 2. Thermodynamic properties: balance

- 5) Experimental determination of the T-x curve for binary systems.
- 6) Determination of pK of chemical indicators.
- 7) Estimating properties with Aspen

MODULE 3. Determination of kinetic parameters and reactor operations

- 8) Continuous Stirred Tank Reactor (CSTR)
- 9) Plug flow Reactor (PFR)

MODULE 4. Heat transfer

- 10) Applied Fluid Mechanics
- 11) Determination of coefficient of heat transfer in exchangers.

MODULE 5. Separation operations

- 12) Synthesis and characterization of zeolites
- 13) Solid-liquid adsorption.
- 14) Simple and fractional distillation.
- 15) Liquid-liquid extraction.

RECOMMENDED COURSES OR KNOWLEDGE

RECOMMENDED PREVIOUS COURSES:

COURSE:

- Separation Operations I
- Chemical Reactors
- Principles of Chemical Processes
- Physical Chemistry
- Experimentation in Chemical Engineering I

TOPIC:

RECOMMENDED PREVIOUS KNOWLEDGE OR ABILITIES:

Finding information (methods, properties, etc.)

- Organization and personnel work performance
- Responsibility for the work in chemical laboratory
- Teamwork
- Reporting

SPECIFIC OUTCOMES FOR THE COURSE

At the end of the course, the student will be able to (or will have ability for):

- Work independently and in teams.
- Plan, design and execute experimental work from the problem-recognition stage to evaluation and assessment of results. Be responsible for such experiments.
- Correctly express the results of an experiment.
- Compare experimental data and calculated data collected in the literature.
- Manage computer to manage, organize and present the information tools.
- Promote critical thinking through discussion of results.
- Concern for quality.
- Plan the work to rationally use the available time.
- Make decisions and solve problems.
- Creativity
- Recognize and implement good scientific and technical measurement and testing practices.
- Manage information, evaluating, interpreting and synthesizing data and chemical information.
- Interpret data from observations and measurements in the laboratory in terms of its significance and theories that support them.
- Search simple data in the literature.
- Build a comprehensive and organized written text. Develop scripts and reports.
- Identify the mistakes made in the experimental work and recognize the limitations of laboratory work.
- Sustainable use of natural resources.

STUDENT OUTCOMES

- ABET_1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
- ABET_3. An ability to communicate effectively with a range of audiences.
- ABET_6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
- ABET_7. An ability to acquire and apply new knowledge as needed using appropriate learning strategies.

BIBLIOGRAPHY

TEXT BOOKS

OTHER MATERIALS

- Basic bibliography:

  Practice guide notes developed by the teaching staff and computerized in the MOODLE computer resources accessible to students of the subject.

- Reference bibliography:

  The students choose and manage their own bibliography since the subject is based to a great extent on the realization of projects and it varies according to the practice that is carried out.

  Practice guide notes and additional material in Moodle: https://moodle.upm.es/titulaciones/oficiales/my/

- Reagents, material, and instrumentation necessary for the development of the laboratory sessions.

55000708 - SEPARATION PROCESSES II

CREDITS:	6 ECTS
DEPARTMENT:	Chemical and Environmental Engineering (CHE)
COURSE COORDINATOR:	S. Galán
TYPE:	Track (Chemical and Environmental Engineering)
YEAR AND SEMESTER:	4th Year / Spring

LIST OF TOPICS

MODULE 1. Molecular Diffusion

- 1) Definitions. Fick's Law and Maxwell-Stefan Equations
- 2) Binary Diffusion
- 3) Estimation of Diffusion Coefficients
- 4) Multicomponent Conservation Equations
- 5) Diffusion in Solids

MODULE 2. Interphase Transfer

- 6) Mass Transfer Coefficients
- 7) Film Theory
- 8) Simultaneous Mass and Energy Transfer
- 9) Mass Transfer in Turbulent Flow. Analogies

MODULE 3. Rate-Based Separation Processes

- 10) Absorption
- 11) Packed Columns
- 12) Adsorption
- 13) Membrane Separations
- 14) Drying of Solids
- 15) Crystallization

RECOMMENDED COURSES OR KNOWLEDGE

RECOMMENDED PREVIOUS COURSES:

COURSE:

TOPIC:

RECOMMENDED PREVIOUS KNOWLEDGE OR ABILITIES:

SPECIFIC OUTCOMES FOR THE COURSE

At the end of the course, the student will be able to (or will have ability for):

- Medium complexity mass-transfer calculations
- Analysis, design and optimization of industrial rate-based separation processes

STUDENT OUTCOMES

- ABET_1. An ability to identify,formulate,and solve complex engineering problems by applying principles of engineering,science,and mathematics
- ABET_2. An ability to apply engineering design to produce solutions that meet specified needs with consideration fo public health,safety,and welfare,as well as global,cultural,social,environmental,and economic factors
- ABET_3. An ability to communicate effectively with a range of audiences
- ABET_7. An ability to acquire and apply new knowledge as needed using appropriate learning strategies

BIBLIOGRAPHY

TEXT BOOKS

Multicomponent mass transfer
R. Taylor & R. Krishna Editorial Wiley, 1993

Transport phenomena (2nd ed.)
R.B. Bird, W. Stewart & E.N. Ligthfoot Editorial Wiley, 2001

Absorption: Fundamentals and applications
R. Zarzycki & A. Chacuk Editorial Pergamon, 1993

OTHER MATERIALS

- Apuntes de la asignatura • Colección de problemas de exámenes • Programas de simulación y diseño • Moodle