CHEMICAL ENGINEERING SYLLABUS
UNIVERSITY OF VALLADOLID

FIRST CYCLE

		COURSES	LECTURE HOURS	PRACTICAL HOURS	TOTAL HOURS	ECTS
1º	1 Semester	Foundations of Mathematics for Engineers	45	15	60	6
		Foundations of Physics for Engineers. I	20	25	45	4,5
		Technical Drawing	15	45	60	6
		Introduction to Chemical Engineering	30	15	45	4,5
		Physical Chemistry	30	15	45	4,5
		Inorganic Chemistry	65	10	75	7,5
		TOTAL	195	135	330	33
	2 Semester	Foundations of Mathematics for Engineers	30	30	60	6
		Foundations of Physics for Engineers. I	20	25	45	4,5
		Technical English	10	35	45	4,5
		Physical Chemistry	40	20	60	6
		Organic Chemistry	45	30	75	7,5
		Programming Fundamentals	20	40	60	6
		TOTAL	180	165	345	34,5
2º	3 Semester	Statistics	30	30	60	6
		Applied Mathematics for Engineers	30	15	45	4,5
		Fluid Flow Unit Operations	30	15	45	4,5
		Introduction to Thermodynamics	30	15	45	4,5
		Analytical Chemistry	40	35	75	7,5
		Chemistry Laboratory	0	45	45	3,5
		TOTAL	180	135	315	30,5
	4 Semester	Chemistry Laboratory	0	45	45	3,5
		Applied Mathematics for Engineers	30	15	45	4,5
		Foundations of Physics for Engineers. II	32	28	60	6
		Transport Phenomena	20	40	60	6
		Fluid Flow Unit Operations	25	20	45	4,5
		Electives	-	-	75	7,5
		TOTAL	150	105	330	32
3º	5 Semester	Heat Transfer Unit Operations	45	30	75	7,5
		Applied Thermodynamics	45	30	75	7,5
		Chemical Engineering Laboratory I	0	60	60	3
		Materials in Chemical Engineering	45	15	60	6
		Free Configuration	-	-	60	6
		TOTAL	135	135	330	30
	6 Semester	Chemical Engineering Laboratory I	0	60	60	6
		Electric Technology	20	40	60	6
		Principles of Structural Design	45	15	60	6
		Applied Chemical Kinetics	45	15	60	6
		Free Configuration	-	-	60	6
		TOTAL	120	120	300	30

SECOND CYCLE

		COURSES	LECTURE HOURS	PRACTICAL HOURS	TOTAL HOURS	ECTS
4º	7 Semester	Environmental Technology	45	30	75	7,5
		Chemical Processes Control and Instrumentation	15	15	30	3
		Separation Processes	45	30	75	7,5
		Chemical Reactors	45	30	75	7,5
		Chemical Engineering Laboratory II	0	45	45	3
		Free Configuration	-	-	60	6
		TOTAL	150	150	360	34,5
	8 Semester	Chemical Engineering Laboratory II	0	75	75	6
		Chemical Process Analysis and Simulation	30	30	60	6
		Chemical Processes Control and Instrumentation	48	27	75	7,5
		Electives	-	-	120	12
		TOTAL	75	135	330	31,5
5º	9 Semester	Projects	54	21	75	7,5
		Equipment and Facilities Design	30	15	45	4,5
		Industrial Chemistry	30	15	45	4,5
		Industrial Economy and Production Management	45	15	60	6
		Electives	-	-	120	12
		TOTAL	150	75	345	34,5
	10 Semester	Safety and Loss Prevention	30	20	50	5
		Equipment and Facilities Design	30	15	45	4,5
		Chemical Process Optimization	30	15	45	4,5
		Electives	-	-	120	12
		Free Configuration	-	-	90	9
		TOTAL	90	45	345	34,5
PROJECT		Final Project Design	0	100	100	10
ELECTIVES		Bioprocess Engineering	35	25	60	6
		Physic and Chemical Processes for Pollution Control	45	15	60	6
		Biological Processes for Pollution Control	45	15	60	6
		Design and Operation of Treatment Plants	15	45	60	6
		Environmental Management	30	30	60	6
		Separation Operations II	45	15	60	6
		Heat Integration	30	30	60	6
		Integrated Process Design	15	45	60	6
		Computer Control	30	30	60	6
		Computing applied to Chemical Engineering	45	15	60	6
		Process Supervision	30	30	60	6
		Evolution of Knowledge in Science and Technol.	50	10	60	6
		Energy Systems: Technology and Exergo-economics	35	25	60	6
		Project Management	45	15	60	6
		Industrial Management	45	15	60	6
		Equipment and Facilities Maintenance	30	30	60	6
		High Pressure Processes in Chem. Engineering	20	40	60	6
		Industrial Stage / Research Work			150	15

FOUNDATIONS OF MATHEMATICS FOR ENGINEERS

Code: **44293-UVA**

Extension: Annual
Credits ......Local: 12

Semester(s): 1&2 Academic year: 1 Cycle: 1
ECTS: 12

Lecture hours: 75
Personal work hours: 192

Practical hours: 45
Laboratory hours: 0

Aims: The aim of this course is to give the student the basic background of calculus, the most useful single branch of mathematics daily used in the chemical technology and industry.

Assessment: Examination (80%) Classwork (20%)

Outline Syllabus:

1. FUNCTIONS OF ONE AND SEVERAL VARIABLES.
2. POWER SERIES AND FOURIER SERIES.
3. INTEGRATION. APPLICATIONS.
4. MULTIPLE INTEGRALS.
5. VECTORIAL ANALYSIS.

Bibliography:

- G. BRADLEY, "Cálculo 1 y 2", Prentice(2001). R. E. LARSON, R.P. HOSTETLER, B.H. EDWARDS, "Calculus", McGraw-Hill (2005).
- J. MARSDEN, "Cálculo Vectorial", Addison-Wesley (2004).

Staff Involved: Mauricio Jalón, José-Fernando Pascual-Sánchez, Francisco Vicente

Department: Applied Mathematics

FOUNDATIONS OF PHYSICS FOR ENGINEERS I

Code: **44292-UVA**

Extension: Annual	Semester(s): 1&2	Academic year: 1	Cycle: 1
Credits ......Local: 9	ECTS: 9		

Lecture hours: 40	Practical hours: 20
Personal work hours: 144	Laboratory hours: 30

Aims: The aim of this course is to give the student the basic background of physics, used by the chemical engineers, and fundamentals for other disciplines.

Assessment: Examination (80%) Laboratory work (20%)

Outline Syllabus:

MECHANICS

1. Relative motion.
2. Material point kinematics. Material point dynamics.
3. Work and energy: force fields.
4. System dynamics.
5. Rigid solid dynamics. Rigid solids statics
6. Relativity mechanics.
7. Elasticity fundamentals.
8. Fluid dynamics.

VIBRATIONS AND MECHANICAL WAVES

9. Oscillations.
10. Ondulatory motion.
11. General properties of waves.
12. Sound waves: elements of acoustics.

OPTICS AND ELEMENTS OF MODERN PHYSICS

13. Geometric optics.
14. Interferences and diffraction.
15. Light polarization.
16. Material waves: introduction to modern physics.

Bibliography:

- ALONSO, M., FINN E.J., “Física”, Addison Wesley, (1995)
- CATALÁ, J. "Física". Ed. Saber, (1985)
- DE JUANA JM., "Física General", vol. 1 y 2, Ed. Alhambra, (1995)
- SEARS F., ZEMANSKY, M. YOUNG, H. "Física Universitaria". Ed. Fondo EducativO IIberamericano, (1988)
- TIPLER A., "Física para la Ciencia y Tecnología", Vol. I y II. Ed. Reverté, (1999)

Staff Involved: Mª Luisa Sánchez/Isidro Pérez/Julia Bilbao/Argimiro Miguel

Department: Chemical Engineering and Environmental Technology

THECNICAL DRAWING

Code: **44291-UVA**

Extension: Half-yearly	Semester(s): 1	Academic year: 1	Cycle: 1
Credits ......Local: 6	ECTS: 6		

Lecture hours: 15	Practical hours: 45
Personal work hours: 96	Laboratory hours: 0

Aims: The fundamental aim is to provide the sufficient knowledge in order that the student could interpret a graphical document, which implies knowing and handling the most usual systems of representation. One tries to announce the graphical resources and basic instruments that they handle in the technical representation and more concretly in the Chemical Engineering. For it, we depart from two big blocks: systems of representation on one hand and concretion of the drawing in engineering for other one. Another fundamental aim is the familiarization with the normalized own(proper) language of every engineer, concretly of the Chemical Engineer, applying the different procedure relative to representation and annotation.

Assessment: Examination (60%) Classwork (40%)

Outline Syllabus:

1. GENERALITIES. The graphical representation in the professional labor of the engineer. Generalities and foundations of the technical representation. Normalized documents.
2. SYSTEMS OF REPRESENTATION. Generalities and foundations. Projections. Interpretation of the different representations.
3. REPRESENTATION NORMALIZED. System Diedrico and System Axonometrico
4. INTERSECTIONS. Types of intersections and methods of resolution
5. NORMALIZATION. Concept and justification of the normalization. Application of the procedure related to the graphical resources, representation and annotation. Type of lines, cut representation, use and meaning of symbols, scales, annotation
6. MECHANICAL COMPONENTS. Conventional representation of mechanical components. Fixed and detachable unions. Indication of superficial conditions
7. SCHEMES. Types of graphical documentation. Symbols, drawings and schemes of facilities. Chemical installation
8. CAD. Theory

Bibliography:

- AENOR, "Normas UNE sobre Dibujo Técnico. Normas Fundamentales" (1997)
- BERMEJO HERRERO: "Geometría descriptiva aplicada". Ed. Tébar Flores (1996)
- COMPANY / VERGARA / MONDRAGON: "Dibujo Industrial". Univ. Jaume I (2007)
- FÉLEZ / MARTÍNEZ: "Dibujo Industrial". Ed. Síntesis (1995)
- FELEZ / MARTÍNEZ: "Fundamentos de Ingeniería Gráfica. Ed. Síntesis (1996)
- FELEZ / MARTÍNEZ: "Ingeniería Gráfica y diseño". Ed. Síntesis (2008)
- RODRÍGUEZ DE ABAJO/ÁLVAREZ BENGOA: "Dibujo Técnico" Ed. Donostiarra. (1990)
- RENDÓN GÓMEZ, A. "Geometría paso a paso" Ed. Tébar (2001)
- SHUMAKER, TH. Process Pipe Drafting. Ed The Goodheart-Willcox Company (1999)

Staff Involved: Raquel Suárez Sánchez

Department: Science of the Materials and Metallurgical Engineering, Graphical Expression in the Engineering, Cartographic, Geodesic Engineering and Fotogrametric, Mechanical Engineering and Engineering of the Manufacturing Processes

INTRODUCTION TO CHEMICAL ENGINEERING

Code: **44294-UVA**

Extension: Half-yearly	Semester(s): 1	Academic year: 1	Cycle: 1
Credits ......Local: 4,5	ECTS: 4,5		

Lecture hours: 30	Practical hours: 15
Personal work hours: 72	Laboratory hours: 0

Aims: The aim of the course is to give the student an understanding of the role of the chemical engineer in chemical processing. To give the student an appreciation for the methodology and quantitative approach of the chemical engineer developing a critical thinking illustrating the role of different subjects in the analysis and design of chemical reactors and separation processes.

Upon completion of this course the students must be able to:

- develop a systematic approach to the solution of mass balance problems being able to perform mass and energy balances on reacting and non-reacting systems.
- present worked solutions to problems in a systematic and professional manner using conventional chemical, mathematical and engineering notation and symbols, feeling comfortable when working with new and unfamiliar processes.
- evaluate the fundamentals and applications of unit operations and its relationship whit chemical processes.

Assessment: Examination (75%), Classwork (25%)

Outline Syllabus:

Part I:

1. CHEMICAL ENGINEERING TOOLS: Dimensions, units and unit systems. Process variables. Relationship between variables: dimensional análisis and scale-up. Chemical reactions: stoichiometry. Properties of gases, liquids and solids: phase diagrams.
2. PROCESS DIAGRAMS: Block diagrams. Process flow diagrams. Symbols and equipment identification. Practical cases.
3. STATIONARY STATE MASS BALANCES: General equation. Individual and global balances. Balances: rules. Reference base changes. Recirculation, purge and bypass. Systems with simultaneous reactions.
4. STATIONARY STATE ENERGY BALANCES: Previous concepts. Energy kinas and het transfer mechanisms. Enthalpy variation: systems with and without state change.
5. NON STATIONARY MASS BALANCES: General equation. Systems with and without concentration change.

Part II

6. CHEMICAL ENGINEERING: Scope and historical evolution. Some definitions. Trends in chemical engineering. Chemical engineer profession.
7. CHEMICAL INDUSTRY: Historical Evolution. Characteristics. Raw materials and products.
8. SAFETY, LOSS PREVENTION AND ENVIRONMENTAL: Risk assessment: parameters and normative. Fire and explosions. Risk studies and operability (HAZOP). Treatment and management of industrial wastes.

Bibliography:

- FELDER.R.M., ROUSSEAU.R.W., "Elementary principles of chemical processes" 3rd Edit., J. Wiley (2000).

- PEIRÓ PÉREZ, J.J., "Balances de materia-Problemas resueltos y comentados" (VOL. I), Univ. Politécnica de Valencia (1997).
- HIMMELBLAU, D.M., "Basic principles and calculations in Chemical Engineering" 5th Ed., Englewood Cliffs (1989).
- REKLAITIS, G.V., "Introduction to material and energy balances", J. Wiley (1983).
- AUSTIN, G.T., "Manual de procesos químicos en la industria", Mc Graw Hill (1992).
- TURTON, R., BAILEY, R.C., WHITING, W.C., "Analysis synthesis and design of chemical processes", Prentice Hall (1998)

Staff Involved: Fidel Mato Vázquez, Ángel Cartón López

Department: Chemical Engineering and Environmental Technology

PHYSICAL CHEMISTRY

Code: **44297-UVA**

Extension: Annual	Semester(s): 1&2	Academic year: 1	Cycle: 1
Credits ......Local: 10,5	ECTS: 10,5		

Lecture hours: 70	Practical hours: 35
Personal work hours: 168	Laboratory hours: 0

Aims: The Physical Chemistry is a theoretical-practice science that addresses the theoretical and quantitative study of constitution, properties and transformation of matter from structural and energetic views using auxiliary of the theoretical and experimental methods of the physics. It is therefore a core area for the study or other subjects of Study Plan of Chemical Engineer. By the nature of these studies, the Physical Chemistry will focus on three key areas: thermodynamics, electrochemical and kinetics. However, we occasionally will use conceptual aspects of quantum and statistical mechanics.

Assessment: 2 written examinations, 5 hours/exam (80 %); Classwork (20 %)

Outline Syllabus:

1. INTRODUCTION: FUNDAMENTAL CONCEPTS. Physical Chemistry: major areas.- Quantities and units.- Thermodinamics: Introduction and general concepts.- Mathematical Review.
2. STATES OF MATTER AND EQUATIONS OF STATE. Properties of gases.- Ideal gas law.- Mixture of gases. Dalton's law.- Real gases. Compressibility factor.- Equations of state.- Liquefaction of gases. Critical constants.- Principle of corresponding states.- Solids and liquids. Isothermal and isobaric compressibilities.- Kinetic Molecular Theory.
3. FIRST PRINCIPLE OF THERMODYNAMICS. Internal energy, work and heat.- First principle.- Enthalpy.- Heat capacities.- Calculations of heat, work, internal energy change and enthalpy change for several processes.
4. SECOND AND THIRD PRINCIPLES OF THERMODYNAMICS. Spontaneous changes.- Entropy.- Second principle.- Calculations of entropy changes in various processes.- Third principle. Absolute entropies.- Free energy functions.- Criteria of equilibium.
5. FUNDAMENTAL EQUATIONS OF THERMODYNAMICS. Fundamental equations for a closed system.- Maxwell relations.- Fundamental equations for open systems. Chemical potential.- Properties of chemical potential.- Activity and standar states.
6. PHASE EQUILIBRIA IN ONE-COMPONENT SYSTEMS. Conditions of phase equilibrium.- Phase transitions. Vapor pressure.- The Phases Diagram.- Enthalpy and entropy changes in phase transitions.- Clapeyron's equation. Applications.- The phase rule.
7. SOLUTIONS. Composition of solutions.- Partial molar properties.- Quantities of mixing.- Vapor pressure of solutions. Raoult's law.- Liquid-vapor diagrams. Distillation.- Azeotrope.- Colligative properties.
8. THERMODYNAMIC FUNCTIONS OF CHEMICAL RECTIONS. Energy and enthalpy changes in chemical reactions.- Calorimetry.- Calculation of reaction enthalpies. Hess's law.- Enthalpies of formation.- Bond energies.- Temperature dependence of reaction enthalpies.- Entropy changes in chemical reactions. Effects of temperature.- Free energy changes in chemical reactions.- Tables of thermodynamic data.
9. CHEMICAL EQUILIBRIUM. Conditions of equilibrium for a chemical reaction.- The law of chemical equilibrium. Equilibrium constant.- Effects of temperature on the equilibrium constants.- Equilibrium constant expressions for gas reactions.- Heterogeneous equilibria.- Effects of temperature, presión and composition changes on the equilibra. Principle of Le Chatelier.

10. ELECTROLITE SOLUTIONS. IONIC EQUILIBRIA. Electrolites.- Thermodynamic properties of ion in solution.- Acid-base equilibria.- Calculation of pH.- Solubility equilibrium.- Complex ions.- Common-ion and salt effects.
11. ELECTROLYTIC CONDUCTANCE. Electrical quantities.- Electrolitic conductors.- Conductance and conductivity.- Molar conductivity.- Ion molar conductivities. Kohlrausch's law.- Theory of electrolites.- Applications of measurement of conductivity.
12. ELECTROCHEMICAL EQUILIBRIUM. GALVANIC CELLS. Redox reactions.- Electrochemical cells.- Electromotive force.- Thermodynamics of galvanic cells. Nernst's equation.- Standard potentials of electrode.- Electrode types.- Cell types.- Applications of standard potentials.
13. ELECTROCHEMICAL PROCESSES. Electrolysis. Descomposition potential.- Corrosion. Methods of inhibition.- Practical cells.
14. CHEMICAL KINETICS. Rate of reaction.- Rate's law. Order of reaction.- Integrated rate laws.- Determination of rate law.- Simultaneous reactions.- Temperature dependence of reaction rates.
15. MECHANISMS OF CHEMICAL REACTIONS. Elementary reactions. Molecularity.- Kinetics of complex reactions. Aproximation methods.- Chain reactions.- Polimerization kinetics.- Photochemical reactions.- Chemical dynamics.
16. CATALYSIS. Homogeneous catalysis.- Adsorption and heterogeneous catalysis.- enzyme catalysis.

Bibliography:

- P. W. ATKINS, "The Elements of Physical Chemistry", Oxford University Press (1992).
- P. W. ATKINS, "Physical Chemistry", Oxford University Press (1998).
- D. W. BALL, "Fisicoquímica", Thomson Learning Inc. (2004)
- I. N. LEVINE, "Fisicoquímica", McGraw-Hill (2002)
- W. J. MOORE, "Fisicoquímica básica", Prentice-Hall Inc. (1986)
- R. J. SILVEY and R. A. ALBERTY, "Physical Chemistry", John Wiley and sons, Inc.(2001)

Staff Involved: Jesús Verdú and José M. Hernando

Department: Physical Chemistry and Inorganic Chemistry

INORGANIC CHEMISTRY

Code: **44295-UVA**

Extension: Half-yearly	Semester(s): 1	Academic year: 1	Cycle: 1
Credits ......Local: 7,5	ECTS: 7,5		

Lecture hours: 65	Practical hours: 10
Personal work hours: 120	Laboratory hours: 0

Aims: The aim is to provide the student with the basic concepts and principles of chemistry, so that they can build up an analytical mind and use this knowledge in their reasoning going forward. The course explains how to obtain elements and compounds, as well as providing information on their main properties and applications.

In the field of metallurgy, the course sets out the basics of extractive metallurgy and some basic concepts on alloys.

This course provides basic knowledge with regards to pollution and the impact of chemistry on the environment.

Assessment: Examination (20% + 60%) Classwork (20%)

Outline Syllabus:

1. INTRODUCTION.
2. ATOMS: Bohr theory. Schrödinger equation. At. structure. Chem.periodicity. Atomic spectra.
3. CHEMICAL BOND: Lewis structures. Molecular shape and VSEPR theory. Hybridization. Molecular orbitals. Structure of solids. Metallic elements. Ionic solids. Structures of ionic solids
4. HYDROGEN: Preparation, production and uses. Ortho and para H. Hydrides of the elements.
5. HALOGENS: General properties of group. Production and uses of the elements. Hydrogen halides. Halides of the elements. Oxides of chlorine. Oxoacids and oxosalts
6. CHALCOGEN GROUP: General properties. Production and uses of the elements. Water. Hydrogen peroxide. Oxides and peroxides.Oxides of sulfur. Oxoacids of sulfur.
7. NITROGEN GROUP: General properties. Production and uses of the elements. Ammonia. Oxides of the elements. Oxoacids of nitrogen and phosphorus.Fertilizents.
8. CARBON GROUP: Chemical properties. Oxides and Carbonates. Carbides. Silanes.
9. ALKALI AND ALKALINE EARTH METALS: General properties. Production and uses. Oxides.
10. TRANSITION ELEMENTS: Electron configurations. Fundamentals of Complex Chemistry.
11. METALLURGY EXTRACTIVE: Concentration of minerals. Production. Purification. Alloys.
12. SIDERURGY: Blast Furnace. Pig Iron. Converter Process. Steel. Diagram Fe-C.

Bibliography:

- HOLLEMAN-WIBERG "Inorganic Chemistry" Academic Press (2001)
- RAYNER-CANHAM "Descriptive Inorganic Chemistry" Freeman and Company (2000)
- GREENWOOD-EARNSHAW "Chemistry of the Elements" Pergamon Press (1998)
- SHRIVER-ATKINS "Inorganic Chemistry" McGraw-Hill (2006)
- BÜCHNER, SCHLIEBS, WINTER "Industrial Inorganic Chemistry" VCH (1989)

Staff Involved: Joan-Gaspar Ribas

Department: Inorganic Chemistry

TECHNICAL ENGLISH

Code: **44299-UVA**

Extension: Half-yearly	Semester(s): 2	Academic year: 1	Cycle: 1
Credits ......Local: 4,5	ECTS: 4,5		

Lecture hours: 10	Practical hours: 35
Personal work hours: 72	Laboratory hours: 0

Aims: Using theoretical functions (classifying, defining exempliying, expressing cause, effect and purpose and giving instructions) in a scientific-technical context; practising reading, writing, speaking and listening in a scientific-technical context; using English terminology related to Chemical Engineering and translating from English into Spanish technical texts, especially those related to Chemical Engineering

Assessment:

Examination (100%) Classwork (+ additional 5%)

Outline Syllabus:

1. UNIT 1: Introduction: numerical expressions, classification, definitions. 'What Chemical Engineers Do'. Translation
2. UNIT 2: Exemplification, describing graphs, trends and predictions. 'Research and Development'. Translation.
3. UNIT 3: Comparison, contrast and similarity. 'Process Design'. Translation
4. UNIT 4: Cause, effect and purpose. 'Plant Operation'. Translation.
5. UNIT 5: Experimenting (giving directions and instructions), 'Controlling the Plant: Instrumentation'. Translation.

Bibliography:

- DONOVAN, P, "Basic English for Science. Student's book", Oxford and New York, Oxford University Press (1978).
- HUGHSON, R. V, "The Language of Chemical Engineering in English", New York, Regents Publishing Company (1979).
- DUDDLEY-EVANS, T, "Writing Laboratory Reports", Australia, Nelson Wadsworth (1985).
- NEUFELD, J. K. "A Handbook for Technical Communication", New Jersey, Prentice Hall International (1987).
- ZIMMERMAN, F, "English for Science", Prentice (1989).
- COCA PRADOS, J, "Inglés para Ingeniería Química", Barcelona, Practicum (2002).
- VENABLES, J. (Ed.), "Communication Skills for Engineers and Scientists", Warwick, Institution of Chemical Engineers (2002).
- JORDAN, R. R, (2nd edition). "Academic Writing Course", London, Harper Collins Publishers (1980/1990).
- HAMP-LYONS, L & B. HEASLEY, "Study Writing. A course in written English for academic and professional purposes", Melbourne (Australia), Cambridge University Press (1987).
- PEARSALL, JUDY (ed.), "The New Oxford English Dictionary", Clarendon Press (1998).
- "Diccionario Oxford español-inglés/inglés-español"· (última edición).

Staff Involved: Marisol Velasco-Sacristán and Esther Álvarez-de la Fuente.

Department: English Department

ORGANIC CHEMISTRY

Code: **44296-UVA**

Extension: Half-yearly	Semester(s): 2	Academic year: 1	Cycle: 1
Credits ......Local: 7.5	ECTS: 7,5		

Lecture hours: 45	Practical hours: 30
Personal work hours: 120	Laboratory hours: 0

Aims: The main skills that students are expected to have developed by the end of their programme in organic chemistry are as follows:

- Draw the structure and provide the systematic (IUPAC) name for different organic compounds.

- Draw the more important resonance structures for any molecule. Assign the relative importance of these structures and estimate their resonance stabilization energy.

- Name, analyze and distinguish the different isomers of organic molecules.

- Understand the conformational study of ethane and butane as cyclohexane and mono and disubstituted derivatives.

- Predict and explain the relationship between structure and behaviour as an acid or base of the organic compounds. Identify nucleophilic and electrophilic compounds.

- Define chirality, stereogenic center and enantiomer, and be able to designate them as R/S using Cahn-Ingold-Prelog rules.

- Understand the concept of functional group and analize, describe and predict the basic reactions of different functional groups.

- Design syntheses of simple organic compounds.

Assessment: Examination (60%) Classwork (40%)

Outline Syllabus:

1. THE ORGANIC COMPOUNDS: The field of Organic Chemistry. Molecular and structural formula; constitutional isomers. The bonds of/in the organic compounds. Resonance and MO theory. Physical properties and molecular structures
2. FUNDAMENTAL SATURATED STRUCTURES. Acyclic compounds; conformations. Cyclic compounds; conformational analysis and cis-trans isomers.
3. FUNCTIONALIZED PRIMARIES STRUCTURES. Carbon-carbon double and triple bond: structure and isomers. Benzene; aromaticity.
4. FUNCTIONAL GROUPS. Functional groups with single bonds. Functional groups with multiple bonds.
5. STEREOCHEMISTRY. Chiral molecules; optical activity. Configuration of chiral centers: Cahn-Ingold-Prelog sequence rules. Molecules with multiple chirality centers; diastereomers. Pharmaceuticals and chirality.
6. THE ORGANIC REACTIONS. Bond breaking and bond making in organic reactions. Types of organic reactions. Unimolecular and bimolecular mechanism; transition state and reactive intermediates; reaction progress diagrams. Termodynamic versus kinetic control in organic reactions.
7. NUCLEOPHILIC SUBSTITUTION ON SATURATED CARBON REACTIONS. The general reaction. Reaction mechanisms; stereochemistry. Competing reactions. Synthetic uses of nucleophilic sustitution reactions.
8. ELIMINATION REACTIONS. The general reaction. Bimolecular elimination; regiochemistry and stereochemistry. Unimolecular elimination. The competition between elimination and substitution. Synthetic uses of elimination reactions.

9. NUCLEOPHILIC ADDITION REACTIONS. General mechanisms; stereochemistry. Addition of hydride. Addition of alcohols. Addition of nitrogen nucleophiles. Formation of carbon-carbon bonds through 1,2- and 1,4-addition reactions.
10. NUCLEOPHILIC SUBSTITUTION ON UNSATURATED CARBON REACTIONS. The general mechanism. Substitutions at the carbonyl group: reactions of carboxylic acids and derivatives. Nucleophilic aromatic substitution reactions. Diazonium ions in nucleophilic aromatic substitution reactions.
11. ELECTROPHILIC ADDITION REACTIONS. The general mechanism. Addition of hydrogen halides. Addition of water. Addition of halogens. Hydroboration-oxidation. Oxidation of alkene double bonds. Catalytic hydrogenation.
12. ELECTROPHILIC SUBSTITUTION AROMATIC REACTIONS. Mechanism for electrophilic aromatic substitution. Effect of substituents. Halogenation. Nitration. Sulfonation. Friedel-Crafts alkylation and acylation. Azo coupling reaction using diazonium salts.
13. SYNTHETIC POLYMERS. Addition polymers. Stereochemistry of polymers; Ziegler-Natta catalyst. Natural and synthetic rubber. Copolymers. Condensation polymers. Physical properties of polymers.
14. INDUSTRIAL ORGANIC CHEMISTRY. Introduction. Important industrial organic chemicals. Chemicals from ethylene. Chemicals from propylene. Chemicals from butylene. Chemicals from benzene and other aromatic compounds.
15. NATURAL PRODUCTS OF BIOLOGICAL AND INDUSTRIAL INTEREST. Carbohydrates. Aminoacids. Fats and related compounds. Alkaloids.

Bibliography:

- CABILDO MIRANDA, M.P.; GARCIA FRAILE, A.; LOPEZ GARCIA, C.; SANTA MARIA GUTIERREZ, M.D., ”Química Orgánica”, UNED (1999).
- HART, H.; CRAINE, L.E.; HART, D.J.; HADAD, C.M., ”Química Orgánica”, McGraw-Hill; 12ª Ed. (2007).
- SOTO, J.L., ”Química Orgánica" vol. I , II y III”. Ed. Síntesis (2005).
- McMURRY, J., ”Química Orgánica”, International Thomson Editores; 6ª Ed., (2004).
- PRIMO YUFERA, E., ”Química Orgánica básica y aplicada”, Ed. Reverté (1994).

Staff Involved: José María Andrés, Alicia Maestro

Department: Organic Chemistry

PROGRAMMING FUNDAMENTALS

Code: **42298-UVA**

Extension: Half-yearly	Semester(s): 2	Academic year: 1	Cycle: 1
Credits ......Local: 6	ECTS: 6		

Lecture hours: 20	Practical hours: 10
Personal work hours: 96	Laboratory hours: 30

Aims: The principal objective of this subject is that the students acquire a global vision of the computer and how they can be used it in order to solve engineering problems. In concrete:

* To know the computer architecture and the elements that constitute the computer

* To use and know the Operative Systems.

* To solve mathematical and/or Chemical Engineering problems (design, numerical methods, equations, etc.) using a computer

* To learn some programming tools: MATLAB and Visual Basic.

Assessment: Examination (60%) Classwork (40%)

Outline Syllabus:

1. COMPUTERS INTRODUCTION. Basic concepts. Computers architecture. Operative systems. Windows. Editors. Compilers. Translator.
2. REPRESENTATION OF THE INFORMATION IN A COMPUTER. Numerical systems. Operations. I/O Codes. Internal representation of the information. Logic functions and circuits.
3. ALGORITHMS. Date types and structures. Pseudo-code and flow charts. Examples.
4. PROGRAMMING LANGUAGES. Languages. Calculation with Matlab. Programming with Matlab. Scripts and Functions.
5. EXCEL INTRODUCTION. Dates and formulas. Cell manipulation. Excel graphics. Two-dimension graphics. Three-dimension graphics. Examples.
6. FUNCTIONS AND COMPLEMENTS. Algebraic equation solving. Minimum and maximum. Optimisation. Practice examples of Chemical Engineering process.
7. EXCEL OBJECTS AND VBA MACROS. Properties and methods. Recording macros. VBA procedures and functions. Examples.
8. INTRODUCTION TO VBA PROGRAMMING. VBA editor. Type of Basic variables. Relationship with Excel cells. Examples.
9. ELEMENTS OF VBA PROGRAMMING. Manipulation of objects. Execution control of the programs: Conditional structures and loops. Examples.

Bibliography:

- PRIETO, E.; LLORIS, A.; TORRES, J.C., "Introducción a la Informática", McGraw-Hill 1992.
- ETTER, D.M. Solución de problemas de Ingeniería con Matlab, Prentice-Hall, 1998.
- WALKENBACH, J. Programación en Excel 2000 con VBA, Anaya, 2000.
- BLOCH, S.C., "EXCEL for Engineers and Scientists",WILEY,2003.

Staff Involved: María Jesús de la Fuente Aparicio / Juan García Serna

Department: System Engineering and Automatic Control / Chemical Engineering

STATISTICS

Code: **44301-UVA**

Extension: Half-yearly   Semester(s): 3   Academic year: 2   Cycle: 1
Credits ......Local: 6   ECTS: 6

Lecture hours: 30   Practical hours: 15
Personal work hours: 96   Laboratory hours: 15

Aims: To know basic statistical models in order to analyse data sets.

Assessment: Examination (--85) Classwork (--15)

Outline Syllabus:

1. Introduction to probability.
2. Descriptive study and populational modelling of univariate data.
3. Some important models for univariate probability distribution.
4. Confidence interval estimation.
5. Tests of hypotheses.
6. Simple linear regression model.

Bibliography:

- MONTGOMERY-RUNGER. "Probabilidad y estadística aplicadas a la ingeniería." McGraw Hill (1994).
- SHELDON M.ROSS. "Introducción a la Estadística." Reverté (2005).
- HINES-MONTGOMERY. "Probabilidad y Estadística para Ingeniería y Administración". Continental (1988).
- PEÑA SÁNCHEZ DE RIVERA. "Estadística. Modelos y Métodos. Vols. I y II." Alianza Universidad (1992).
- CUADRAS. "Problemas de Probabilidades y Estadística. Vols. I y II." PPU.(1990).
- SARABIA y MATÉ." Problemas de Probabilidad y Estadística. Elementos teóricos, cuestiones, aplicaciones con statgraphics."CLAGSA (1993).

Staff Involved: María Cruz Valsero

Department: Statistics and Operational Research

APPLIED MATHEMATICS FOR CHEMICAL ENGINEERS

Code: **44307-UVA**

Extension: Annual	Semester(s): 3&4	Academic year: 2	Cycle: 1
Credits ......Local: 9	ECTS: 9		

Lecture hours: 60	Practical hours: 30
Personal work hours: 144	Laboratory hours: 0

Aims: Basic understanding of Ordinary and Partial differential equations.
Introduction to Numerical Analysis of differential equations
Mathematical modelling of dynamical processes in Chemical Engineering

Assessment: Written Examination (80%), Classwork (20%)

Outline Syllabus:

1. Elementary Integration of first order Ordinary Differential Equations, ODE's.
2. Higher Order Linear Equations.
3. Systems of ODE's.
4. Numerical Methods for ODE's and Systems.
5. Laplace Transform. Applications.
6. Dynamical systems. Linearization.
7. Introduction to Variational calculus.
8. Introduction to Partial differential equations PDE's.
9. Method of separation of variables for solving PDE's.
10. Euler, Bessel and Legendre equations.

Bibliography:

- AYRES, FRANK "Teoría y problemas de ecuaciones diferenciales", Ed MacGraw-Hill (1980).
- DUCHATEAU, PAUL "Teoría y problemas de ecuaciones diferenciales parciales"; Ed. MacGraw-Hill, 1990.
- SAN MARTÍN MORENO, JESÚS, "Métodos matemáticos:ampliación de matemáticas para ciencias e ingeniería" , Ed.Thomson, 2005.

Staff Involved: Mariano Esteban Piñeiro, J.-Fernando Pascual-Sánchez

Department: Applied Mathematics

FLUID FLOW UNIT OPERATIONS

Code: **44305-UVA**

Extension: Annual Credits ......Local: 9	Semester(s): 3&4 Academic year: 2 Cycle: 1 ECTS: 9

Lecture hours: 55 Personal work hours: 144	Practical hours: 35 Laboratory hours: 0

Aims: The main aim of this subject is to analyze and understand the behaviour of fluids flowing in pipes and around solid materials. A second aim is to study the unit operations for separation of solids from fluid streams and the main equipment used in the industry for this purpose. At the end of the course the students must solve problems of fluid flow (gases and liquids), select pumping equipment, pipes and instrumentation for flow lines and perform basic calculations of unit operations involving separations of solid from fluid streams and flow through granular beds and packed columns.

Assessment: Written Examination (85%), Coursework (15%)

Outline Syllabus:

1. FUNDAMENTALS: Physical properties. Fluid static.
2. FLOW IN PIPES AND CHANNELS: Energy and mass balances. Head losses along a pipe. Pressure drop in pipes with two phase (gas-liquid) flow. Flow in open channels. Flow in complex systems. Non-stationary flow.
3. PUMPING OF LIQUIDS: Pumping equipment for liquids. Centrifugal pumps. Reciprocating pumps. Positive displacement pumas. Characteristic curves. Selection of pumps.
4. FLOW OF COMPRESSIBLE FLUIDS: Flow of gas through a nozzle or orifice. Flow in pipes. Shock waves. Blowers and compressors. Steam-jet ejectors.
5. FITTINGS AND PIPES: Mechanical design of pipes. Standards dimensions. Fitting selection. Valves, characteristics and types.
6. LIQUIND MIXING: Stirring and mixing. Stirred vessels (power consumption, scaled-up). Equipment.
7. PRESSURE AND FLOW MEASUREMENT: Pressure measuring devices. Measurement of fluid flow.
8. SOLID HANDLING: Solid particle characterization. Particle size measurement and classification.
9. PARTICLE SIZE REDUCTION AND MEHCANICAL SEPARATIONS: Equipment of particle size reduction. Energy consumption.
10. SOLID TRANSPORT AND STORAGE: Silos and hoppers. Equipment for solid transport and selection criteria.
11. MOTION OF PARTICLES IN A FLUID: Drag force on a particle. Terminal falling velocities.
12. SEDIMENTATION: Sedimentation of fine particles. Sedimentation of coarse particles. The Kynch Theory. Calculus in thickeners.
13. FLOW OF FLUIDS THORUGH GRANULAR BEDS AND PACKED COLUMNS: Pressure drop in granular beds. Packed columns: packings, pressure drop estimation, Loading and Flooding points. Degree of wetting in a packed column. Industrial applications.
14. FLUIDISATION: Minimum fluidising velocity. Pressure drop. Geldart Diagram. Applications in Chemical Engineering.
15. FILTRATION. General equations. Equipment and applications.
16. CENTRIFUGATION: General equations. Equipment and applications.

Bibliography:

- COULSON & RICHARDSON. “Chemical Engineering” Vols. 1 & 2. Pergamon.
- PERRY & CHILTON. “Chemical Engineers´Handbook”, Mc Graw-Hill.
- MOTT R.L., “Applied fluid mechanics”, Prentice-Hall Inc., (2006).
- VALIENTE. A. “Problemas de flujo de fluidos” Limusa, 2ª Edición (1998).
- DARBY. R. “Chemical Enginering Fluid Mechanics”, M. Dekker 2ª Ed. (2001)
- LEVENSPIEL. O. “Flujo de fluídos a Intercambiadores de Calor” ,Ed. Reverte, (1993)
- CREUS A. “Instrumentación Industrial”, Editorial Marcombo, 6ª Edición (1997).
- SCHWEITZER P.A., “Handbook of Separation Techniques for Chemical Engineers”, McGraw-Hill, 3rd Edition (1997)

Staff Involved: Mar Peña, Esther Alonso

Department: Chemical Engineering and Environmental Technology

INTRODUCTION TO THERMODYNAMICS

Code: **44303-UVA**

Extension: Half-yearly	Semester(s): 3	Academic year: 2	Cycle: 1
Credits ......Local: 4,5	ECTS: 4,5		

Lecture hours: 30	Practical hours: 15
Personal work hours: 72	Laboratory hours: 0

Aims:

The course aims to be impregnated by a more dynamic and active participation, and to be less masterful. This is seen as serving the learning, which we consider as a very important dimension in education. This is especially important in a university traditionally more concerned about transmitting knowledge and attitudes than about shaping and developing skills.

At the same time, the development of this subject seeks other goals, more specific from the point of view of a thermodynamic perspective. Among these particularly relevant for our students we include:

- to know the formal, rigorous and logical development of our science.
- to attain the vocabulary and the conceptual background that characterizes Thermodynamics
- to acquire both the basic and formal knowledge that should permit to gain and develop the capacity to study and analyze any system from the points of view of energy, entropy and exergy.
- to master the methodology for the thermodynamical analysis of systems
- to get the analytical capacity needed to analyze issues, texts, problems, etc..
- to have the capacity to perform, in a given situation, the most appropriate choice of independent variables, the analysis of the results of a problem, and so on.
- to get the knowledge and to have the practice required to overcome simple algebraic exercises to generate an equation from another, to express a equation in terms of new independent variables, etc.
- to gain more experience in numerical handling by considering issues that lead to a transcendental equation, a numerical integration, etc..
- to play an active role as the subject in the development and the dynamics of the matter, and especially to build hid/her own course within the guidelines contained in the training materials given to the students and those appearing during the development of the classes.
- to understand the methodological correlation of this matter with other areas of science.
- to highlight the utility and the correlation of this matter with others in their curriculum which should help to develop them correctly.

Achieving these objectives requires firstly, a very cooperative and participative development of the subject, but also a daily dedication of the student in order to allow them to participate and follow the route drawn in the program and reach objectives referred above

Assessment: Examination (50%) Classwork (50%)

Outline Syllabus:

I. INICIAL CONCEPT

1- The aim of Thermdynamics.- The thermodynamic system and the volumen of control.- The thermodynamic walls and restrictions and degrees of freedom

Macroscopic and microscopic descriptions. Questions and Exercices to allow understanding and assimilation of the subject.

II. FORMAL STRUCTURE

1- The first postulate: thermodynamic state of equimilibrium. Thermodynamic variables. Euler's theorem. Space and thermodynamic processes. Questions and Exercices to allow understanding and assimilation of the subject.

2- The second postulate: parametrization of the equilibrium state. Temperature. Measurements of temperature. Thermometric scales. Questions and Exercices to allow understanding and assimilation of the subject.

3- Mathematical formulation of the second postulate: energetic and thermal equations of state. Thermal properties. Questions and Exercices to allow understanding and assimilation of the subject.

4- The first principle (energy conservation law). The concepts of internal energy, heat and work Configurational work and dissipative work.mathematical formulation of the energy balance. Energetical analysis of cycles. Questions and Exercices to allow understanding and assimilation of the subject.

5- Evaluation of the energy transferred as configuration work for thermodynamic systems. Generalized thermodynamic forces and displacements. Questions and Exercices to allow understanding and assimilation of the subject.

6- Evaluation of the energy transferred as heat. Information contained in the energetic equation of state: energetical properties of a system. Questions and Exercices to allow understanding and assimilation of the subject.

7- Basic thermodynamic processes. Functional equations for the thermodynamic processes Questions and Exercices to allow understanding and assimilation of the subject.

8- Second principle (energy transformation law). Asymmetry in the interconversion of heat and work. Asymmetry in the system+environment ensemble. Reversible and irreversible processes. Theorem and corolary of Carnot. Absolute scale of temperature. The efficiency of thermal machines as a function the absolute temprature. Questions and Exercices to allow understanding and assimilation of the subject.

9- Second principle. A new corolary: the Clausius inequality. The entropy function: Mathermatical and themodynamical properties and its physical meaning. Evaluation of entropy changes. Questions and Exercices to allow understanding and assimilation of the subject.

10- Sencond principle formulated for both reversible and irreversible processes. Aplications of the second principle to the system+environment ensemble and to the universe. Questions and Exercices to allow understanding and assimilation of the subject.

11- Entropy balance for closed systems and control volumes. Concepts of exergy and dead state. Balance of exergy in closed systems and control volumes.Questions and Exercices to allow understanding and assimilation of the subject.

III. METHODOLOGY.

1- Thermodynamic analysis of a system. Thermodynamical representations. Energetic and entropic representations. Questions and Exercices to allow understanding and assimilation of the subject.

2- Equilibrium conditions for a thermodynamic system.- Thermodynamical study of thermal and mechanical interactions. Questions and Exercices to allow understanding and assimilation of the subject.

3- Thermodynamic system with a variable number of particles. Chemical potencial. Thermodynamical study of the material interactions. Questions and Exercices to allow understanding and assimilation of the subject.

4- Other thermodynamic representations. Representations of the Helmholtz potential, the Gibb's potentail and the entalpy. Throttling processes. Relationships between the thermodynamic potentials: Gibbs-Helmholtz equations. Questions and Exercices to allow understanding and assimilation of the subject.

5- The third principle. Evaluation of chemical affinitis. Thermal and energetic behaviour near 0K. Evaluation of absolute entropies. Evaluation of entropy for an ideal gas. Inaccesibility of the absolute zero temperature. Questions and Exercices to allow understanding and assimilation of the subject.

Bibliography:

- Theory: ABBOTT M. Y VANNESS, “H.Termodinámica” MacGraw-Hill, 1998. FEIT, M. “Thermodynamique et Optimistion Energetique”, Edit. Tec-Doc, 1987 KONDEPUDI, D. and PRIGOGINE, I.” Modern Thermodynamics”, Edit. John Wiley, 1998 ; MORÁN, M.J. «Fundamentos de Termodinámica Técnica ». Edit. Reverté, 1994 ; TEJERINA. F. “Termodinámica” Yunus A. Çengel y Michael A. Boles. “Termodinámica” McGraw-Hill Interamericana, 2002 Problems:BARRIO CASADO, MARÍA del.”Problemas resueltos de Termodinámica”. Edit. Thomson, 2005. PELLICER, J. y F. TEJERINA. “Problemas resueltos de Termodinámica”. Servicio Publicaciones UVA, 1997. SALA LIZARRAGA,J.Mª. “Problemas de Termodinámica Fundamental”. Edit UR, 2000

Staff Involved: Fernando Tejerina

Department: Applied Physics

ANALYTICAL CHEMISTRY

Code: 44306-UVA

Extension: Half-yearly	Semester(s): 3	Academic year: 2	Cycle: 1
Credits ......Local: 7,5	ECTS: 7,5		

Lecture hours: 40	Practical hours: 35
Personal work hours: 120	Laboratory hours: 0

Aims: The main aim oft his subject is to provide the students with a clear and equilibrated vision of the actual Analytical Chemistry, in order to be able to apply the knowledge to elaborate and develop strategies for the resolution of analytical problems.

Assessment: Written Examination (70%), Classwork (30%)

Outline Syllabus:

CHEMICAL EQUILIBRIUM AND THE METHODOLOGY OF ANALYSIS

1. Analytical Chemistry: the analytical problem and the chemical measurement process (CMP)
2. The assessment of analytical data.
3. Introduction to chemical reactions. Acid-base equilibria.
4. Titrimetry. Acid-base titrations.
5. Complexes in Analytical Chemistry. Complexometric titrations.
6. Oxidation-Reduction equilibria and titrimetric applications.
7. Precipitation reactions and titrations.
8. Gravimetry.

INSTRUMENTAL ANALYSIS TECHNIQUES

9. Generalities on instrumental techniques.
10. Electrochemical techniques I: Introduction and Potentiometry.
11. Electrochemical techniques II: Electrogravimetry. Industrial electrochemistry.
12. Introduction to optical instrumental techniques.
13. Atomic Spectrometry.
14. Molecular Spectrophotometry.
15. Separation techniques I.
16. Separation techniques II: Chromatography.

Bibliography :

- HARRIS, D.C. “Análisis Químico Cuantitativo”. 2ª Ed., Ed. Iberoamericana. Mexico , (2001)
- VALCÁRCEL, M., “Principios de Química Analítica”, Springer, Barcelona, (1999)
- KELNER R., MERMET J.M., et al. “Analytical Chemistry”,Willey-VCH, N.Y., (1998)
- CHRISTIAN G. D., “Analytical Chemistry”, 5ª Ed., Wiley, (1994)
- SKOOG D.A., HOLLER F.J., NIEMAN T.A., “Principios de Análisis instrumental”, Mc Graw-Hill, Madrid, (2001)

Staff Involved : Enrique Barrado

Department: Analytical Chemistry

CHEMISTRY LABORATORY

Code: 44304-UVA

Extension: Annual	Semester(s): 3 &4	Academic year: 2	Cycle: 1
Credits ......Local: 9	ECTS: 7		

Lecture hours: 0	Practical hours: 0
Personal work hours: 90	Laboratory hours: 90

Aims: The main aim of this subject is to analyze and understand the behaviour of fluids flowing in pipes and around solid materials. A second aim is to study the unit operations for separation of solids from fluid streams and the main equipment using in the industry for this purpose. The students should solve problems of fluid flow (gases and liquids), select pipes and instrumentation for pipelines and perform basic calculations of unit operations.

Assessment: 3 hours Written Examination (25%), Coursework (75%)

Outline Syllabus:

Destilation
Combustion Enthalpies. Calorimetric Bomb.
Electrolytic conductivity. Determination of solubilities and activity coefficients of electrolytes.
Determination of partial molar volumes.
Kinetics of the saponification of the ethyl acetate. Conductimetric Method.
Determination of breakup enthalpies and of reaction. Law of Hess.
Ternary systems. Triangular diagram of phases
Electrochemical cells: EMF
Kinetics of the fading of the glass violet
Isoamyl acethate synthesis
Technical of purification. Recristalizacin. Synthesis of the aspirin.
Preparation of a detergent and a soap.
Copper(II) compounds:

- Preparation from metalic copper
- Qualitative and Quantitative analysis: Nitrogen by Kjeldalh method
- Cu by AAS and electrogravimetry

Iron compounds:

- Preparation from metalic iron
- Quantitative analysis of Iron by gravimetry and by UV-V spectrophotometry previous extraction with oxine

Complexometric titrations: Determination of the water hardness
Redox titrations: Determination of the Chemical Oxygen Demand (COD). Determination of the total fat of a sample. Determination of the fatty acids by means of Gas Chromatography.

Staff Involved: Enrique Barrado Esteban & Jesús Verdú Dólera

Department: Analytical Chemistry and Physical Chemistry

FOUNDATIONS OF PHYSICS FOR ENGINEERS II

Code: **44300-UVA**

Extension: Half-yearly	Semester(s): 4	Academic year: 2	Cycle: 1
Credits ......Local: 6	ECTS: 6		

Lecture hours: 32	Practical hours: 28
Personal work hours: 96	Laboratory hours: 0

Aims: Knowledge of electromagnetic magnitudes.

Adequate use of such magnitudes.

Ability to anticipate the behavior of the environment undergoing the effect of electromagnetic field sources.

Application of the electromagnetic magnitudes to electric and electronic circuits: Systematic analysis of circuits. Identification of electromagnetic noise sources and their effect on measurement systems and setups.

Assessment: Examination (80%) Classwork (20%)

Outline Syllabus:

1. FOUNDATIONS OF ELECTROMAGNETICS: Electrostatic field in vaccuum and in matter. Electric currents. Magnetic field in vaccuum and in matter. Electromagnetic induction.
2. INTRODUCTION TO ELECTRONIC DEVICES.
3. CIRCUIT THEORY: Systematic analysis of circuits. Transient and stationary response. AC circuits. Analog electronic circuits.
4. INTRODUCTION TO THE ELECTROMAGNETIC SPECTRUM: Maxwell's equations. Electromagnetic waves.

Bibliography:

- P. A. TIPLER, G. MOSCA, “Física”, Vol. 2, Reverté (2005)
- M. ALONSO, E. I. FINN, “Física. Volumen II: Campos y Ondas”, Fondo Educativo Interamericano, (1985)
- R. J. SMITH, R. C. DORF, “Circuits, devices and systems”, Wiley (1992)
- J. D. IRWIN, “Análisis básico de circuitos en Ingeniería”, Limusa-Willey (2003)
- J. W. NILSSON Y S. A. RIEDEL, “Circuitos eléctricos”, Addison-Wesley Iberoamericana (2001)
- J. V. MÍGUEZ, F. MUR, M. A. CASTRO, J. CARPIO, "Fundamentos Físicos de la Ingeniería: Electricidad y Electrónica", McGraw-Hill (2008)

Staff Involved: Óscar Alejos

Department: Electricity and Electronics.

TRANSPORT PHENOMENA

Code: **44302-UVA**

Extension: Half-yearly	Semester(s): 4	Academic year: 2	Cycle: 1
Credits ......Local: 6	ECTS: 6		

Lecture hours: 20	Practical hours: 40
Personal work hours: 96	Laboratory hours: 0

Aims: The overall objective of the course is to acquire a phenomenological view of real processes, in terms of momentum, heat and mass transport. This knowledge should be combined with that of thermodynamics and chemical kinetics to model the behaviour of the systems being studied. At the end of the course, students must: 1) identify and assess the weight of all transport phenomena involved in a process, 2) describe them in mathematical terms, and 3) calculate and evaluate variables relevant to the design and operation of such processes.

Assessment: Examination (Three partial and one final exams:100%) Classwork (0%)

Outline Syllabus:

1. VISCOSITY AND THE MECHANISMS OF MOMENTUM TRANSPORT: Newton's law of viscosity. Non-newtonian fluids. Experimental measurement of viscosity. Viscosity of gases. Viscosity of liquids.
2. THE EQUATIONS OF CHANGE FOR ISOTHERMAL SYSTEMS: Shell momentum balances and boundary conditions. The equation of continuity. The equation of motion. The equation of mechanical energy. Dimensionless equations of change. Boundary layer and potential flow.
3. THERMAL CONDUCTIVITY AND THE MECHANISMS OF ENERGY TRANSPORT: Fourier's law of heat conduction. Experimental measurement of thermal conductivity. Conductivity of gases. Conductivity of liquids. Conductivity of solids.
4. THE EQUATIONS OF CHANGE FOR NONISOTHERMAL SYSTEMS: Temperature profiles in solids and laminar flow fluids. The energy equations. The nonisothermal equation of motion in forced and free convection. Dimensional analysis of the equations of change. Boundary layer and potential flow.
5. DIFFUSIVITY AND THE MECHANISMS OF MASS TRANSPORT: Concentration, velocity and mass flux definitions. Fick's law of binary diffusion. Experimental measurement of diffusion. Prediction and correlation equations for liquids and gases. Analogies in transport laws.
6. EQUATIONS OF CHANGE FOR MULTICOMPONENT SYSTEMS: Shell Mass Balances and Boundary Conditions. The Equation of Continuity for a binary Mixture. The Equation of Continuity in terms of fluxes. The Equation of Continuity in terms of transport properties.
7. TRANSPORT IN TURBULENT FLOW: Turbulent flow. Turbulent momentum transport. Time-smoothed equations of change. The time-smoothed velocity profile. Turbulent energy transport. Turbulent mass transport.
8. FRICTION FACTOR AND MACROSCOPIC MOMENTUM BALANCE: The macroscopic mass balance. The macroscopic momentum balance. Momentum transport: the friction factor. Flow in tubes. Flow around particles. The macroscopic mechanical energy balance: the Bernouilli equation. Macroscopic balances in multicomponent systems.
9. HEAT TRANSFER COEFFICIENT AND MACROSCOPIC ENERGY BALANCE: The macroscopic energy balance. Heat transfer coefficient. Experimental values and correlation equations. Global coefficients. Macroscopic balances in multicomponent systems.
10. MASS TRANSFER COEFFICIENT AND MACROSCOPIC MASS BALANCE: The macroscopic multicomponent mass balance. Mass transfer coefficient. Experimental values and correlation equations. Heat and mass transfer analogies. Global coefficients.

Bibliography:

- BIRD R.B., STEWART W.E. y LIGHTFOOT E.N. "Fenómenos de Transporte", Editorial Reverté (1962).
- POLING B.E., PRAUSNITZ J.M., O"CONNELL J.P., "The properties of gases and liquids", 5th. ed., McGraw-Hill (2001).
- COSTA NOVELLA E. et al., "Ingeniería Química. 2. Fenómenos de Transporte", Alhambra Universidad (1984).
- "Perry´s Chemical Engineers' Handbook", 7ª Ed., McGraw-Hill (1999).
- DEEN W.M., "Analysis of Transport Phenomena", Oxford University Press (1998).
- TOSUN I., "Modelling in Transport Phenomena", Elsevier Health Sciences (2002).

Staff Involved: Francisco Sobrón, Rafael Mato

Department: Chemical Engineering and Environmental Technology

HEAT TRANSFER UNIT OPERATIONS

Code: **44308-UVA**

Extension: Half-yearly	Semester(s): 5	Academic year: 3	Cycle: 1
Credits ......Local: 7,5	ECTS: 7,5		

Lecture hours: 45	Practical hours: 30
Personal work hours: 120	Laboratory hours: 0

Aims: To understand and be able to apply the heat transfer mechanisms. To learn the basic equipment features for heat transfer. To learn the standards procedure for tubular heat exchangers design. To apply this knowledge to equipment design. To apply this knowledge to the study of heat transfer operations: condensation, boiling, evaporation and vapour generation.

Assessment: Examination (80%) Classwork (20%)

Outline Syllabus:

1. FUNDAMENTALS. Heat transfer in Chemical Industry. Heat transfer mechanisms. Individual and overall coefficients. Mean temperature difference. Temperature measurement.
2. HEAT TRANSFER BY CONDUCTION. Fourier equation. Unidirectional conduction. Thermal resistances. Unsteady state conduction. Heating and cooling of solids and particles. Conduction with internal heat source.
3. HEAT TRANSFER BY CONVECTION. Natural and forced convection. Application of dimensional analysis to convection. Natural convection.
4. HEAT TRANSFER BY CONDENSATION OF VAPOURS. Film coefficients for vertical and inclined surfaces. Condensation in vertical and horizontal tubes. Drop-wise condensation.
5. HEAT TRANSFER IN BOILING LIQUIDS. Types of boiling. Pool boiling. Convective boiling. Heat transfer coefficients and heat flux.
6. HEAT TRANSFER BY RADIATION. Fundamentals of thermal radiation. View factors. Radiation transfer between black surfaces, refractory and grey surfaces. Radiation from gases.
7. THERMAL INSULATION. Heat losses through lagging. Economic thickness of lagging. Critical thickness of lagging.
8. HEAT TRANSFER EQUIPMENT. Shell and tube heat exchangers. Plate heat exchangers . Finned tubes. Air coolers exchangers. Safety in heat exchanger equipment. Heat transfer units.
9. SHELL AND TUBE EXCHANGERS. Standards for heat exchange equipment. Construction details. General design consideration. Tube-side and shell side coefficients and pressure drop.
10. CONDENSATION, BOILING and VAPORIZATION. Condensation of mixtures. Condensation with non-condensable. Condensation equipment. Boiling equipment.
11. EVAPORATION. Heat transfer in evaporation. Single effect evaporators. Multiple effect evaporators. Improvement efficiency in evaporation. Equipment for evaporation.
12. HEAT GENERATION. Fundamentals. Furnaces and boilers. Fired heaters calculation.

Bibliography:

- COULSON J.M. and RICHARDSONS "Chemical Engineering". Vol. 1, Vol. 2, Vol. 6. Ed. Pergamon (2006).

Staff Involved: María José Cocero

Department: Chemical Engineering and Environmental Technology

APPLIED THERMODYNAMICS

Code: **44331-UVA**

Extension: Half-yearly	Semester(s): 5	Academic year: 3	Cycle: 1
Credits ......Local: 7,5	ECTS: 7,5		

Lecture hours: 45	Practical hours: 30
Personal work hours: 120	Laboratory hours: 0

Aims: This course will provide an overview of applied thermodynamics with a special emphasis on the thermodynamic behaviour of substances and the thermodynamic analysis of industrial chemical processes. The goal is to provide students with the vocabulary, modelling tools, and theoretical background to understand and evaluate properties, chemical and phase equilibrium, vapour and gas power systems, refrigeration and psychrometric systems and to tackle the sort of complex problems that they will encounter in their dissertation research and beyond.

Assessment: Examination (80%) Classwork (20%)

Outline Syllabus:

1. THERMODYNAMIC PROPERTIES OF REAL FLUIDS: P-v-T relation. Thermodynamic properties. Property diagrams. Property tables.
2. EQUATIONS OF STATE: Ideal gas model. Generalized compressibility chart. Cubic equations of state. Mixing rules.
3. EVALUATING PROPERTIES: Maxwell relations. Evaluating enthalpy, entropy and fugacity. Other properties.
4. PHASE EQUILIBRIUM: Phase equilibrium for a single-component system. Phase equilibrium for a multicomponent system
5. CHEMICAL EQUILIBRIUM: Criterion for chemical equilibrium. Equilibrium constant. Calculating equilibrium compositions
6. PROCESS ANALYSIS USING ENERGY: Irreversibility. Exergy. Energy balances for control volumes. Entropy balances for control volumes. Exergy balance for control volumes. Efficiency
7. REACTING MIXTURES AND COMBUSTION: Introducing combustion. Fuels. Adiabatic flame temperature. Energy generation and distribution
8. VAPOUR POWER SYSTEMS: Analyzing vapour power systems: Rankine cycle. Improving performance: superheat, reheat and regenerative vapour power cycle
9. GAS POWER SYSTEMS: Internal combustion engines: Otto and Diesel cycles. Gas turbine power plants: Brayton cycle. Regenerative gas turbines. Combined cycles.
10. REFRIGERATION SYSTEMS: Vapor refrigeration systems. Analyzing vapour-compression refrigeration systems. Refrigerant properties. Cascade and multistage vapour-compression systems. Gas refrigeration systems. Absorption refrigeration
11. PSYCHROMETRIC APPLICATIONS: Introducing psychrometric principles. Psychrometric charts. Analyzing air-conditioning processes. Cooling towers

Bibliography:

- SMITH, J.M., VAN NESS, H.C. Y ABBOTT, M.M., "Introducción a la Termodinámica en Ingeniería Química" (séptima edición). McGraw-Hill, (2005).
- ÇENGEL, Y.A., BOLES, M.A., "Termodinámica" (4ª Edición). McGraw-Hill, (2003).
- MORAN, M.J. Y SHAPIRO, H.N., Fundamentals of Engineering Thermodynamics, 5th edition. Wiley, (2004).

Staff Involved: Susana Lucas, Fidel A. Mato

Department: Chemical Engineering and Environmental Technology

CHEMICAL ENGINEERING LABORATORY I

Code: **44309-UVA**

Extension: Annual	Semester(s): 5&6	Academic year: 3	Cycle: 1
Credits ......Local: 12	ECTS: 9		

Lecture hours: 0	Practical hours:
Personal work hours: 120	Laboratory hours: 120

Aims: Students who complete this laboratory course should be able to: Understand the applications of the chemical engineering principles that are studied in the theoretical classes. Apply and integrate knowledge of the elements of chemical engineering to identify, formulate, and address experimentally chemical process problems. In a multifunctional team, design and conduct experiments; record, analyze, and interpret engineering data; professionally report results. Safely use chemical engineering process equipment.

Assessment: Written examination (33%) + Laboratory work (33%) + Laboratory report (33%)

Outline Syllabus:

1. FLUID FLOW
   - Head loss of accessories
   - Valve characterization: Cv and Kv coefficients
   - Pipe roughness.
   - Centrifugal Pumps: Characteristics curves. Affinity laws. Pump association
2. TRANSPORT PHENOMENA
   - Diffusivity of a vapour in air.
   - Non-newtonian fluid characterization.
   - Thermal diffusivity of a solid.
   - Mass transfer coefficient of oxygen in water
3. HEAT TRANSFER UNIT OPERATIONS
   - Heat transfer in stirred tanks. Steady and unsteady state.
   - Pilot plant: Evaporative concentration of solutions.
   - Heat exchangers Pilot plant: Shell and tubes heat exchanger. Plate heat exchanger.
4. APPLIED THERMODYNAMICS
   - Binary vapor-liquid equilibrium
   - Heat pump (R-134a) & Refrigeration bench (R-12)
5. OPERATIONS INVOLVING SOLIDS
   - Fluidized bed
   - Cake filtration

Bibliography:

- COULSON and RICHARSON´S "Chemical Engineering" , Vol. 1, Sixth Edition, (1999)
- MCKETTA J.J. "Heat Transfer Design Methods". Ed. Dekker (1992)
- BIRD R.B. "Transport Phenomena". John Wiley & Sons, 2nd ed.New York , (2002)
- COULSON and RICHARDSON´S. " Chemical Engineering", Vol. 2 Fifth Edition, 2002

Staff Involved: Esther Alonso; Mar Peña, Juan García

Department: Chemical and Environmental Engineering Department

MATERIALS IN CHEMICAL ENGINEERING

Code: **44314-UVA**

Extension: Half-yearly	Semester(s): 5	Academic year: 3	Cycle: 1
Credits ......Local: 6	ECTS: 6		

Lecture hours: 45	Practical hours: 15
Personal work hours: 96	Laboratory hours:

Aims: Introduction to the Materials Science. Description of the structural characteristics of the materials. Properties and applications of metals, polymers, ceramics and composites

Assessment: Examination (90%) Classwork (10%)

Outline Syllabus:

1. INTRODUCTION TO THE MATERIALS: Relationship between structure, properties and processes. Crystalline structure. Defect structures in crystals. Testing of materials.
2. METALIC MATERIALS: Treatments. Solidification and alloys. Non-ferrous alloys. Ferrous alloys.
3. POLYMERIC MATERIALS: Solid state of polymers. Types of polymeric materials. Additives.
4. COMPOSITE MATERIALS: Composites materials of polymeric matrix. Properties and processes.
5. CERAMIC MATERIALS: Structures of the ceramics. Processing of ceramics

Bibliography:

- CALLISTER W.D., "Introducción a la Ciencia e Ingeniería de los Materiales", Ed. Reverté (1995)
- SHAKELFORD J.F., "Introducción a la Ciencia de Materiales para ingenieros", Ed. Pearson Prentice Hall (2005)
- YOUNG R.J., "Introduction to Polymers", Ed. Chapman and Hall (1987)
- HULL D., Materiales Compuestos, Ed. Reverté (1987)

Staff Involved: José María Pastor

Department: Condensed Matter Physics

ELECTRIC TECHNOLOGY

Code: **44312-UVA**

Extension: Half-yearly	Semester(s): 6	Academic year: 3	Cycle: 1
Credits ......Local: 6	ECTS: 6		

Lecture hours: 20	Practical hours: 10
Personal work hours: 96	Laboratory hours: 30

Aims: The students will have the opportunity of acquiring technical knowledge about electrical facilities, power generation, transport and distribution and the main uses and means of use of eletrical power in industry. The students will develop the following abilities: (i) Correct use of electrical measurement equipment; (ii) Electrical risk assesment and use of safety equipment for people and facilities; (iii) Knowledge about electrical equipment for power transport and distribution; (iv) Knowledge about electrical motors; (v) Specifying electrical motors for industry applications; (vi) Development of teamwork skills; (vii) Development of effective communication skills of electric technical concepts.

Assessment: Examination (40%) Classwork (20%) Laboratory work (40%)

Outline Syllabus:

1. INTRODUCTION.
2. BALANCED THREE-PHASE ELECTRICAL SYSTEMS.
3. GENERATION, TRANSPORT AND DISTRIBUTION OF ELECTRICAL POWER.
4. LOW-VOLTAGE ELEMENTS OF MANEUVER AND ELECTRICAL PROTECTION.
5. ELECTRICAL PROTECTION OF PEOPLE AND FACILITIES.
6. ELECTRICAL POWER APPLICATIONS. LOW-VOLTAGE FACILITIES.

LABORATORY WORK

1. ELECTRICAL MEASUREMENT EQUIPMENT AND TECHNIQUES (I): BASIC CONCEPTS.
2. ELECTRICAL MEASUREMENT EQUIPMENT AND TECHNIQUES (II): MEASUREMENTS IN SINGLE-PHASE AC SYSTEMS.
3. APPLICATION TO SINGLE-PHASE ELECTRICAL SYSTEMS.
4. ELECTRICAL MEASUREMENT EQUIPMENT AND TECHNIQUES (III): MEASUREMENTS IN THREE-PHASE AC SYSTEMS.
5. APPLICATION TO THREE-PHASE BALANCED ELECTRICAL SYSTEMS.
6. EQUIPMENT FOR MANEUVER AND ELECTRICAL PROTECTION.
7. PEOPLE AND FACILITIES PROTECTION IN LOW-VOLTAGE SYSTEMS AGAINST INDIRECT AND DIRECT FAULTS.
8. POWER TRANSFORMER TESTS.
9. STARTING METHODS OF THREE-PHASE INDUCTION MOTORS.
10. SPEED REGULATION METHODS IN DC AND THREE-PHASE INDUCTION MOTORS.

Bibliography:

- ANÓNIMO, "Manual A.E.G.", A.E.G. Telefunken (1967).
- ANÓNIMO, "Reglamento sobre condiciones técnicas y garantías de seguridad en líneas eléctricas de alta tensión", MITYC (2008).
- ANÓNIMO, "Reglamento electrotécnico de baja tensión", MITYC (2002).
- BOIX, O.; CORCOLES, F.; SAINZ, L. and SUELVES, F.J., "Tecnología Eléctrica", CEYSA (2002).
- BOLDEA, I. and NASAR S.A., "Electric drives", CRC (2005).

- BUCHHOLD-HAPPOLDT, "Centrales y redes eléctricas", Editorial Labor (1974).
- FELDMAN, J.E., "Specifying electric motors", Chemical Engineering (1987), Vol. 94, nº7, pp. 37-48.
- FINK, D. G. and BEATY, H. W., "Manual de ingeniería eléctrica", McGraw-Hill (1996).
- FRAILE MORA, J., "Introducción a las instalaciones eléctricas", Servicio de Publicaciones del Colegio de Ingenieros de Caminos, Canales y Puertos (2000).
- GARCÍA TRASANCOS, J., "Instalaciones eléctricas en media y baja tensión", Paraninfo (1999).
- GARCÍA TRANSANCOS, J., "Electrotecnia", Thomson.
- MERINO AZCÁRRAGA, J.M., "Arranque industrial de motores asíncronos", McGraw-Hill (1995).
- MORENO, N.; BACHILLER, A. and BRAVO, J.C., "Problemas resueltos de Tecnología Eléctrica", Thomson (2003).
- PILLAY, P., "Applying energy-efficient motors in the petrochemical industry", IEEE Industry Applicantions Magazine (1997), Vol. 3, nº 1, pp. 32-40.
- RAHILL, T. and FOUSHA, M.C., "Navigating petrochemical industry induction motor standards", IEEE Petroleum and Chemical Industry Technical Conference (2007).
- ROGER, J.; RIERA, M. and ROLDAN, C., "Tecnología Eléctrica", Editorial Síntesis (2000).
- SANZ FEITO, J., "Máquinas eléctricas", Prentice Hall (2001).
- SANZ FEITO, J., "Centrales Eléctricas", Sección de Publicaciones de la E.T.S.I.I. de Madrid (1985).
- THURNHERR, P. and SCHWARZ, G., "Selection of electrical equipment for hazardous areas", IEEE Industry Applications Magazine (2009), Vol. 15, Nº 1, pp. 50-55.
- TOLIYAT, H.A. and KLIMAN, G.B., "Handbook of electric motors", CRC (2004).

Staff Involved: Daniel Moriñigo-Sotelo, Gregorio Pérez-Ordax, Mª Ángeles Rodríguez-Negro

Department: Electrical Engineering

PRINCIPLES OF STRUCTURAL DESIGN

Code: **44313-UVA**

Extension: Half-yearly	Semester(s): 6	Academic year: 3	Cycle: 1
Credits ......Local: 6	ECTS: 6		

Lecture hours: 45	Practical hours: 15
Personal work hours: 96	Laboratory hours: 0

Aims: BACKGROUND AND GENERAL GOALS:

The students are involved in a strongly oriented Chemical Engineering background. They will attend this single 6-credit course about structures. Thus, something as “to qualify them to solve complex structural problems” would be doubtfully desirable, and also an unrealistic goal.

It is considered that the main goal should be to get them ready to judge, in the preliminary steps of design, the general outlines of the structural solution that would be suitable for a particular situation or problem, and also to properly talk to a specialist when eventually needed in their professional live. Basic knowledge and understanding about common structural settlements used in industrial environments is required for that. While it may not be the case in other fields, in the case of structures this “basic knowledge and understanding” could be hardly achieved in the absence of some calculations. The calculations presented to the students have to be as simple as possible, related to typical structural settlements, and carefully chosen so that they serve to the purpose of enlightening relevant aspects of the structural behaviour. The emphasis should be far more on “knowledge and understanding” than in the calculations per se, in this single course about structures.

On the other hand, the students come into the course with little knowledge about some basic topics (as static equilibrium is), which are needed to achieve an elementary understanding on how a solid with bearing, or otherwise resisting, functionality do work.

This implies that the lectures in this course about structural design have to cover from the very basics of static equilibrium, to some selected aspects of solid mechanics and structures which are of “daily use” in structural design. There is a big gap in between, and bringing the students across it in six credits of lectures is an interesting challenge, which also involves compromises.

ABOUT THE CONTENTS:

Taking into account the previous ideas, a succinct selection of specially chosen topics is included in the course. They start with basic notions of static equilibrium, a brief presentation of solid behaviour and related magnitudes, a simplified study on straight beams (including buckling), and an elementary study of the effect of internal pressure in thin walled pipes ans vessels, which are frequent in chemical industry. Once the basics are established, the students are presented to the most typical kinds of metallic structures found in industrial environments. They are expected to achieve a basic understanding of its “whys and hows” trough the analysis of simple typical configurations.

When required, the analysis stage can easily get complicated even for a quite simple structure. The use of a particular, simple, freely distributable computer program, serves to the purpose of alleviate these situations and also has collateral formative benefits.

PARTICULAR GOALS:

The following are particular goals related to the contents of the course. They are considered to be reasonably well within the average student abilities.

- Identification and application of static equilibrium conditions.
- Identification of the magnitudes describing the behaviour, and eventual fail, of steel and other materials.
- Identification of requirements of structural design following current legal regulations.

- Understanding shear and bending diagrams for beams, and its implications. Calculation in simple cases.
- Basic knowledge of buckling. Calculation based on current normative.
- Identification of the most common types of metallic structures. Resolution of simple design problems.
- Basic knowledge of the effects of internal pressure and torsion. Resolution of simple design problems related to these actions.
- Acknowledgment, at an informative level, of different typical settlements used in joints and supports.
- Basic understanding of foundations and associated magnitudes. Identification of the most common types.
- Ability to operate a simple computer program for structural analysis, at a level of novice user.

Assessment: Examination (95%) Classwork (5%)

Outline Syllabus:

6. INTRODUCTION AND GROUNDWORK. The Theory of Elasticity and the Strength of Materials. The engineering of structures. Structural elements. Materials. Loads. Goals of the structural analysis. Basic hypothesis.
7. STRESS. Concept of equilibrium. Application of vector algebra to statics. Stress concept. Local equilibrium. Principal stresses. Mohr's diagram.
8. THE ELASTIC SOLID. Concept of strain. Uniaxial tension test. Torsion Test. Variables related to strain. Material behaviour. Tresca and Von-Mises Yield criteria.
9. TRACTION AND FLEXION OF STRAIGHT BEAMS. Basic hypothesis. Operational conventions. Equilibrium equations. Diagrams of shear forces and bending moments. Calculation of normal stresses. Calculation of shear stresses. Calculation of displacements using Navier-Bernouilli model.
10. 5.- BUCKLING OF STRAIGHT BEAMS. Concept of mechanical instability. Critical load, effective length, and slenderness ratio. Notions on "partial coefficients" method.
11. BEAM STRUCTURES. Concept of statical determinacy. Analysis of plane pin-jointed trusses. Cremona's method. Analysis of bending beams and frames. Notions on computer based methods.
12. EFFECT OF TORSION AND INTERNAL PRESSURE. Basic design guidelines. Thin walled circular cross section. Torsion in other closed non-circular thin walled cross sections. Basics of internal pressure in pipes and vessels.
13. AN INTRODUCTION TO FOUNDATIONS. Typology. Grounding bolts. Concrete. Shallow foundations. Ground characterization. Notions of calculus.
14. SOME TYPICAL SETTLEMENTS. Joints and stiffeners. Rivets. Bolts. High resistance bolts. Welded joints. Stiffeners. Some practical arrangements for joints. Frames for ceiling. Frame-type beams. Composed columns. Typical settlements in industrial buildings.

Bibliography:

- MINISTERIO DE INDUSTRIA, "Código Técnico de la Edificación", Tecnos (2006).
- J.C. del CAÑO, "Elasticidad", Servicio Publicaciones ETSII Valladolid (1998).
- J.A. GARRIDO y A. FOCES, "Resistencia de Materiales", Secretariado Publicaciones Univ. Valladolid (1994).
- J.M GERE, "Timoshenko Resistencia de Materiales", Thomson (2002).
- E.P. POPOV, "Mecánica de Sólidos", Pearson Educación (2000).

Staff Involved: Juan C. del Caño

Department: Architectural Building, Soil Engineering, and Continuum Mechanics & Theory of Structures

APPLIED CHEMICAL KINETICS

Code: **44310-UVA**

Extension: Half-yearly	Semester(s): 6	Academic year: 3	Cycle: 1
Credits ......Local: 6	ECTS: 6		

Lecture hours: 45	Practical hours: 15
Personal work hours: 96	Laboratory hours: 0

Aims: This course will provide an overview of applied chemical kinetics and reaction engineering at an intermediate to advanced level. The goal is to provide students with the vocabulary, modelling tools, and theoretical background to understand current chemical homogeneous and heterogeneous kinetics and reaction engineering literature and to tackle the sort of complex problems that they will encounter in their dissertation research and beyond.

Assessment: Examination (80%) Classwork (20%)

Outline Syllabus:

1. ELEMENTS OF REACTION KINETICS: Reaction rate. Conversion and extent of reaction. Order of reaction. Thermodynamics of chemical equilibrium. Reaction mechanisms
2. CHEMICAL REACTION KINETICS: Mathematical characterization of simple and complex reactions
3. KINETICS OF BATCH REACTORS: Batch and semibatch reactors. Collection and analysis of kinetic data
4. KINETICS OF CONTINUOUS REACTORS: The fundamental mass, energy and momentum balance equations. Plug flow reactor. Perfectly mixed flow reactor. Design equations. Collection and analysis of kinetic data
5. KINETICS OF HETEROGENEOUS CATALYTIC SOLID-FLUID REACTIONS I: Adsorption on solid catalyst. Rate equations. Single reactions. Model discrimination and parameter estimation
6. CATALYTIC SOLID-FLUID REACTIONS II. INTERFACIAL GRADIENT EFFECTS: Reaction at the surface of a solid. Mass and heat transfer resistances. Concentration and temperature gradients between bulk fluid and catalyst particle surface
7. CATALYTIC SOLID-FLUID REACTIONS III. INTRAPARTICLE GRADIENT EFFECTS: Catalyst internal structure. Pore diffusion. Diffusion and reaction inside catalyst particles. Non-isothermal particles. Thermal gradients inside catalyst particles. External and internal temperature gradients
8. CATALYST DEACTIVATION: Types of catalyst deactivation. Kinetics of catalyst poisoning. Kinetics of catalyst deactivation by coking. Kinetics of catalyst aging
9. KINETICS OF NON-CATALYTIC GAS-SOLID REACTIONS: General model. Shrinking unreacted core model. Experimental determination of controlling step. Models based on the structure of the solid
10. GAS-LIQUID REACTIONS: Models for transfer at a gas-liquid interface. Two-film theory. Surface renewal theory. Experimental determination of the kinetics of gas-liquid reactions. Specific equipment
11. KINETIC OF BIOCHEMICAL REACTIONS: Kinetics of enzymatic reactions. Kinetics of microbial growth. Determination of kinetic parameters

Bibliography:

- GONZÁLEZ VELASCO, J.R., GONZÁLEZ MARCOS, J.A., GONZÁLEZ MARCOS, M.P., GUTIÉRREZ ORTIZ, J.I., GUTIÉRREZ ORTIZ, M.A., "Cinética Química Aplicada", Ed. Síntesis, (1999)

- FROMENT, G.F., BISCHOFF, K.F., "Chemical Reactor Analysis and Design", John Wiley & Sons, Inc., 2nd Edition, (1990)
- FOGLER, H.S., "Elements of Chemical Reaction Engineering", Prentice-Hall International, Inc., 3rd Edition, (1990)
- LEVENSPIEL, O., "Ingeniería de las Reacciones Químicas", Ed. Reverté, Barcelona, 3a Edición, (2004)

Staff Involved: Susana Lucas

Department: Chemical Engineering and Environmental Technology

ENVIRONMENTAL TECHNOLOGY

Code: **44320-UVA**

Extension: Half-yearly	Semester(s): 7	Academic year: 4	Cycle: 2
Credits ......Local: 7,5	ECTS: 7,5		

Lecture hours: 45	Practical hours: 30
Personal work hours: 120	Laboratory hours:

Aims: The aim of the course is to show the techniques used in waste treatment and pollution prevention, and to raise awareness on environmental protection as a part of the conceptual design and operational strategy of industrial processes.

Assessment: Examination (60%) Classwork (40%)

Outline Syllabus:

1. INTRODUCTION: Environmental pollution. Fundamentals of environmental processes
2. WATER POLLUTION CONTROL: Water quality. Physic and chemical processes for treatment of wastewater. Biological processes for treatment of wastewater
3. AIR POLLUTION CONTROL: Air contaminats characterization. Emission control. Physic pollution
4. SOLID WASTES: Solid wastes characterization and treatment
5. ENVIRONMENTAL MANAGEMENT: Waste minimization. Environmental Impact Assessment. Environment Management Systems

Bibliography:

- BISHOP P.L. "Pollution Prevention: Fundamentals and Practice". McGraw-Hill International. Boston. 2000.
- DE NEVERS N. "Air pollution control engineering". Mc Graw-Hill. Boston, 2000.
- KIELY G. "Ingeniería Ambiental. Fundamentos, entornos, tecnologías y sistemas de gestión". Mc Graw-Hill. Madrid. 1999.
- LAGREGA M.D., BUCKINGHAM P.L., EVANS J.C. Hazardous Waste Management Mc Graw-Hill. New York, 1994.
- METCALF & EDDY, INC. "Wastewater Engineering. Treatment, disposal and reuse". McGraw-Hill. New York, 1995.
- PEAVY H.S., ROWE D.R., TCHOBANOGLOUS G. "Environmental Engineering" Mc Graw-Hill. New York, 1985.

Staff Involved: Pedro A. García Encina; Raúl Muñoz Torre

Department: Chemical Engineering and Environmental Technology

CONTROL AND INSTRUMENTATION

Code: **44316-UVA**

Extension: Annual	Semester(s): 7&8	Academic year: 4	Cycle: 2
Credits ......Local: 10,5	ECTS: 10,5		

Lecture hours: 63	Practical hours: 12
Personal work hours: 168	Laboratory hours: 30

Aims: To provide the student with the fundamental concepts and methodology of Control and Instrumentation, so that he is able to understand, analyse, design and operate automatic control systems of the process industry.

Assessment: Examination (70%) Classwork (30%)

Outline Syllabus:

1. INTRODUCTION: 1.Dynamical systems. Inputs and outputs. Aims in control system. 2. Open and Closed loop control. Elements in a control loop. Discrete and continuous systems. Examples. Process diagrams. ISA standards.

2. INSTRUMENTATION: 3. Transmitters. Measurements systems. Measurement of process variables. 4. Actuators. Control valves. 5. Controllers. PID controllers. Elementary tuning and closed loop dynamics. 6. PLC. Sequential control. Logic and security systems.

3. LINEAR SYSTEMS MODELLING: 7. Dynamical models. Linearised models. Model validation. State space models. Impulse response models. 8. The Laplace transform. Transfer functions. Gain, Poles and zeros. Delays . Pade aproximation. 9. Time domain response. First and second order systems. Tiem response of higher order systems. Poles and zeros locations and time responses. Concepts of input-output stability. Process identification. 11. Block diagrams. Closed loop transfer functions. Closed loop time responses.

4. LINEAR SYSTEMS ANALYSIS: 12. Closed loop analysis. Root locus. Dynamic response and stability. 13. Steady state errors. relation with the transfer funcion. 14. Concet of frequency response. Bode and Nyquist diagrams. Signal filtering. Stability in the frecuency domain. Stability margins. Sensibility and Robustness.

5. CONTROLLER DESIGN: 15. Industrial controllers. Design methodology. Control specifications. Wind-up and auto/man transfers. Digital controllers. 16. PID tuning. Rule and model based tunning. Autotunners. Smith Predcitors. 17. Common control loops (flow, pressure, level, temperature). Process design and operability. 18. Control structures. Cascade. Feedforward. Ratio, selective, overrride. Examples (reactors, destillation colums, furnaces, compressors, etc.). Design methodology. Implementation technologies (DCS). 19. Interactive systems. Multivariable processes. RGA. Decoupling control. Advanced control systems.

Use of LABVIEW software

Bibliography:

- B.A. OGUNNAIKE, W.H. RAY,"Process Dynamics, Modeling and Control", Oxford U.P. (1994)
- SMITH,CORRIPIO "Principles and practice of Automatic process control", J.Wiley, (2006)
- OLLERO, FDEZ.-CAMACHO "Control e Instrument. de procesos químicos", Sintesis, (1997)
- OGATA "Ingenieria de control moderna", Prentice Hall Inter. 4ª edc, (2003)

Staff Involved: César de Prada Moraga . Systems Engineering and Automatic Control
Miguel Ángel Urueña Alonso and Franciso Cantero Chemical Eng. and Environmental Technol.

Department: Systems Engineering and Automatic Control / Chemical Engineering and Environmental Technology

SEPARATION PROCESSES

Code: **44317-UVA**

Extension: Half-yearly	Semester(s): 7	Academic year: 4	Cycle: 2
Credits ......Local: 7,5	ECTS: 7,5		

Lecture hours: 45	Practical hours: 30
Personal work hours: 120	Laboratory hours:

Aims: Acquisition of the necessary knowledge for selection, analysis, design, operation and application of the main basic operations of mass transfer and simultaneous mass and heat transfer.

Assessment: Examination (60%) Classwork (40%)

Outline Syllabus:

1. SEPARATION PROCESSES INTRODUCTION. Industrial separation processes. Mechanism of separation. Methods of Operation. Selection of feasible separation processes.
2. SIMPLE EQUILIBRIUM PROCESSES. Binary and multicomponent flash distillation. Single-stage and cross-flow liquid-liquid and solid-liquid extractions.
3. EQUILIBRIUM STAGED COUNTERCOURRENT PROCESSES. Binary Distillation. Mc Cabe-Thiele and Lewis analysis. Absorption and stripping. Kremser equation. Extraction of partially miscible systems. Introduction to multicomponent distillation. Equipment design and selection.
4. MASS TRANSFER ANALYSIS FOR PACKED TOWERS. Distillation. Absorption. Cooling towers, humidification and dehumidification.
5. RATE CONTROLLED SEPARATIONS. Drying of process materials. Fixed bed adsorption and ion exchange. Crystallization from solutions. Membranes

Bibliography:

- P. C. WANKAT. "Separation Process Engineering" (2nd Edition). Prentice Hall (2007).
- J.D. SEADER &E.J. HENLEY "Separation Process Principles" (2nd Edition). John Wiley & Sons (2005).
- W. MCCABE, J. SMITH, P. HARRIOT. "Unit Operations of Chemical Engineering" (7th Edition). Mc Graw Hill's (2005).
- C.J. GEANKOPLIS. "Transport Processes and Separation Process Principles"(4th Edition). Prentice Hall (2003).

Staff Involved: Silvia Bolado

Department: Chemical Engineering and Environmental Technology Department

CHEMICAL REACTORS

Code: **44318-UVA**

Extension: Half-yearly	Semester(s): 7	Academic year: 4	Cycle: 2
Credits ......Local: 7,5	ECTS: 7,5		

Lecture hours: 45	Practical hours: 30
Personal work hours: 120	Laboratory hours: 0

Aims: Analysis and Design of Chemical Reactors, homogeneous and heterogeneous. Influence of flow pattern in the chemical conversion. Stability evaluation.

Assessment: Examination (80%) Classwork (20%)

Outline Syllabus:

1. Fundamentals of Chemical Reactor Design.

HOMOGENEOUS REACTORS

2. Continuous Stirred Tank Reactor
3. Batch Stirred Tank Reactor.
4. Tubular Reactor.
5. Optimization. Multiple Reactions

NON IDEAL FLOW

6. Non-Ideal Flow Characterization.
7. Conversion in Non-Ideal Reactors.

HETEROGENEOUS REACTORS

8. Fixed Bed Catalytic Reactors.
9. Fluidized Bed Catalytic Reactors.
10. Non-Catalytic Solid-Fluid Reactors.
11. Gas – Liquid Reactors.
12. Multiphase Reactors
13. Safety in Chemical Reactors

Bibliography:

- SMITH J.M., "Chemical Engineering Kinetics", Mc Graw- Hill, (1981)
- FROMENT G.F., BISCHOFF K.B., "Chemical Reactor. Analysis and Design", J. Wiley and Sons (1990)
- MISSEN R.W., MIMS Ch. A., SAVILLE B. "Introduction to Chemical Reaction and Kinetics" J. Wiley and Sons, (1999)
- FOGLER H.S. "Elements of Chemical Reaction Engineering", Prentice Hall (1999)
- CARBERRY J.J., "Chemical and Catalytic Reaction Engineering", Mac Graw - Hill (1976)
- HIMMELBLAU D.M., BISCHOFF K.B. "Análisis y Simulación de Procesos", Reverté (1976)
- BAILEY J.E., OLLIS D.F., "Biochemicals Engineering Fundamentals", Mc Graw - Hill (1986)

Staff Involved: María Teresa García, Gerardo González

Department: Chemical Engineering and Environmental Technology

CHEMICAL ENGINEERING LABORATORY II

Code: **44315-UVA**

Extension: Annual	Semester(s): 7 &8	Academic year: 4	Cycle: 2
Credits ......Local: 12	ECTS: 9		

Lecture hours:	Practical hours:
Personal work hours: 120	Laboratory hours: 120

Aims: Experimental observation of the main concepts that govern the operations and unit processes in Chemical Engineering. Introduction to the experimental planning and efficient and safe work in laboratory and in pilot plant

Assessment: Work in lab. (30%); lab. report (in groups) (30%); Individual oral exam (30%); Group project (10%)

Outline Syllabus:

1. SEPARATION PROCESSES. Differential distillation. Distillation in packed columns (HETP and HTU). Distillation in trayed columns (Efficiency). Stripping in packed columns. Ionic exchange in fixed bed. Leaching. Solid drying. Drowning-out crystallization. Membrane processes: Microfiltration, Ultrafiltration, Reverse Osmosis
2. CHEMICAL REACTORS. Kinetic study in a batch stirred tank reactor. Real flow models. Mixed flow reactor. In serie tanks isothermal operation. Isothermal Plug flow reactor. RTD and conversion: Macromixing effects.
3. ENVIRONMENTAL TECHNOLOGY. Air pollution: Particle determination and gaseous components analysis. Wastewater treatment: heavy metals removal, coagulation-floculation processes, anaerobic reactor.

Bibliography:

- W. MCCABE, J. SMITH, P. HARRIOT. "Unit Operations of Chemical Engineering" (7th Edition). Mc Graw Hill's (2005)
- H.S. FOGLER. "Elements of Chemical Reaction Engineering" (4^{th} Edition). Prentice Hall (2006).
- METCALF & EDDY "Ingeniería de aguas residuales" McGraw-Hill (1995).
- APHA. "Standard methods for the examination of water and wastewater" American Public Health Association (2005).

Staff Involved: Silvia Bolado, Francisco Javier Cantero, Mª Teresa García, Rafael Mato

Department: Chemical Engineering and Environmental Technology Department

CHEMICAL ANALYSIS AND SIMULATION

Code: **44319-UVA**

Extension: Half-yearly	Semester(s): 8	Academic year: 4	Cycle: 2
Credits ......Local: 6	ECTS: 6		

Lecture hours: 30	Practical hours: 30
Personal work hours: 96	Laboratory hours: 0

Aims: This discipline aims to identify systems, planning, solving and optimizing models representing real processes. At the end of the course students must be able to: Read a word description of a process and determine the appropriate components and physical property relationships. Identify models based in transport phenomena and globalized physical-chemical models. Demonstrate skills in optimization by executing parametric runs and developing an appropriate optimization scheme. Estimate parameters and analyse experimental data. Determine analogies between processes.

Assessment: Examination (70%) Classwork (30%)

Outline Syllabus:

1. Introduction.
2. Models Based on Transport Phenomena Principles.
3. Lumped Model Examples.
4. Distributed Model Examples.
5. Population-Balance Models.
6. Parameter Estimation.
7. Analogies between Processes.
8. Treatment of Experimental Data.

Bibliography:

- HIMMELBLAU D.M. & BISCHOFF K.B., “Análisis y Simulación de Procesos”. Reverté, (1992).
- FINLAYSON B.A, “Nonlinear Analysis in Chemical Engineering”, McGraw-Hill, (1980).

Staff Involved: Francisco Sobrón Grañón

Department: Chemical Engineering and Environmental Technology Department

PROJECTS

Code: **43340-UVA**

Extension: Half-yearly	Semester(s): 9	Academic year: 5	Cycle: 2
Credits ......Local: 7,5	ECTS: 7,5		

Lecture hours: 54	Practical hours: 21
Personal work hours: 113	Laboratory hours: 0

Aims: Methological: Conceptualize, design, develop, interpret and evaluation of Chemical Engineering Projects within the Chemical Engineering framework.

Organising: Work in teams, determine the differente tasks and stages of a project and distribute the man-hours leading the project when required.

Management: Relate with other engineers, communicate the results efficiently, ask engineering questions and ask for technical requisitions.

Assessment: Examination (60%) Classwork (50%)

Outline Syllabus:

PART I. Introduction to Project Engineering

1. Introducción general a la Ingeniería de Proyectos
2. Morphology of a Chemical Engineering Projects
3. Technology Transfer
4. Alternatives in a Project

PART II. Process Engineering

1. Process Engineering (I).Process Flow Diagram. Material & Energy Balances
2. Process Engineering (II). Piping and instrumentation Diagrams (P&IDs)
3. Process Engineering (III). Equipment Specification (Process Data Sheets)
4. Plant and Equipment Layout
5. Utilities (I). Water in a plant
6. Utilities (II). Other services

PART III. Economy, Safety, Environmental Impact, Management, Quality Control and New Trends for Design

1. Cost Engineering
2. Safety and Health
3. Environmental Impact
4. Project Management
5. Management of Quality
6. New trends for Design in Chemical Engineering

Bibliography:

- ENCYCLOPEDIAS: (1) Ullmann's Encyclopedia of Industrial Chemistry, Verlag Chemie, Weinheim, FRG, 7th Edition, (2004). (2) Kirk-Othmer Encyclopedia of Chemical Technology, DialogOnDisc, 4th ed., (2002). (3) J. McKetta, Encyclopedia of Chemical Processing and Design, Marcel Dekker, (1997)
- PROCESS AND EQUIPMENT MANUALS: (1) E.E. Ludwig, Applied Process Design for Chemical and Petrochemical Plants, Vols. 1-3, 3rd ed., Gulf Professional Publishing, (1999). (2) Perry, Green, and Maloney, Perry's Chemical Engineers Handbook, McGraw-Hill, 7th ed.,

New York, (1999). (3) J.R. Couper, W.R. Penney, J.R. Fair, S. Walas, Chemical Process Equipment - Selection and Design -, 2nd ed. Gulf Professional Publishing, (2004).

- BASIC CHEMICAL ENGINEERING AND PLANT DESIGN: (1) W.D. Baasel, Preliminary Chemical Engineering Plant Design, 2nd ed., (1989). (2) J.M. Douglas, Conceptual Design of Chemical Processes, McGraw-Hill, New York (1988). (3) M.S. Peters, K.D. Timmerhaus, R.E. West, M. Peters, Plant Design and Economics for Chemical Engineers, McGraw-Hill, New York, 5th ed., (2002). (4) R.K. Sinnott, J.M. Coulson, and J.F. Richardson, Chemical Engineering, Vol. 6, Design, Butterworth Heinemann, Third edition, Oxford, (1999). (5) Lieberman, Process Design for Reliable Operations, Gulf Pub Co, 2nd ed., (1988).
- PHYSICAL PROPERTIES: (1) D.R. Lide, Handbook of Chemistry and Physics, CRC-Press, 79th ed., (1998). (2) American Petroleum Institute (API), Technical Data Book: Petroleum Refining, 6th ed., (1997).
- Other specific bibliography: specific by topic, given to the student during the year.
- Websites: specific by topic, given to the student during the year.

Staff Involved: Juan García-Serna, Fernando Fdz-Polanco, Rafael González, Andrés Herguedas

Department: Chemical Engineering and Environmental Technology Department

EQUIPMENT AND FACILITIES DESIGN

Code: **44338-UVA**

Extension: Annual Credits ......Local: 9	Semester(s): 9&10 ECTS: 9	Academic year: 5 Cycle: 2

Lecture hours: 60 Personal work hours: 144	Practical hours: 15 Laboratory hours: 15

Aims: The main aim of this course is to provide the students with basic knowledge of industrial design, behaviour of materials, corrosion and inspection of materials, and quality control and supervision

Assessment: Examination (70%), Classwork (30%)

Outline Syllabus:

1. Industrial design.
2. Chemical Industrial design. Pressure Vessel. Storage tanks.
3. Technological Material.
4. tecnológicos de interés industrial.
5. Forming Thecnics of materials. Welding.
6. Industrial Protection and Corrosion
7. Behaviour of materials.
8. Materials in high and low temperature.
9. Inspection of materials.
10. Reyclability.
11. Quality control. Codes. Non Destructive Testing.

Bibliography:

- Materials Selection: DI CAPRIO G., "Los aceros inoxidables", Grupinox, (1999). APRAIZ B.J. "Tratamientos térmicos de los aceros", Ed. Dossat.(2002). APRAIZ B.J. "Aceros especiales". Ed. Dossat, (2002). APRAIZ B.J. "Fundiciones", Ed. Dossat, (2002).
- General Design and Forming: MORRAL, MOLERA y JIMENO. "Metalurgia General". (2 Vols.), Ed. Reverté. (2000), FLINN, R.; TROJAN, P. "Materiales de Ingeniería y sus aplicaciones". Ed. McGraw-Hill.8"002).
- Protection and Corrosion: OTERO, H.E. "Corrosión y degradación de materiales", Ed. Síntesis. (2003). GONZÁLEZ F., J.A. "Teoría y práctica de la lucha contra la corrosión", Ed. CSIC, (1984). RAMÍREZ G., F. "Introducción a los métodos de END de control de la calidad de los materiales", Ed. INTA, (1980).
- Design Equipment: MEGYESY, Eugene F. "Manual de Recipientes a Presión". Ed. Limusa. (1995). MOSS, Dennis R. "Pressure Vessel Design Manual". Gulf Publishing Division. (1996). ASME. "Boiler and Pressure Vessel Code". ASME (Ed.). New York, Normas: UNE-EN. ASTM. (2002), Reglamentos: RAP, RAQ, RGL, Código API para tanques de almacenamiento, Código Europeo Armonizado de Recipientes a Presión. Directiva 97/23/CE. Norma Europea EN-13445.AENOR. (2002), Directiva 87/404/CEE de Recipientes a Presión Simples. MINER. Madrid. Norma Europea EN-286.
- Bibliography for Practices: COCA R. y ROSIQUE J. "Ciencia de Materiales. Teoría. Ensayos. Tratamientos". Ed. Pirámide. (1990), LASHERAS, J.M.CARRASQUILLA F. "Ciencia de Materiales". Ed. Donostiarra. (1992), RAMIREZ G. "Introducción a los métodos de Ensayos No Destructivos de control de la calidad de los materiales" , Ed. INTA,(1980).

Staff Involved: Juan José García

Department: Mechanical Engineering and Materials Engineering

INDUSTRIAL CHEMISTRY

Code: **44341-UVA**

Extension: Half-yearly	Semester(s): 9	Academic year: 5	Cycle: 2
Credits ......Local: 4,5	ECTS: 4,5		

Lecture hours: 30	Practical hours: 15
Personal work hours: 72	Laboratory hours:

Aims: This introductory industrial chemistry course covers the important areas of the bulk organic and inorganic chemical industry. At the end of this course students should be able to: Recognise the main commercial processes at the Chemical Industry. Know principals and methodologies employed in industrial production. Identify the technical challenges, which are encountered during process, R&D and manufacturing and the contributions made by chemical engineers in the profitability of the chemical industry.

Assessment: Written examination (40%), Classwork (60%)

Outline Syllabus:

ORGANIC AND PETROCHEMICAL INDUSTRY

1. Petroleum: origin, location and composition. Prospecting and extraction. Crude distillation
2. Cracking and reforming. Refinery products
3. Petrochemical industry: bulk chemicals and derivatives. Methane, acetylene
4. Ethylene, Propylene. C4 fraction. Aromatic hydrocarbons
5. Fine chemistry products: colorants, pharmaceuticals, etc.

INDUSTRIAL INORGANIC CHEMICALS

6. Nytrogen industry: fertilizer industry. Ammonia synthesis. Nitric acid. Nitrogen fertilizers
7. Sulfur industry: sulphuric acid
8. Cement: raw material. The Portland cement.
9. Chloro-alkali industry: sodium chloride. Sodium carbonate. Sodium and sodium hydroxide. Chlorine and chloride acid

OTHER CHEMICAL INDUSTRIES

10. Food and Agriculture industry: Sugar Industry. Milk and Dairy industries. Oil and Fats.
11. Biotransformation industries: alcoholic fermentation.
12. Other industries: use of vegetal materials resources. Paint. Rubber.

Bibliography:

- ULLMANN´s: "Encyclopedia of Industrial Chemistry" Verlag Chemie, Weinheim, FRG, 7th Edition, (2004).
- KIRK-OTHMER: "Encyclopedia of Chemical Technology", DialogOnDisc, 4th ed., (2002).
- VIÁN, A., "Introducción a la Química Industrial", 2ª ed., Reverté (Barcelona), (1994).
- THOMPSON R., "Industrial Inorganic Chemicals: Production and uses". The Royal Society of Chemistry (Cambridge), (1995)
- AUSTIN G.T., "Shreve's Chemical Process Industries", 5ªEd.. McGraw-Hill, (1984).
- MOUJLIN J.A., MAKKEE M., VAN DIEPEN A, "Chemical Process Technology", John Wiley & sons, Ltd., (2001).

Staff Involved: Francisco Sobrón Grañón

Department: Chemical Engineering and Environmental Technology Department

INDUSTRIAL ECONOMY AND PRODUCTION MANAGEMENT

Code: **44339-UVA**

Extension: Half-yearly	Semester(s): 9	Academic year: 5	Cycle: 2
Credits ......Local: 6	ECTS: 6		

Lecture hours: 45	Practical hours: 15
Personal work hours: 96	Laboratory hours:

Aims: To provide the students with the basic knowledges o economical theory related with the industrial environment (Macroeconomy) and market structure (Microeconomy). With this course we help the students to think as economists (economical efficiency) together as engineers (technical efficiency).

Assessment: Written examination (100%)

Outline Syllabus:

1. Macroeconomy
2. Financial and monetary systems.
3. Market analysis I
4. Industrial Engineering.
5. Organization theory and management.
6. Management information systems.
7. Operations planning and control.
8. Design of operational systems.
9. Operations strategy and the firm.
10. Production audits.

Bibliography :

- BELZUNEGUI, B. y otros. "Macroeconomía". McGraw-Hill, Madrid, 1993.
- PINDYCK, R. y D.L. RUBINFELD. "Microeconomía". 4ª ed.Prentice Hall, Madrid, (2000).
- TUGORES, J. y otros. "Introducción a la economía: problemas y cuestiones", Vives, Barcelona, (1995).

Staff Involved: Cesáreo Hernández Iglesias

Department: Organization and Management

SAFETY AND LOSS PREVENTION

Code: **44342-UVA**

Extension: Half-yearly	Semester(s): 10	Academic year: 5	Cycle: 2
Credits ......Local: 5	ECTS: 5		

Lecture hours: 30	Practical hours: 20
Personal work hours: 80	Laboratory hours:

Aims: The aim of this course is to provide background safety criteria and methods for hazard identification and risk quantification. At the end of the course students will be able to: Identify and observe safety, health, and environmental criteria regarding all job tasks and regulatory compliance issues. Identify and describe safety, health, and environmental equipment uses. Identify and handle chemical hazards using fire and explosion index**.** Perform HAZOP studies**.** Know the legislation governing safety in design and operation of chemical plants.

Assessment: Written examination (100%)

Outline Syllabus:

1. Introduction and general concepts
2. Risks: types, statistics and data sources
3. Risk identification techniques
4. Consequence analysis: fire and explosion. Leak of dangerous compounds
5. Vulnerability of people and installations
6. Quantitative risk evaluation
7. Risk reduction in design, operation and maintenance
8. Emergency planning
9. Legislation, rules and design codes

Bibliography :

- J.M. Storch de Gracia, "Manual de Seguridad Industrial en plantas químicas y
- petroleras: Fundamentos, Evaluación de riesgos y Diseño". McGraw-Hill.
- J.M. Santamaría y P.A. Braña, "Análisis y reducción de riesgos en la Industria
- Química". Fundación MAPFRE.
- R.L. Tuve, "Principios de la Química de Protección contra Incendios", CEPREVEN.
- D. Tuhtar, "Protección contra el Fuego y Explosiones, Desarrollo de Sistemas",
- Paraninfo S.A.
- G.L. Wells, "Safety in Process Plant Design", John Wiley & Sons.
- Fundación MAPFRE, "Manual de Higiene Industrial", Fundación MAPFRE.
- AUDELCO, "Prevención de Riesgos Laborales", Aranzadi & Thomson.

Staff Involved: Gregorio Antolín, Fernando Gutiérrez

Department: Chemical Engineering and Environmental Technology Department

CHEMICAL PROCESS OPTIMIZATION

Code: **44337-UVA**

Extension: Semestral	Semester(s): 10	Academic year: 5	Cycle: 2
Credits ......Local: 4,5	ECTS: 4,5		

Lecture hours: 30	Practical hours: 5
Personal work hours: 72	Laboratory hours: 10

Aims: After finishing the course, the student should be able to formulate decision making problems related to the process industry as optimization ones, as well as to identify the different types of optimization problems and to be able of solving them using his knowledge of methods and algorithms and the appropriate software tools.

Assessment: Examination (70%) Classwork (30%)

Outline Syllabus:

1. INTRODUCTION: Decision making problems. Optimization fundamentals. Mathematical basis. Convexity.
2. UNCONSTRAINED OPTIMIZATION 1.1- Scalar methods 1.2- Finobacci and golden search algorithms. 1.3- Polynomial approximation methods. 1.4- Method based in the gradient of the function. 1.5- Applications to chemical engineering problems. Vectorial Optimization 2.1- Methods of direct search: simplex algorithm. 2.2- Methods based on the function gradient. 2.3- Quasi-Newton methods. 2.4- Applications to chemical engineering problems.
3. LINEAR PROGRAMMING (LP). 3.1 the simplex method. 3.2 Duality theory. 3.3- sensibility of the solutions 3.4 Interior point methods 3.5 LP software (GAMS) 3.5- Applications to chemical engineering problems.
4. NON-LINEAR PROGRAMMING (NLP) 4.1 Lagrange multipliers 4.2 KKT conditions 4.3 Quadratic programming (QP). 4.4 Penalty functions 4.5 Non linear programming (NLP) SQP, GRG y CP methods. 4.6 Convexification 4.7 NLP Software (GAMS) 4.8 Applications to chemical engineering problems. 4.9 Stochastic methods of optimization
5. MIX-INTEGER OPTIMIZATION (MIP) 4.1 Modelling of logical conditions with 0-1 variables. 4.2 Mix-integer problems (MILP). 4.3 Branch and Bound algorithm 4.4 Applications to chemical engineering problems
6. INTRODUCTION TO SCHEDULING Batch processes operation. Fundamental concepts of scheduling. Formulation of optimization problems.

Bibliography:

- T.F. EDGAR, D.M. HIMMENBLAU, L.S. LASDON “Optimization of Chemical Processes”, McGraw Hill, (2001)
- L.T. BIEGLER, I.E. GROSSMANN, A.W. WESTERBERG “Systematic Methods of Chemical Process Design” , Prentice Hall (1997)
- G.V. REKLAITIS, A. RAVINDRAN, K.M. RAGSDELL, J, “Engineering Optimization”, J. Wiley (1983)

Staff Involved: Cesar de Prada / Gloria Gutierrez

Department: Systems Engineering and Automatic Control

BIOPROCESS ENGINEERING

Code: **44329-UVA**

Character: **ELECTIVE**

Extension: Half-yearly	Semester(s): 8	Academic year: 4	Cycle: 2
Credits ......Local: 6	ECTS: 6		

Lecture hours: 35	Practical hours: 10
Personal work hours: 96	Laboratory hours: 15

Aims: Analysys and design of bioprocess: fermentation technology and biotransformations. Down stream operations. Practical applications: case study

Assessment: Examination (60%) Classwork (40%)

Outline Syllabus:

1. Fermentations and Biotransformations.
2. Basic Microbiology, Biochemistry and Metabolism
3. Kinetics of catalysed-enzymatic reactions
4. Microbial process kinetics
5. Immobilization of biocatalysts
6. Basic Bioreactors design
7. Ideal bioreactors.
8. Reactors with non-ideal mixing
9. Transport phenomena: Power requirements, Mass-transfer and Heat interchange
10. Sterilization techniques
11. Instrumentation and control
12. Downstream processing
13. Strategies of bioseparations

Practices:

- Enzymatic processes.
- Fermentation Industries
- Environmental Biotechnology

Bibliography:

- Bailey J.E.; Ollis D.F., "Biochemical Engineering Fundamentals", McGraw-Hill,(1986)
- J. Bu'Lock, B. Kristiansen, "Basic Biotechnology" , Academic Press, (1987)
- Doran P.M., "Bioprocess Engineering Principles", Academic Press, (1995)
- Belter P.A., Cussler E.L., Hu W.S., "Bioseparations Downstream Processing for Biotechnology", John Wiley and Sons, (1988)
- W.R. Vieth, "Bioprocess Engineering" , John Wiley and Sons, (1994)
- T. Palmer , "Understanding Enzymes" , John Wiley and Sons, (1985)

Staff Involved: María del Mar Peña, Gerardo González

Department: Chemical Engineering and Environmental Technology

PHYSIC AND CHEMICAL PROCESSES FOR POLLUTION CONTROL

Code: **44335-UVA**

Character: **ELECTIVE**

Extension: Half-yearly	Semester(s): 8	Academic year: 4	Cycle: 2
Credits ......Local: 6	ECTS: 6		

Lecture hours: 45	Practical hours: 15
Personal work hours: 96	Laboratory hours: 0

Aims: The aim of the course is to provide knowledge on existing physic and chemical processes broadly used for pollution control in air and water streams, solid wastes and soils. This knowledge includes process design and operation, applications, advantages and disadvantages, removal efficiencies and rates, cross media effects and costs.

Assessment: Team work activities using cooperative learning methods (100%)

Outline Syllabus:

1. Introduction. Transport phenomena and thermodynamics of environmental systems.
2. Operations removing particulate material. Screening, settling, flotation, filtration and centrifugation.
3. Operations removing colloidal and dissolved contaminants. Extraction, adsorption, ionic exchange, membranes, coagulation-floculation, neutralization, precipitation, oxidation-reduction.
4. Operations involving gases and vapours. Absorption, stripping, soil vapor extraction, odor control.
5. Other operations. High pressure processes, thermal processes, stabilization, solidification and land disposal.

Bibliography:

- Metcalf & Eddy, Inc. "Wastewater engineering". McGraw-Hill (2003)
- Eckenfelder W.W. "Industrial Water Pollution Control". McGraw-Hill International (2000)
- Liu D.H.F. and Lipták B.G. "Air Pollution". Lewis Publishers (2000)
- Weber W.J. J. "Environmental Systems and Processes". John Wiley and Sons (2001)
- Freeman H.M. "Standard handbook of hazardous waste treatment and disposal". Mc Graw-Hill (1997)
- Reynolds T.D. and Richards P.A. "Unit Operations and Process in Environmental Engineering". PWS Publishing Company (1996)

Staff Involved: Santiago Villaverde

Department: Chemical Engineering and Environmental Technology

BIOLOGICAL PROCESSES FOR POLLUTION CONTROL

Code: **44334-UVA**	Character: **ELECTIVE**

Extension: Half-yearly	Semester(s): 9	Academic year: 5	Cycle: 2
Credits ......Local: 6	ECTS: 6		

Lecture hours: 45	Practical hours: 15
Personal work hours: 96	Laboratory hours: 0

Aims: Environmental biotechnology applies the principles of microbiology to the solution of environmental problems. Applications of biological processes for pollution control include: (1)Treatment of industrial and municipal solid waste and wastewaters. (2) Control and treatment of atmospheric pollution. (3) Restoration of industrial, commercial, residential and government sites contaminated with hazardous materials. (4) Protection or restoration of rivers, lakes, estuaries and coastal waters from environmental contaminants. (5) Reduction in industrial residuals in order to reduce resource consumption and the production of pollutants requiring disposal

Assessment: Examination (60%) Classwork (40%)

Outline Syllabus:

1. BASICS OF MICROBIOLOGY: Bacteria and Archaea, Metabolism and Microbial ecology
2. MICROBIAL STOICHIOMETRY, ENERGETICS AND KINETICS: stoichiometry in biological processes, energy reactions, microbial kinetics and biofilm kinetics
3. REACTORS: reactor types (suspended-growth and biofilm), batch reactor, CSTR and plug-flow with effluent recycle reactors with recycle of settled sludge, reactor engineering design
4. THE ACTIVATED SLUDGES PROCESS: characteristics of activates sludge, process configurations, design and operating criteria, aeration systems, analysis and design of settlers, bulking and other sludge-settling problems, activated sludge design, IWA model
5. AEROBIC BIOFILM PROCESSES: microbial aggregation, trickling filters and biological towers, rotating biological contactors, fluidized-bed and circulating-bed biofilm reactors, hybrid biofilm/suspended-growth processes
6. ANAEROBIC PROCESSES: process chemistry and microbiology, process kinetics, special factors affecting the process, reactor configurations, design of anaerobic processes
7. NUTRIENTS REMOVAL: nitrification, denitrification, phosphorus removal, sulphur removal
8. SOLID WASTE: sludge production, municipal solid waste production, anaerobic digestion, composting processes
9. GAS TREATAMENT: biofilters, scrubbing, biogas treatment

Bibliography:

- ECKENFERLDER W.W. "Industrial Water Pollution Control". Third Edition. McGraw-Hill International. Boston. (2000).
- EWEIS J.B., ERGAS S.J. CHNAG D.P AMD SCHROEDER E.D. "Principios de biorrecuperación. Tratamientos para la descontaminación y regeneración de suelos y aguas subterráneas mediante procesos biológicos y físico-químicos". Mc Graw-Hill, Madrid. (2005).
- HENZE M., HARREMOËS P., LA COUR J., ARVIN E. "Wastewater treatment. Biological and Chemical processes". Springer. Berlín. (2002).
- RITTMANN B.E. AND MCCARTY P.L "Environmental Biotechnology: principles and applications". McGraw-Hill International Editions (2001)

Staff Involved: María Fdz-Polanco

Department: Chemical Engineering and Environmental Technology

DESIGN AND OPERATION OF TREATMENT PLANTS

Code: **44324-UVA**

Character: **ELECTIVE**

Extension: Half-yearly	Semester(s): 10	Academic year: 5	Cycle: 2
Credits ......Local: 6	ECTS: 6		

Lecture hours: 15	Practical hours: 45
Personal work hours: 70	Laboratory hours:

Aims: The aim of the course is to apply the adquired knowledge in previous subjects to design and operate pollution treatment plants, including selection of alternatives and the proposal of adequate treatment schemes. To know the influence of the main operational parameters used in the design and control of the waste treatment plants. To elaborate operational protocols for these plants.

Assessment: Examination (50%) Classwork (50%)

Outline Syllabus:

1. PLANT DESIGN: Problem definition, Selection of alternatives. Hydraulic design
2. OPERATION OF TREATMENT PLANTS: Wastewater treatment plants, Solid waste treatment plants, Landfill management, Soil remediation
3. EXPLOTATION AND MAINTENANCE: Plant maintenance and explotation, Energy and chemical consumption, Human management
4. SOIL REMEDIATION: Site characterization, Risk evaluation and Analysis of alternatives

Bibliography:

- CORBITT R.A. Standard Handbook of Environmental Engineering. Mc Graw-Hill. New York 1998
- HENZE M., HARREMOËS P., LA COUR J., ARVIN E. •Wastewater treatment. Biological and Chemical
- Intelligen Inc.(1999). Super Pro Designer. Versión 2.7.
- LAGREGA M.D., BUCKINGHAM P.L., EVANS J.C. Hazardous Waste Management Mc Graw-Hill. New York, 1994.
- MYCOCK J.C., McKENNA J.D. THEODORE L. Handbook of Air Pollution Control Engineering and Technology. CRC Press. Boca Ratón. 1995.
- QASIM S.R. Wastewater Treatment Plants. Planning, Design and Operation. Technomic. Lancaster. 1999.
- WEF Operation of Municipal Wastewater Treatment Plants. MOP 11.WEF, Alexandria1996
- WEF, ASCE Design of Municipal Treatment Plants.1991
- WEF Pretreatment of Industrial Wastes. Manual of Practice FD-3. WEF, Alexandria1994.

Staff Involved: Pedro A. García Encina; Raúl Muñoz Torre

Department: Chemical and Environmental Engineering

ENVIRONMENTAL MANAGEMENT

Code: **44326-UVA**	Character: **ELECTIVE**

Extension: Half-yearly	Semester(s): 10	Academic year: 5	Cycle: 2
Credits ......Local: 6	ECTS: 6		

Lecture hours: 30	Practical hours: 30
Personal work hours: 96	Laboratory hours:

Aims: The aim of the course is to establish the technological and economical of the industrial waste management and to get the knowledge of the minimization options. To apply the environmental management tools to different industrial activities and to evaluate its options. To include sustainability in industrial activities

Assessment: Examination (50%) Classwork (50%)

Outline Syllabus:

1. Environmental policies and regulations
2. Waste minimization: Plan of minimization of wastes, Conservation of water and energy, Fugitive loss
3. Environmental Management Systems, Environmental Auditing
4. Other tools for environmental management. Environmental Impact Assessment, Programs of municipal pollution control, Risk evaluation and decision analysis
5. Sustainable development

Bibliography:

- AENOR. “Gestión medioambiental e ISO 14000”. AENOR. 1999.
- BISHOP P.L. “Pollution Prevention: Fundamentals and Practice”. McGraw-Hill. 2000.
- CANTER L.W. “Manual de evaluación de impacto ambiental. Técnicas para la elaboración de los estudios de impacto”. Mc Graw-Hill Madrid, 2000
- El-HALWARY M.M. “Pollution Prevention through Process Integration. Systematic Design Tools”. Academic Press, San Diego, 1997
- FIKSEL J. “Ingeniería de diseño medioambiental. DFE Desarrollo integral de.productos y procesos ecoeficientes”. McGraw-Hill. Madrid 1997
- FREEMAN H.M. Manual de prevención de la contaminación industrial Mc Graw-Hill.Mexico 1998.
- KUHRE W.L. “ISO 14010s. Environmental Auditing”. Prentice Hall. Upper Saddle River 1996.
- RUBIN E.S. “ Introduction to engineering & environment”. McGraw-Hill 2001

Staff Involved: Pedro A. García Encina; Sara I. Pérez Elvira, Andrés Herguedas

Department: Chemical and Environmental Engineering

SEPARATION OPERATIONS II

Code: **44333-UVA**

Character: **ELECTIVE**

Extension: Half-yearly	Semester(s): 9	Academic year: 5	Cycle: 2
Credits ......Local: 6	ECTS: 6		

Lecture hours: 45	Practical hours: 15
Personal work hours: 96	Laboratory hours:

Aims: The aim of the course is to enphasize on separation operations in chemical industries

Assessment: Examination (--) Classwork (100%)

Outline Syllabus:

1. Multicomponent distillation and absorption separations.
2. Advanced liquid-liquid extraction.
3. Packed bed adsorption systems.
4. Adsorption and ion exchange cyclic processes.
5. Chromatographic separations.
6. Crystallization from the melt
7. Crystallization from solution. Crystal size distributions.
8. Membrane separations.
9. Flow patterns in membrane processes.

Bibliography:

- MULLIN, J.W. “Crystallization”, Butterworth-Heinemann, Oxford (1993)
- ROUSSEAU , R.W. “Handbook of Separation Process Technology”, John Wiley, New York
- (1987)
- RUTHVEN, D.M. “Principles of Adsorption and Adsorption Processes”. John Wiley, New York (1987)
- ENCYCLOPEDIAS: (1) Ullmann’s Encyclopedia of Industrial Chemistry, Verlag Chemie, Weinheim, FRG, 7th Edition, (2004). (2) Kirk-Othmer Encyclopedia of Chemical Technology, DialogOnDisc, 4th ed., (2002). (3) J. McKetta, Encyclopedia of Chemical Processing and Design, Marcel Dekker, (1997)

Staff Involved: Ángel Cartón López

Department: Chemical and Environmental Engineering

HEAT INTEGRATION

Code: **44331-UVA**

Character: **ELECTIVE**

Extension: Half-yearly	Semester(s): 9	Academic year: 5	Cycle: 2
Credits ......Local: 6	ECTS: 6		

Lecture hours: 30	Practical hours: 30
Personal work hours: 70	Laboratory hours: 0

Aims: Students will get the fundamentals and required skills to perform heat integration analysis of real processes using the Pinch design method. They will learn to develop practical heat exchanger network proposals for heat recovery and energy saving.

Assessment: Examination (50%) Classwork (50%)

Outline Syllabus:

1. HEAT EXCHANGER NETWORK ANALYSIS: Data extraction. Composite and Grand composite curves.
2. UTILITIES: Selection and dimensioning. Standalone and combined utilities (boilers, furnaces, cooling systems...). Integration of reactors, separation units, evaporators, dryers and cogeneration systems.
3. HEAT EXCHANGER NETWORK SYNTHESIS: Minimal networks. Network evolution: paths and rings. Operability.

Bibliography:

- DOUGLAS, J.M. , "Conceptual Design of Chemical Processes. (Chemical Engineering Series)", McGraw-Hill, (1988)
- LINHOFF,
  B. et al. , “User Guide on Process Integration for the Efficient Use of Energy”, Institution of Chemical Engineers, (1994)
- ROBIN SMITH, “Chemical Process Design”, McGraw-Hill, (1995)

Staff Involved: Fidel Mato

Department: Chemical and Environmental Engineering

INTEGRATED PROCESS DESIGN

Code: **44323-UVA** Character: **ELECTIVE**

Extension: Half-yearly	Semester(s): 8	Academic year: 4	Cycle: 2
Credits ......Local: 6	ECTS: 6		

Lecture hours: 15	Practical hours: 45
Personal work hours: 96	Laboratory hours: 0

Aims: To teach the students to: 1) find the essential required specifications in the design of the reactor and the recirculation-separation system, in order to achieve an integrated design process, 2) calculate and evaluate alternative PFDs using a commercial process simulator, and 3) identify and analyse the influence of the key variables in a given PFD.

Assessment: Examination (40%) Classwork (60%)

Outline Syllabus:

PART 1. Integration

1. Hierarchy in chemical process design.
2. Choice of reactor I.
3. Choice of reactor II.
4. Choice of reactor III. Example: Monoethanolamine production.
5. Choice of separation system
6. Distillation sequencing. Example: Separation of a mixture of xylenes.
7. Residue curve maps.
8. Reactor-separation integration.

PART 2. Simulation

1. Introduction. Tutor mode. Chemical process simulator structure.
2. Rigurous definition: Forms. Problem specification. Process flow diagram.
3. Rigurous definition: Basic Forms I. Setup. Components: Databanks, Selection, User Defined.
4. Rigurous definition: Basic Forms II. Components: Electrolytes. Reliable design of new components. CSTR kinetic reactors.
5. Analysis. Links. Sensitivity analysis.
6. Specifications management I. Design Specifications. Control Panel: calculation sequence management. Calculator block: FORTRAN.
7. Practical exercises. Distillation: changing the feed stream vapor fraction. Using two levels of pressure to separate azeotropic mixtures.
8. Specifications management II. Calculator block: EXCEL. User defined Parameter.
9. Extractive distillation. Balance. PFD. Report. Heat/Work streams. Heat Exchangers. Stream properties.
10. Separation of a methanol + water mixture. Property Method Selection. Model parameters. Experimental data correlation. Optimization. Column design specifications.

Bibliography:

- ROBIN SMITH, "Chemical Process Design and Integration", Wiley (2005).
- J.M. DOUGLAS, "Conceptual Design of Chemical Processes", McGraw Hill (1988).
- "User Guide" and "Reference Manuals", Aspen Plus ©, Aspen Technologies.
- L. LUYBEN, "Distillation Design and Control Using Aspen Simulation", J.Wiley & Sons (2006).

- R. TURTON, "Analysis, Synthesis, and Design of Chemical Processes" 2nd Ed., Prentice Hall (2002).

Staff Involved: Rafael Mato

Department: Chemical Engineering and Environmental Technology

COMPUTER CONTROL

Code: **44322-UVA** Character: **ELECTIVE**

Extension: Half-yearly	Semester(s): 10	Academic year: 5 Cycle: 2
Credits ......Local: 6	ECTS: 6	

Lecture hours: 30	Practical hours: 15
Personal work hours: 96	Laboratory hours: 15

Aims: The main purpose of this course is to provide a background in the design and operation of digital control systems. The student has already acquired basic concepts on modeling, systems analysis and design of continuous process control. Modelling and analysis of sampled systems, signal processing, models identification methods from experimental data and multivariable predictive control techniques are the main topics. Additionally the student will get to know the advanced control technologies that nowadays are used in the industry.

Assessment: Continuous assessment through practical work (100%)

Outline Syllabus:

1. INTRODUCTION TO COMPUTER CONTROL SYSTEMS: Elements and functions of a computer process control; Distributed computer control systems
2. MODELLING, ANALYSIS and DESIGN of SAMPLED SYSTEM: Modelling of digital systems; Discrete state space models; The shift operator; Sampling of signals; Reconstructing original signals; Time domain analysis of digital systems; Time domain response; Zeros and poles; Stability;closed loop systems;Time and frequency domain analysis; Digital controllers design
3. SIGNAL PROCESSING: Stochastic processes; Correlations; Power spectrum; White noises; ARMA and ARIMA models; Introduction to the digital filters
4. SYSTEMS IDENTIFICATION: Methodology; Identification using special inputs; Parameter estimation; Identification practice; Experiment design; Toolboxes; Validation; Adaptative control
5. PROCESS ADVANCED CONTROL: Multivariable predictive control; Control with constraints; Set-point optimization

Bibliography:

- ÅSTRÖM K. J., WITTENMARK B., "Sistemas controlados por computador", Paraninfo (1997)
- OGATA K., "Sistemas de control en tiempo discreto", Pearson Educación, 2º edición.
- OLLERO A., "Control por computador", 1991
- PHILLIPS, C. L., NAGLE H. T., Digital Control System Analysis and Design, 1994 o Spanish version: Sistemas de Control Digital, Análisis y Diseño, 1993
- LANDAU I., ZITO GIANLUCA, Digital Control Systems: Design, Identificaction and Implementation, Springer, 2006
- BOX G. E. P., JENKINS G. M., Time series analysis. Forecasting and Control, 1976
- LJUNG L., System Identification Theory for the User, 1987.
- CAMACHO, E., BORDONS C., Model Predictive Control in the Industry Process, 1995/1999
- MACIEJOWSKI J.M, Predictive control with constraints, 2002

Staff Involved: Smaranda Cristea

Department: Systems Engineering and Automatic Control

COMPUTING APPLIED TO CHEMICAL ENGINEERING

Code: **44328-UVA**

Character: **ELECTIVE**

Extension: Half-yearly Semester(s): 10 Academic year: 5 Cycle: 2
Credits ......Local: 6 ECTS: 6

Lecture hours: 30 Practical hours: 15
Personal work hours: 96 Laboratory hours: 15

Aims: The aim of this course is to give students a basic understanding of operating systems and networks as well as their application to chemical processes. It is expected that students will: Devise solutions and implement solutions to database queries using interactive SQL DML commands. Devise and implement efficient database design. Describe OPC techniques, capabilities and issues. Build, apply and debug Model-based OPC. Describe the main features of the two most popular buses; Foundation-Fieldbus and PROFIBUS. Use the C++ Programming language. Identify and use the basic elements of Object Oriented Programming

Assessment: 2 hours WRITTEN Examination (50%) and 2 hours PRACTICAL Examination (50%)

Outline Syllabus:

1. INTRODUCTION: Importance of Computing in Chemical Engineering
2. DATABASES: Relational databases. SQL. ODBC. Real-time databases
3. COMPUTER NETWORKS: Internet. XML. OPC
4. FIELDBUSES: Structure. Profibus and Fieldbus Foundation. Configuration
5. PROGRAMMING: Programming in Windows. Object-Oriented programming. Programming in C++

Bibliography:

- ULLMAN, LARRY "Guía de aprendizaje MySQL / Larry Ullman" Madrid [etc.] : Prentice Hall, (2003)
- MANUEL LAZARO, ANTONIO "LabView 7.1 : programación gráfica para el control de instrumentación / Antoni Mánuel Lázaro, Joaquín del Río Fernández" Madrid [etc.] : Thomson, (2005)
- STALLINGS, WILLIAM "Comunicaciones y redes de computadores / William Stallings" Madrid [etc.] : Prentice-Hall, 6th Ed. (2000)
- "Fundamentos de informática y programación científica : Resolución en C y Matlab / Jesús María Zamarreño Cosme...[et al.]" [Sevilla] : Minor Network, (2002)
- CASTRO, ELIZABETH "Guía de aprendizaje XML / Elizabeth Castro" Madrid, Prentice-Hall, (2001)

Staff Involved: Jesús M. Zamarreño

Department: Systems Engineering and Automatic Control

PROCESS SUPERVISION

Code: **44330-UVA**

Character: **ELECTIVE**

Extension: Half-yearly	Semester(s): 10	Academic year: 5	Cycle: 2
Credits ......Local: 6	ECTS: 6		

Lecture hours: 30	Practical hours: 10
Personal work hours: 96	Laboratory hours: 20

Aims: The objective of this subject is the acquisitions of the necessary elements to implement an advance control and supervision system by computer in the process industry. We start with the distributed control system; the commercial SCADAS, the estimation techniques, the intelligent control and the process supervision based on statistical techniques are examined.

Assessment: Examination (70%) Classwork (30%)

Outline Syllabus:

6. DISTRIBUTED CONTROL SYSTEMS: introduction, architectures, components, applications.
7. COMPUTING APPLIED TO PROCESS ENGINEERING: man-machine interfaces, SCADAS, data mining: classification systems, MES system, etc.
8. STATISTIC PROCESS CONTROL: introduction, normal operation, detection of changes, control graphs, etc.
9. ESTIMATION OF UNMEASURED VARIABLES: State variables model, software sensors: Kalman filter, artificial neural networks.
10. EXPERT SYSTEMS AND INTELLIGENT CONTROL. Expert Systems in the process control, control based on rules, fuzzy logic, fuzzy controllers, fault detection and diagnosis.

LAB WORK

Computer control of a real plant.

SCADA configuration for a real plant.

Modelling of a process with different artificial neural networks.

Implementation of a fuzzy controller for a plant.

Bibliography:

- BENNETT A., "Real Time Computer Control. An Introduction". Prenctice Hall, 1988.
- JOHN S. OAKLAND, "Statistical Process Control", Butterworth-Heinemann Ltd. 2007.
- GUSTAF OLSSON and GIANGUIDO PIANI. "Computer systems for automation control". Prentice Hall, 1992.
- MARTIN DE BRIO, B. and SANZ MOLINA A. "Redes Neuronales y Sistemas difusos". Ed. Rama, Madrid, 1997.

Staff Involved: María Jesús de la Fuente Aparicio

Department: System Engineering and Automatic Control

EVOLUTION OF KNOWLEDGE IN SCIENCE AND TECHNOLOGY

Code: **44325-UVA**

Character: **ELECTIVE**

Extension: Half-yearly	Semester(s): 7	Academic year: 4	Cycle: 2
Credits ......Local: 5	ECTS: 6		

Lecture hours: 50	Practical hours: 10
Personal work hours: 96	Laboratory hours: 0

Aims: This is an elementary level course designed to provide the student with a basic analysis and description of some of the most relevant aspects of the history of science and technology.

Science is often conceived as a body of knowledge; reflection, however, will lead to the conclusion that this cannot be its true nature. History has repeatedly shown that a body of scientific knowledge that ceases to develop soon ceases to be science at all. Science of one age has often become nonsense of the next. It therefore behoves the historian of science to be very humble in his judgements and presentations of those who have gone before him. He needs to remeber that he is dealing with the work of erring and imperfect human beings, each of whom had, like himself, at best but a partial view of truth, but many of whom had a sweep of genius far beyond his own. Science, then, as we will show in this course, is no a static body of knowledge but rather an active process that can be followed through history.

Assessment: Examination (40%) Classwork (60 %)

Outline Syllabus:

1. THEORETICAL EXPLANATIONS IN THE CLASSROOM: Ancient World Science; Middle Age Science and Technology; The Renaissance and the Scientific Revolution.
2. PROJECT (the students must submit a project in which they are expected to provide an in-depth and scientific analysis of one of the topics included in the program): The Scientific Revolution; The Enlightenment Science and Technology; References about Contemporary Science.

Bibliography:

- D. CARDWELL, "Historia de la tecnología", Alianza (2001).
- J. ORDÓÑEZ el alt., "Historia de las ciencias", Espasa, (2004).
- C. SOLÍS, M. SELLÉS, "Historia de la Ciencia", Espasa (2005).
- L. LÓPEZ-OCÓN, "Breve historia de la ciencia española", Alianza (2003).
- J. GRIBBIN, "Historia de la Ciencia, 1543-2001", Crítica (2003).
- J.D. BERNAL, "Historia social de la ciencia", Península (1991).

Staff Involved: Mauricio Jalón

Department: Applied Mathematics

ENERGY SYSTEMS: TECHNOLOGY AND EXERGOECONOMICS

Code: **44336-UVA**

Character: **ELECTIVE**

Extension: Half-yearly	Semester(s): 9	Academic year: 5	Cycle: 2
Credits ......Local: 6	ECTS: 6		

Lecture hours: 35	Practical hours: 23
Personal work hours: 110	Laboratory hours: 2

Aims: Students understand theoretical concepts and models of innovation processes in the energy sector. They are able to evaluate different energy options within their technological and social context and to test their feasibility. They can apply the exergy method in the solution of practical cases.

Assessment: Examination (50%) Classwork (50%)

Outline Syllabus:

1. INTRODUCTION. Basic concepts. Energy conversion. Fundamentals review.
2. THE EXERGY METHOD. Exergy concept. Exergy calculations of different energy forms. Chemical exergy. Exergy balance and efficiency.
3. DEVICES AND INSTALATIONS FOR ENERGY CONVERSION. Fuels. Thermal energy. Heat engines. Refrigeration systems. Electric energy. Cogeneration. Energy Storage.
4. ENERGY SYSTEMS PLANIFICATION. Energy audits. Energy management. Energy Policy. Energy efficiency.
5. ENERGY RESOURCES. Fossil fuels: coal, petroleum and natural gas. Nuclear energy. Hydraulic energy. Solar energy. Biomass. Wind energy.
6. ENERGY: SUSTAINTABILITY AND ENVIRONMENT.

Bibliography:

- J.M. SALA LIZARRAGA, "Cogeneración. Aspectos termodinámicos, tecnológicos y económicos", Servicio Editorial de la UPV, Bilbao (1994)
- I. DANCER, M.A. ROSEN, “Exergy: energy, environment and sustainable development”, Elsevier (2007)
- V. BERMÚDEZ, "Tecnología Energética", Editorial de la Universidad Politécnica de Valencia (2000)

Staff Involved: Mª del Carmen Martín

Department: Energy Systems Engineering and Fluid Mechanics.

PROJECT MANAGEMENT

Code: **44327-UVA**	Character: **ELECTIVE**

Extension: Half-yearly Semester(s): 10 Academic year: 5 Cycle: 2
Credits ......Local: 6 ECTS: 6

Lecture hours: 45 Practical hours: 15
Personal work hours: 96 Laboratory hours: 0

Aims: The aim of this course is to introduce students into the use of basic tools for projects' management. Students upon completion of this course will: Describe the project management framework and its knowledge areas. Use tools and techniques in project management. Produce management documents for a project: scope management plan, schedules, Gantt Charts, Network diagrams and PERT charts, and risk Register. Develop a risk register. Produce reports of project cost estimate and budget

Assessment: Written Examination (75%) Coursework (25%)

Outline Syllabus:

1. Introduction to Project Management.
2. Project Planning, Schedulling and Control.
3. The project organisation: project-based organisations.
4. Project risk management.
5. Economic issues: budget and valuation.

Bibliography:

- AEPRIO, "Fundamentos de la dirección de proyectos. Asociación Española de Ingeniería de Proyectos". (1998).
- Nicholas, J.M. "Project management for business and technology". Prentice Hall: New Jersey. (2001)
- CHASE, R.B.; AQUILANO, N.J.; JACOBS, F.R. "Production and Operations Management: Manufacturing and Services". McGraw-Hill. (1998).
- DOMÍNGUEZ MACHUCA, J.A. (Director) "Dirección de Operaciones: Aspectos Tácticos y Operativos en la Producción y los Servicios". McGraw-Hill. (1997).
- HEIZER, J.; RENDER, B. "Dirección de la Producción: Decisiones Tácticas". Prentice-Hall. (1998).

Staff Involved: Angel M. Gento Municio

Department: Economics and Business Administration

INDUSTRIAL MANAGEMENT

Code: **44321-UVA**

Character: **ELECTIVE**

Extension: Half-yearly	Semester(s): 8	Academic year: 4	Cycle: 2
Credits ......Local: 6	ECTS: 6		

Lecture hours: 45	Practical hours: 15
Personal work hours: 96	Laboratory hours: 0

Aims: The student will learn the main concepts in entrepreneurship, firm creation, accounting and finance. On completion of this course students will: Acquire a general overview of the economics of a firm. Understand the role of the accounting information in the society. Manage the basic concepts of accounting. Have an overview of the structure and items of the financial statements. Record the basic types of business transactions and adjustment entries. Understand the fundamentals of preparing financial statements. Manage the different concepts of costs and their behaviour. Apply financial and economic analysis

Assessment: Written Examination (75%) Coursework (25%)

Outline Syllabus:

1. The firm: business targets, environment, types of firms.
2. Business management: planning, organisation, management and control.
3. Accounting information systems (I)
4. Accounting information systems (II).
5. Financial and Economics Analysis
6. Cost accounting

Bibliography:

- AMAT, O. “Análisis de los estados financieros”. Ed. Gestión 2000. Barcelona. (1996)
- CUERVO GARCÍA, A., “Introducción a la administración de empresas”, Civitas, Madrid, (1994)
- MALLO, C.; KAPLAN, R. S.; MELJEM, S. y GIMÉNEZ, C. “Contabilidad de costos y Estrategia de Gestión” Prentice Hall. Madrid. (2000)
- OMEÑACA, J. “Contabilidad general adaptada al nuevo plan” (7ª Ed.). Ed. Deusto. Bilbao. (1996)

Staff Involved: Angel M. Gento Municio

Department: Economics and Business Administration

MAINTENANCE OF EQUIPMENTS AND INSTALLATIONS

Code: **44332-UVA**	Character: **ELECTIVE**

Extension: Semestral	Semester(s): 8	Academic year: 4	Cycle: 2
Credits ......Local: 6	ECTS: 6		

Lecture hours: 30	Practical hours: 15
Personal work hours: 96	Laboratory hours: 15

Aims: To acquire the competitions of the insurance of the mantenance of the installations with Quality, Security and Profitability, which strikes in a direct way in: (a) costs of production, (b)quality of product and service, (c) safety and industrial hygiene, (d) quality of life in the collaborators, (e) image and environmental safety. To know the Organization, the Planning and the Types of maintenance, the Management of costs and the Methods of analysis and solution of problems. To analyze the reliability in the facilities, actions and methods of improvement.

Assessment: Examination (60%) Classwork (40%)

Outline Syllabus:

1. General concepts of the industrial maintenance
2. The reliability
3. Types of maintenance and technologies of application
4. Levels of intervention of maintenance
5. Planning of the maintenance
6. Organization and programming of the maintenance
7. Technologies of management of the maintenance
8. Computerization of the maintenance
9. Management of replacement pieces
10. Logistic engineering of the maintenance. Management of costs and indicators of control.
11. T.P.M. (Productive total maintenance)
12. Contracted maintenance
13. Regulation and codes
14. Methods of analysis: Cycle PDCA; AMDEC, MBRs, QCStorys and analysis of problems
15. Human resources and prevention of labour risks in the maintenance

Bibliography:

- A.BALDIN, FURLANETTO, ROVERS: "Manual de Mantenimiento e Instalaciones". Ed. G. Gili. Barcelona.
- J.P. SOURIS: "El mantenimiento fuente de beneficio". Ed. Díaz de Santos. Madrid.
- F. MONCHY: "Teoría y práctica del mantenimiento industrial". Ed. Masson, S.A. Barcelona.
- REY SACRISTAN: "Hacia la excelencia del mantenimiento". Ed. TGPHOSPIN, S.L. Madrid.
- A.KELLY, M. HARRIS: "Gestión del mantenimiento industrial" (Fundación REPSOL). Ed. Díaz de Santos. Madrid
- F.MONCHY: "La fonction maintenance : formation à la gestion de la maintenance industrielle"

Staff Involved: Pablo Martín Pacho

Department: Dpto. Sciences of the Materials and metallurgical Engineering, Graphical Expression in the Engineering, Cartographic Engineering, Geodesy and Aerial map-making, Mechanical Engineering and Engineering of the Manufacturing processes

HIGH PRESSURE PROCESSES IN CHEMICAL ENGINEERING

Code: **1264-UVA**

Character: **ELECTIVE**

Extension: Semestral
Credits ......Local: 6

Semester(s): 8 Academic year: 4 Cycle: 2
ECTS: 6

Lecture hours: 20
Personal work hours: 96

Practical hours: 30
Laboratory hours: 10

Aims: To learn the fundamentals of separation and reaction processes in fluids at pressures and temperatures above the critical point (supercritical fluids). To apply this knowledge to the study of novel separation processes using supercritical fluids. To apply this knowledge to the study of novel reaction processes in superheated water and in supercritical water.

Assessment: Design project (80%) Classwork (20%)

Outline Syllabus:

1. Pressurized fluids. Dense gases and/or supercritical fluids. Fundamentals of supercritical fluids. Industrial use of SCFs in reaction processes. Industrial use of SCFs in separation processes.

Tutorial 1. Literature review in Chemical Engineering. Data bases. Electronic Journals. Literature review in supercritical fluids and high pressure processes.

2. Properties of supercritical fluids. Density (PVT Behaviour). Thermodynamic properties. Transport properties. Properties estimation.

Tutorial 2. Properties calculation. Energy balances in supercritical fluids processes.

3. Phase equilibria.General concepts on Phase Equilibria calculations. High-pressure phase equilibria. Equations of state. Thermodynamic models. Classification of the most common GE models of applications. Experimental methods of vapor-liquid equilibria determination.

Tutorial 3. Thermodynamic modelling for supercritical fluids processes. Phase equilibria modelling using several EoS.

4. Kinetic properties at high pressures. Effect of pressure on reaction rate. Activation volume. Evaluation of the activation volume from experimental data. Prediction of the activation volume. Activation volume as a tool for the elucidation of reaction mechanism. Change of reaction rate constant as a function of pressure. Measurement of reaction rates. Examples.

5. High Pressure equipment. Classification of pressure vessels. Methods of construction. Vessel design. Closure systems. Design and development of equipment for the continuous extraction of solids. Valves, fittings and others devices. High pressure pumps and compressors.

Tutorial 4. High pressure equipment calculations. AD Merkblätter for pressure equipment design. Practical exercise.

6. Supercritical extraction process from solid matrix. Fundamentals of extraction. Transport phenomena in the solid phase. Extraction curves. Influence of process parameters and conditions of the solid substrate in the extraction process. Modelling and scale-up SCE processes. Design criteria. Laboratory and pilot plants. Equipment. Industrial applications.

7. Supercritical fluids for materials processing. SCF as a solvent: RESS process (Rapid Expansion of Supercritical Solutions). SCF as an antisolvent: GAS processes (Gas Antisolvent Processes and Supercritical Antisolvent Processes). SCF as a cosolvent: PGSS (Particles from Gas Saturated Solutions).

8. Practical case.Development of a supercritical extraction process. SFE of vegetable and edible oils. Supercritical extraction plant for wheat germ oil production.

9. High pressure polymerisation of ethylene. Radical polymerization of ethylene. Tubular reactors. Autoclave reactors. Practical case: 150000 t/y polyethylene plant.

10. High Pressure hydrogenation processes. Gas/liquid hydrogenation reactions. Hydrogenation reactions under supercritical conditions. Process description. Kinetic and thermodynamic studies. Operational variables. Applications. Industrial processes.

11. Supercritical water oxidation.Process description. Operational variables. Kinetics and reaction mechanism. Equipment. Application to industrial wastewater treatment. Industrial processes. Practical case: Selfsufficiently SCWO processes.

Tutorial 5. Multipurpose plant for supercritical fluid extraction from plants, or Hydrogenation of terpenes in supercritical fluids, or Terephtalic acid production by oxidation of p-xylene in supercritical water.

12. Student’s presentation of team projects.

Bibliography:

- Bruner, G. "Gas extraction". Springer. New York. (1994)
- Bertuco, A. and G. Vetter "High Pressure Process Technology: Fundamentals and Applications". Elsevier. Amsterdam. (2001)
- Arai J., "Supercritical Fluids", Springer Verlag (2001)
- Journals and reviews in chemical engineering and supercritical fluids.

Staff Involved: María José Cocero

Department: Chemical Engineering and Environmental Tecnology